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The value of telemedicine for the pediatric surgery patient in the time of COVID-19 and beyond



Gregory A. Metzger^c, Jennifer Cooper^c, Carley Lutz^c, Kris R. Jatana^b, Leah Nishimura^c, Katherine J. Deans^{a,c}, Peter C. Minneci^{a,c}, Ihab Halaweish^{a,*}

^a Department of Pediatric Surgery, Nationwide Children's Hospital, Columbus, OH, USA

^b Department of Pediatric Otolaryngology, Nationwide Children's Hospital, Columbus, OH, USA

^c The Center for Surgical Outcomes Research, Nationwide Children's Hospital, Columbus, OH, USA

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ABSTRACT

Background: Prior to COVID-19, the use of telemedicine within pediatric surgery was uncommon. To curb the spread of the virus many institutions restricted non-emergent clinic appointments, resulting in an increase in telemedicine use. We examined the value of telemedicine for patients presenting to a pediatric surgery clinic before and after COVID-19

Methods: Perspectives and the potential value of telemedicine were assessed by surveying patients or caregivers of patients being evaluated by a general pediatric surgeon in-person prior to COVID-19 and by patients or caregivers of patients who completed a telemedicine appointment with a pediatric surgical provider during the COVID-19 period.

Results: The pre-COVID survey was completed by 57 respondents and the post-COVID survey by 123. Most respondents were white and were caregivers 31–40 years of age. Prior to COVID-19, only 26% were familiar with telemedicine, 25% reported traveling more than 100 miles and >50% traveled more than 40 miles for their appointment. More than 25% estimated additional travel costs of at least \$30 and in 43% of households, at least one adult had to miss time from work. Following a telemedicine appointment during the COVID-19 period, 76% reported the care received as excellent, 86% were very satisfied with their care, 87% reported the appointment was less stressful for their child than an in-person appointment, and 57% would choose a telemedicine appointment in the future.

Conclusion: For families seeking an alternative to the in-person encounter, telemedicine can provide added value over the traditional in-person encounter by reducing the burden of travel without compromising the quality of care. Telemedicine should be viewed as a viable option for pediatric surgery patients and future research directed toward optimizing the experience for patients and providers.

Level of Evidence: III.

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1. Introduction

The use of telemedicine has grown over the past several decades, and in 2016 > 60% of institutions were estimated to have a telemedicine program in place [1]. Telemedicine offers an opportunity to address disparities due to the inequity of access to specialists, such as pediatric surgeons, based on locale and ability to travel [2]. For many physicians, telemedicine is now seen as a valuable adjunct to the traditional in-person clinic visit; however, use within pediatric surgery remains uncommon and understudied. Prior to the outbreak of COVID-19, we were preparing for the implementation of telemedicine at our institution by surveying caregivers about their perspectives on the potential benefits and

drawbacks of receiving remote evaluation. In response to the outbreak of COVID-19, telemedicine was rapidly expanded to include pre- and post-operative clinic appointments in order to continue providing care for patients while adhering to institutional policies restricting in-person contact during the initial phase of COVID-19.

The objectives of this study were to evaluate caregiver perspectives on the potential value of telemedicine for pediatric surgery patients, as determined by: 1) the caregiver's burden for in-person evaluation, and 2) the caregiver's perspective of telemedicine prior to and during the COVID-19 period.

2. Materials and methods

2.1. Study design

This project occurred in two phases and made use of two surveys. The first survey was distributed in-person to caregivers pre-

* Corresponding author.

E-mail address: ihab.halaweish@nationwidechildrens.org (I. Halaweish).

senting to a pediatric surgery clinic prior to COVID-19. The second survey was distributed electronically to patients who completed a telemedicine appointment with a pediatric surgeon during the COVID-19 period. The pre-COVID-19 survey was designed to be distributed to caregivers who had very little experience with telemedicine; whereas the post-COVID-19 survey was distributed after the completion of a telemedicine appointment. The goal of both was to determine the caregiver perspective on the use of telemedicine in pediatric surgery, but the questions were structured differently between the two surveys to account for the different context and phases of care in which they were completed. The pre-COVID survey focused on the caregiver's perceived comfort with technology and remote evaluation by a surgeon, and the post-COVID survey focused on the actual experience of completing a telemedicine appointment. Both surveys are available for review as Appendix A and Appendix B, respectively.

