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Decannulation: sociodemographic, clinical and speech-language indicators predictive of success

Decanulação: indicadores sociodemográficos, clínicos e fonoaudiológicos preditivos de sucesso

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ABSTRACT

Purpose: Identify the prevalence of success in decannulation in adult tracheostomized patients and the sociodemographic, clinical and speech-language indicators predictive in the process. **Methods:** Retrospective, observational study with analysis of medical records of 189 hospitalized tracheostomized adult patients, from June 2014 to December 2016, comparing the sociodemographic, clinical and speech-language variables between the decannulated and non-decannulated groups through univariate and multivariate logistic analyses. **Results:** Success in decannulation was 42.8%. The proportion of females and males was similar in both groups, with lower mean age for the decannulated patients. The most frequently observed diseases in both groups were diabetes mellitus and neurological diseases. There was a greater proportion of decannulated patients among those who presented functional swallowing, absence of vocal disorders, spontaneous swallowing of saliva, higher levels of consciousness, oral feeding, negative Blue Dye test results, effective cough, ability to remove lung secretions, absence of abundant secretions, deflated cuff, replacement of plastic cannula with metal cannula, absence of active infections, and absence of oxygen therapy. Multivariate analysis revealed the following variables as associated with success in decannulation: absence of abundant secretions, ability to remove lung secretions, and tracheostomy-tube occlusion time. **Conclusion:** Decannulation occurred in 42.8% of the hospitalized adult patients and the indicators predictive of success in this process were associated with pulmonary secretion and stomal occlusion capacity, keeping the upper airway open.

Keywords: Tracheostomy; Cannula; Deglutition disorders; Cough; Speech, Language and hearing sciences

RESUMO

Objetivos: Identificar a prevalência de sucesso na decanulação em pacientes adultos traqueostomizados e analisar os indicadores sociodemográficos, clínicos e fonoaudiológicos preditivos no processo. **Métodos:** Estudo retrospectivo, observacional, com análise de prontuário de 189 pacientes adultos traqueostomizados internados, de junho de 2014 a dezembro de 2016, comparando variáveis sociodemográficas, clínicas e fonoaudiológicas entre os grupos decanulados e não decanulados, por meio de análise logística univariada e multivariada. **Resultados:** A prevalência de sucesso na decanulação foi de 42,8%. A proporção entre sexo feminino e masculino foi semelhante nos dois grupos, com menor média de idade dos decanulados. As doenças mais observadas, nos dois grupos, foram diabetes mellitus e doenças neurológicas. Houve maior proporção de pacientes que decanularam entre os que apresentaram deglutição funcional, ausência de alterações vocais, deglutição espontânea de saliva, maior nível de consciência, dieta por via oral, teste *Blue Dye* negativo, tosse eficaz, capacidade para remover as secreções pulmonares, ausência de secreções abundantes, balonete desinsuflado, troca de cânula plástica por metálica, ausência de infecções ativas e de oxigenoterapia. A análise multivariada revelou, como variáveis associadas ao sucesso na decanulação, a ausência de secreções abundantes, a capacidade de remover secreções e o tempo de oclusão da traqueostomia. **Conclusão:** A decanulação ocorreu em 42,8% dos pacientes adultos internados e os indicadores preditivos para o sucesso neste processo foram relacionados à secreção pulmonar e a capacidade de oclusão do estoma, mantendo a via aérea superior pérvia.

Palavras-chave: Traqueostomia; Cânula; Transtornos de deglutição; Tosse; Fonoaudiologia

Study conducted at the Programa de Mestrado em Ciências Fonoaudiológicas, Faculdade de Medicina, Universidade Federal de Minas Gerais – UFMG – Belo Horizonte (MG), Brasil.

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INTRODUCTION

Tracheostomy is the surgical procedure of an opening on the anterior wall of the trachea through the neck to allow the passage of air through the upper airway. It is indicated for prolonged respiratory failure, lowering of consciousness level, ineffectiveness of airway protective reflexes, upper airway obstruction, and respiratory muscle weakness, or for providing the upper airways with stability in patients with prolonged tracheal intubation[1-4].

Although tracheostomy shows advantages compared with the orotracheal tube, such as ease of removal of tracheobronchial secretions and safe maintenance of the airway, improved oral hygiene, and greater ease of communication for the patient, among others, it produces mechanical and physiological impacts on the processes of vocal production and swallowing, compromising quality in the performance of these functions and influencing the protection mechanisms of the lower airways[5,6].

