



Surgeon, patient, and caregiver perspective of pediatric surgical telemedicine in the COVID-19 pandemic era

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Abstract

Purpose Adoption of telemedicine (TME) in surgical specialties, prior to the COVID-19 pandemic, has previously been slow. The purpose of this prospective, observational, single institution study is to evaluate surgeon and caregiver perspectives of TMEs during the pandemic.

Methods Surveys were distributed to surgical faculty regarding perceptions of TME early during the pandemic and 2 months later. Caregivers (or patients > 18 years old) were asked after each TME to complete a survey regarding perceptions of TMEs.

Results Surveys were distributed to 73 surgeons. Response rates were 71% initially and 63% at follow-up. Sixty-eight percent reported no prior TME experience. No significant differences were noted in the overall satisfaction. An inverse relationship between surgeon age and satisfaction at the follow-up survey was identified ($p=0.007$). Additional surveys were distributed to 616 caregivers or patients (response rate 13%). Seventy-two percent reported no prior experience with TME and 79% described TME as similar to an in-person visit. Audiovisual satisfaction of the TME was higher in greater income households ($p=0.02$).

Conclusions Pre-pandemic experience with TME was low in both groups; however, experiences were perceived as satisfactory. Positive experiences with TME may encourage increased utilization in the future, although demographic variations may impact satisfaction with TME.

Trial registration Unique identifier NCT04376710 at Clinicaltrials.gov (5/6/2020).

Keywords Telemedicine · COVID-19 · Surgery · Pediatrics

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Introduction

The current SARS-CoV-2 (COVID-19) pandemic is providing healthcare organizations with considerable challenges and opportunities for rapid cycle improvement efforts in diagnostic and patient management arenas. Safety of patients and healthcare workers can be achieved by limiting opportunities for viral exposure.

To address these practice changes and concerns, pediatric surgical providers are rapidly adopting and implementing telemedicine evaluations (TME) into their daily practice. The COVID-19 pandemic has created a unique scenario that has disseminated this technology broadly, to even those individuals and organizations initially hesitant to its implementation. TME has been successfully applied in multiple medical subspecialties such as anesthesiology, cardiology, critical care, dermatology, oncology, psychiatry, and radiology [1]. Application of this technology in surgical specialties has been met with mixed reviews due to the importance

of physical examination (PE) to accurately diagnose surgical conditions. However, many aspects of surgery such as education, clinical consultation, operating room guidance, and actual surgical interventions such as robotic surgery with a remotely located operator are amenable to telemedicine [1].

Early during the pandemic, the United States federal government began waiving Health Insurance Portability and Accountability Act (HIPAA) penalties for good faith use of TME during the COVID-19 pandemic, promoted similar to in-person visit reimbursement, and relaxed interstate medical licensing regulations to assist with rapid implementation of TME. At our institution, the stay-at-home order began March 26, 2020 and lasted through April 30, 2020, however, continued utilization of TME was encouraged with the state of Colorado safer-at-home order which subsequently followed and currently remains in effect.

The purpose of this study is to assess surgeon, caregiver, and patient perspectives of TME during the current pandemic, as well as to identify the barriers to large scale implementation within the pediatric surgical community.

Methods

Institutional review board approval was obtained for this prospective, single institution, observational study. The approved protocol was also registered at Clinicaltrials.gov (NCT04376710). Consent and anonymous surveys were distributed via email. Five-dollar gift card incentives were distributed for the first 50 participants in each group. Survey link to redcap databases were sent via email to respondents.

Telemedicine encounters

TMEs were conducted over a secure and Health Insurance Portability and Accountability Act (HIPAA) compliant platform via the electronic health record (Epic; Epic Systems Corporation). Patients and caregivers who participated in TMEs were registered and instructed how to access the TME via the Epic MyChart application (Epic Systems Corporation), which is accessible via computer, tablet, or mobile telephone. Seven days before the TEM, patients and caregivers received a communication through the MyChart platform prompting them to update their health and medication information. This was then confirmed by clinic medical assistants or nurses and updated in the chart prior to the TME, similar to an in-person visit. The VidyoConnect (Vidyo Inc, Hackensack, NJ, USA) software-based teleconference application, a HIPAA compliant platform, was used to connect providers and patients in a secure fashion. Prior to TME, technology support staff contacted participants and ensured proper functioning of the TME platform. Faculty who were familiar with the TME prior to the pandemic functioned as

mentors for faculty that were unfamiliar with the platform prior to the pandemic.