2.2. Pre-COVID-19 survey development

Prior to COVID-19, a survey was developed to determine the caregiver perspective on the use of telemedicine for completing clinic visits with a pediatric surgeon. The aims of the survey were to determine the perceived burden of attending in-person clinic appointments, to determine a baseline of caregiver knowledge pertaining to the use of telemedicine, and to determine potential interest in using telemedicine services to complete future appointments with a pediatric surgeon. The assessments of comfort using telemedicine and perceived cost used a 5-point Likert-type scale, and all other questions were presented at the categorical or ordinal level. Participants were given space at the end of the survey to write clarification or other comments. Modifications were made following feedback from attending surgeons in the Division of Pediatric Surgery, resulting in the final list of questions that can be found in Appendix A. The survey was reviewed by the local IRB and the study approved with a waiver of written consent.

2.3. Pre-COVID-19 survey distribution

From January 13, 2020 through March 12, 2020 the survey was offered to families attending outpatient general pediatric surgery clinic at a single institution. There was no restriction based on reason for the visit, and there was no preselection process. The survey was preloaded onto an iPad, with participants entering answers directly into the Research Electronic Database Capture portal (REDCap) via a secure network [3]. Families that completed the survey were provided with debit card with a preloaded value of \$5. To reduce the potential for bias, responses were anonymous and entered independent of the presence of research personnel.

2.4. Post-COVID-19 survey development

Following the introduction of telemedicine appointments in the pediatric surgery department at our institution, a survey was developed to assess caregivers' perceived impact of the use of telemedicine for surgery clinic visits. The aim of the survey was to assess any observed technical limitations, the perceived quality of care received, and caregivers' interest in using telemedicine to complete future appointments with a pediatric surgical provider. The assessments of comfort using telemedicine and perceived cost used a 5-point Likert-type scale, and all other questions were presented at the categorical or ordinal level. Participants were given space at the end of the survey to write clarification or other comments. Modifications were made following feedback from the Division of Pediatric Surgery, resulting in a final list of questions that can be found in Appendix B. The survey was reviewed by the local

IRB and approved for distribution with a waiver for written consent. There was no financial incentive provided for completion of the post-COVID survey.

2.5. Post-COVID-19 survey distribution

Medical records were reviewed to identify patients that completed a telemedicine visit with a pediatric surgical provider from May 4, 2020 to May 15, 2020. The following divisions were included: general pediatric surgery, cardiothoracic surgery, colorectal surgery, dentistry, gynecology, neurosurgery, otolaryngology, orthopedic surgery, plastic surgery, and urology. Email addresses were extracted from the medical record and used to send requests for survey completion to potential subjects (patient ≥ 18 years of age or caregivers of minor patients) via REDCap. The links were unique to the individual subject, and responses were entered directly into REDCap by the respondent.

2.6. Analysis

Descriptive statistics were generated from the data. Percentages and frequencies were calculated for categorical variables. Chi square tests were used to explore differences based on appointment type (video vs. audio-only) or provider specialty. Significance was determined at a p-value of <0.05 .

3. Results

3.1. Response rate and demographics

A total of 57 out of a possible 120 caregivers (47.5%) presenting to a pediatric surgery clinic completed the pre-COVID survey. The post-COVID survey was completed by 123 of a potential 827 participants (14.9%). Demographic characteristics were similar between the two groups, with the majority of respondents to both the pre- and post-COVID survey being white (70.9% and 82.8%) and aged between 31 and 40 years (50.9% and 52.9%). More than half of patients were covered by private insurance (50.0% and 53.3%) and slightly less by public insurance (44.4% and 38.5%), with uninsured patients accounting for 5.6% of visits in the pre-COVID group and 8.2% in the post-COVID population. All caregivers completing the pre-COVID survey reported access to a smart phone and 93% indicated access to a computer or tablet (Table 1).

3.2. Pre-COVID survey - The burden of attending a pediatric surgery clinic

The most common responses from caregivers regarding travel was an estimated travel distance of less than 20 miles (33%) and an estimated travel time between 30 min and 1 h (35.7%). However, nearly one-fourth (24.6%) of families traveled more than 100 miles and over a third (35.7%) spent at least 2 h in travel. Estimates of the cost of travel and additional expenses were mixed, with the most common responses being less than \$10 for each (41.8% and 52.6%), with 29% estimating at least \$30 in travel costs and 28.1% spending at least \$20 in additional costs. More than 40% of households lost wages to attend the clinic appointment, and nearly 80% reported visiting a physician for their children at least twice per year (Table 2).