Tracheostomy removal, also called weaning or decannulation, is a gradual process indicated to minimize the risks of complications including changes in the swallowing mechanism, infections and bleeding of the airways, impaired vocalization, malaise, stenosis, and esophageal fistulas[2]. The decannulation process varies between health services, but it usually begins with cuff deflation and, if good tolerance is observed, the plastic cannula is replaced with a metal cannula until the tracheostomy tube is removed and the stoma occlusive dressing is applied, allowing the patient to breathe through the upper airway[4,6-8].

There is no consensus on indicators of readiness for decannulation in the literature, and the criteria of indication and success are based on clinical experience, routine of some health services, experience reports of professionals and interdisciplinary teams, and protocols prepared by the medical teams[6,7].

The following criteria are suggested for indication and success in decannulation: ability to tolerate cuff deflation for 24h[9,10]; presence of respiratory muscle strength and resistance[11,12]; effective cough with ability to remove lung secretions[7,9-11,13-15]; voluntary and reflexive cough[7,10,11,13]; intact upper airways[5,9,13,15]; absence of glottic or subglottic stenosis[16,17]; preserved swallowing capacity[7,9,11-13,15-17]; performance of the Blue Dye test[6,11,13,18]; absence of previous head and neck surgery[7,11]; use of phonation valve[11,14]; tolerance to tracheostomy occlusion, with or without need for oxygen therapy[9,11,12,15,17]; stable oxygen saturation for longer than 24h after tube occlusion[7,9–11,13,17]; absence of wet voice[6,9]; absence of diabetes mellitus[2,15]; hemodynamic stability[7,9]; clinical stability[16]; stability of arterial blood gases[9]; absence of fever or active infections[9,13]; preserved levels of awareness and alertness[9-11,13,14,16,17]; absence of psychoemotional and neurological changes[9]; minimal amount of tracheal secretion with clear fluid aspect[7,9–13,15,17]; need of fewer than two or three endotracheal tube aspirations within eight hours[9,13,15].

Aiming to avoid or minimize functional complications resulting from tracheostomy, which generate significant emotional impact on the quality of life of patients and on family relationships[19], the tube removal process should be initiated as early as possible, and speech-language pathology (SLP) assessment and monitoring are essential in identifying some criteria that contribute to the success in weaning, such as functional swallowing, ability to protect the lower airways[7,9,13-15,20,21], absence of pulmonary aspiration, spontaneous swallowing of saliva, and facilitation of verbal and non-verbal communication[12,19].

The absence of a protocol with well-established criteria can often generate complications in weaning from mechanical ventilation and tube removal, with consequent need to to return to mechanical ventilation or tracheostomy. Determination of clinical and SLP indicators aiming at a more careful decannulation enables greater safety in the process and minimizes the risks of failure, worsening of the patient's respiratory condition, and recannulation.

This study aimed to identify the prevalence of success in decannulation in adult tracheostomized patients and the sociodemographic, clinical and SLP indicators predictive in the process.

METHODS

The present study was approved by the Research Ethics Committee of the Universidade Federal de Minas Gerais under protocol no. CAAE 59859816.3.0000.5149, with waiver of Informed Consent Form signing, considering that the data were collected from the patients' medical records.

This is a retrospective, observational, analytical, cross-sectional study conducted with a non-probabilistic sample at the Hospital Governador Israel Pinheiro (HGIP), a general hospital that assists civil servants of Minas Gerais state and their family members at all levels of health complexity in several medical and multiprofessional specialties.

Inclusion criteria comprised tracheostomized adult patients of both genders, aged ≥18 years, with scores >8 on the Glasgow Coma Scale (ECG), attended by the SLP team between June 2014 and December 2016. Patients under mechanical ventilation and/or previously submitted to head and neck oncologic surgery were excluded from the study. Thus, the final study sample was composed of 189 patients, whose data were collected by the researchers at the time of tracheostomy weaning.

