

# Tracheal Decannulation Protocol in Patients Affected by Traumatic Brain Injury

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## Abstract

**Introduction** The frequency of tracheostomy in patients with traumatic brain injury (TBI) contrasts with the lack of objective criteria for its management. The study arose from the need for a protocol in the decision to remove the tracheal tube.

**Objective** To evaluate the applicability of a protocol for tracheal decannulation.

**Methods** A prospective study with 20 patients, ranging between 21 and 85 years of age (average 33.55), 4 of whom were women (20%) and 16 were men (80%). All patients had been diagnosed by a neurologist as having TBI, and the anatomical region of the lesion was known. Patients were evaluated following criteria for tracheal decannulation through a clinical evaluation protocol developed by the authors.

**Results** Decannulation was performed in 12 (60%) patients. Fourteen (70%) had a score greater than 8 on the Glasgow Coma Scale and only 2 (14%) of these were not able to undergo decannulation. Twelve (60%) patients maintained the breathing pattern with occlusion of the tube and were successfully decannulated. Of the 20 patients evaluated, 11 (55%) showed no signs suggestive of tracheal aspiration, and of these, 9 (82%) began training on occlusion of the cannula. The protocol was relevant to establish the beginning of the decannulation process. The clinical assessment should focus on the patient's condition to achieve early tracheal decannulation.

**Conclusion** This study allowed, with the protocol, to establish six criteria for tracheal decannulation: level of consciousness, respiration, tracheal secretion, phonation, swallowing, and coughing.

## Keywords

- ▶ craniocerebral trauma
- ▶ tracheostomy
- ▶ weaning

## Introduction

Over many years, the interference of tracheostomy on swallowing has been studied; tracheostomy may increase the risk of aspiration, as it interferes directly in the pharyngeal phase of swallowing.<sup>1</sup> The type of cervical incision, surgical technique applied, type of cannula used, and inflation of the cuff may, separately or together, contribute to a further fixing of the larynx, increasing aspiration. The loss of sensitivity of the

larynx caused by lack of air traffic contributes to the reduction of coughing reflex, facilitating secretion and food aspiration.<sup>2</sup> However, frequency of tracheostomy in traumatic brain injury (TBI) management when patients are receiving mechanical ventilation contrasts with the lack of evidence as to when tracheostomy should be removed.<sup>3</sup>

Tracheostomy is indicated when there is upper airway obstruction, when the patient requires prolonged mechanical ventilation and/or has difficulty in weaning, when there are

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excessive tracheobronchial secretions, and when the patient needs continuous airway protection against aspiration.<sup>4</sup>

Approximately 10% of critically ill patients undergo tracheostomy for respiratory support and facilitation of air passage into airways, providing better quality of life for patients and reducing hospital expenses.<sup>5,6</sup>

Dysphagia presents a close relationship with tracheostomy, not only because this procedure is indicated in patients with swallowing problems and tracheal aspiration but because the tracheostomy itself may cause aspiration.<sup>1</sup> Although it is a common procedure, the presence of a tracheostomy tube is not devoid of complications. The cause of aspiration is unknown, but probably results from these multiple factors.<sup>7</sup>

Five mechanisms are responsible for the aggravation of aspiration after tracheostomy: decreased laryngeal elevation, esophageal obstruction, cleaning of larynx with airflow, laryngeal desensitization, and uncoordinated laryngeal closure. Tracheostomy prevents normal airflow toward the larynx. This airflow deviation and the interruption of normal vocal function have great implications throughout respiratory, phonatory, and swallowing systems. In some cases, even post-tracheostomy scar, fixing the trachea to the skin, without any other disease can cause dysphagia.<sup>8</sup>