3.3. Pre-COVID survey - Caregiver perspective on telemedicine

Despite a high rate of interaction with technology, as evidenced by daily internet use (cellphone – 98%, computer – 87%) and weekly video chat (cellphone – 84%, computer – 70%), only 26%

Table 1
Respondent Characteristics (n = 180).

	Pre-COVID (n = 57)		Post-COVID (n = 123)	
	N	%	N	%
Relationship to patient (N = 55, 123)				
Parent or guardian	50	(90.9)	117	(95.1)
Grandparent	3	(5.5)	0	(0)
Foster parent	2	(3.6)	0	(0)
Patient	0	(0)	6	(4.9)
Age (N = 55, 121)				
Less than 20 years	1	(1.8)	1	(0.8)
20–30 years	14	(25.5)	30	(24.8)
31–40 years	28	(50.9)	64	(52.9)
41–50 years	8	(14.6)	17	(14.1)
51 years or older	4	(7.3)	9	(7.4)
Race (N = 55, 116)				
White	39	(70.9)	96	(82.8)
Black	12	(21.8)	10	(8.6)
Asian, Native Hawaiian, or other Pacific Islander	2	(3.6)	3	(2.6)
Multiracial	0	(0)	5	(4.3)
Native American	0	(0)	0	(0)
Other	2	(3.6)	2	(1.7)
Patient's Insurance (N = 54, 122)				
Private	27	(50.0)	65	(53.3)
Medicaid/Medicare	24	(44.4)	47	(38.5)
No Insurance	3	(5.6)	10	(8.2)
Family Income (N = 46, 98)				
Less than \$20,000	7	(15.2)	4	(4.1)
\$20,000–\$40,000	11	(23.9)	18	(18.4)
\$40,000–\$100,000	14	(30.4)	32	(32.7)
\$100,000 or more	14	(30.4)	44	(44.9)
Access to a computer or tablet				
Yes	53	(93.0)	NA	
No	4	(7.0)		
Access to a cell phone (N = 56)				
Yes	56	(100.0)	NA	
No	0	(0)		

Table 2
The Burden of Attending a Pediatric Surgery Clinic (N = 57).

	N (%)	
Estimated miles traveled	Less than 20 miles	19 (33.3)
	20–40 miles	9 (15.8)
	40–60 miles	8 (14.0)
	60–100 miles	7 (12.3)
	More than 100 miles	14 (24.6)
Estimated time spent on travel (N = 56)	Less than 30 min	8 (14.3)
	30 min – 1 h	20 (35.7)
	1–2 h	8 (14.3)
	2–3 h	11 (19.6)
	More than 3 h	9 (16.1)
Estimated cost of travel (N = 55)	Less than \$10	23 (41.8)
	\$10–20	11 (20.0)
	\$20–30	5 (9.1)
	\$30–50	9 (16.4)
	More than \$50	7 (12.7)
Estimated additional costs	Less than \$10	30 (52.6)
	\$10–20	11 (19.3)
	\$20–30	9 (15.8)
	\$30–50	3 (5.3)
	More than \$50	4 (7.0)
At least one adult had to miss time from work	25 (43.9)	
At least one adult lost wages to attend the appointment (N = 56)	23 (41.1)	
Children in the household collectively visit a physician at least twice per year (N = 54)	43 (79.6)	

of respondents had ever heard of telemedicine. The vast majority (84%) indicated that seeing a surgeon face-to-face is important; however, following a brief description of telemedicine, the majority of respondents indicated an interest in using telemedicine for pre- and post-operative appointments (67% and 71%, respectively) (Table 3).

3.4. Post-COVID survey – Patient satisfaction

The majority of respondents rated the provider's ability to diagnose and treat the patient as excellent (77%) and were very satisfied with the overall care received (86%). Compared to an in-person appointment, telemedicine appointments were less stress-

Table 3
Caregiver perspective on telemedicine before COVID-19.