Sociodemographic data consisted of age and gender. Clinical data included baseline disease, time of orotracheal intubation, mechanical ventilation time, level of consciousness, active infections, replacement of plastic cannula by metal cannula, and presence of oxygen therapy. SLP data comprised presence of dysphagia or functional deglutition at decannulation, presence of vocal disorders and spontaneous swallowing of saliva, oral feeding (VO) - exclusive or mixed (VO + nutritional enteral therapy due to mild dysphagia or nutritional needs), Blue Dye test results, effective cough to mobilize secretions, ability to remove lung secretions by swallowing or expectorating, absence of abundant respiratory secretions, and use of phonation valve.

The assessment protocols used in the health service were defined by the SLP team in meetings. The Dysphagia Risk Evaluation Protocol (DREP) was used for the assessment and classification of dysphagia, whereas post-extubation vocal evaluation and the Blue Dye test were applied for structural assessment; evaluation routines adapted from protocols published in the literature were prepared[20,21]. All SLP assessments and procedures performed by the team are duly registered in Standard Operating Protocols (SOP) approved and published by the hospital quality sector.

In order to analyze the results, the collected data were recorded using the Access 2013 software, entered in Excel spreadsheet, and submitted to statistical analysis. Descriptive analysis of all study variables was performed by means of absolute and relative frequency distribution of categorical variables and

numerical synthesis of continuous variables; univariate and multivariate inferential analyses were conducted using multiple logistic regression.

Decannulation was the response variable, which was divided into two categories: decannulated and non-decannulated, whose results were compared for discussion of the indicators present in successful decannulation. For the univariate analyses, because all variables showed asymmetric distribution, the Chi-squared test or the Fisher's exact test was applied for the categorical variables and the Mann-Whitney non-parametric test was used for the quantitative variables.

Variables associated with success in decannulation were included in the univariate analysis using logistic regression at a 20% significance level. The stepwise backward method was used in multiple logistic regression analysis, and a 5% significance level was adopted for definition of the final model. Odds ratios (OR) and the respective confidence intervals were estimated to evaluate the magnitudes of the associations. Variables correlated and with missing data were excluded from the multivariate analysis to ensure a better fit of the model.

Data were processed in Statistical Package for the Social Sciences (SPSS), 21.0 and Stata, 12. A significance level of 5% ($p \leq 0.05$) and a 95% confidence interval were adopted for all statistical analyses.

RESULTS

Of the 189 tracheostomized patients, 81 (42.8%) were successfully decannulated. The proportion of females and males was similar in both groups, with greater prevalence of the male gender. Significant statistical difference ($p<0.001$) was observed between the groups of decannulated and non-decannulated individuals regarding their mean age: 67 and 74 years, respectively. The most commonly observed diseases in both groups were diabetes mellitus and neurological diseases (stroke, traumatic brain injury, subdural hematoma, encephalopathy, epilepsy, and brain tumors) (Table 1).

Univariate analysis of correlation between clinical and SLP characteristics and decannulation showed that all variables were associated with success in decannulation ($p<0.001$), with higher proportion of decannulated patients among those who presented functional swallowing (88.9%), absence of vocal disorders (58%), spontaneous swallowing of saliva (98.8%), higher level of consciousness (85.2%), oral feeding (VO) - exclusive or mixed (VO + nutritional enteral therapy due to mild dysphagia or nutritional needs) (98.8%), negative Blue Dye test results (96.1%), effective cough (97.5%), ability to remove lung secretions by swallowing or expectorating (96.3%), absence of abundant respiratory secretions (93.8%), use of phonation valve (61.7%), tolerance to cuff deflation (100%), replacement of plastic tube with metal tube (91.4%), absence of active infections (91.4%), and absence of oxygen therapy (82.7%) (Table 2).

With respect to hospitalization outcome, hospital discharges accounted for 97.5 and 39.8% of the decannulated and non-decannulated patients, respectively, with higher proportion of deaths in the latter (60.2%) compared with the first (2.5%). Analysis of the correlation between success in decannulation, intubation time, mechanical ventilation time, and tracheostomy-tube occlusion time showed that only tracheostomy-tube occlusion time was associated with success in decannulation ($p<0.001$), and the mean time that the patients remained under tracheostomy-tube occlusion was longer in the decannulated group (60.5h) than in the non-decannulated group (2.6h). The mean times of tracheostomy-tube occlusion and mechanical ventilation were similar for both groups (Table 3).