Information is needed on the treatment of dysphagic and tracheostomized individuals, including information on intervention methods, which must be evaluated objectively. One study with tracheostomized patients assessed a multidisciplinary approach in tracheal decannulation. Patients were separated into two groups: the first group received a multidisciplinary approach and the other group was retrospectively assessed through medical charts, answering to a clinical protocol. The group that underwent a multidisciplinary treatment showed a significant decrease in mean length of cannulation time to 28 days, compared with those without the approach who had an average of 33 days.<sup>9</sup>

The early speech therapy intervention in a hospital aims a fast identification of dysphagia, which is an important factor for decreasing risks involving aspiration-related pneumonia and poor nutrition and preventing complications arising from the same clinics; this may reduce hospital stay, leading the patient to an early independence and an improvement of life quality.<sup>10</sup>

Speech therapy within an interdisciplinary team is responsible for therapeutic management of dysphagic patient to optimize airway protection, aiming at reintroduction of oral intake in a fast and secure way, as well as helping with the decannulation process.<sup>11,12</sup>

Following specific protocols in tracheostomy prescription is common, but there is no protocol description for the decannulation process. Most hospitals have an interdisciplinary team that is responsible for this process, and clinician, nurse, physiotherapist, and speech pathologist interaction reduces time of tracheostomy use, accelerates weaning, and increases safety for the patient while reducing risk of failure and complications.<sup>13</sup>

Clinical speech therapy evaluation should occur prior to the actual condition before decannulation is attempted of the patient so that, under favorable conditions (high level of

consciousness, adequate breathing pattern, minimum quantity of orotracheal secretions, good phonation, normal swallowing, and effective coughing), decannulation can be performed quickly and effectively, avoiding the impact of tracheostomy in the laryngotracheal region.<sup>14</sup>

Recent research established some guidelines for speech pathologists prior to tracheal decannulation: the patient should be able to clean the oral tract; during cuff deflation, only minimum secretion from above the cuff should need to be suctioned; during tube occlusion, the patient must breathe spontaneously and sufficiently through the upper airway with sufficient and stable oxygen saturation; the patient should have efficient spontaneous coughing with subsequent swallowing and must have improved vigilance.<sup>9</sup>

Other researchers found the following criteria for tracheostomy decannulation: stable arterial gasometry, absence of respiratory distress, hemodynamic stability, absence of fever or active infection, PaCO<sub>2</sub> < 60 mm Hg, absence of delirium or psychiatric disorder, normal endoscopic evaluation or revealing lesion occupying < 30% of airway, adequate swallowing, and expectoration capability.<sup>4</sup>

Because little is known about how health care professionals make a decannulation decision, a survey was conducted with professionals working in this field, in large centers around the world, to determine clinical factors they believe to be important in decannulation recommendation. Four determinant criteria for tracheostomy decannulation were found: level of consciousness, ability to tolerate tracheostomy tube capping, coughing effectiveness, and secretion quantity. Of mild importance were the following: patient comorbidities, etiology of respiratory failure, swallowing, and oxygen rates. Age of patient was the only factor classified as irrelevant. These factors may drive the creation of specific decannulation protocols.<sup>15</sup>

Even though there are specialist recommendations to guide management decisions for decannulation, there is no objective protocol to establish guideline criteria. Consequently, variation in clinical practice limits the effectiveness of tracheostomy weaning.

Therefore, to aid in evaluating a tracheostomized patient's clinical state for possible decannulation and making speech therapy rehabilitation possible, the main objective of this research was to evaluate the applicability of a protocol tracheal decannulation.

## Methods

Twenty patients were assessed in this prospective study; the patients were between 21 and 85 years of age (average 33.55), and there were 4 women (20%) and 16 men (80%). All patients had been diagnosed by a neurologist as having TBI, and anatomical region of the lesion was known (► **Table 1**).

Included in this study were adult patients over 18 years of age suffering from TBI, tracheostomized, alert and responsive at the time of evaluation, and with medical approval for a speech therapy evaluation. This research took place in the neurology wing of a general hospital in Curitiba, Brazil. Excluded from this study were patients with previous neurologic disorders and other comorbidities.