Caregiver Perspective Before COVID-19 (N = 57)	
Caregiver reports using a computer or tablet to...	N (%)
Access the Internet daily (N = 53)	46 (86.8)
Use Video Chat at least weekly (N = 53)	37 (69.8)
Search for Health Information at least weekly (N = 53)	34 (64.2)
Caregiver reports using a cellphone to...	
Access the Internet at least daily (N = 56)	55 (98.2)
Use Video Chat at least weekly (N = 55)	46 (83.6)
Search for Health Information at least weekly (N = 56)	43 (76.8)
The following are <i>somewhat or very important</i> when seeing a surgeon...	
Minimizing cost (N = 54)	40 (74.1)
Minimizing time spent on travel (N = 54)	37 (68.5)
Getting the correct diagnosis/scheduling surgery (N = 53)	48 (90.6)
Receiving communication from the surgeon (N = 55)	49 (89.1)
Being able to ask questions directly (N = 54)	48 (88.9)
Seeing the surgeon in person (N = 54)	45 (83.3)
Perspective on Telemedicine	
Ever heard of telemedicine	15 (26.3)
Report being likely or very likely to use telemedicine for a pre-operative appointment (N = 54)	36 (66.7)
Report being likely or very likely to use telemedicine for a post-operative appointment (N = 55)	39 (70.9)

Table 4
Caregiver perspective on telemedicine after having completed a telemedicine appointment.

Caregiver Perspective After Completing Telemedicine Appointment (N = 123)	
Type	N(%)
Phone	35 (28.5)
Video	88 (71.5)
Any reported technical issue	
Yes	22 (17.9)
No	101 (82.1)
Surgical Specialist Seen Via Telemedicine	
Adolescent Gynecology	9 (7.3)
General Pediatric Surgery (includes Colorectal)	14 (11.4)
Orthopedic Surgery	9 (7.3)
Otolaryngology	53 (43.1)
Neurosurgery	10 (8.1)
Plastic Surgery	2 (1.6)
Urology	26 (21.1)
Rated the following areas as <i>excellent</i>	
The provider's ability to diagnose problems and treat the child (N = 114)	87 (76.3)
The information given by the provider about the illness and treatment (N = 119)	95 (79.8)
The coordination of care (N = 121)	98 (81.0)
Were <i>very satisfied</i> with the following...	
How well the staff responded to the child's needs (N = 116)	102 (87.9)
Efforts to keep the child as comfortable and stress-free as possible (N = 98)	90 (91.8)
The amount of time spent attending to the child's emotional needs (N = 88)	78 (88.6)
The overall care that was received (N = 115)	99 (86.1)
Compared to an in-person appointment, the telemedicine appointment...	
Was less stressful for the child (N = 105)	91 (86.7)
Was less stressful for caregiver and family (N = 110)	93 (84.6)
Provided care that was equal or better than an in-person appointment (N = 111)	87 (78.4)
If given the choice of visit type for future appointments, I would choose: (N = 122)	
Video telemedicine	59 (48.4)
Phone telemedicine	11 (9.0)
In-person	52 (42.6)

ful for the child (87%) and family (85%). Despite generally positive responses regarding the experience, 43% of respondents indicated they would choose an in-person visit for future encounters with their surgical provider (Table 4).

3.5. Post-COVID survey – Perception on quality of care

Roughly 80% of respondents reported that the quality of care received via telemedicine was at least equivalent to an in-person appointment. Nearly three-quarters of telemedicine appointments among survey respondents during the pandemic period were carried out using video (72%), with 17.9% experiencing at least one technical issue. Of the 123 respondents to the survey, 53 (43%) had completed an appointment with a

provider from otolaryngology, 26 (21%) had completed an appointment with a provider from urology, and 14 (11%) had completed an appointment with a provider from general pediatric surgery. There were no telemedicine appointments with providers in cardiothoracic surgery or dentistry during the study period. At least 1 technical issue was reported by 18% of respondents (Table 4). The type of appointment (video vs. audio only) was marginally significantly associated with satisfaction, with 90% of respondents indicating that they were very satisfied when a video appointment was completed compared to only 76% of respondents who completed phone appointments ($p = 0.07$) (Table 5). There were no differences in the perceived quality of care or level of satisfaction based on the provider specialty (Table 6).

Table 5
Differences in reported quality of care or satisfaction with the appointment according to appointment type (phone vs. video).

