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Tracheostomy decannulation at the Royal Hospital for Sick Children in Glasgow: Predictors of success and failure

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ABSTRACT

Background: Tracheostomy techniques, indications and care are extensively covered in the literature. However, little is written about the process of removing the tracheostomy tube. At the Royal Hospital for Sick Children in Glasgow we use a stepwise ward-based protocol for safe tracheostomy decannulation. Our aim therefore was to review all the paediatric tracheostomy decannulations that we attempted over the last 3 years to evaluate our protocol, to determine our success rate and to see whether any modifications to the protocol are required.

Method: We reviewed all patients who had undergone ward decannulation between January 2012 and May 2015. We extracted data from clinical records including patient characteristics, indications for tracheostomy, timing of decannulation and success or failure of the process.

Results: The 45 children in the study underwent 57 attempts at decannulation during the study period. 25 were male (56%) and 20 were female (44%), and they were aged between 1 day and 16 years 6 months at the time of the original tracheostomy operation. 33 attempts were successful (58%). 10 children had more than one attempt at decannulation. Children were found to fail at every stage of the protocol, with the commonest point of failure being day 2 when the tracheostomy tube was capped.

Discussion: We have demonstrated that our current protocol for ward decannulation is effective and safe, and that all five days of the protocol are required.

1. Introduction

Tracheostomy indications, surgical procedure, and care are extensively covered in the published literature. However, there is surprisingly little written about the process of removing the tracheostomy tube. In adults, many tracheostomies are inserted for a short period of time to facilitate weaning from mechanical ventilation and the airway can be expected to be normal. Decannulation is a simple and rapid process in most cases. In children, however, the tracheostomy has often been in place for months or years, and the child may have some kind of residual airway pathology or respiratory problem. Respiratory insufficiency after tube removal may be immediate or may only appear after a period of careful nursing observation. Simply removing the tube to see what happens, as one might do in an adult patient, can be dangerous as the stoma may close and reinsertion of the tube may be difficult. Deaths have occurred after simple tube removal [1]. As a result, various techniques have been described for safe tracheostomy removal in children.

The Great Ormond Street Hospital ward decannulation protocol proceeds over five days beginning with endoscopic airway assessment, followed by downsizing, capping and finally removal of the tracheostomy tube [2]. At the Children's Hospital of Philadelphia, the decannulation procedure is similar but the tube capping trial is longer and proceeds at home [3]. The child is readmitted to hospital for removal of the tube only once they can tolerate capping all day. This method of decannulation has been shown to have a 16% hospitalisation-specific failure rate and a 9% overall failure rate, and seems to be a common way to proceed in the USA [4,5]. The University of Iowa Children's Hospital use a similar ward-based protocol but with a fenestrated tracheostomy tube in place to make breathing easier [6]. These ward-based protocols are basically similar in all the important respects. Firstly, an initial airway endoscopy is essential to ensure that any airway pathology has resolved and that no new airway pathology has developed, such as granulations or malacia caused by the tracheostomy itself [7–9].

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Secondly, the procedure is stepwise and progressive, allowing for tube reinsertion at any stage if the child is showing signs of respiratory difficulty. There is a built-in "hurdle" in that the child must demonstrate that they are able to breathe around a small obstructed tube (or through a fenestrated tube), thus showing they have adequate respiratory reserve to cope with respiratory infections or the requirements of exercise. At pediatric hospitals in Sydney, Australia, polysomnography is performed with a capped tracheostomy tube as an objective predictor of decannulation outcome [10]. Statistical differences have been seen in the total apnoea/hypopnoea index and desaturations in children who failed to decannulate and those who were successful [10].

Despite the presence of a number of protocols for the ward decannulation process, there is still little literature on success and failure rates and whether the protocols are effective in providing a safe method of decannulation. Our aim therefore was to review all the paediatric tracheostomy decannulations that we attempted over the last 3 years to evaluate our protocol, determine our success rate and to see whether any modifications to the protocol are required.

In this context, the effectiveness of the *protocol* is assessed in terms of its efficiency (minimum time required) and safety (freedom from adverse events), and is quite distinct from the effectiveness of the *trial of decannulation* itself (how many tracheostomy tubes are successfully removed). There is always a degree of uncertainty in deciding when a child might be suitable for a trial of decannulation, and we should not expect 100% of trials to be successful. Sometimes we have to make a trade-off between the chance to live free of tracheostomy and the chance that the decannulation trial might fail. What is most important is that the child is not put at undue risk of adverse events while this trial takes place.