**Table 1** Distribution of patients in relation to age, sex, anatomical region of lesion, and TBI level of injury

Patient identification	Sex	Age (y)	Anatomical region of lesion	TBI level
1	M	31	Right temporal	Severe
2	M	56	Left frontal lobe	Severe
3	M	36	Left frontal lobe	Severe
4	M	22	Bilateral frontal lobe	Severe
5	M	23	Right frontal lobe	Severe
6	M	28	Bilateral frontal lobe	Severe
7	F	24	Right frontal lobe	Severe
8	M	28	Left frontal lobe	Severe
9	F	25	Left frontal lobe	Severe
10	M	36	Right frontal-parietotemporal	Severe
11	M	21	Bilateral frontal-parietotemporal	Severe
12	M	52	Right parietotemporal	Severe
13	M	28	Bilateral parietotemporal	Severe
14	M	56	Right frontal lobe	Severe
15	F	24	Left frontal-parietotemporal	Severe
16	F	85	Bilateral frontal lobe	Severe
17	M	26	Right parietotemporal	Severe
18	M	26	Bilateral frontal lobe	Severe
19	M	21	Right frontal-parietotemporal	Severe
20	M	23	Left frontal-parietotemporal	Severe

Abbreviation: TBI, traumatic brain injury.

The Research Ethics Committee of the Hospital do Trabalhador approved this study under No. 213.216. Subjects signed a consent form with the knowledge of the objectives, procedures, and responsibilities and received answers to any questions regarding the survey.

The subjects were evaluated following tracheal decannulation criteria, through a clinical assessment protocol developed by the authors: the speech therapy tracheal decannulation protocol (**Appendix I**). Speech therapy clinical evaluation consisted of patient identification data analysis considering the variables age, gender, diagnostic, anatomical region of the lesion, and six criteria for tracheal decannulation as described:

1. Level of consciousness: Measured by the Glasgow Coma Scale, the level of consciousness was considered insufficient to protect the airway when the score was consistently less than 8 points.<sup>3</sup> Measurement was made by the medical team, and during speech therapy assessment, the patient's most recent score was noted.
2. Respiration: Tube material was noted (plastic or metal), as was whether the cuff was inflated, deflated, or partially inflated and if the patient kept the cuff deflated. Whether the patient maintained breathing pattern during tube capping was also assessed.
3. Tracheal secretion: Secretions in the tracheostomy region were observed and amount, aspect, and color were noted. Amount was quantified as little, normal, or abundant, and

thickness, consistency, and color (clear or yellowish) were noted.

4. Phonation: It was observed whether the patient was orally responsive or nonresponsive. Orally responsive patients were checked for presence of "wet" (gurgly) voice. Patients not verbalizing were evaluated for reaction to pain, moaning, coughing, and/or frequent throat clearing.
5. Swallowing: A clinical evaluation of swallowing was performed with occluded tracheostomy, offering food in various consistencies and noting the findings of swallowing phases. The Functional Oral Intake Scale (FOIS) graded the functional oral intake of patients at specific levels, with level 1 being nothing by mouth and level 7 being total oral diet with no restrictions.<sup>16</sup>
6. Coughing: Coughing was observed in food intake or in the event of tracheal aspiration, as was the presence of voluntary coughing and whether it was effective or ineffective, because coughing is a reflex mechanism for airway protection.

Statistical analysis applied the Fisher exact test, which was the basis for comparative process of tabulated data. The level of statistical significance was considered to be  $p < 0.05$ .