	Compared to an in-person appointment, the telemedicine appointment provided care that was equal to or better than an in-person appointment		P
	No	Yes	
Video	17 (21.3)	63 (78.7)	0.88
Phone (audio only)	7 (22.6)	24 (77.4)	
	Very satisfied with the overall care received		
	No	Yes	
Video	8 (9.8)	74 (90.2)	0.07
Phone (audio only)	8 (24.2)	25 (75.8)	

Table 6
Differences in reported quality of care or satisfaction with the appointment according to provider specialty.

	Compared to an in-person appointment, the telemedicine appointment provided care that was equal to or better than an in-person appointment		P
	No	Yes	
Adolescent Gynecology	2 (22.2)	7 (77.8)	0.72
General Pediatric Surgery	3 (25.0)	9 (75.0)	
Orthopedic Surgery	0 (0)	8 (100.0)	
Otolaryngology	14 (27.5)	37 (72.6)	
Neurosurgery	2 (20.0)	8 (80.0)	
Plastic Surgery	0 (0)	2 (100.0)	
Urology	3 (15.8)	16 (84.2)	
	Very satisfied with the overall care received		
	No	Yes	
Adolescent Gynecology	2 (25.0)	6 (75.0)	0.86
General Pediatric Surgery	8 (15.7)	43 (84.3)	
Orthopedic Surgery	0 (0)	8 (100.0)	
Otolaryngology	8 (15.7)	43 (84.3)	
Neurosurgery	1 (11.1)	8 (88.9)	
Plastic Surgery	0 (0)	2 (100.0)	
Urology	4 (16.7)	20 (83.3)	

4. Discussion

Prior to COVID-19, caregivers presenting to a pediatric surgery clinic were largely unaware of telemedicine. However, following a brief description, caregivers indicated that they were likely to use remote options for future pre- and post-operative appointments. After introducing telemedicine appointments during the COVID-19 pandemic, respondents who completed telemedicine appointments with a pediatric surgical provider reported excellent treatment scores and were satisfied with the overall quality of care that was received, with no differences identified based on provider specialty. This study indicates that telemedicine services are desired amongst many caregivers presenting for evaluation by a pediatric surgeon in the United States. Telemedicine has value as a tool for potentially decreasing disparities in care, reducing the burden for families, and increasing the effective reach of providers and should be considered for an expanded role beyond the COVID-19 period.

Children requiring surgical intervention experience fewer complications when their operation is performed by a high-volume pediatric surgeon, but there is currently an inequality of access to specialized pediatric providers [4–6]. Telemedicine can help to mitigate the disparity in care that exists for children seeking evaluation by a pediatric surgeon by creating more opportunities for access [4,5,7–9]. A patient's access to a surgeon is affected by direct barriers such as geographic location and provider availability, as well as by indirect barriers that include insurance status, hidden costs, and employment status. In their study exploring the potential impact of telemedicine for patients presenting to a pediatric surgeon in Canada, Bator et al. focused on savings created through reduced travel [10]. Our study represents the first to explore the perceived barriers for telemedicine in pediatric surgery in the US, where healthcare is delivered outside of a single-payer system and population density and provider availability vary widely by location.

The use of telemedicine can mitigate the disproportionately negative effect of access for patients in rural settings due to a healthcare delivery model that restricts patients to in-person appointments. The number of pediatric surgeons is growing in number, but the proportion of pediatric specialists practicing in rural areas has remained relatively stagnant, creating a discrepancy in access for children in non-urban areas [11,12]. The utilization of pediatric specialists is related to provider availability, and currently 76% of members of the American Association of Pediatric Surgeons reside in the 50 largest metropolitan areas [13]. Children residing in areas with the lowest supply of pediatric specialists are less likely to visit a subspecialist and more likely to utilize the emergency department to receive care, creating unnecessary costs to the healthcare system and contributing to worse outcomes for rural Americans [12,14]. In our study, 25% of respondents reported traveling more than 100 miles to seek evaluation by a pediatric surgeon. To put this into context, the Health Resources and Services Administration (HRSA) estimates that 20% of Ohio's population is considered rural, compared to approximately 14% of The United States as a whole [15]. Telemedicine is effective for evaluating patients in the pre- and post-operative phases and can be used to improve the quality of care for families living in rural areas or for those wishing to reduce the cost associated with travel.

