# Tracheostomy decannulation protocol in a tertiary pediatric hospital

Review Article

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Article received on July 13, 2023.
Accepted for publication on October 22, 2023.

## Abstract

Introduction - Pediatric tracheostomy is associated with significant morbidity, with decannulation being the primary outcome, as soon as the underlying indication for the procedure is resolved. There is great variability in pediatric decannulation protocols, making it imperative to create a protocol that reflects the reality of Portuguese hospitals.
Objectives - To describe the decannulation protocol at Hospital Dona Estefânia, highlighting the essential steps for the decannulation of pediatric patients with long-term tracheostomies. Discuss preliminary observations about the safety and efficacy of this protocol.
Material and Methods - A systematic literature review was carried out in the MEDLINE, Cochrane Central Register of Controlled Trials and Cumulative Index to Nursing and Allied Health Literature databases, based on the PRISMA model (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), selecting papers published between January 2011 and December 2021. Based on this review, the decannulation protocol at Hospital Dona Estefânia was constructed.
Results - A total of 22 studies were reviewed, including 2387 patients. Modifications to the tracheostomy tube included the use of a cap (n = 18, 82%), size reduction (n = 12, 55%) and use of a fenestrated tube (n = 1, 5%). Measurements of respiratory gas exchange prior to decannulation included oximetry (n = 9, 41%), capnography (n = 3, 14%), blood gases (n = 2, 9%) and polysomnography (n = 14, 64%). Laryngotracheoscopy was routinely used in 21 of the 22 (95.5%) protocols. After decannulation, patients are transferred to the ward or intensive care unit, most of them staying in room air and for an observation period of no more than 48 hours (77% of protocols).
In the proposed protocol for HDE, the child considered fit for decannulation must be without the need for ventilatory support, tolerate the reduction in the size of the tracheostomy tube and the use of a lid, without desaturation or signs of respiratory difficulty, daytime, nighttime or in exercise.
Conclusions - Evidence-based guidelines that standardize pediatric tracheostomy care and the decannulation process remain a priority.
Keywords: decannulation, pediatric tracheotomy, protocol

## Introduction

Tracheostomy in children is associated with a high rate of serious complications, varying from 10% to 58%[1], along with an overall mortality rate of 22.1% and tracheostomy-related mortality rate of 1.2%.[2]. Moreover, it has significant psychosocial effects on the children and their families, including a negative impact on the quality of life, sleep, relationships, and social and academic life[3,4]. Therefore, decannulation is a goal shared by patients, caregivers, and healthcare professionals. Although decannulation is very much desired, it requires careful planning because acute failure of decannulation is potentially associated with high morbidity and mortality.

Decannulation is only possible when the conditions that led the child or adolescent to need a tracheostomy have resolved or improved considerably. The existing literature regarding the best pediatric decannulation practice is limited. In addition, there are different approaches for decannulation depending on the underlying comorbidities, indication for tracheostomy, potential need for ventilation, age at decannulation, distance from the place of residence to the healthcare center, and available resources[5]. Moreover, complications associated with the tracheostomy tube need to be addressed before decannulation, such as the presence of peristomal granulation tissue, stenosis, or infection of the tracheostomy wound. After decannulation, the patient may develop acute or chronic obstruction of the airways, chronic aspiration, or difficult airway[6].

This is a systematic review of the literature on protocols of pediatric tracheostomy decannulation, including the methods used to assess the possibility of decannulation, the adopted hospital flow pattern, and the clinical results. Subsequently, a protocol for a Portuguese tertiary pediatric hospital, Hospital Dona Estefânia (HDE), was developed that follows the best international clinical practices regarding decannulation while reflecting the Portuguese reality and resources.

## Materials and Methods

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines[7]. The online databases MEDLINE, Cochrane Central Register of Controlled Trials (CCRCT), and Cumulative Index to Nursing and Allied Health Literature (CINAHL) were searched for the relevant literature. The search was performed between November 1, 2022 and November 18, 2022, and the review included studies published between January 2011 and December 2021.