Surgeon surveys

Baseline surveys were distributed to surgical faculty at the University of Colorado via email in early June 2020. Baseline surveys collected surgeon demographic data and aimed to evaluate previous videochat experience, opinions regarding TME, and perceived barriers TME implementation barriers. Follow-up surveys were distributed in a similar fashion in late August 2020 to assess surgeon adjustment over time to the continued use of TMEs for outpatient assessments at our institution, and to explore future barriers to TMEs. Based on the low utilization level for TMEs at our institution prior to the pandemic, a follow-up survey was deemed necessary to capture the changing perceptions over time among surgical faculty.

Patient and caregiver surveys

Instructions, consent, and surveys were offered in both the English and Spanish languages. Surveys were distributed daily after TMEs for surgical patients seen in the following clinics during June and July of 2020: general surgery, otolaryngology, orthopedic surgery, neurosurgery, vascular malformation surgery, plastic surgery, gynecology, and urology. Surveys were delivered to the primary caregiver of the pediatric patient (< 18 years old) or to the adult patient (≥ 18 years old) email address provided in the patient's electronic health record. Caregivers and patients without email addresses were excluded. Familiarity with computer usage by caregivers and adult-aged patients was assumed for those participating in a successful TME due to the technology literacy required for these encounters. Since > 90% of adults in the United States have access to email, it was felt this would allow surveys to be distributed and returned in a timely manner during the early pandemic, while still allowing for anonymous responses.

Statistical analysis

Continuous and categorical measures are summarized as mean (standard deviation) and frequency (percent), respectively. Comparisons between various stratifying categorical factors, such as income distribution for patients or baseline versus follow-up survey for surgeons, and our Likert or categorical survey responses were completed using Fisher's exact test to accommodate the presence of cells with few or no observations. The association of satisfaction with age was examined using logistic regression models, with satisfaction dichotomized as any satisfaction versus neutral or

dissatisfaction. All analyses were completed using R v3.6.3 (Vienna, Austria).

Results

Telemedicine encounters since the start of the COVID-19 pandemic

There was an overall increase in utilization of TMEs at our institution across the first months of the pandemic (Fig. 1). TME utilization decreased after stay-at-home orders were lifted but remained above pre-pandemic levels.

Surgical faculty responses

Response rate for surgeons was 71% (52/73) initially and 63% (46/73) at follow-up. Table 1 describes surgeon demographics for the initial and follow-up surveys. Female surgeons comprised 35.8% and 28.3% on initial and follow-up survey respondents. There were no significant mean age differences on initial (45.9 years; SD 9.6, range 30–69) and follow-up (48.1 years; SD 10.1, range 30–68) evaluations. Furthermore, there were no significant differences in the distribution of surgical specialty respondents. On initial survey, 62.3% of surgeons conducted the TMEs at home (vs. 43.5 at follow-up), while 41.5% conducted this encounter at the work office or clinic (vs. 54.3% at follow-up). Surgical faculty predominately utilized personal computers (77.4% initially; 93.5% at follow-up), home internet (58.5% initially; 43.5% at follow-up) for conducting telemedicine visits and lived within 20–40 min of the clinic ($n=40$, 75.4%). During the pandemic there was an increase in the use of teleconferencing for personal conversations (65.2% vs 80.4%), work related meetings (13% vs 65.2%), local conferences (6.5% vs 43.5%), national conferences (8.7% vs 45.7%), and international conferences (4.3% vs 19.6%).