Insurance status is an important factor in determining a child's access to care and can affect the likelihood of being referred to a specialist [16–18]. More than 50% of the children that completed a telemedicine appointment in our study were covered through private insurance. However, the recent surge in unemployment related to COVID-19 is affecting private healthcare coverage for millions of families, and will result in a transition in coverage for the children of affected families [19]. Interruptions in insurance coverage create a barrier to accessing care and can lead to delayed medical treatment [20]. Children from low-income households are already less likely to have access to pediatric specialists and on av-

erage receive fewer procedures when compared to children from high-income households – this is likely to be exacerbated by the loss of medical coverage [21]. Improvements in referral systems and increased access to vital health resources, including pediatric specialists, are thus particularly important for children from low-income families [22,23]. Telemedicine affords patients an opportunity to be evaluated by a pediatric surgeon at a reduced cost and can be leveraged to decrease the gap in equitable care that currently exists for children by increasing access to the pediatric surgeons best suited for treating children with surgical needs.

The indirect costs of care warrant consideration when discussing the true burden for families seeking evaluation by a pediatric surgeon. If a child requires surgery, then there will be a minimum of three times that families must contact the hospital system – the pre-operative visit, the surgery, and the post-operative evaluation. For our study population, 29% of caregivers estimated spending at least \$30 in travel and 28% reported at least \$20 in additional costs related to a single appointment. The cost was compounded for 42% of respondents who lost wages to attend the appointment and for the more than 75% of families who reported visiting a clinician for their children at least twice per year. The traditional model of delivering care in-person is essential when a procedure is necessary or when a physical exam is required to make a diagnosis. However, the value of an in-person appointment becomes less clear when a physical exam is not necessary to guide treatment recommendations. The majority of studies on telemedicine in surgery have focused on its use in the post-operative period, finding it to be an effective tool for monitoring recovery and discovering complications [24–27]. Although studies exploring the use of remote evaluation in the pre-operative setting are limited, results have been promising, with high rates of concordance reported between diagnoses made in-person and through virtual evaluation [28–32]. All respondents in our study had access to a cellphone, and 93% reported access to a computer or tablet, which is consistent with estimates for internet access in young adults as reported by the Pew Research Center [33]. With patients possessing near universal access to the resources necessary to carry out a virtual appointment, it is possible to reduce the burden of being evaluated and treated by a pediatric surgeon without compromising the quality of care. The period of increased use in response to COVID-19 has created an opportunity to study the impact of telemedicine use across a large and diverse surgical population and can provide a means to optimize its use in the perioperative phases going forward.

Telemedicine has shown promise and warrants further investigation as a potential tool to help reduce disparities in care for the pediatric surgical patient. However, as with any change in the healthcare delivery model, it will be essential to evaluate for any negative effects. Nearly 20% of patients in our cohort experienced at least one technical issue, and patients completing appointments by phone were less satisfied than those who used video. In recognition of the importance of telemedicine services, the Federal Communications Commission recently earmarked funds to promote increased access to reliable internet services for low-income families [34]. These efforts are necessary to ensure equitable access to telemedicine and to avoid creating additional disparities for disadvantaged Americans.

No differences were reported in the level of satisfaction based on provider specialty, but the variability in usage varied widely across the pediatric surgical divisions. Patients requiring in-office procedures, such as those being seen by an orthopedist or oral surgeon, are less likely to derive benefit from a virtual evaluation and will continue to be reliant on the regional availability of providers.

This study was not without limitations. The response rate of 14.8% for the post-COVID survey was lower than expected, and with only 123 responses it can be difficult to determine whether

the findings of this study accurately reflect the views of a larger population. Our goal with the post-COVID-19 survey was to obtain a sample of responses across all pediatric surgical divisions at our institution. This included more than 10 divisions and over 60 providers, prohibiting the use of research personnel to recruit patients at the time of the telemedicine appointments. There was no financial incentive included for completion of the post-COVID survey due to limited funds. When coupled with the decision to limit recruitment efforts to a single post-appointment email, the result was a decrease in the response rate for the post-COVID survey compared to the pre-COVID survey. Despite these limitations, we obtained completed responses from more than 120 patients and caregivers, representing a heterogeneous population. Given the study's small sample size and focus on a single pediatric institution, the results of this study may not be generalizable to all institutions or pediatric surgical populations. Our goal in this study was to highlight observations that we made during the initial phase of expansion, with hope that it can be used to guide future research exploring ways to optimize the experience for a larger group of patients and caregivers. The long-term success of telemedicine in pediatric surgery will require organizational support and provider buy-in. Additional research is needed to monitor the long-term impact that telemedicine may have reimbursement practices, disparities in access to care, as well as disease-specific outcomes.

