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Efficiency and usability of an elementary hand-held suction assembly in paediatric tracheostomised patients

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Abstract

Objective. Commercially available suction devices are expensive, large and heavy, and need electricity, and thus restrict the outdoor activity of tracheostomised children and their carers. This study evaluated the efficacy and usability of a simple suction assembly using a syringe and feeding tube in paediatric tracheostomised patients.

Methods. Following the domiciliary usage of this suction assembly instead of their existing suction device for a minimum of 15 days, carers responded to a set of questionnaires containing a subjective scoring system.

Results. Ninety-three per cent of the carers considered this assembly as average, good or very good in cleaning the tracheostomy tube. Eighty per cent of the carers considered that this assembly would be suitable when their existing suction machines are unavailable, indicating high usability, and 66.67 per cent of the carers would be confident using this assembly in outdoor settings.

Conclusion. Larger studies with objective evaluation methods can validate the high efficacy of this simple, inexpensive and easy-to-use, hand-held suction apparatus as reported by the carers of 15 paediatric tracheostomised patients in this study.

Main Article

Dr P Sagar takes responsibility for the integrity of the content of the paper

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Introduction

The indications for paediatric tracheostomy have increased many-fold in the last couple of decades, and cover numerous medical and surgical conditions. The decision for paediatric tracheostomy is taken carefully because of the associated concerns, such as the challenging surgical procedure, demanding post-operative care, and morbidities consequent to bypassed nasal breathing, including an inability to phonate. Tracheostomised paediatric patients need considerable attention and care at home as well as during outdoor activities. Maintenance of the tube patency by regular and effective tube suctioning is a major concern for carers. Inadvertent tube blockage by secretions, mucus plug or blood clot might lead to respiratory distress, hypoxic brain damage and even death if not relieved promptly.

Different types of suctioning devices and units are commercially available for the domiciliary care of tracheostomised patients. Electric suction units are expensive (US $110–160), heavy and large, and need elaborate maintenance, as well as an electric point source for functioning, which limits their usage in hospitals and indoor spaces. Pedal-operated suction units are also expensive (US$40–65), heavy and sizable. It is invariably cumbersome for the carers to carry these suction units beyond the premises of their house, which results in restricted outdoor activities. Hand-held suction units are compact, lighter in weight and less expensive (slightly less than US$30), but are only available at a very limited number of outlets. For this reason, the majority of paediatric tracheostomised patients, especially in developing countries, experience significantly restricted outdoor as well as social activities, with increased risk of tube blockage during travel, at school and so on.

We intend to share the effectiveness and usability, of a very simple and inexpensive suction assembly, in clearing out the secretions from paediatric tracheostomy tubes.

Materials and methods

The elementary assembly used in this study for suction cleaning of paediatric tracheostomy tubes is composed of universally available, inexpensive medical consumables as an alternative to the abovementioned devices.

The assembly consists of a 50 ml plastic syringe connected to an infant feeding tube of appropriate size and length (Figure 1). As per the inner diameter and length of the tracheostomy tube (calculated according to a Portex tracheostomy tube, which is commonly used in our set-up), a chart was prepared depicting the size and length of the feeding tube, which is to be inserted to the tip or just beyond the tip of the tracheostomy tube to avoid direct contact with the tracheal mucosa beyond the tracheostomy tube (Table 1).

Following complete insertion of the feeding tube inside the tracheostomy tube, the piston of the syringe is withdrawn to create negative pressure while slowly withdrawing the

Fig. 1. Hand-held suction assembly, consisting of a 50 ml syringe connected to a feeding tube of appropriate size and length.

syringe–feeding tube assembly. The contents of the syringe are then discarded, and the feeding tube is reintroduced into the tube if all the secretions have not been completely sucked out. In a co-operative child who does not move significantly during this process, one carer can securely perform the suctioning procedure. The syringe and the feeding tube are then cleaned for the next use. This assembly can be used four to five times, which is adequate for a day's use, following which it is replaced by a new assembly.

At the outset, we used this assembly in indoor patients, with satisfactory results in terms of ease of use and effectiveness as compared with the electric suction device. However, its use at home by the carers needed to be evaluated.

Following due permission from the institute's ethical committee to conduct this prospective study, we analysed the effectiveness and usability of this hand-held suction assembly in paediatric tracheostomised patients, as compared with their existing suction devices, in a domiciliary setting.

Fifteen tracheostomised patients aged up to six years, whose carers already used a suction device (electric, pedal or hand-held suction units) for clearing the secretion or mucus plug from the child's tracheostomy tube, were recruited from the out-patient and in-patient departments. The carers were provided with the suction assembly (sufficient for two weeks' use) appropriate for the size of the child's tracheostomy tube. Preparation of the assembly, the suctioning technique and the cleaning method were demonstrated to the carers. They were also encouraged to use the assembly to clear secretions from the child's tracheostomy tube in front of the clinicians or staff nurse. They were asked to use the suction assembly at home each time they needed to clean the child's tracheostomy tube, for a period of at least 15 days, both indoors and during outdoor activities. They were advised to use their existing suction device after using this assembly in cases of inadequate clearance of secretion from the tube. The carers were then asked a set of questions either telephonically or physically.