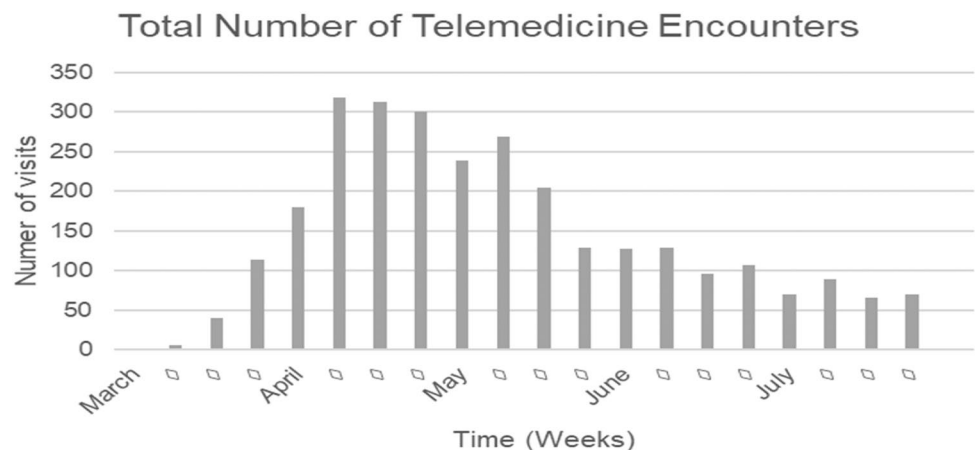
Table 1 Surgeon demographics

	Initial survey Overall (N=53)	Follow-up survey Overall (N=46)
Female gender	19 (35.8%)	13 (28.3%)
Mean age	45.9 years (SD 9.6)	48.1 years (SD 10.1)
Specialty		
Pediatric general surgery	10 (18.9%)	11 (23.9%)
Pediatric neurosurgery	3 (5.7%)	3 (6.5%)
Pediatric orthopedics	14 (26.4%)	10 (21.7%)
Pediatric otolaryngology	8 (15.1%)	8 (17.4%)
Pediatric plastic surgery	2 (3.8%)	1 (2.2%)
Pediatric urology	3 (5.7%)	3 (6.5%)
Other	8 (15.1%)	4 (8.7%)
Missing	5 (9.4%)	6 (13.0%)
Location for TME		
Home	33 (62.3%)	20 (43.5%)
Work office or clinic	22 (41.5%)	25 (54.3%)
Other	1 (1.9%)	0 (0.0%)
Travel time to main campus		
< 20 min	13 (24.5%)	13 (28.3%)
20–40 min	27 (50.9%)	19 (41.3%)
40–60 min	2 (3.8%)	2 (4.3%)
1–2 h	4 (7.5%)	5 (10.9%)
2–3 h	1 (1.9%)	0 (0.0%)
Missing	6 (11.3%)	7 (15.2%)
First time using TME during the pandemic	36 (67.9%)	31 (67.4%)

Reports surgeon age, surgical specialty, location of surgeon at time of telemedicine visit, surgeon driving distance from hospital, and prior experience with telemedicine. Data are presented as (n, percent) or (average, standard deviation)

TME telemedicine encounter, SD standard deviation, Mins minutes

Fig. 1 Telemedicine visits during initial peak of pandemic. TMEs rapidly following the onset of the pandemic at our institution. TMEs increased from < 10 per week to a peak of more than 300 per week in mid-late April 2020. TME telemedicine



Thirty-six surgeons (67.9%) in the initial survey reported using a TME for the first time during the pandemic with inability to perform physical exam ($n = 19$, 38.58%) and lack of awareness ($n = 13$, 24.5%) cited as the most common barriers (Table 2). The most commonly cited barriers for future TME use on follow-up survey were inability to perform a physical exam ($n = 30$, 65.2%), long-term reimbursement ($n = 20$, 43.5%), and multi-state licensing ($n = 20$, 43.5%) (Table 2).

TMEs were initially viewed as positive; surgeons were either somewhat or very satisfied in terms of ease of hearing and seeing the patient (audiovisual satisfaction; $n = 34$, 64.2%), quality of health care provided ($n = 41$, 77.3%), treatment plan and educational materials provided ($n = 40$, 75.5%), convenience ($n = 45$, 84.9%), and overall satisfaction ($n = 39$, 73.6%) with TMEs (Fig. 3). Twenty-four surgeons (45.2%) reported TMEs to be similar or better to an in-person visit and 36 (67.9%) would consider utilizing the technology in the future. On follow-up comparison of TME visit satisfaction, no significant differences were observed.