The included studies addressed the process of tracheostomy decannulation in children and adolescents aged 18 years or under and were published in English or Portuguese. Articles were excluded if they discussed the tracheostomy procedure but not the decannulation protocol; the objectives of the described studies were other than investigating the outcomes of decannulation; they contained no original research (such as review articles), or they did not involve the pediatric population.

Duplicate articles were excluded first. Two independent reviewers analyzed the titles and abstracts and excluded the articles that did not meet the inclusion criteria. The full text of the remaining articles was obtained and screened for final eligibility by the reviewers, who also collected the necessary data independently.

The demographic data collected from the studies included sex, age at the time of tracheostomy, age at decannulation, and time during which the patient remained tracheostomized. The methods used to assess the possibility of patients progressing to decannulation were analyzed, and included the use of modifications to the tracheostomy tube (size reduction, use of a fenestrated tube, and use of a cap), measurement of respiratory gas exchange (daytime and/or nocturnal oximetry, polysomnography [ PSG], capnography, or arterial blood gas test), and laryngo-tracheoscopy (flexible or rigid). After tracheostomy decannulation, data on the site of admission, duration of the observation

period, mode of ventilation, success and failure rates, and complications were collected. The definition of failed decannulation attempt was used for those patients in whom acute decannulation was impossible or those who needed recannulation within the following six months.

The clinical and demographic characteristics, methods used to evaluate the possibility of decannulation, and post-decannulation monitoring are presented using descriptive statistics. The rates of success and failure are expressed as percentages of all the decannulation attempts.

## Results

### Selection of Studies

The search conducted in the abovementioned databases yielded a total of 699 articles (Figure 1), and 436 articles were analyzed after the elimination of duplicates. Of these, after the titles and abstracts were read and the inclusion and exclusion criteria applied, 41 articles were selected for full-text review. Finally, 22 studies were selected after complete analysis (21 retrospective cohort studies and one prospective cohort study) (Table 1). More than half of the articles (63.6%) were published during and after 2017.

