

ORIGINAL RESEARCH

Utility of telemedicine in tracheostomy-dependent children

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Abstract

Objectives: Telemedicine can improve access to pediatric otolaryngology care by decreasing travel time and cost, and lowering the risk of viral transmission during the SARS-CoV-2 (COVID-19) pandemic. This study aims to identify the clinical role and outcomes of telemedicine for tracheostomy-dependent children before and during the COVID-19 pandemic.

Methods: Retrospective chart review of 42 tracheostomy-dependent pediatric patients who utilized telemedicine between October 2013 and April 2020 (pre-COVID-19), and 111 patients who utilized telemedicine between May 2020 and July 2021 (during COVID-19) at a tertiary free-standing children's hospital outpatient clinic.

Results: The majority of pre-COVID-19 telecommunication solely addressed tracheostomy stomal concerns as compared with during COVID-19 (99% vs. 3%, $p < .001$), while telecommunication during COVID-19 was mainly used for routine follow-up as compared with pre-COVID-19 (99% vs. 0%, $p < .001$). Telemedicine visits during COVID-19 were significantly less likely to result in the need for in-person office visits as compared with those pre-COVID-19 (4% vs. 22%; $p < .001$). There was no significant difference in urgent emergency department (ED) evaluation following telemedicine pre- and during COVID-19 (16% vs. 11%). The most common reasons for ED presentation both pre- and during COVID-19 following telemedicine visit included respiratory distress, dislodged tracheostomy tube, and tracheostomy bleeding.

Conclusion: The clinical role of telemedicine has evolved from problem-based evaluation to routine follow-up during the COVID-19 pandemic. Although telemedicine can decrease the need for in-person office evaluation of routine tracheostomy concerns, respiratory complications and tracheostomy bleeding still require urgent in-person ED evaluation.

Level of evidence: Level 4.

KEYWORDS

COVID-19, pediatric otolaryngology, telemedicine, tracheostomy

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1 | INTRODUCTION

Access to subspecialty pediatric providers can be limited by socioeconomic and geographic barriers, which can lead to significant health disparities, over-reliance on emergency departments (EDs), and increased inpatient hospitalizations for specialized pediatric care.¹⁻⁴ Telemedicine has been utilized as a means to overcome some of these barriers, including minimizing the need for caregivers to miss work and decreasing the costs and time associated with travel.^{1,2} Medically complex pediatric patients, including those who are tracheostomy-dependent and ventilator-dependent, often require additional costs and time for coordination of travel to attend in-person medical visits.^{2,5} Telemedicine can serve as a useful tool to improve access to pediatric otolaryngology care for tracheostomy-dependent children.^{2,5,6}

The introduction of the SARS-CoV-2 (COVID-19) pandemic has presented additional challenges for physicians and caregivers of tracheostomy-dependent children. Limitations to in-person clinic visits during the COVID-19 pandemic include increased family travel constraints, office staffing shortages, and high infectious risk from aerosolizing physical examination procedures.^{5,7-9} Although telemedicine had been used in the care of tracheostomy-dependent children prior to the COVID-19 pandemic, its role was mainly confined to parental support and education, tracheostomy stomal evaluation, and ventilator adjustments.^{2,3,5,6} There has been a paucity of studies describing the evolution of telemedicine for tracheostomy-dependent children during the COVID-19 pandemic.^{5,7,8} This study aims to address the changing scope of telemedicine practice during the COVID-19 pandemic and to assess the utility of telemedicine in reducing the need for in-person clinic or ED visits in the pediatric tracheostomy-dependent population.

2 | MATERIALS AND METHODS

After full approval of the Institutional Review Board, a retrospective review was conducted of tracheostomy-dependent children who underwent telemedicine evaluation from October 2013 to July 2021 at a tertiary free-standing children's hospital outpatient otolaryngology clinic. All telemedicine visits prior to April 2020 were characterized as "pre-COVID-19" while those after April 2020 were characterized as "during COVID-19." Full bi-directional video communication was implemented at this institution by May 2020.

Pre-COVID-19 telecommunications were patient-driven, and occurred via a combination of email, photograph, and telephone communication. Telemedicine visits during COVID-19 were both provider and patient-driven, and all except one encounter occurred via bi-directional video conferencing. Pre-COVID-19 telemedicine patient encounters were identified using an internal provider database. Telemedicine encounters during COVID-19 were identified via an electronic medical record query of established patient visits with a tracheostomy-related ICD-10 diagnosis code and a telemedicine modifier.