An association of surgeon age with satisfaction rating of TMEs at the follow-up surveys was identified with questions dichotomized into satisfied and neutral or dissatisfied. On initial survey, there were no significant age association with regards to satisfaction ratings including ease of hearing and seeing the patient (OR 0.95, 95% CI 0.88–1.02, $p = 0.183$), quality of provided health care (OR 1.02, 95% CI 0.92–1.16, $p = 0.757$), treatment plan and education materials received (OR 0.95, 95% CI 0.85–1.05, $p = 0.298$), and overall satisfaction (OR 1.03, 95% CI 0.94–1.15, $p = 0.598$).

Convenience was unable to be modeled due to lack of information to estimate OR and p value. While there was no significant association between surgeon age and ease of hearing and seeing patients at the follow-up survey (OR 0.98, 95% CI 0.91–1.05, $p = 0.529$), there was an association between increasing surgeon age with decreased satisfaction of quality of care (OR 0.88, 95% CI 0.77–0.96, $p = 0.017$), treatment plan and education materials provided (OR 0.87, 95% CI 0.77–0.96, $p = 0.016$), convenience (OR 0.83, 95% CI 0.68–0.94, $p = 0.018$), and overall satisfaction (OR 0.79, 95% CI 0.62–0.9, $p = 0.007$).

Caregiver and patient responses

Surveys were distributed to 616 caregivers or patients, with a 13% ($n = 82$) completion rate. Respondents were primarily female ($n = 73$, 89%) with a mean age of 41.5 years; the majority of surveys were completed in English ($n = 81$, 99%). Median reported household income of respondents was \$80,000–100,000 and 65% ($n = 54$) and lived within 60 min of clinic. Respondents primarily used personal computers ($n = 41$, 50%) or cellular phones ($n = 28$, 34.1%) with personal home Wi-Fi internet connections ($n = 71$, 86.6%) for TMEs. Seventy-two percent of respondents reported no prior experience with TMEs (Table 3). Prior experience with regular video chat prior to the pandemic was reported by 32.9% ($n = 27$) of respondents; this increased to 76.8% ($n = 63$) during the pandemic.

Table 2 Surgeon responses

	Initial survey Overall ($N = 53$)	Follow-up survey Overall ($N = 46$)
Reasons for no prior TMEs		
Lack of awareness	13 (24.5%)	14 (30.4%)
Lack of availability at institution	9 (17.0%)	13 (28.3%)
Security concerns	1 (1.9%)	1 (2.2%)
Challenges accepting new technology	9 (17.0%)	9 (19.6%)
Billing concerns	8 (15.1%)	7 (15.2%)
Inability to perform a physical exam	19 (35.8%)	17 (37.0%)
Other	6 (11.3%)	3 (6.5%)
Concerns for continued TMEs		
Billing		14 (30.4%)
Reimbursement		20 (43.5%)
Malpractice/legal concerns		9 (19.6%)
Multi-state licensing		20 (43.5%)
Security concerns		1 (2.2%)
Inability to perform a physical exam		30 (65.2%)
Other		4 (8.7%)
No concerns		4 (8.7%)

Reports prior and future barriers to telemedicine utilization. Data are presented as n , percent
TME telemedicine encounter

Table 3 Caregiver and patient demographics

	Overall (N=82)
Female patient	44 (53.7%)
Mean age	41.5 years (SD=8.3)
Female respondent	73 (89.0%)
Preferred language	
English	81 (98.8%)
Spanish	1 (1.2%)
Household income	
\$0–\$10,000	3 (3.7%)
\$10,001–\$20,000	1 (1.2%)
\$20,001–\$40,000	6 (7.3%)
\$40,001–\$60,000	12 (14.6%)
\$60,001–\$80,000	7 (8.5%)
\$80,001–\$100,000	6 (7.3%)
\$100,001–\$120,000	7 (8.5%)
\$120,001–\$160,000	6 (7.3%)
\$160,001–\$200,000	14 (17.1%)
\$200,001 and above	17 (20.7%)
Device used to connect	
Cell phone	28 (34.1%)
Computer	41 (50.0%)
Tablet	12 (14.6%)
Type of connection	
Personal home Wi-Fi	71 (86.6%)
Wi-Fi outside of home	5 (6.1%)
Phone data plan	4 (4.9%)
First time using TME during the pandemic	59 (72.0%)