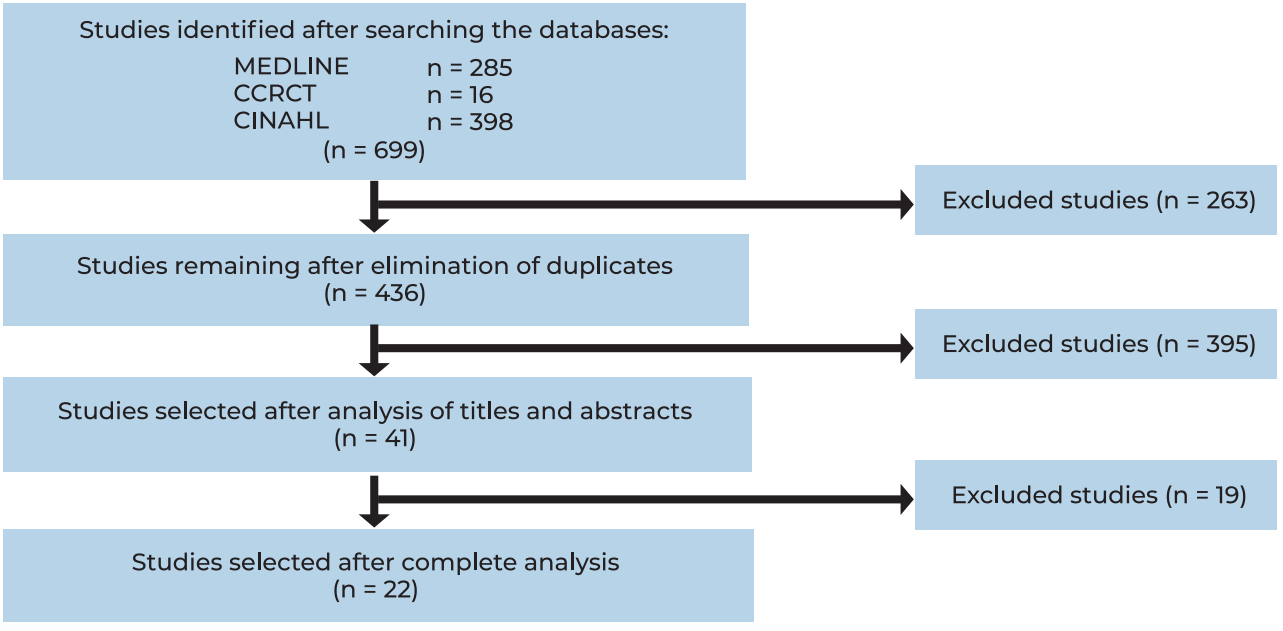
### Demographic characteristics

The 22 selected studies included a total of 2387 patients with a male to female ratio of 1.4:1. The number of patients in the studies varied between 18 and 439. Age at the time of tracheostomy varied from one month to 18 years (mean of one year and seven months). Age at decannulation varied between 0 and 18 years (mean of four years). Only 10 articles mention the length of the period during which the patients were tracheostomized (mean of two years and eight months). The demographic characteristics are summarized in Table 1.

### Pre-decannulation assessment

Among the selected articles, 20 described the following modifications to the tracheostomy tube (Table 2): use of a cap (18, 82%), reduction in the size of the tracheostomy tube (12, 55%), and use of a fenestrated tube (1, 5%). Of the 22 analyzed protocols, 11 included cap use, with one (9.1%) using it within 12 hours before decannulation[18], three (27.3%) between 12 and

**Figure 1**
Flowchart according to the PRISMA guidelines for the selection of studies for inclusion in the literature review. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; CCRCT, Cochrane Central Register of Controlled Trials; CINAHL, Cumulative Index to Nursing and Allied Health Literature.



24 hours before decannulation[6,8,11], four (36.4%) with gradual progression from daytime to nocturnal use over several days[10,16,19,20], and three (27.3%) with a single nocturnal test of the cap[13,14,26]. Measurement of respiratory gas exchange before decannulation was described in 17 of the 22 analyzed studies and included PSG (n = 14, 64%), oximetry (n = 9, 41%), capnography (n = 3, 14%), and arterial blood gas test (n = 2, 9%). Of the nine articles that reported the use of oximetry, eight specified its duration, with two using daytime oximetry alone, three using nocturnal oximetry alone, and three using both daytime and nocturnal oximetry. Laryngo-tracheoscopy was used routinely in 21 of the 22 (95.5%) protocols, with only one group reporting not using endoscopic techniques before decannulation[17]. Nine articles specified the type of bronchoscopy that was used, including flexible and rigid bronchoscopy in six (66.7%) protocols, rigid bronchoscopy in two (22.2%) protocols, and flexible bronchoscopy in one (11.1%) protocol.

### Outcomes of decannulation

After decannulation, the patients were admitted to the ward (most patients, n = 7; 53.8%) or intensive care unit (ICU) (n = 5; 38.5%). Only one protocol (7.7%) had the children admitted to a rehabilitation center (Table 3), while nine protocols (40.9%) did not mention where the patients were admitted after decannulation. The duration of hospital observation varied between 0 and 32 days,