## Results

All subjects in this study were diagnosed with a severe degree of TBI, characterized by anatomical region and hemisphere of

**Appendix I** Speech Therapy Protocol for Tracheal Decannulation

**Patient Identification:**  
 Name: \_\_\_\_\_  
 Age: \_\_\_\_\_ DOB: \_\_\_\_\_ Medical Chart Number: \_\_\_\_\_ Sex: ( ) M ( ) F  
 Diagnosis: \_\_\_\_\_  
 Type and location of lesion: \_\_\_\_\_

**1. Level of consciousness**  
 Glasgow: 3 4 5 6 7 8 9 10 11 12 13 14 NA

**2. Respiration**  
 Type of tube: ( ) plastic ( ) silicone ( ) metal  
 ( ) fenestrated ( ) not fenestrated ( ) without cuff ( ) cuffed  
 ( ) inflated ( ) partially inflated ( ) deflated  
 Condition to keep cuff deflated: ( ) yes ( ) no  
 At the closing of tracheostomy:  
 ( ) maintain breathing pattern ( ) does not maintain breathing pattern

**3. Tracheal secretion**  
 Secretions in tracheal region: ( ) present ( ) absent  
 Quantity: ( ) little ( ) normal ( ) great  
 Aspect: ( ) thick ( ) fluid  
 Color: ( ) clear ( ) yellowish

**4. Phonation**  
 Responsive patient: ( ) no ( ) yes  
 Wet voice: ( ) yes ( ) no

**5. Swallowing**  
 According to Functional Oral Intake Scale (Crary et al, 200516):  
 Level 1: Nothing by mouth  
 Level 2: Tube dependent with minimal attempts of food or liquid  
 Level 3: Tube dependent with consistent oral intake of food or liquid  
 Level 4: Total oral diet of a single consistency  
 Level 5: Total oral diet with multiple consistencies, but requiring special preparation or compensations  
 Level 6: Total oral diet with multiple consistencies without special preparation, but with specific food limitations  
 Level 7: Total oral diet with no restrictions

**Consistencies and findings of clinical swallowing assessment**

Consistency findings	Liquid									Nectar									pudding											
	FS			5 mL			10 mL			FS			5 mL			10 mL			FS			5 mL			10 mL					
Swallow number	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Oral phase																														
Bolus capture																														
Lip closure																														
Bolus preparation																														
Extra oral loss																														
Oral transit time																														
Oral and pharyngeal phase coordination																														
Postswallowing oral residue																														
Pharyngeal phase																														
Laryngeal elevation																														
Aspiration signs																														
If present?																														
Cough reflex																														
Dyspnea																														
Wet voice																														
Throat clear																														
Discomfort																														

Note: E = efficient; NE = not efficient; P = present, A = absent.

**6. Coughing**  
 Voluntary cough: ( ) no ( ) yes ( ) effective ( ) ineffective  
 Patient able to start decannulation process: ( ) yes ( ) no  
 OBS.: \_\_\_\_\_

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the lesion; these variables were correlated with the decannulation indicator. Eleven (55%) patients had frontal lobe lesion, 1 (5%) had lesion in the temporal lobe, 3 (15%) in parietotemporal region, and 5 (25%) in the frontal-parietotemporal region. Of the total, in 8 (40%) patients the lesion was located in the right hemisphere, 6 (30%) in the left, and 6 (30%) bilaterally (– Table 1).

Successful decannulation was performed in 12 of 20 patients (60%). We did not find any positive statistical correlation between sex and decannulation, which confirms other studies.<sup>17</sup> Patients underwent a clinical evaluation to assess their clinical conditions at the time of the procedure and to establish speech therapy criteria for tracheal decannulation.

For criterion level of consciousness, patients were given a Glasgow Coma Scale score; of the 20 patients, 6 (30%) had scores less than 8, which was considered insufficient for airway protection, and at the time of the evaluation 14 (70%) had scores greater than 8. Of the 14, only 2 (14%) could not start the decannulation process, because one could not maintain cuff deflation and the other could not keep the breathing pattern with closed cannula. The correlation between level of consciousness by the Glasgow Coma Scale and decannulation was significant ( $p = 0.0007$ ).