Table 1. Predetermined feeding tube size and length, based on tracheostomy tube size*

Tracheostomy tube size (inner diameter (mm))	Feeding tube size (French gauge unit)	Feeding tube length (mm)
3.0	6	35 + 1
3.5	7	39 + 1
4.0	8	43 + 1
4.5	9	50 + 1
5.0	10	50 + 1
5.5	10	50 + 1
6.0	10	50 + 1

*Feeding tube was attached to a 50 ml syringe

Results

Fifteen paediatric patients, comprising nine boys and six girls, with a mean age of 33.5 months (range, 5–72 months) were recruited into this study. The average duration between tracheostomy and recruitment into this study was 13 months (range, 1–54 months). The tracheostomy tube size varied from 3.5 mm to 6 mm, with 3.5 mm being the median tube size. Nine carers had pre-existing electric suction units, whereas five of them had pedal suction devices and only one carer used a hand-held suction device.

The carers rated the efficiency of this suction assembly and their existing suction unit on a five-point scoring system, whereby 5 = very good, 4 = good, 3 = average, 2 = poor and 1 = very poor. Thirteen (86.7 per cent) and five (33 per cent) carers were very satisfied with the efficiency (scores of 4 and 5) of their existing suction units and the suction assembly, respectively. Fourteen out of 15 carers (93 per cent) rated this assembly as average, good or very good in clearing the tube secretions, and only 1 carer rated the assembly with a score of 2. The mean scores for the efficacy of the electric suction unit and this suction assembly were 4.8 and 3, respectively ($p < 0.001$), as rated by the carers possessing electric suction devices ($n = 9$). Similarly, carers possessing a pedal suction device ($n = 5$) rated the efficacy of their existing device and this suction assembly with mean scores of 3.6 and 3.8, respectively (two-tailed p-value = 0.6547).

We examined the relation between tracheostomy duration and parent-rated efficiency of our suction assembly, and observed a statistically significant association ($p = 0.004$), indicating better efficiency with increasing tracheostomy duration. However, no significant association ($p = 0.076$) was found between tracheostomy tube size and suction assembly efficiency.

Carers were asked about the frequency of needing to use their existing suction unit when our suction assembly could not effectively clear secretions from the tracheostomy tube. They had to choose their answer from four options: seldom (less than 25 per cent of times), occasionally (26–50 per cent of times), frequently (51–75 per cent of times) and almost always (76 per cent and greater number of times). This frequency was reported as seldom in four (26.7 per cent), occasionally in nine (60 per cent) and frequently in the remaining two carers. Overall, 86.7 per cent of the carers ($n = 13$) needed the existing suction units following the use of our suction assembly fewer than 50 per cent of times.

All carers were asked when they would opt to use this suction assembly, with four provided scenarios: always, when the existing suction device is out of order, in emergency situations and never. They had the option of selecting multiple scenarios as well. One carer mentioned that she had not used her existing hand-held suction apparatus for more than two months, and would like to continue using our suction assembly. In addition, 53.3 per cent of carers ($n = 8$) mentioned that they would use this suction assembly as an alternative when their existing suction units malfunction. Of the carers, 46.7 per cent ($n = 7$) stated they would use this suction assembly in emergency situations, such as when there is an urgent need for tracheostomy tube cleaning because of noisy breathing

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and respiratory difficulty. Three of the carers (20 per cent) who had existing electronic suction apparatus stated they would never use this suction assembly.

Convenience of sterilisation and storage of the existing suction device and this suction assembly were rated on a five-point scoring system (5 = very easy, 4 = easy, 3 = manageable, 2 = difficult and 1 = very difficult). None of the carers rated their existing suction unit as very easy to sterilise and store, as compared with 33 per cent ($n = 5$) for this suction assembly. Eighty per cent of users of this suction assembly (12 out of 15) found the sterilisation and storage easy or very easy, as compared with 40 per cent (6 out of 15) for their existing suction units ($p = 0.0306$). On comparing the association between the type of existing suction device and this suction assembly, the average sterilisation and storage convenience score for electric suction unit users was 3.44 as compared with 3.78 for the suction assembly ($p = 0.73$); the average score for pedal suction units was 2.8 as compared with 4 for this suction assembly ($p = 0.0027$).

When questioned about the convenience of transportation, using the same five-point scoring system, none of the carers rated transportation as very easy or easy for their existing devices, whereas 33.3 per cent and 66.7 per cent of users rated this suction assembly as very easy and easy, respectively ($p < 0.001$). Regarding the transportation convenience of the existing suction units, 46.7 per cent ($n = 7$) and 46.7 per cent ($n = 7$) were rated as difficult and manageable, respectively. The mean score was 2.44 for the electric suction units and 4.44 for this suction assembly in terms of the ease of transportation ($p < 0.001$). Similarly, for those with a pre-existing pedal suction device, the mean score for transportation convenience was 2.2, as compared with 4 for this suction assembly ($p < 0.001$).