In conclusion, for caregivers seeking an alternative to the in-person appointment with a pediatric surgeon, telemedicine offers both direct and indirect benefits that combine to provide added value for the family. Prior to COVID-19, caregivers presenting for evaluation by a pediatric surgeon incurred the cost and time of travel and were largely unaware of telemedicine. After completing a telemedicine appointment with a pediatric surgery provider, caregivers reported that the experience was less stressful for their child than a traditional appointment and that the perceived quality of care was equitable. Telemedicine is a viable option for evaluating pediatric surgery patients and can be used by surgeons to increase the perceived value for caregivers seeking an alternative to the in-person appointment,

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Author contributions

Study conception and design: GM, KJ, KD IH, PM
Acquisition of data: GM, CL, LN, KJ
Analysis and Interpretation of data: JC, GM, KJ, IH, KD, PM
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References

- [1] Report to Congress: E-health and Telemedicine. In: Services USDoHaH, ed.; 2016.
- [2] Marcin JP, Shaikh U, Steinhorn RH. Addressing health disparities in rural communities using telehealth. *Pediatr Res* 2016;79(1–2):169–76.
- [3] Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform* 2009;42(2):377–81.
- [4] Drews JD, Cooper JN, Onwuka EA, Minneci PC, Aldrink JH. The relationships of surgeon volume and specialty with outcomes following pediatric thyroidectomy. *J Pediatr Surg* 2019;54(6):1226–32.
- [5] Kalfa D, Chai P, Bacha E. Surgical volume-to-outcome relationship and monitoring of technical performance in pediatric cardiac surgery. *Pediatr Cardiol* 2014;35(6):899–905.
- [6] McAteer JP, LaRiviere CA, Drugas GT, Abdullah F, Oldham KT, Goldin AB. Influence of surgeon experience, hospital volume, and specialty designation on outcomes in pediatric surgery: a systematic review. *JAMA Pediatr* 2013;167(5):468–75.
- [7] Heller MA, Lind MN, Boss EF, Cooper JN. Differences in Tonsillectomy use by Race/Ethnicity and type of health insurance before and after the 2011 tonsillectomy clinical practice guidelines. *J Pediatr* 2020;220:116–24 e3.
- [8] Marcin JP, Ellis J, Mawis R, Nagrampa E, Nesbitt TS, Dimand RJ. Using telemedicine to provide pediatric subspecialty care to children with special health care needs in an underserved rural community. *Pediatrics* 2004;113(1 Pt):1–6.
- [9] Morche J, Mathes T, Jacobs A, Pietsch B, Wessel L, Gruber S, et al. Relationship between volume and outcome for congenital diaphragmatic hernia: a systematic review protocol. *Syst Rev* 2018;7(1):185.
- [10] Bator EX, Gleason JM, Lorenzo AJ, Kanaroglou N, Farhat WA, Bağli DJ, et al. The burden of attending a pediatric surgical clinic and family preferences toward telemedicine. *J Pediatr Surg*. 2015;50(10):1776–82.
- [11] Randolph GD, Pathman DE. Trends in the rural-urban distribution of general pediatricians. *Pediatrics* 2001;107(2):E18.
- [12] Ray KN, Bogen DL, Bertolet M, Forrest CB, Mehrotra A. Supply and utilization of pediatric subspecialists in the United States. *Pediatrics* 2014;133(6):1061–9.
- [13] Nakayama DK, Burd RS, Newman KD. Pediatric surgery workforce: supply and demand. *J Pediatr Surg*. 2009;44(9):1677–82.
- [14] Johnson WG, Rimsza ME. The effects of access to pediatric care and insurance coverage on emergency department utilization. *Pediatrics* 2004;113(3 Pt 1):483–7.
- [15] Services USDoHaH. Rural Health Information Hub, <https://www.ruralhealthinfo.org/guides> ; 2020].