Of the 20 individuals who participated in the survey, 3 (15%) had a metal cannula and 17 (85%) with a plastic cannula with cuff at the time of assessment. Eight (47%) had inflated cuff, 1 (6%) was partially inflated, and 8 (47%) were deflated. Of those with plastic cannula cuff, 11 (65%) were eligible for decannulation, and the other 6 (35%) showed no conditions were ineligible for decannulation. Of the individuals with a metal cannula, 1 (33%) could be decannulated and the other 2 (67%) could not. Despite being relevant information for assessment, this study revealed that these data were not significant for the rate of decannulation ( $p = 0.3439$ ).

Of the 17 subjects using a cuff, 13 (76%) were able to keep it deflated and 4 (24%) were not. Two (15%) of those who were able to keep the cuff deflated were unable to be decannulated for other reasons; however, 11 (64.7%) were able to begin the decannulation process, proving this criterion to be significant ( $p = 0.0063$ ). Patients were also observed with tracheostomy tube occluded; out of total population of the study, 12 (60%) maintained the breathing pattern after brief tube capping and 8 (40%) had alterations in the breathing pattern. Consequently, 12 (60%) patients were able to close the tube and 8 could not keep it occluded, which also confirmed a significant relationship between respiration and decannulation ( $p = 0.0000$ ).

Fifteen (75%) patients had secretions in the tracheal region and 5 (25%) did not. Of these 15, 8 (53%) had a small amount and could be decannulated, but those who had great amounts were not considered capable of decannulation. Of the patients who had secretions in the tracheal region, 1 (7%) had thick secretions and was decannulated. Seven patients (47%) with fluid secretion were able to close the cannula. Four (20%) patients without secretion were able to close the cannula, and 1 (5%) patient, showing no secretion, was not able to close the cannula. Still, regarding the secretion criterion, it was possible to close the tracheostomy in 7 (47%) patients who had clear secretion. Of the total of 15 patients with tracheal

secretions, 1 (7%) had yellowish secretion and could begin the process of decannulation. From these data, the amount, thickness, and color of the secretion in relation to decannulation indications were found to be significant ( $p < 0.05$  for every aspect).

Thirteen patients (65%) were capable of verbalizing and with the exception of 1 (5%), all the others were able perform the training to close the tube. In the sample surveyed, 7 (35%) were considered to have no verbal responses, and none of these could be decannulated, which also confirmed a significant relationship between phonation and decannulation ( $p = 0.0001$ ). Of the 20 total patients, 3 (15%) had wet voice and were to occlude the tracheostomy, and 9 (45%) did not have this vocal pattern and were also able to cap the tube. It should be noted that patients with absent phonation were not evaluated for wet voice because at the time of assessment they were not verbally responsive.

Regarding swallowing, of 20 patients evaluated, 8 (40%) were graded as level 1 (nothing by mouth in FOIS) and could not have tracheostomy tube closed. Only 1 (5%) was graded at the same level, and the other 11 (55%) patients were classified at levels 2, 3, 4, and 5 and could occlude the tracheostomy tube. No patient was graded at level 6 or 7 of FOIS. Swallowing was also assessed for signs of aspiration, considering cough reflex, dyspnea, wet voice, throat clearing, and/or discomfort at one or all offered consistencies. Of the 20 patients evaluated, 11 (55%) showed no suggestive signs of aspiration during intake and of these, 9 (82%) began training to close the tube and 2 (18%) were not considered capable. Of the total sample, 9 (45%) aspirated during the intake, and of them, 3 (33%) patients were able to cap the tracheostomy and 6 (67%) were not. These data showed that aspiration was significantly correlated to decannulation ( $p = 0.0399$ ).

Of the total of evaluated patients, 12 (60%) had coughing and could be decannulated, 2 (10%) had coughing but were not able to occlude the cannula, and 6 (30%) had no coughing, none of whom were able to be decannulated. The relationship between coughing and decannulation was significant ( $p = 0.0007$ ). However, the effectiveness of coughing was not significant ( $p = 0.8571$ ).