**Table 1**
Studies included in the literature review and data on the selected tracheostomized patients

| Study (Authors) | Year of publication | Study design | Number of Patients (M/F) | Age at tracheostomy, years (mean) | Age at Decannulation years (mean) | Duration of tracheostomy, years (mean) |
|---|---|---|---|---|---|---|
| Funamara et al.[8] | 2012 | Retrospect. Cohort | 113 (NR) | 5.2 | 0.1–18 | 0 – 5 |
| Han et al.[9] | 2012 | Retrospect. Cohort | 25 (13/12) | NR | NR | 8 |
| Prickett et al.[10] | 2015 | Retrospect. Cohort | 50 (29/21) | 0–16.6 | 5.5 | NR |
| Beaton et al.[11] | 2016 | Retrospect. Cohort | 45 (25/20) | NR | 2.5 | 2.8 |
| Henningfield et al.[12] | 2016 | Retrospect. Cohort | 46 (25/21) | 0.3 | 3.4 | NR |
| Lee et al.[13] | 2016 | Retrospect. Cohort | 30 (20/10) | NR | 7.6 | 2.5 |
| Liptzin et al.[14] | 2016 | Retrospect. Cohort | 18 (17/1) | NR | 2.6 | NR |
| Wirtz et al.[15] | 2016 | Retrospect. Cohort | 35 (NR) | NR | 0.4–17 | 1.5 |
| Maslan et al.[16] | 2017 | Retrospect. Cohort | 46 (NR) | 1.6 | 4.3 | 2.5 |
| Pozzi et al.[17] | 2017 | Retrospect. Cohort | 84 (54/30) | NR | 9.5 | NR |
| Sachdev et al.[18] | 2017 | Retrospect. Cohort | 49 (35/14) | NR | 3 | 0.7 |
| Bashir et al.[19] | 2018 | Retrospect. Cohort | 148 (88/60) | 0.4 | 3.1 | NR |
| Quinlan et al.[20] | 2019 | Retrospect. Cohort | 125 (72/53) | NR | NR | NR |
| Seligman et al.[6] | 2019 | Retrospect. Cohort | 23 (11/12) | 0.3 | 2 | NR |
| Canning et al.[21] | 2020 | Retrospect. Cohort | 131 (76/55) | NR | 4.8 | 2.3 (0 – 12) |
| Chauhan et al.[22] | 2020 | Retrospect. Cohort | 67 (45/22) | 4.9 | NR | NR |
| Schweiger et al.[23] | 2020 | Retrospect. Cohort | 160 (93/67) | 0.6 | NR | 1.2 |
| Chorney et al.[24] | 2021 | Retrospect. Cohort | 239 (120/119) | 0.6 | NR | NR |
| Hebbar et al.[25] | 2021 | Retrospect. Cohort | 164 (95/69) | 0.6 | 2.6 | NR |
| Karlic et al.[26] | 2021 | Retrospect. Cohort | 125 (NR) | 0.3 | 6.1 | 2.8 |
| Kolb et al.[27] | 2021 | Retrospect. Cohort | 439 (259/180) | 0.4 | 1 | NR |
| Veder et al.[28] | 2021 | Retrospect. Cohort | 225 (133/92) | 0.2 | 1.8 | NR |

M, male; F, female; NR, not reported

**Table 2**
Pre-decannulation management and assessment of the selected tracheostomized patients

| Study (Authors) | Modifications to the tracheostomy tube | Measurement of respiratory gas exchange | Laryngo-tracheoscopy, type |
|---|---|---|---|
| Funamara et al.[8] | Cap | Daytime oximetry | Yes |
| Han et al.[9] | Size Reduction | PSG, Blood gas test | Yes |
| Prickett et al.[10] | Cap | PSG | Yes |
| Beaton et al.[11] | Size Reduction, Cap | Nocturnal oximetry, PSG | Yes |
| Henningfield et al.[12] | Cap | PSG | Yes, flexible and rigid |
| Lee et al.[13] | Size Reduction, Cap | PSG | Yes |
| Liptzin et al.[14] | Size Reduction, Cap | PSG, Capnography, Blood gas test | Yes, flexible and rigid |
| Wirtz et al.[15] | None | NR | Yes, flexible and rigid |
| Maslan et al.[16] | Cap | Daytime and nocturnal oximetry, PSG | Yes, flexible and rigid |
| Pozzi et al.[17] | Size Reduction, Cap | Daytime and nocturnal oximetry, PSG | No |
| Sachdev et al.[18] | Cap | Daytime oximetry | Yes, flexible |
| Bashir et al.[19] | Size Reduction, Cap | Nocturnal oximetry, PSG, Capnography | Yes |
| Quinlan et al.[20] | Size Reduction, Cap | PSG | Yes |
| Seligman et al.[6] | Fenestrated tube, Cap | Daytime and nocturnal oximetry | Yes, rigid |
| Canning et al.[21] | Size Reduction, Cap | Nocturnal oximetry, PSG, Capnography | Yes, flexible and rigid |
| Chauhan et al.[22] | Size Reduction, Cap | NR | Yes, rigid |
| Schweiger et al.[23] | Size Reduction, Cap | NR | Yes |
| Chorney et al.[24] | NR | NR | Yes |
| Hebbar et al.[25] | NR | NR | Yes |
| Karlic et al.[26] | Cap | Oximetry, PSG | Yes |
| Kolb et al.[27] | Size Reduction, Cap | PSG | Yes |
| Veder et al.[28] | Size Reduction, Cap | PSG | Yes, flexible and rigid |