Inclusion criteria included all tracheostomy-dependent children who underwent documented telemedicine evaluation by a pediatric otolaryngologist or pediatric otolaryngology physician assistant in an outpatient setting. Exclusion criteria included all tracheostomy-dependent children who no longer had a tracheostomy in place at the time of their telemedicine visit, and those who were evaluated by providers other than a pediatric otolaryngologist or pediatric otolaryngology physician assistant. Data collected include patient demographics, ventilator dependence, reason for tracheostomy, medical comorbidities, reason for telemedicine visit and outcomes following telemedicine visit.

To compare the characteristics of patients who utilized telemedicine pre-COVID-19 versus during the COVID-19 pandemic, Chi-squared tests were used for categorical variables and Wilcoxon rank sum test for continuous variables. All analyses were performed using SAS version 9.4 (SAS Institute Inc.).

3 | RESULTS

This study included 42 patients who utilized telemedicine (91 telemedicine visits) pre-COVID-19, and 111 patients who utilized telemedicine (155 telemedicine visits) during COVID-19 (Table 1). Pre-COVID-19 telecommunication was solely via email, photos, and/or phone conversations (Figure 1), while bi-directional video telecommunication was used during COVID-19 at this institution. Patients who utilized telemedicine during the COVID-19 were more likely to have neurologic comorbidity than those who utilized telemedicine prior to COVID-19 (61% vs. 43%; $p = .04$). However, other patient demographic and clinical characteristics did not differ between those who utilized telemedicine pre-COVID-19 versus during COVID-19 pandemic.

Reasons for telemedicine evaluation differed between visits occurring pre- and during the COVID-19 pandemic. The majority of pre-COVID-19 telecommunication solely addressed tracheostomy stomal concerns as compared with telemedicine encounters during COVID-19 (99% vs. 3%, $p < .001$). Nearly all telemedicine visits during COVID-19 were used for routine follow-up, which encompassed stomal concerns in addition to other concerns, as compared with pre-COVID-19 visits (99% vs. 0%, $p < .001$).

Outcomes following telemedicine visits also differed between the two groups. For the pre-COVID-19 patients, 18% were asked to clinically monitor, 68% were provided wound care instructions, and 10% were scheduled for an earlier clinical appointment. For patients who underwent telemedicine visits during the COVID-19 pandemic, 45% were asked to monitor clinically, 8% were provided wound care instructions, and 22% were scheduled for an earlier clinical appointment (Table 1). Telemedicine visits during COVID-19 were significantly less likely to result in the need for in-person clinic visits as compared with those pre-COVID-19 (4% vs. 22%; $p < .001$). There was no significant difference in urgent ED evaluation following telemedicine pre- and during COVID-19 (16% vs. 11%) (Table 2).

TABLE 1 Telemedicine in tracheostomy-dependent children before and during COVID-19 pandemic

	Before COVID-19, n (%) (n = 42)	During COVID-19, n (%) (n = 111)
Total number of patients		
Age tracheostomy, median (IQR; range), years	0.9 (0.2–2.2; range 0–28)	0.5 (0.1–3.1; range 0–22)
Age telecom, median (IQR; range), years	6.6 (4.1–14.1; range 0.5–38.1)	5.3 (2.6–14.7; range 0.3–40.7)
Average number of telecom, mean (SD)	2.2 (±2.3)	1.4 (±0.7)
Female	16 (38%)	39 (35%)
Ventilator dependent	17 (41%)	55 (50%)
Reason for tracheostomy		
Prolonged intubation/respiratory failure	27 (64%)	67 (60%)
Subglottic stenosis	4 (10%)	9 (8%)
Vocal cord paralysis	3 (7%)	5 (5%)
Congenital anomalies	6 (14%)	7 (6%)
Neurologic deficit	6 (14%)	11 (10%)
OSA (Obstructive Sleep Apnea)	3 (7%)	11 (10%)
Other	4 (10%)	36 (32%)
Comorbidities		
Neurologic	18 (43%)	68 (61%)
Cardiac	14 (33%)	23 (21%)
General developmental delay/autism	13 (31%)	33 (30%)
Congenital syndromes/disorders	24 (57%)	59 (53%)
Total number of telecom	(n = 91)	(n = 155)
Reason for telecom		
Stoma	90 (99%)	5 (3%)
Routine follow-up	0 (0%)	131 (85%)
Other	1 (1%)	19 (12%)
Outcomes after telecom		
Monitor	16 (18%)	69 (45%)
Wound care trial	62 (68%)	13 (8%)
Scheduling clinic appointment earlier	9 (10%)	34 (22%)
Keeping original clinic appointment	3 (3%)	20 (13%)
Other	1 (1%)	19 (12%)