Reports patient sex, age of respondent, sex of respondent, preferred language, reported household income, device, and internet type utilized for TME, prior TME experience. Data are presented as (n, percent) or (average, standard deviation)

TME telemedicine encounter, SD standard deviation

In general, caregivers or patients were very satisfied with TMEs in terms of audiovisual satisfaction during visit (n=55, 67%), the quality of health care they received (n=64, 78%), the treatment plan and educational materials provided (n=60, 73.2%), TME convenience (n=64, 78%), and overall TME satisfaction (n=53, 64.6%) (Fig. 2). Of note, there were two or three missing responses in each metric studied. Seventy-nine percent (n=65) of respondents reported the visit to be the same or better than an in-person visit and 75% (n=62) would consider using a TME for future visits (Fig. 3).

No statistical differences were noted on patient and caregiver stratification based on location for their primary clinic within our hospital system. Additionally, no significant differences after income stratification were noted in reported quality of health care received, treatment plan and educational materials provided, convenience, overall satisfaction, ratings between TME or in-person visit, and TME preference for future encounters (p>0.05). However, audiovisual satisfaction was higher among survey responders with higher household income (p=0.022).

Free-text themes reported by surgeon, patients, and caregivers

Free-text comments were assessed by study members and summarized into the following themes: need for interpreter services, stable internet connection concerns, and need for user-friendly platforms. Both groups recommended TMEs for simple consultations, straightforward follow-up evaluations, and for patients who live far from the healthcare facility.

Fig. 2 Surgeon satisfaction ratings. Surgeons predominately reported being satisfied or very satisfied at both the initial and follow-up surveys. Data are presented as percent of number of responses for each category

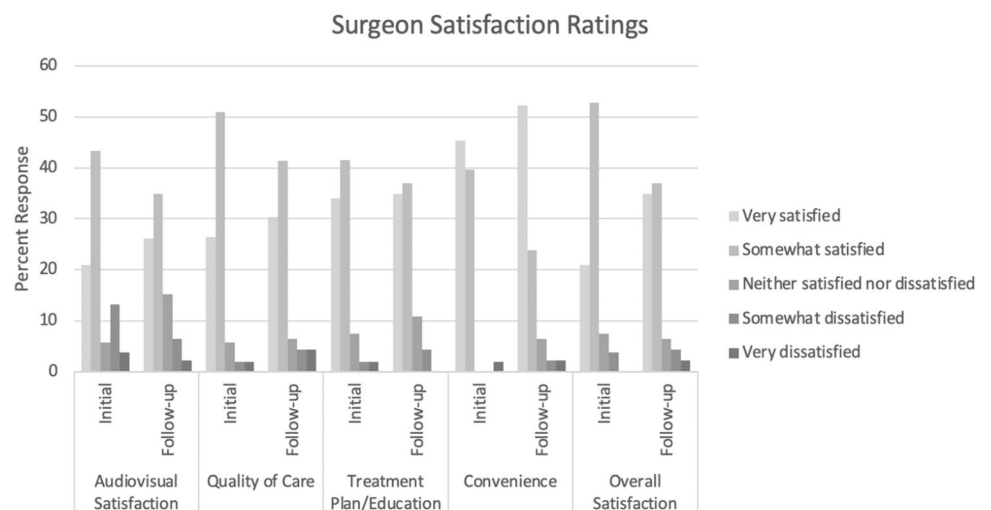
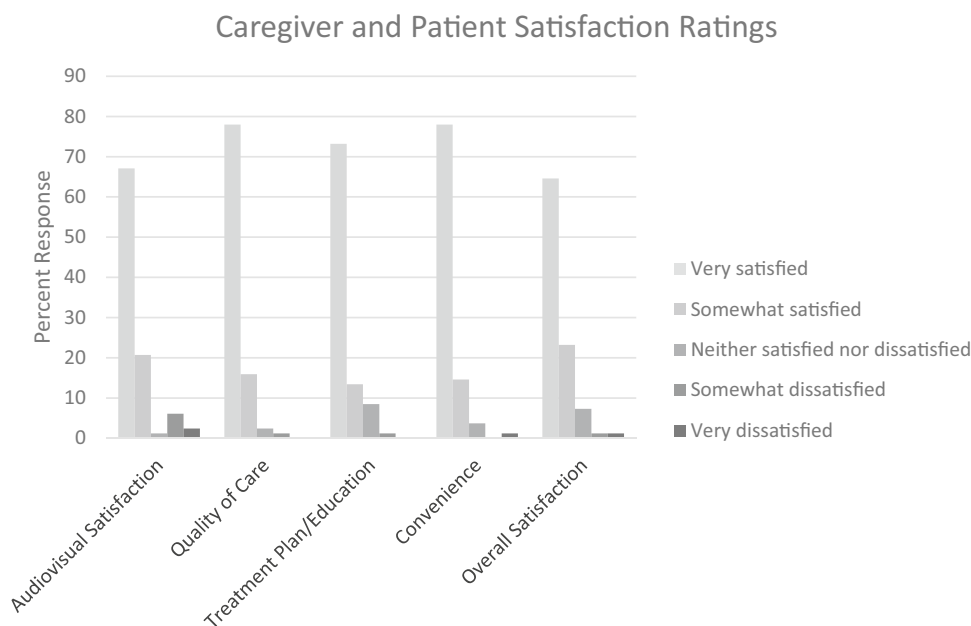