NR, not reported; PSG, polysomnography

and the patients were discharged on the day of decannulation in only one protocol. Of the 12 protocols that specified the duration of follow-up after decannulation, 10 (76.9%) established a period of observation of 48 hours or less.

Data on the ventilation method used after decannulation were reported in 10 of the analyzed studies. All protocols had the children transition completely to room air, but five (50%) protocols included the use of non-invasive ventilation (NIV) and only one (10%) protocol had the patients remain under orotracheal intubation in the ICU before transitioning to room air.

The overall success rates varied between 22% and 100%, with a mean decannulation success rate of 78.2%. Only 13 articles addressed the issue of complications associated with decannulation and three (23.1%) of these did not report any complication. Of the 10 remaining articles, five mentioned the development of tracheocutaneous fistulas in a total of 67 patients, corresponding to 22% of all children included in these studies. It is worth noting that although tracheocutaneous fistula was the most frequently reported complication, several studies consider it a sequela of long-term tracheostomy rather than a complication of decannulation. Four articles reported on 10 patients (4% of the study sample) that required recannulation, the causes being obstructive peristomal granulomas (n = 5, 50%), hypoxia (n = 1, 10%), airway infection (n = 10%), and unspecified

**Table 3**
Outcomes of decannulation in the selected tracheostomized patients

| Study (Authors) | Admission after decannulation | Observation period, days | Ventilation after decannulation | Rate of Success (%) | Rate of failure (%) | Complications (%) |
|---|---|---|---|---|---|---|
| Funamara et al.[8] | NR | NR | NR | 32 (100%) | 0 (0%) | NR |
| Han et al.[9] | NR | 12–32 | NR | 13 (52%) | 12 (48%) | None |
| Prickett et al.[10] | ICU | 2 | Room air, VNI | 41 (89%) | 5 (11%) | None |
| Beaton et al.[11] | NR | 2 | Room air | 33 (58%) | 24 (42%) | Tracheocutaneous Fistula (n = 19, 42%) |
| Henningfield et al.[12] | NR | NR | Room air, VNI | 46 (98%) | 1 (2%) | Sepsis (n = 1, 2%) |
| Lee et al.[13] | Ward | NR | Room air, VNI | 26 (87%) | 4 (13%) | Airway Infection (n = 1, 3%) |
| Liptzin et al.[14] | Ward | 1–5 | NR | 18 (86%) | 3 (14%) | NR |
| Wirtz et al.[15] | ICU | 1–5 | Room air | 33 (94%) | 2 (6%) | Tracheocutaneous Fistula (n = 1, 3%) |
| Maslan et al.[16] | Ward | 0–1 | NR | 45 (98%) | 1 (2%) | Recannulation (n = 2, 4%) |
| Pozzi et al.[17] | Rehabilitation Center | NR | NR | 84 (100%) | 0 (0%) | None |
| Sachdev et al.[18] | ICU or Ward | 2 | Room air | 38 (88%) | 5 (12%) | Recannulation (n = 5, 10%) |
| Bashir et al.[19] | ICU | NR | Room air, NIV | 146 (95%) | 7 (5%) | NR |
| Quinlan et al.[20] | Ward | 1–2 | NR | 101 (95%) | 5 (5%) | NR |
| Seligman et al.[6] | NR | 1–2 | Room air | 22 (85%) | 4 (15%) | Tracheocutaneous Fistula (n = 11, 48%) |
| Canning et al.[21] | ICU or Ward | 2 | Room air, NIV, Orotracheal intubation | 132 (84%) | 26 (16%) | Tracheocutaneous Fistula (n = 2, 2%) |
| Chauhan et al.[22] | NR | NR | NR | 61 (91%) | 6 (9%) | NR |
| Schweiger et al.[23] | Ward | 1–2 | NR | 36 (23%) | 124 (77%) | NR |
| Chorney et al.[24] | NR | NR | NR | 57 (23%) | 182 (77%) | NR |
| Hebbar et al.[25] | NR | NR | NR | 36 (22%) | 128 (78%) | NR |
| Karlic et al.[26] | ICU | 1 | NR | 103 (98%) | 2 (2%) | Recannulation (n = 1; 0.8%) Hypoxia (n = 5; 4%) |
| Kolb et al.[27] | ICU | 2 | Room air | 159 (92%) | 14 (8%) | NR |
| Veder et al.[28] | NR | NR | NR | 141 (63%) | 84 (37%) | Recannulation (n = 2; 1%); Tracheocutaneous Fistula (n = 34; 15%) |