Those requiring in-person clinic visits before COVID-19 were more likely to present for stomal evaluation (75%), while those requiring in-person clinic visits during COVID-19 were more likely to present for tracheostomy tube down-sizing and pre-operative direct laryngoscopy and bronchoscopy education (66.7%). Respiratory distress was the most common reason for ED presentation following



FIGURE 1 Photo and telephone telecommunication regarding tracheostomy stomal concern pre-COVID-19 pandemic. Four-year-old patient with cerebral palsy, subglottic stenosis, bronchopulmonary dysplasia, and biphasic stridor secondary to bilateral vocal fold paresis status post tracheostomy in 2015 presented for telemedicine consultation in 2018 due to increased secretions and granulation tissue along inferior stoma. After review of photo and telephone discussion with the parents by the pediatric otolaryngology physician assistant, the patient was prescribed a 10-day course of Tobradex ointment which improved the stoma site. Patient did not require an earlier in-person visit

TABLE 2 Telemedicine in tracheostomy-dependent children before and during COVID-19 pandemic

	Before COVID-19, n (%)	During COVID-19, n (%)
Required in person visit	20/91 (22%)	6/155 (4%)
Reason for in person visit		
Stoma	15	0
Trach bleed	1	0
Trach downsize	0	2
Pre-op DLB (direct laryngoscopy and bronchoscopy) education	0	2
Other	4	2
ED (Emergency Department) visit	15/91 (16%)	17/155 (11%)
Reason for ED visit		
Stoma	3	1
Bleed	5	7
Infection	2	0
Respiratory distress	7	10
Dislodged trach	3	1

telemedicine visit both pre- and during COVID-19 (46.7% and 58.8%). The two other most common reasons for ED presentation both pre- and during COVID-19 were tracheostomy bleeding and dislodged tracheostomy tube (Table 2).

4 | DISCUSSION

Telemedicine has been described in the complex pediatric population as a means to optimize access to tertiary specialty care, improve caregiver education and comfort, and decrease the need for office and ED visits.^{1,2,6,10} As telemedicine becomes increasingly adopted in pediatric population, it can decrease caregiver burden by reducing the cost of transportation, lost caregiver wages, and childcare fees for other children associated with travel to in-person clinic visits.^{1,2,11} By improving patient access to specialty physicians, telemedicine can reduce delays in seeking medical care, improve timeliness of in-person and/or emergency room evaluation, and potentially prevent unnecessary hospitalizations.⁴ One study of medically complex children, including tracheostomy-dependent patients, found that patients who were provided bi-directional video telecommunication had a significantly lower hospitalization rate, resulting in \$9425 per patient savings compared with the control group.⁴

Prior to the COVID-19 pandemic, telemedicine visits in this population were primarily utilized for acute medical concerns, medication changes, and parental education and support.^{2,6,10} The scope of telemedicine has expanded during the COVID-19 pandemic to include both problem-based and routine follow-up care as a means to decrease the risk of viral transmission. This study found that in the pediatric tracheostomy-dependent population, the role of telemedicine has significantly shifted from problem-based care pre-COVID-19, such as stomal evaluation and wound care, to routine tracheostomy surveillance and monitoring during COVID-19. While there was an overall lower percentage of patients who required in-person visits following telecommunication during COVID-19 (4% vs. 22%), a higher percentage of patients during COVID-19 required an earlier-than-scheduled in-person clinic appointment following telecommunication than pre-COVID (22% vs. 10%). The latter finding may be secondary to a decrease in frequency of scheduled in-person clinic appointments due to the pandemic, and the evolving role of telemedicine from adjunctive care with scheduled in-person visits to primary surveillance care in lieu of in-person visits.