From the univariate analysis, the following variables, with ($p \leq 0.20$), were selected for the initial logistic regression model: psychiatric illness, gastrointestinal disease, age, deglutition at

Table 1. Socio-demographic characteristics and baseline disease (N=189)

Characteristics	Decannulation		*p* value*
	Yes n (%)	No n (%)	
Gender			
Male	45 (55.6)	56 (51.9)	0.613
Female	36 (44.4)	52 (48.1)	
Total	81 (100)	108 (100)	
Baseline disease and associated comorbidities			
Neurological disease	32 (39.5)	36 (33.3)	0.382
Diabetes mellitus	30 (37.0)	45 (41.7)	0.52
Respiratory disease	16 (19.8)	25 (23.1)	0.575
Kidney disease	14 (17.3)	12 (11.1)	0.223
Cancer	8 (9.9)	7 (6.5)	0.393
Psychiatric illness	6 (7.4)	2 (1.9)	0.066
Gastrointestinal disease	6 (7.4)	20 (18.5)	0.028
Dementia	2 (2.5)	2 (1.9)	0.575
Cardiovascular disease	2 (2.5)	3 (2.8)	0.634
Age (years)			
Median	68	76	<0.001**
Mean	66.9	73.9	
Standard deviation	11.8	11	
Minimum	36	19	

*Chi-squared test; **Mann Whitney test
Subtitle: N = number of individuals

Table 2. Clinical and speech-language characteristics of tracheostomized patients at decannulation (N=189)

Characteristics	Decannulation		*p* value*
	Yes N (%)	No N (%)	
CLINICAL			
Level of consciousness			
09-12	12 (14.8)	79 (73.1)	**<0.001**
13-15	69 (85.2)	29 (26.9)	
Total	81 (100.0)	108 (100.0)	
Active infections			
Yes	74 (91.4)	40 (37.0)	<0.001
No	7 (8.6)	68 (63.0)	
Total	81 (100.0)	108 (100.0)	
Tolerance to cuff deflation			
Yes	81 (100)	24 (22.2)	**<0.001**
No	0 (0.0)	84 (77.8	
Total	81 (100.0)	108 (100.0)	
Replacement of plastic tube with metal tube			
Yes	74 (91.4)	29 (26.9)	**<0.001**
No	7 (8.6)	79 (73.1)	
Total	81 (100.0)	108 (100.0)	
Presence of oxygen therapy			
Yes	67 (82.7)	4 (13.3)	**<0.001**
No	14 (17.3)	26 (86.7)	
Total	81 (100.0)	30 (100.0)	
Tracheostomy-tube occlusion time (TOT)			
<24 h	10 (12.3)	105 (97.2)	**<0.001**
≥24 h	71 (87.7)	3 (2.8)	
Total	81 (100.0)	108 (100.0)	
SPEECH-LANGUAGE			
Spontaneous swallowing of saliva			
Yes	80 (98.8)	48 (44.4)	**<0.001**
No	1 (1.2)	60 (55.6)	
Total	81 (100.0)	108 (100.0)	
Deglutition at decannulation			
Functional swallowing	72 (88.9)	18 (16.7)	**<0.001**
Dysphagia	9 (11.1)	90 (83.3)	
Total	81 (100.0)	108 (100.0)	
Oral feeding (VO)			
Yes	80 (98.8)	20 (18.5)	**<0.001**
No	1 (1.2)	88 (81.5)	
Total	81 (100.0)	108 (100.0)	
Vocal disorders			
Absent	47 (58.0)	4 (3.7)	**<0.001**
Present	34 (42.0)	104 (96.3)	
Total	81 (100.0)	108 (100.0)	
Blue Dye test (N=141)**			
Negative	73 (96.1)	21 (32.3)	**<0.001**
Positive	3 (3.9)	44 (67.7)	
Total	76 (100.0)	65 (100.0)	
Effective cough			
Yes	79 (97.5)	46 (42.6)	**<0.001**
No	2 (2.5)	62 (57.4)	
Total	81 (100.0)	108 (100.0)	
Ability to remove lung secretions			
Yes	78 (96.3)	29 (26.9)	**<0.001**
No	3 (3.7)	79 (73.1)	
Total	81 (100.0)	108 (100.0)	

*Chi-squared Pearson's test or Fisher's exact test; **Blue Dye test not performed with 48 individuals
Subtitle: N = number of individuals

Table 2. Continued...

