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# Utilization and Adequacy of Telemedicine for Outpatient Pediatric Surgical Care



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## ARTICLE INFO

## Article history:

Received 29 December 2021

Received in revised form

25 February 2022

Accepted 8 April 2022

Available online 20 May 2022

## Keywords:

COVID-19

Pediatric surgery

Post-operative care

Telemedicine

## ABSTRACT

**Introduction:** Telemedicine (TM) use accelerated out of necessity during the COVID-19 pandemic, but the utility of TM within the pediatric surgery population is unclear. This study measured utilization, adequacy, and disparities in uptake of TM in pediatric surgery during the COVID-19 pandemic.

**Methods:** Scheduled outpatient pediatric surgery clinic encounters at a large academic children's hospital from January 2020 through March 2021 were reviewed. Sub-group analysis examined post-operative (PO) visits after appendectomy and umbilical, epigastric, and inguinal hernia repairs.

**Results:** Of 9149 scheduled visits, 87.9% were in-person and 12.1% were TM. TM visits were scheduled for PO care (76.9%), new consultations (7.1%), and established patients (16.0%). Although TM visits were more frequently canceled or no shows ( $P < 0.001$ ), most canceled TM visits were PO visits, of which 41.7% were canceled via electronic communication reporting the absence of any PO concerns. TM visits were adequate for accomplishing visit goals in 98.2%, 95.5%, and 96.2% of PO, new, and established patient visits, respectively. Patients utilizing TM visits were more frequently of white race, privately-insured, from less disadvantaged neighborhoods, and living a greater distance from clinic ( $P < 0.001$  for all comparisons).

**Conclusions:** TM was adequate for the majority of visits in which it was utilized, including the basic PO visits that occurred via TM. TM was used more by patients with greater travel and less by those of minority race, with public insurance, and from more disadvantaged neighborhoods. Future work is necessary to ensure broad access to this useful tool for all children requiring surgical care.

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## Introduction

The delivery of healthcare was quickly changed by the COVID-19 pandemic. Unnecessary in-person (IP) clinic visits

were suspended, and telemedicine (TM) soon became a necessary and widely used portal for the healthcare field to reduce the risk of COVID-19 transmission.<sup>1</sup> The accelerated adoption of TM in healthcare created opportunities to

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<https://doi.org/10.1016/j.jss.2022.04.060>

explore novel methods to successfully deliver surgical care.<sup>2</sup>

Within the field of pediatric surgery, studies have suggested that TM can be an effective and efficient means of delivering care, including post-discharge surgical follow-up visits.<sup>3-9</sup> TM can also save patients and their families significant time, travel, and monetary resources.<sup>3-8,10-13</sup> The field of pediatric urology has demonstrated broad success with TM use, which is encouraging for TM implementation within pediatric surgery and other pediatric subspecialties.<sup>10,14-16</sup> Given these successes and the increasingly widespread use of technology, TM has garnered interest as a potential tool to overcome barriers to accessing care and to reduce known racial, socioeconomic, and geographic disparities in children's surgical care.<sup>17-23</sup> However, disadvantaged populations must have the technological means, ability, and willingness to use TM for this tool to be successful in mitigating disparities.

The objective of this study was to measure the utilization and adequacy of TM in pediatric surgery and to evaluate for racial, socioeconomic, or geographic disparities in the uptake of TM use among children during the COVID-19 pandemic. We hypothesized that (1) TM would be adequate for accomplishing visit goals in the majority of encounters for which TM was offered, (2) visit no-shows and cancellations would be lower for TM than for IP visits, and (3) patients utilizing TM would be similar to those utilizing IP visits with regard to race, neighborhood-level socioeconomic status, geographic residence, and insurance type.