NR, not reported; ICU, Intensive Care Unit; NIV, Non-invasive ventilation

causes (n =3). Other complications were as follows: one case of sepsis (2%), one case of airway infection (3%), and one article reported five cases of hypoxia, corresponding to 4% of the study participants. No decannulation-related deaths were reported.

**Decannulation Protocol at HDE**

In the protocol proposed for HDE (Figure 2), those patients who are selected to start the process of decannulation are evaluated in the outpatient clinic of pediatric laryngology, where the physician confirms that the indication for tracheostomy is over and assesses the existing comorbidities and functional status of the child/adolescent. Flexible nasolaryngoscopy is an essential step of this evaluation as it helps to confirm that the underlying disease is resolved and that the airway is permeable. Subsequently, if the patients are considered ready to start the process of decannulation, the tracheostomy tube is replaced by a smaller one (never by a tube with an internal diameter smaller than 3.5 mm), followed by an adaptation to the speaking valve. For many patients, tolerating the latter requires collaboration with a speech therapist, according to the protocol already in place in HDE. Caregivers are instructed to check for signs of breathing difficulty in patients who use a valve during the day (both during everyday activities and exercise). In addition, the caregivers monitor and video record the patient's sleep while using the speaking valve, and the valve should be removed in the absence of monitoring. After a period with no evidence of desaturation or breathing difficulty (during the day, night, and exercise), as reported by the caregivers, tracheostomy capping is performed. The assistance of a speech therapist may still be necessary at this point. Decannulation is performed after waiting for another period without desaturation or breathing difficulty.

In patients with evidence of breathing difficulty during adaptation to the speaking valve and/or tracheostomy cap, flexible laryngo-tracheoscopy, namely drug-induced sleep endoscopy (DISE), is performed under sedation in the operating room. During this exam, the presence of obstructive changes that impede decannulation is assessed. The most common changes are the presence of suprastomal granulation tissue, tracheomalacia, subglottic stenosis, or hypertrophy of the adenoid and tonsil lymphatic tissue. These changes are corrected in the same surgical time whenever possible. If the process of decannulation fails once again, with discrepancies between DISE and clinical findings, the patients are referred for PSG.