Characteristics	Decannulation		*p* value*
	Yes N (%)	No N (%)	
Absence of abundant secretion			
Yes	76 (93.8)	20 (18.5)	**<0.001**
No	5 (6.2)	88 (81.5)	
Total	81 (100.0)	108 (100.0)	
Use of phonation valve			
Yes	50 (61.7)	33 (30.6)	**<0.001**
No	31 (38.3)	75 (69.4)	
Total	81 (100.0)	108 (100.0)	

*Chi-squared Pearson's test or Fisher's exact test; **Blue Dye test not performed with 48 individuals
Subtitle: N = number of individuals

Table 3. Correlation between success in decannulation, intubation time, mechanical ventilation time, and tracheostomy-tube occlusion time (N=189)

Characteristics	Decannulation		*p* value*
	Yes	No	
Intubation time (days)			
Median	12	11	0.895
Mean	12.05	11.88	
Standard deviation	5.36	4.87	
Minimum	2	0	
Maximum	33	27	
Mechanical ventilation time (days)			
Median	20	25.5	0.072
Mean	26.07	29.38	
Standard deviation	18.5	25.82	
Minimum	4	5	
Maximum	120	250	
Tracheostomy-tube occlusion time (hours)			
Median	72	0	<0.001
Mean	60.54	2.6	
Standard deviation	32.49	8.82	
Minimum	0	0	
Maximum	120	72	

*Mann Whitney test
Subtitle: N = number of individuals

decannulation, vocal disorders, spontaneous swallowing of saliva, level of consciousness, oral feeding (VO), Blue Dye test, effective cough, ability to remove lung secretions, absence of abundant secretions, use of phonation valve, tolerance to cuff deflation, replacement of plastic cannula with metal cannula, presence of active infections, presence of oxygen therapy, hospitalization outcome, mechanical ventilation time, and tracheostomy-tube occlusion time.

However, due to the high correlation between some variables and the number or absence of data in other variables, some of them were excluded from the multivariate analysis, as justified ahead: deglutition at decannulation and absence of abundant secretions were highly correlated, with better adjustment of the latter, which was thus chosen to be included in the logistic regression model; psychiatric illness had a small occurrence; all decannulated patients showed tolerance to cuff deflation; oral feeding (VO) and spontaneous swallowing of saliva showed only one response and were absent in only one decannulated patient; the Blue Dye test was not performed in 48 individuals, and its inclusion in the model would expressively reduce the number of occurrences. Therefore, the following variables were included in the initial model of multivariate logistic regression: age, gastrointestinal disease, vocal disorders, level of consciousness, effective cough, ability to remove lung secretions, absence of abundant secretions, use of phonation valve, cannula replacement, active infections, presence of oxygen therapy, mechanical ventilation time, and tracheostomy-tube occlusion time. Because the variable presence of oxygen therapy showed 111 occurrences, this number was used in the final regression models.

In the final model of multivariate logistic regression, the variables absence of abundant secretions (OR=28.7), ability to remove lung secretions (OR=14.2), and tracheostomy-tube occlusion time (OR=1.1) were associated with success in decannulation. Despite the strong association found, the OR confidence intervals were broad, probably due to the small number of occurrences in some categories. Nevertheless, the Hosmer–Lemeshow (H&L) goodness of fit of the models was considered adequate ($p>0.05$) and the final model was better than the initial model, showing smaller final Akaike's Information Criterion (AIC). Table 4 shows the initial and final models of the multivariate logistic regression.

Table 4. Multivariate logistic regression of factors associated with successful decannulation (N=189)

Characteristics	Success in decannulation in tracheostomized patients							
	Initial Model				Final Model			
	OR	95%CI	Total sample subjects	*p* value*	OR	95%CI	Total sample subjects	*p* value*
Age	0.96	0.879	1.038	0.28	–	–	–	–
Absence of gastrointestinal disease	5.11	0.413	63.298	0.204	–	–	–	–
Absence of vocal disorders	2.61	0.326	20.813	0.366	–	–	–	–
Presence of effective cough	8.29	0.055	1247.838	0.408	–	–	–	–
Ability to remove lung secretions	5.92	0.55	63.629	0.142	14.22	2.01	100.57	**0.008**
Absence of abundant secretion	12.6	1.264	125.612	0.031	28.66	4.657	176.38	**<0.001**
Use of phonation valve	0.61	0.098	3.819	0.599	–	–	–	–
Cannula replacement	3.38	0.343	33.437	0.297	–	–	–	–
Absence of active infections	5.45	0.726	40.928	0.099	–	–	–	–
Mechanical ventilation time (days)	0.96	0.893	1.028	0.232	–	–	–	–
Tracheostomy-tube occlusion time (hours)	1.08	1.037	1.126	<0.001	1.09	1.049	1.125	**<0.001**
Level of consciousness 9-12	1.25	0.209	7.496	0.807	–	–	–	–