2. Method

We reviewed the records of all patients who had an attempt at ward decannulation of their tracheostomy between January 2012 and May 2015 at the Royal Hospital for Sick Children in Glasgow. We recorded patient characteristics, indications for tracheostomy, timing of decannulation and success or failure of the process. As this was a retrospective study our institution does not require ethics approval.

All children are decannulated under the care of the otolaryngology team in our hospital. We have had the same 5-day protocol for ward decannulation in children since 1986, with the only modification in that time being the addition in 2007 of an overnight sleep study while the tube is capped (pulse oximetry with transcutaneous carbon dioxide measurement). The protocol is very similar to that described by the team at Great Ormond Street Hospital [2]. We do not use home capping trials, and children are never decannulated by simply removing the tube in the operating theatre unless this is part of a single stage laryngotracheal reconstructive procedure.

Children deemed suitable to undergo a trial of ward decannulation are identified at the complex airway clinic. Respiratory medicine, ENT and complex airway nurse specialists are present at the clinic and clinical judgment by the MDT is made on a case by case basis.

Trial of decannulation on the ward is a stepwise process normally occurring over five days with careful nursing observations at each stage. If at any time the child is felt to be showing signs of increased work of breathing or impaired gas exchange then the age-appropriate size of tracheostomy tube is reinserted and the trial of decannulation is abandoned.

Firstly, all children must undergo an endoscopic airway assessment under general anaesthesia (microlaryngoscopy and bronchoscopy, MLB) to ensure any previous airway pathology has resolved and that no new pathology related to the tracheostomy itself (such as granulations or stenosis) has arisen. Obstructive pathology may be dealt with at the time of this procedure, such as the removal of large obstructive granulations, or may require interval surgery such as adenotonsillectomy or cartilage grafting of the anterior tracheal wall. If the airway is judged favourable at MLB, the child then proceeds to the decannulation trial on the ward. In most cases, this begins the day after the MLB but in some cases it may be delayed by up to 6 weeks at the request of parents or for operational reasons relating to nurse staffing of the ward.

Following a favourable MLB, day 1 of the decannulation trial involves the tracheostomy tube being downsized to one of a much smaller diameter, typically size 3.0. If the child remains stable in the following 24 h with the smaller tube, on day 2 the tracheostomy tube will be capped off. During the 24 h when the tube is capped off the child undergoes overnight transcutaneous oxygen and carbon dioxide monitoring. If the child continues to be well and the overnight monitoring is satisfactory, the tube is removed and the stoma occluded with waterproof adhesive tape. The child is discharged home after a further 48 h of observation.

3. Results

Forty-five patients underwent a trial of decannulation during the period between January 2012 and May 2015. Twenty-five were male (56%) and 20 were female (44%). The children were aged between 1 day and 16 years 6 months at the time of their original tracheostomy operation (median age 3 months). The indications for tracheostomy are shown in Table 1 and the children's non-airway comorbidities are shown in Table 2.

The 45 children in the study underwent 57 attempts at decannulation during the study period. Ten children had more than one attempt at decannulation. Of these ten, nine had 2 attempts at decannulation and one patient had five attempts.

The mean duration of tracheostomy for all the children in the series was 34 months. Children being decannulated were aged between 6 months and 16 years 8 months (median age at decannulation: 2 years 6 months; Fig. 1). The mean weight of the children at the time of decannulation was 14.3 kg (median 12.4 kg).

Thirty-three attempts at decannulation were successful (58%). Twenty-five children (55.5%) were successful on the first attempt at decannulation. The effects of age, weight and duration of tracheostomy on likelihood of successful decannulation are shown in Table 3.

The stage of the protocol where failure occurred is shown in Fig. 2. Of the 6 children failing at the stage of endoscopic airway assessment, 4 have since undergone reconstructive surgery with removal of the tracheostomy and 2 are awaiting adenotonsillectomy and a subsequent attempt at ward decannulation. Of the patients failing on day 1, two children had suspected chest infections and were commenced on antibiotics. All three children have their tracheostomy tube still in place but are scheduled to have a further attempt at ward decannulation. Of the 51 airways deemed appropriate for decannulation, 33 (65%) went on to successfully decannulate following MLB. Day 2 was found to be the commonest point of failure in the study. All patients failed due to the presence of stridor, increased work of breathing or an inability to maintain their oxygen saturations on polysomnography. The patient who failed on removal of their tracheostomy tube (day 3) went on to be successfully decannulated three months later with no other interventions required. Noisy breathing and use of accessory muscles of respiration was noted on day 4 in one patient, requiring reinsertion of their tracheostomy tube. This child is scheduled to