The mode of telecommunication plays an important role in the breadth of clinical care provided via telemedicine. Bi-directional video, as compared with telephone calls, has been shown to improve parent satisfaction and reduce the need for both office visits and ED visits.^{1,10,12} In a study by Robinson et al., newly discharged NICU infants with access to in-person nursing visits were randomized to receive supplemental telephone calls or video calls.¹⁰ Video telemedicine resulted in higher parent satisfaction, improved physician confidence in making medical decisions, and decreased number and frequency of in-person and ED visits.¹⁰ In tracheostomy-dependent children, bi-directional video telecommunication has been effectively

used to evaluate work of breathing, examine tracheostomy stoma sites, adjust ventilator settings and offer parental tracheostomy education.^{3,5,6} Although unable to control for the effect of COVID-19, this study found that bi-directional video telemedicine visits during COVID-19 resulted in a significantly lower rate of in-person clinic visits as compared with telephone or email telecommunication pre-COVID-19. This finding suggests that routine tracheostomy surveillance may be completed via bi-directional video telemedicine in lieu of in-person clinic visits for a select group of patients.

Although bi-directional video telemedicine may provide a widened scope of clinical evaluation, the need for urgent ED visits emphasizes the inherent limitations of telemedicine. In a study by Ross et al., of 17 medically complex children, including those who were tracheostomy and/or ventilator-dependent, 9 patients still required ED visits within 1-month of their bi-directional video telemedicine visit. Seventy-one percentage of these visits were due to respiratory distress and 14% were due to medical technology failure; all ED visits were determined by an independent physician to have been unlikely preventable.² In concordance with Ross and colleagues, the present study also identifies respiratory distress as the most common indication for ED presentation following telemedicine visit both pre- and during COVID-19. Other common indications for ED evaluation in this study included tracheostomy bleeding and dislodged tracheostomy tube. These findings highlight a major limitation of telemedicine: the inability to perform a tracheoscopy, which is critical in the aforementioned clinical situations to assess and/or establish a safe airway. Routine surveillance in-person tracheoscopy and direct laryngoscopy and bronchoscopy in the operating room are still warranted to identify development of granulation tissue, monitor for appropriateness of tracheostomy size, and evaluate for the possibility of decannulation.¹³

As the global healthcare community aims to improve the care and safety of tracheostomy-dependent children, telemedicine should serve as an effective adjunct to achieve that mission. The Global Tracheostomy Collaborative, established in 2014 as a multi-institutional, multidisciplinary organization, has identified five key drivers for quality improvement in the tracheostomy-dependent population: coordinated multi-disciplinary teams, standardization of care protocols, coordinated interdisciplinary education, patient and family centered care, and use of data to drive improvement.^{9,14-16} Multiple studies have found that empowering caregivers and effective tracheostomy education can optimize tracheostomy care and potentially avoid complications.^{15,17} Telemedicine currently has the ability to provide individualized care for families at home, increase avenues for communication between providers and patients, and continue tracheostomy education following hospital discharge.

Limitations of this study include retrospective design and patient selection bias, as all patients who underwent bi-directional video telemedicine visits during COVID-19 required a mobile device or computer with stable internet connectivity. This study could not control for the mode of telecommunication or whether the telecommunication was patient-driven or provider-driven, as bi-directional video telecommunication was only formally offered to patients at this institution following the start of the COVID-19 pandemic. Therefore, the significantly lower rate of in-person visits following telemedicine visits

during COVID-19 may be due to a combination of the mode of telecommunication, reason for telecommunication (i.e., acute medical concerns pre-COVID-19 vs. routine surveillance during COVID-19), and increased thresholds for clinic visits during the pandemic due to risk of COVID-19 transmission and limited clinic space and personnel. Finally, this institution does not yet have a standardized protocol for the use of telemedicine in the care of tracheostomy-dependent pediatric patients, or the ability to provide multi-disciplinary care via a telemedicine platform. Future studies may aim to integrate telemedicine into a routine pediatric tracheostomy care protocol and incorporate multi-disciplinary care via a virtual platform for these medically complex pediatric patients.

5 | CONCLUSION

Telemedicine can improve healthcare access for tracheostomy-dependent children by decreasing travel time and costs and lowering the risk of COVID-19 transmission. The role of telemedicine has expanded from problem-based care to routine tracheostomy surveillance during the COVID-19 pandemic. Integration of bi-directional video communication as part of routine tracheostomy surveillance may reduce the need for in-person clinic evaluation in a select group of patients. Serious adverse events, such as respiratory complications and tracheostomy bleeding, may be identified via telemedicine and prompt urgent in-person ED evaluation.

CONFLICTS OF INTEREST

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