*Wald test; Reference categories: presence of gastrointestinal disease, presence of vocal disorders, absence of effective cough, inability to remove lung secretions, presence of abundant secretion, absence of phonation valve, absence of cannula replacement, presence of active infections, 9-12 level of consciousness in the Glasgow scale. Initial Model: H&L: *p*=0.688; R2= 0.911; AIC=68.45 Final Model: H&L: *p*=0.871; R2= 0.885; AIC=65.54

Subtitle: OR = Odds Ratio; CI = OR confidence interval; N = number of individuals; AIC = Akaike's Information Criterion; H&L = Hosmer–Lemeshow goodness of fit

DISCUSSION

Identification of clinical and SLP indicators associated with success in decannulation of tracheostomized patients is important for a safer procedure with lower risk of complications. Reestablishment of the upper airway mechanism allows the functions of breathing, communication, and swallowing to be activated through normal physiology.

Prevalence of success in decannulation was 42.8%; this finding is in agreement with those of other studies that showed variation between 35 and 60%[22-25]. Success in decannulation was observed in 35% of the patients under intensive long-term hospital care[22]; in 54% of the individuals when the endoscopic evaluation protocol was followed[23]; in 57% of the patients in intensive care unit and rehabilitation center[24]; in 60% of the individuals with traumatic brain injury[25]. Although the health service where the study was conducted has a multidisciplinary team that acts collaboratively in the decannulation process, it was verified that success in decannulation still needs improvement despite being consistent with the literature.

The mean and median ages observed in this study were lower in the decannulated than in the non-decannulated patients, with statistical relevance, suggesting a correlation between age and success in decannulation. Some studies have described the variables age and gender as secondary factors associated with success in decannulation[9,11,12]; however, two studies have identified significant correlation between age and success in decannulation, with patients with more advanced ages showing greater risks of process failure[18,26], because the older the patient, the greater the possibility of comorbidities, which may interfere with the tracheostomy weaning process in this population[25].

Regarding the clinical and SLP parameters, all the variables studied were associated with success in decannulation in the univariate analysis, with higher proportion of decannulated patients among those who showed functional swallowing, absence of vocal disorders, spontaneous swallowing of saliva, higher level of consciousness, negative Blue Dye test results, effective cough, ability to remove lung secretions, absence of abundant secretions, use of phonation valve, tolerance to cuff deflation, replacement of plastic tube with metal tube, absence of active infections, and absence of oxygen therapy.

Statistically significant correlation was observed between decannulation and the parameters absence of active infections, high level of consciousness, and absence of oxygen therapy. The literature describes that the main clinical indicators predictive of success in decannulation are stability of arterial blood gases, hemodynamic stability, absence of fever or active infections, and adequate level of consciousness, according to the Glasgow Coma Scale[7,9,11,27], evidencing the need for clinical stability of patients to achieve success in this process.

In the present study, the indicators tolerance to permanent cuff deflation (tolerated by all patients in the sample) and replacement of plastic cannula with metal cannula seemed to be associated with success in decannulation because, in practice, it has been observed that deflated cuff allows airflow through the upper airway, promoting improvement in laryngeal elevation and sensitivity, removal of lung secretions, protection of the lower airways, voice, and in deglutition. These data are in agreement with the literature, which establishes some guidelines for decannulation readiness, recommending that the patient should present a minimum volume of supra-cuff secretion when aspirated, and be able to keep the oral cavity clean when the cuff is deflated[9,22].

Presence of abundant secretions and need for frequent tracheal aspirations in a 24-hour period are considered contraindications to decannulation[13,16]. It is worth emphasizing that cuff deflation favors better functionality of the larynx, thus allowing airflow through the upper airway, improved laryngeal elevation and sensitivity, removal of lung secretions, protection of the lower airways, voice, and deglutition. Therefore, it is important that the speech-language pathologist stimulate stomal occlusion when the cuff is deflated so that the larynx intensifies the reestablishment of the communication and swallowing functions.