Fig. 3 Caregiver and patient satisfaction ratings. Caregivers and patients predominately reported being very satisfied with TMEs. Data are presented as percent of number of responses for each category. *TME* telemedicine encounter



Discussion

This prospective, single institution, observational study reports generally high satisfaction for caregiver, patients, and surgeons with TMEs during the COVID-19 pandemic. These results are similar to other studies evaluating TME satisfaction in both the pre-pandemic and pandemic time periods [2–6]. Satisfaction did not seem to change throughout the study period. This study does identify two novel “digital-divides.” First, we identified an inverse relationship between surgeon age and TME satisfaction at the follow-up survey. Older surgeons reported less satisfaction in the quality of care provided, the treatment plan and education materials provided, as well as overall convenience and satisfaction with TMEs at the follow-up survey. Satisfaction for caregivers and patients was not associated with driving distance from clinic or income, however, audiovisual satisfaction during the TME was higher among caregivers and patients who reported higher household income suggesting a second “digital divide”. Caregivers, patients, and surgeons would consider using TME in the future for certain visits. Barriers to implementations identified by surgeons included the need to perform an in-person PE, concerns over reimbursement in the long-term, and multi-state licensing requirements. To the authors knowledge there were no issues for reimbursement during the pandemic, however, faculty expressed this as a concern after cessation of emergency protocols. Additional concerns expressed by both groups included the need for interpreter services, issues with internet connectivity, and need for user-friendliness TME platforms. Caregivers, patients, and surgeons expressed similar views that TMEs would be optimal for simple consultations, straightforward

follow-up evaluations, and for patients who live far from the healthcare facility.

One “digital divide” highlighted in this study was the difference in age of surgeon and level of satisfaction with TMEs, with older surgeons being less satisfied with TMEs at the follow-up survey. These findings are consistent with a survey of 800 physicians in 2019 which found an inverse relationship between willingness to participate in TMEs and age [7]. Similar trends have been shown with past introductions of new technology into the medical field. For example, younger physicians were more likely to be “early adopters” and have a higher opinion of electronic medical records after initial introduction [8, 9]. Despite the association between age and satisfaction, there was no significant difference in surgeon TME preference at the follow-up survey. Additionally, it would not be surprising if the association of age and TME satisfaction dissipates with time as younger physicians are now exposed to TME in their training or early careers.