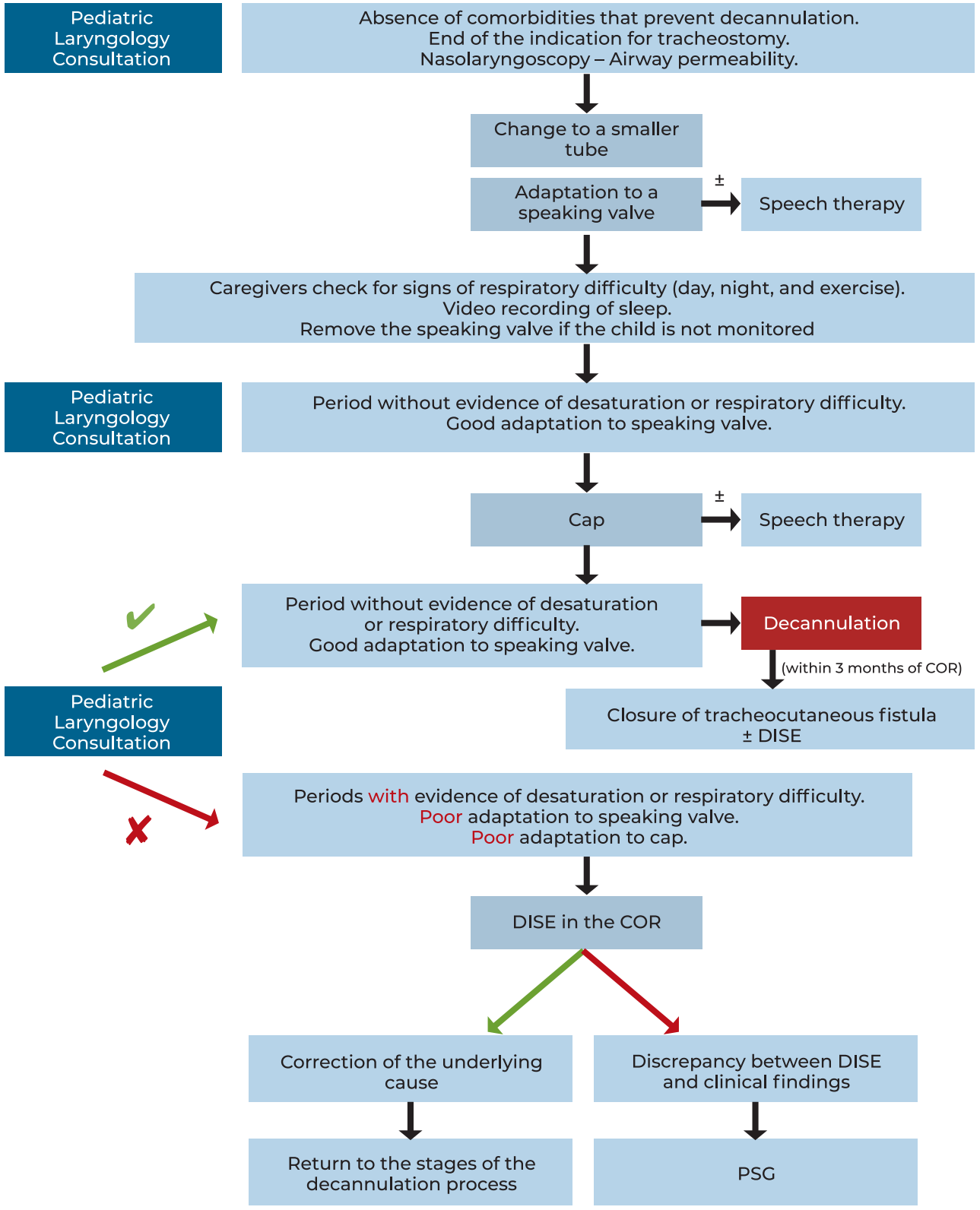
In long-term tracheostomized patients, surgical closure of the tracheocutaneous fistula is usually planned for one to three months after decannulation. This interval ensures that the residual orifice is not working and reduces the risk of post-decannulation emphysema. If doubts remain about the complete permeability of the airway, DISE is performed during the same surgery as tracheocutaneous fistula closure.

## Discussion

In Portugal, the lack of evidence-based guidelines on the best strategy for decannulation in children has led to a variety of clinical practices. In this review, we have summarized the main available protocols for tracheostomy decannulation in children.

Before decannulation, most protocols (90.1%) require patients to undergo modifications of the tracheostomy tube. Although these modifications are a common clinical practice, the type of modification and its duration vary considerably among protocols. The use of a cap was found to be the most frequent change, followed by a reduction in the size of the tube. Fenestrated tracheostomy tubes were only mentioned in one article[6]. The aim of modifying the tracheostomy tube is to evaluate the patient's breathing through the upper airways[4]. However, reducing the size of the tube carries an increased risk of obstruction by secretions, both in the tube and airway. Signs of failure include increased respiratory effort, stridor, or cough[4]. For this

**Figure 2**
Decision flowchart of the Protocol of Decannulation at Hospital Dona Estefânia; COR, Central Operating Room; DISE, Drug-Induced Sleep Endoscopy; PSG, Polysomnography



reason, Seligman et al. recommended the use of fenestrated tubes in children aged less than two years[6]. However, this type of tube is also associated with an increased risk of granulation tissue formation[4]. Moreover, the minimum duration of implementation of these modifications varies significantly. This review showed that it was 24 h or less in seven out of the 11 protocols (63.6%) that mentioned how long the patients were kept with a tracheostomy cap.