The indicator preserved deglutition capacity was associated with decannulation, as well as spontaneous swallowing of saliva and presence of oral feeding (both exclusive and mixed). These findings are also in agreement with the literature, which describes that presence of preserved and adequate swallowing capacity, with absent or deflated cuff, without signs of pulmonary

aspiration, effective swallowing of saliva, and coordination of deglutition and respiration are aspects that can be influenced by tracheostomy, or by the patient's baseline disease, and that contribute to success in decannulation[12] This evidences the role played the speech-language therapist in the multidisciplinary team that assists tracheostomized patients, aiming to restore the biomechanics of swallowing in cases of dysphagia in order to provide a safe and efficient decannulation process.

It is worth noting that the presence of tracheostomy causes physiological changes in the normal swallowing process that may reduce hyolaryngeal elevation during swallowing, cause inflammation and stenosis, or excessive coughing and compression of the esophagus with inflated cuff, causing decreased protection of the lower airways during deglutition, risk of pulmonary aspiration of food and secretions and, consequently, of aspiration pneumonias, which are complicating factors in the weaning process[12,22] Thus, the earlier the decannulation occurs, the better the efficient and safe swallowing.

Application of the Blue Dye test in tracheostomized patients is a procedure used by speech-language pathologists to assess the swallowing of saliva and food in different consistencies and volumes. This test detects the presence or absence of tracheal aspiration and facilitates identification of aspirated material in the lower airways; however, there is no consensus in the literature on the accuracy, performance, and standardization of this test[6,11,18]. Despite controversies, the Blue Dye test is recommended by some studies in the literature, and is a resource used in clinical practice[6,13,21]. In the present study, the Blue Dye test was performed in 141 patients at the time of decannulation, with predominance of negative results for pulmonary aspiration in the decannulated patients and positive results for pulmonary aspiration in the non-decannulated patients, demonstrating that this is an important criterion to be analyzed regarding success in decannulation, because it is directly and intrinsically associated with the quality of swallowing and the capacity to protect the lower airways[6,11,13,18].

As for vocal quality, it was observed that the frequency of vocal disorders was higher in the non-decannulated group, evidencing that this variable is significantly associated with decannulation. Vocal disorders are described in the literature as important warning signs for indication of SLP assessment, as they may be indicative of paresis or paralysis of the vocal folds, with consequent impairment of the larynx sphincter action during deglutition, causing possible presence of saliva, secretions or food in the vocal folds and inside the laryngeal vestibule, as well as risk of tracheal aspiration, which are factors that can compromise success in decannulation[6,9,28]. Vocal fold paralysis in adduction reduces the glottic space volume, resulting in increased air resistance, inducing persistent dyspnea exacerbated with physical exertion, and inflammatory processes of the upper airway, with reference to surgical correction and possibility of decannulation assessment between four and eight weeks after surgery[28]. In addition to the voice impairment caused by vocal fold paralysis, the speech-language therapist should be aware of the other characteristics of the voice quality of tracheostomized patients at the time of decannulation, such as wet voice after swallowing, throat clearing, tense, rough and breathy voice, etc., because these vocal disorders may be associated with food or saliva stasis in the larynx and, consequently, with risk of pulmonary aspiration.

Use of phonation valve is a resource that can contribute to decannulation, and is highly relevant due to the various benefits that can provide to swallowing, oral communication, and facilitation of weaning from mechanical ventilation[6,29]. With the use of phonation valve, adequacy of phonation and swallowing in tracheostomized patients occurs through the reestablishment of airflow through the glottis, increased subglottic pressure, and stimulation of peripheral and central nerve endings, contributing to accelerate the decannulation process[11,14,29]. It is the speech-language therapist's responsibility, in a joint action with the multidisciplinary team, to evaluate the patient's ability to tolerate the phonation valve, that is, assess the level of consciousness, airway protection, phonation, secretion management, and recommendations on the use of phonation valve and/or communication strategies[11,17,29,30]. Adaptation to phonation valve and swallowing in tracheostomized patients under mechanical ventilation is conducted interdisciplinarily between speech-language therapists and physical therapists. In this study, the phonation valve was used in greater proportion in the decannulated patients than in the non-decannulated patients, which suggests a positive contribution of this criterion to success in decannulation, as described in the literature[11,14,29].