- [16] Skinner AC, Mayer ML. Effects of insurance status on children's access to specialty care: a systematic review of the literature. *BMC Health Serv Res* 2007;7:194.
- [17] Johnson TR, Nguyen A, Shah K, Hogue GD. Impact of insurance status on time to evaluation and treatment of meniscal tears in children, adolescents, and college-aged patients in the United States. *Orthop J Sports Med* 2019;7(10):2325967119875079.
- [18] Akande M, Minneci PC, Deans KJ, Xiang H, Cooper JN. Association of medicaid expansion under the affordable care act with outcomes and access to rehabilitation in young adult trauma patients. *JAMA Surg* 2018;153(8):e181630.
- [19] Woolhandler S, Himmelstein DU. Intersecting US. Epidemics: COVID-19 and lack of health insurance. *Ann Intern Med*. 2020;173(1):63–4.
- [20] Aiken KD, Freed GL, Davis MM. When insurance status is not static: insurance transitions of low-income children and implications for health and health care. *Ambul Pediatr* 2004;4(3):237–43.
- [21] Ozgediz D, Poenaru D. The burden of pediatric surgical conditions in low and middle income countries: a call to action. *J. Pediatr. Surg.* 2012;47(12):2305–11.
- [22] Schickedanz A, Dreyer BP, Halfon N. Childhood Poverty: understanding and preventing the adverse impacts of a most-prevalent risk to pediatric health and well-being. *Pediatr Clin North Am* 2015;62(5):1111–35.
- [23] Pascoe JM, Wood DL, Duffee JH, Kuo A. Mediators and adverse effects of child poverty in the United States. *Pediatrics* 2016;137(4).
- [24] Wirthlin DJ, Buradagunta S, Edwards RA, Brewster D.C., Cambria R.P., Gertler J.P., et al. Telemedicine in vascular surgery: feasibility of digital imaging for remote management of wounds. *J Vasc Surg* 1998;27(6):1089–99; discussion 99–100.
- [25] Leshner AP, Shah SR. Telemedicine in the perioperative experience. *Semin. Pediatr. Surg.* 2018;27(2):102–6.
- [26] Segura-Sampedro JJ, Rivero-Belenchón I, Pino-Díaz V, Rodríguez Sánchez MC, Pareja-Ciuró F, Padillo-Ruiz J, et al. Feasibility and safety of surgical wound remote follow-up by smart phone in appendectomy: a pilot study. *Ann Med Surg (Lond)* 2017;21:58–62.
- [27] Asiri A, AlBishi S, AlMadani W, ElMetwally A, Househ M. The use of telemedicine in surgical care: a systematic review. *Acta Informatica Medica: AIM: J Soc Med Inform Bosnia & Herzegovina: Casopis Društva za Medicinsku Informatiku BiH* 2018;26(3):201–6.
- [28] Scerri GV, Vassallo DJ. Initial plastic surgery experience with the first telemedicine links for the British Forces. *Br J Plast Surg* 1999;52(4):294–8.
- [29] Robie DK, Naulty CM, Parry RL, Motta C, Darling B, Micheals M, et al. Early experience using telemedicine for neonatal surgical consultations. *J Pediatr Surg* 1998;33(7):1172–6 discussion 7.
- [30] Hands LJ, Jones RW, Clarke M, Mahaffey W, Bangs I. The use of telemedicine in the management of vascular surgical referrals. *J Telemed Telecare* 2004;10(Suppl 1):38–40.
- [31] Lee S, Broderick TJ, Haynes J, Bagwell C, Doarn CR, Merrell RC. The role of low-bandwidth telemedicine in surgical prescreening. *J Pediatr Surg* 2003;38(9):1281–3.
- [32] Wood EW, Strauss RA, Janus C, Carrico CK. Telemedicine consultations in oral and maxillofacial surgery: a follow-up study. *J Oral Maxillofac Surg* 2016;74(2):262–8.
- [33] Perrin A.D., .M. Americans' Internet Access: 2000–2015, <https://www.pewresearch.org/internet/2015/06/26/americans-internet-access-2000-2015/> ; 2015 [accessed April 15,2020].
- [34] Promoting Telehealth for Low-Income Consumers. In: Commission FC, ed.; 2020:1–93.