Table 2 depicts the overall efficiency and usability of our suction assembly as rated by the carers, including their preference for using it in outdoor and/or indoor spaces.

Table 2. Parameters indicating efficiency and usability of suction assembly as rated by carers

Features	Carers* (n (%))
Efficacy	
– Good or very good	5 (33.33)
– Average	9 (60)
– Poor or very poor	1 (6.67)
Ease of sterilisation & storage	
– Easy or very easy	12 (80)
– Manageable	2 (13.33)
Ease of transportation	
– Easy or very easy	15 (100)
– Manageable	0 (0)
Need for existing suction unit following suction assembly use	
– ≤50% of times	13 (86.67)
– >50% of times	2 (13.33)
When use suction assembly?	
– Always	1 (6.67)
– In emergency situations	7 (46.67)
– When existing suction unit malfunctions	8 (53.33)
– Combination of above scenarios	12 (80)
– Never	3 (20)
Where use suction assembly?	
– Indoor only	4 (26.67)
– Outdoor ± indoor	10 (66.67)

*Total $n = 15$

Discussion

Of the numerous underlying co-morbid illnesses that result in paediatric tracheostomy, chronic lung disease, neurological impairment and upper airway anomalies are the most common categories.[1] Age at tracheostomy is less than one year in approximately 33–50 per cent of paediatric patients.[2] Paediatric tracheostomised patients are successfully decannulated in 28–51 per cent of cases, and the mean duration between tracheostomy and decannulation has been reported as two years.[3–9] These data provide an overview of the significant number of tracheostomised paediatric patients at any given point of time.

Tracheostomy has been associated with physical, emotional and social morbidities, for the carers as well as the patients.[10] In paediatric patients, tracheostomy complications have been reported in 15–19 per cent of cases.[1,11] These complications range from mild (not requiring hospitalisation) to life-threatening. Tracheostomy tube blockage is a common complication, which may result in mortality in paediatric patients if not addressed immediately. Adequate humidification and frequent suctioning of the tracheostomy tube are important steps to decrease the risk of tube obstruction. Although the amount of tracheal secretion decreases with time, crusting and increased mucus production during episodes of respiratory tract infections mandate constant domiciliary care of tracheostomy tubes.

Of the various devices and units available for tube suctioning, the majority are expensive, sizable and need electricity for operation. We studied the efficiency and usability of an elementary assembly using a syringe and a feeding tube as a quick, affordable, easy-to-carry suctioning method, evaluated with a questionnaire-based scoring system administered to carers.

In this study, 93 per cent of the carers considered this assembly as average, good or very good in cleaning the tracheostomy tube lumen, and only 13 per cent of parents needed the help of the existing suction units following the use of this suction assembly, fewer than 50 per cent of times. The main reason for this suction assembly not being as efficient as the electric and pedal suction units is the degree of negative pressure that can be generated using a 50 ml syringe. However, to keep the assembly lightweight and easy to carry, we kept the size of the syringe to 50 ml. The negative pressure thus created could clear secretions in 93 per cent of patients. The users of existing electric suction units scored this suction assembly relatively lower, as compared with users of pedal suction devices, primarily because of the wide range of negative pressures that can be created by electric suction units.

Eighty per cent of the carers considered this assembly suitable for use always, in an emergency situation or when their existing suction units were out of order, indicating the high usability of this suction device. In addition, 66.67 per cent of carers were willing to use this assembly in outdoor settings. As well as the easy sterilisation, storage and transportation of this assembly as compared with the existing devices, its

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inexpensive and easy-to-use qualities are contributory to these parental satisfaction rates.

- Paediatric tracheostomy requires considerable time from carers to avoid complications
- Tracheostomy tube blockage due to mucus plugs or crusting can be life-threatening if not resolved in a timely manner
- Suction devices are effective in clearing tube secretions, but are expensive, large, heavy, and difficult to transport and store
- A simple assembly of a disposable syringe and appropriately sized feeding tube is effective for quick, easy clearance of secretions from tracheostomy tubes, as rated by carers
- This assembly is low cost, easy to use, lightweight and easy to carry, and can be used outdoors

This prospective study has the limitations of a small sample size and the lack of objective methods of assessment of different parameters, such as comparing the negative pressure created by this assembly with that of the available suction devices.

Conclusion

Our simple, inexpensive suction assembly can address the important issue of domiciliary care of paediatric tracheostomised patients in resource-limited environments. This elementary suction assembly has been found to be reasonably effective as compared with other available suction devices, as rated by carers of paediatric tracheostomised patients. Because of its compactness and ease of use, the carers expressed their willingness to use this assembly in emergency scenarios and during outdoor activities. The encouraging results of this pilot study can be utilised as an avenue for larger studies and detailed analysis for improvising a more efficacious, simple, lightweight and inexpensive suction apparatus, which can be used in outdoor and indoor settings, for paediatric and adult patients.

Competing interests. None declared

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