PSG and oximetry were the most frequently used measurements of respiratory gas exchange before decannulation. The main advantage of PSG is that it allows evaluation of the respiratory function during sleep when pharyngeal muscle tone is diminished. Its main disadvantage is its low availability and long waiting time in many hospitals in Portugal. Lee et al. reported that the apnea-hypopnea index (AHI) was significantly lower in children who had a successful decannulation than in those who could not be decannulated[13]. However, other studies do not demonstrate a clear association between PSG findings and decannulation outcomes[4]. Moreover, there are several PSG protocols, with patients undergoing PSG without changes to the tracheostomy tube or during the period when capping is being performed.

Laryngo-tracheoscopy was used routinely in 21 of the 22 (95.5%) protocols before attempting decannulation. This practice, which was relatively consistent among protocols, ensures an adequate airway and reassessment of the underlying diseases that led to the tracheostomy. Pozzi et al. authored the only protocol that did not include routine laryngo-tracheoscopy to evaluate pediatric patients, the aim being to minimize the number of procedures in this age group based on the argument that the role of endoscopy has not been established yet [17]. Although Pozzi et al. did not present any case of failed decannulation, their protocol includes a long period of hospitalization before the procedure, which provides an added assurance when attempting decannulation.

There is no consensus among protocols on the ideal timing for decannulation after laryngo-tracheoscopy, varying from immediately after to three months after the exam.

The duration of hospital observation after decannulation also varied among protocols. In this review, 76.9% of protocols required a period of observation of 48 h or less. Some authors have suggested that shorter periods of observation are safe and promote more efficient resource management[4]. Prickett et al. reported that all failed decannulations occurred in the first 12 h in the hospital setting[10]. The majority of children did not need ventilation support after decannulation and were safely transitioned to room air.

This literature review has some limitations, namely the fact that 21 of the 22 studies were retrospective cohort studies that depended on the quality of the reviewed clinical records. Secondly, the study samples were heterogeneous and the protocols did not reflect the patients' individual characteristics, especially the expected differences in terms of the outcomes after considering the primary indication for tracheostomy. No study included in the present review presented a comparison of the decannulation outcomes based on the primary indication for tracheostomy. Thirdly, most studies presented the results of a single pediatric center and this probably affected the ability to generalize the collected data, considering that human and material resources vary greatly among centers. Furthermore, in this review, the follow-up of complications was restricted to six months after decannulation and thus the results may not reflect other long-term negative outcomes.

Future studies that reflect the reality of the Portuguese national health service are necessary as none of the articles addressed the Portuguese population. Moreover, the role of PSG performed before decannulation remains unclear and further studies are needed to determine which children may benefit from it, depending on the underlying conditions.

## Conclusion

In this systematic review, the steps necessary to assess pediatric patients during the process of decannulation and their follow-up in the hospital after the procedure were discussed.

Once the indication for tracheostomy is over, the initiation of the decannulation process may be considered. Thus, in the protocol proposed for HDE, it is required that the child no longer needs a ventilator and tolerates the reduction in the size of the tracheostomy tube and use of a cap without desaturation or signs of breathing difficulty, both during the day and night.

Further efforts are needed to develop protocols of decannulation for children that are related to the indication for tracheostomy because of the high variability of outcomes.

### Conflicts of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

### Data Confidentiality

The authors declare having followed the protocols in use at their working center regarding patients' data publication.

### Protection of humans and animals

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the 2013 Helsinki Declaration of the World Medical Association.


### Funding Sources

This work did not receive any contribution, funding or scholarship.


### Availability of scientific data

There are no datasets available, publicly related to this work.

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