## Discussion

This study evaluated 20 patients of both sexes, between 21 and 85 years of age, affected by TBI and tracheostomized with an open cannula. The decreased level of consciousness of the patient has been described as a related factor to oropharyngeal dysphagia and in the literature is associated with aspiration and pneumonia. This positive influence of the patient's awareness confirms the findings of other studies that a preserved level of consciousness decreases the risk of aspiration pneumonia and is considered so protective that it allows a better prognosis for improving communication and swallowing.<sup>18,19</sup>

Deficient respiratory conditions have been reported as risk factors for aspiration and dysphagia, complicating the rehabilitation of patients with dysphagia. The more dependent on respiratory support, the less airway protection ability

patients have, causing a greater risk to their clinical state and to speech therapy interventions with food.<sup>18</sup> A recent study compared breathing through the tracheostomy cannula to breathing through the upper airway with capped cannula. Results showed an increase in tidal volume in breathing through the upper airways. The authors conclude that the work of breathing increases in 30% of patients due to higher ventilation requirements and therefore tracheal decannulation is extremely important.<sup>20</sup>

Secretion should have acceptable volume and thickness (clear and fluid). Secretion aspect (thick or fluid) in the tracheal region or aspirated indicates the level of hydration and humidification. Color (white or yellow) may indicate the absence or improvement of infection. Patients with a large amount of secretion are more likely to have laryngotracheal penetration and aspiration.<sup>21</sup> Decannulation failures could be attributed to uncontrolled secretions and severe glottic stenosis.<sup>14</sup>

*Voice quality* is the term used to denote a set of characteristics that identify the voice and aims to identify the presence or absence of wet voice after food intake by comparing the voice before and after swallowing. Changes in voice quality may suggest paresis or paralysis of the vocal fold, which in addition to altering vocal quality of the patient is an indication of impaired sphincter action of the larynx when swallowing, which could cause aspiration. A wet voice confers the possibility of presence of saliva, secretions, or food in the vocal cords and into the laryngeal vestibule. It is necessary to give prominence to the wet voice with spontaneous throat clearing or hoarse/breathy voice quality, in combination with other changes observed during the assessment, as these characteristics are often associated with increased risk of aspiration.<sup>22,23</sup> The neurologic aspects often determine a condition for vocal change.<sup>24</sup>

In 2005 the FOIS was validated, which grades at specific levels the amount of oral intake; the grading may be applied throughout the therapy process to monitor patients' evolution, and so it was chosen to measure swallowing.<sup>16</sup> Tracheal aspiration occurs when the material being swallowed enters the airway below the true vocal folds. The material over the inflated cuff can drip down into trachea and lungs. When the cuff is deflated for swallowing tests, it is important to suction the area above the cuff before deflating it to remove all accumulated food and secretions.<sup>7</sup> The identification of clinical signs of aspiration not only speeds up speech therapy but also enables airway assessment, eliminating any factor that can make weaning difficult or impossible (stenosis, granuloma, tracheomalacia, and significant dysphagia).<sup>25,26</sup>

The coughing reflex may be decreased due to both sensory (internal superior laryngeal nerve) and motor components (recurrent laryngeal nerve). The recurrent laryngeal nerve, in addition to laryngeal motricity, is responsible for cough as protection and cough in general, of a different etiology than aspiration. This distinction is very important as it allows understanding that the aspiration is likely to occur silently, without the normal response of cough and choking.<sup>18</sup>

The criteria described above were relevant to establish the beginning of decannulation process of tracheostomy. However, the data collected are based on the start of a further longitudinal research with an increase of the population assessed.

## Conclusion

This study used a protocol to establish six criteria for tracheal decannulation in patients affected by TBI: level of consciousness, respiration, tracheal secretion, phonation, swallowing, and coughing.

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