All these variables that showed correlation in the univariate analysis may, however, be strongly associated with and dependent on each other. Thus, the multivariate logistic regression model revealed that only the variables absence of abundant secretions, ability to remove lung secretions, and tracheostomy-tube occlusion time were associated with success in decannulation.

Among the patients who were able to remove lung secretions, the chance of success in decannulation was 14.2 times higher than that of those who did not show this capacity. The strong statistical correlation observed between the indicators effective cough, ability to remove lung secretions by swallowing or expectorating, and voluntary cough on command after decannulation, revealed evidence that these factors may be associated with success in decannulation. The importance of these abilities is in agreement with the literature, which indicates as the main criteria for decannulation, effective cough, ability to remove secretion through the mouth, intact upper airways, swallowing capacity, speech with phonation valve or tracheostomy-tube occlusion, and absence of oxygen therapy[4,11,15]. It is necessary to evaluate the efficacy of reflex, spontaneous or induced cough, because absence of effective cough is a contraindication for decannulation[13] It is the speech-language pathologist's responsibility to evaluate cough and secretion mobilization capacity during the weaning process, because it will be intrinsically associated with the capacity to protect the lower airways during dysphagia rehabilitation.

Among the individuals who did not show abundant secretions, it was observed that the chance of success in decannulation was 28.6 fold that of those who had these secretions. Presence of abundant secretions and need for frequent aspirations over a 24-hour period are causes of contraindications for decannulation[13,16]. It is known that the presence of inflated cuff does not prevent the aspiration of saliva, but its use minimizes macro-aspiration [6,13,21]. When mechanical ventilation is no longer needed, secretion is under control, and the origin of the respiratory problem is resolved, weaning off tracheostomy can begin with the cuff deflation, followed by replacement of plastic cannula with metal cannula, and tracheostomy-tube occlusion for 24h, in order to verify whether the patient is able to breathe spontaneously and expectorate secretions[7].

With regards to tracheostomy-tube occlusion time, increasing occlusion in 1h increased the chance of success in decannulation by 9%. These findings are confirmed in the literature, which describes that the decannulation occlusion test is necessary for success in decannulation - the only way to fully evaluate the upper airways and vocal fold integrity. This test should

be performed gradually up to the time of decannulation by monitoring respiratory parameters during occlusion, and the level of oxygen saturation, the ability to maintain adequate respiration in ambient air, or the need for oxygen therapy are of fundamental importance[7,9,10,13]. At this time, the speech-language therapist, as a member of the multidisciplinary team, should evaluate laryngeal integrity, requesting vocalizations, and the ability to protect the lower airways during swallowing.

Clinical indicators are important in clinical practice, thus this study is relevant because it demonstrated that in order obtain success in decannulation, all members of the multidisciplinary team, in their attributions and specificities, should be attentive to the presence and volume of lung secretion, assisting with its mobilization and removal, and to the capacity of stomal occlusion, in addition to making efforts to keep the upper airway open and functional.

Limitations to this study include the subjective evaluation of the vocal impairment parameters and the exclusion of patients previously submitted to head and neck oncologic surgery, because of the clinical and SLP characteristics of the cases. Positive aspects include the significant sample size, the complete data obtained from the patients' electronic medical records, the presence of sufficient clinical resources, and the multidisciplinary composition of the assessment and assistance team.

The study results reinforce the importance of multidisciplinary practice and the need for further research on this theme and preparation and validation of an assessment protocol for decannulation, including relevant indicators to define the ideal time to conduct the procedure.

CONCLUSION

Prevalence of success in decannulation was 42.8%, and the study demonstrated that the following indicators were predictive of success in this process: absence of abundant secretions, ability to remove lung secretions by swallowing or expectorating, and tracheostomy-tube occlusion time. It is worth noting that, unlike the three determinants, some clinical and SLP variables were strongly associated with and dependent on others.

Tracheostomy decannulation is a recurrent procedure in hospital care, and it is important to verify the indicators predictive of success that enables the development of decannulation protocols based on scientific evidence, including the relevant indicators to define the best time to perform this procedure, thus ensuring greater efficacy, smaller risk, and greater safety to the decannulation process.

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