The relationship identified between income and audiovisual satisfaction during TMEs in this study may highlight another “digital divide” hinting at possible inequalities in the availability of internet access or devices to optimally conduct TMEs. While TMEs were hypothesized, particularly in the pre-pandemic time, to increase access to medical care to rural and underserved patients, these communities often have less access to the most up-to-date technology to facilitate TMEs [10–14]. Low socioeconomic status is associated with poor health status [15]. Poor health status is also associated with the greatest morbidity and mortality from the SARS-CoV-2 virus [16]. Therefore, those most vulnerable during the pandemic may have to choose between seeking medical care or avoiding viral exposure at hospitals

and clinics due to poor or absent access to technology utilized for TMEs.

One of the most frequent deciding factors whether to choose a TME versus in-person visit in the future for both groups was the need for a physical exam. These findings are consistent with previous TME surveys, including surgical subspecialties, which have demonstrated lack of PE as a barrier to TME use [3, 17–20]. Recently, several studies have published guidelines on physical examination during TMEs [21, 22]. Adult studies have shown reliable diagnostic accuracy of TMEs for multiple surgical specialties [23–26]. However, pediatric patients represent a unique population who may not always be able to communicate to provide additional feedback that would otherwise assist the provider with the interpretation of the PE during TMEs, potentially limiting the utility of TMEs in this population [27].

TMEs appear to be a safe and effective means of continuing patient care while limiting viral exposure risks and providing a positive experience for patients, caregivers, and surgeons. Several case series have been published describing delays in diagnosis and subsequent morbidity as a result of avoiding medical care due to fear of viral exposure during the COVID-19 pandemic [28–33]. The full effect of delays or adjustments in medical and surgical care as a result of the pandemic is unlikely to be known in the near future, therefore, it is critical that patients continue to have access to medical services [34].

Most surgeon, patients, and caregivers in this study expressed interest in utilizing TMEs in the future. Several previously mentioned incentives provided by the federal government to encourage TME utilization had been previously shown to be prohibitive to the implementation of TMEs prior to the pandemic [35–37]. Theoretically, the continuation of these incentives, even after the pandemic, may be critical to the persistent use of TMEs in the future as surgeons in this study expressed concerns regarding reimbursement in the long-term, maintaining medical licenses in multiple states, and medicolegal issues. Future studies examining surgical outcomes and cost analyses may be helpful to best identify patients or visit types that are best suited for a TME [24–27].

Limitations

Limitations to this study include the single center, observational nature of the study design. Additionally, the caregiver/patient response rate was low, primarily female, and predominately preferred to respond in the English language; therefore, our results may not be generalizable to a larger population. Exclusion of caregivers and patients without email addresses also pose a limitation that is unavoidable based on the study design. Satisfaction ratings may be biased in the setting of a pandemic, as there may not be any

other alternative to physician consultation; however, pre-pandemic studies have shown comparable high satisfaction rates [38–41]. While there no in-person control group due to institutional limitations to type of visit, participants were asked to compare their satisfaction to previous in-person experiences. As the pandemic continues, longer follow-up between the surgical faculty surveys may produce differences in perceptions.

Conclusion

Perceptions of TMEs by surgeon, patients, and caregivers in the pediatric population during the pandemic era are mostly positive. Positive experiences with TMEs may encourage increased utilization in the future, however, demographic variations may impact widespread utilization and satisfaction with TMEs. Novel findings of this study include identification of two “digital-divides” among older surgeons and their lower satisfaction with TMEs, and also between caregivers and patients with higher incomes reporting higher TME audiovisual satisfaction, which warrants further investigation.

Author contributions All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by JD-M, SO, AK, SA, and TI. The first draft of the manuscript was written by JD-Mand SO (equally) and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Declarations

Consent to participate Informed written consent was obtained from all individual participants or legal guardians included in the study.

Conflict of interest The authors have no conflicts of interest to declare that are relevant to the content of this article.

Ethics approval The human subject research division of the institutional review board for the University of Colorado (COMIRB) approved this study. Separate approval by the ethics committee was not required.

Data statement Due to the sensitive nature of the questions asked in this study, survey respondents were assured raw data would remain confidential and would not be shared.

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