## Material and Methods

### Study population

All children <18 y old who were scheduled for an outpatient pediatric surgery clinic visit between January 1, 2020 through March 31, 2021 at Children's Wisconsin (CW), a large academic-affiliated free-standing children's hospital, were included. The study was approved by the CW Institutional Review Board with a waiver of informed consent. Visits were scheduled with a physician or a physician assistant at either the main pediatric surgery clinic or one of six regional pediatric surgery clinics associated with CW and staffed by the same surgical providers. These regional clinics are provided primarily as an option for patients living more remotely, although patients may be scheduled at the clinic of their choosing. Three of these regional clinics are still generally within the greater Milwaukee area, while three clinics are approximately 90-120 miles from the main pediatric surgery clinic. Nurse visits were excluded from the study. In addition, prenatal consultations were excluded, given the unique nature of these visits in which no direct patient care is provided to a child and communication is solely with future parents.

The CW Division of Pediatric Surgery expanded its TM options in 2019 beyond telephone visits to include video visits, which became a vital mode of outpatient care in 2020 due to the COVID-19 pandemic. Video visit completion occurred through the patient portal of the electronic medical record, and therefore a family's enrollment in the patient portal was a pre-requisite for video visit completion. Families were

encouraged to enroll in the patient portal at each point in the care process, most commonly in the pre-operative period and in the peri-operative period when arranging for outpatient follow-up. Given the complexity of arranging interpreters for video visits, telephone visits with the use of a translator remained the primary form of TM offered to non-English speaking families. Telephone visits were otherwise minimal compared to the use of video visits and occurred only when necessary or desired by the patient's caregiver.

At the height of the pandemic, any IP clinic visits that could be delayed were suspended or converted to a video visit if amenable to TM, including many post-operative (PO) follow-up visits. IP visits were scheduled only as necessary for IP physical examinations. When deemed safe, IP visits were offered again, but video visits were still encouraged for those visits not requiring IP physical examinations.

A limited number of new consultation visits were offered as video visits; for example, patients with chest wall deformities and patients requiring gastrostomy tube placement were seen initially as video visits when families were receptive of this mode of care. Many established patient visits were also offered as video visits when IP physical examination was deemed unnecessary. Most commonly, however, video visits were especially encouraged and routinely offered for many PO visits.

In particular, families of children needing "basic" PO follow-up, defined as follow-up after appendectomies and inguinal, epigastric, and umbilical hernia repairs, were encouraged to enroll in the patient portal to enable PO video visits. In addition, a system was implemented in which potentially unnecessary PO visits (both IP and TM) could be avoided all together through communication via the patient portal. Specifically, families were provided the opportunity to electronically answer a questionnaire and provide wound photos to confirm the absence of any PO concerns, at which point the surgical team would render the scheduled PO visit (IP or TM) unnecessary and approve its cancellation. In addition, if families were not enrolled in the patient portal or if they preferred to communicate via telephone, a conversation with the surgical team over the phone could be used to report adequate PO recovery and a desire to cancel the scheduled PO visit.

### Patient and visit characteristics

Age, sex, race/ethnicity, primary language, home address, and payer source were collected. Clinic visits were categorized as *new* (no pediatric surgery encounter within the prior three years), *PO* (first scheduled visit within 90 d following a procedure), or *established* (follow-up visits other than scheduled PO visits). Visits were further categorized as *arrived/completed* (visit was completed as scheduled), *no-show* (lack of presentation for a clinic visit without prior cancellation or re-scheduling), and *canceled* (visit was intentionally canceled prior to the scheduled time, with or without re-scheduling).

All TM visits and basic PO visits were further scrutinized according to the outcome of the visit. Arrived/completed TM visits were categorized as *adequate* (all visit goals were successfully accomplished), *inadequate* (visit goals could not be achieved, and an IP visit was necessary), or *limited by technical*

challenges that required conversion to a telephone visit. No-shows were categorized based upon whether there was any further communication with the family and whether the visit was re-scheduled. Canceled visits were categorized based upon whether the visit was approved for cancellation after electronic communication with the surgical team via the patient portal as described above and whether or not re-scheduling occurred.

### Geographic measures

Patients' home addresses were used to calculate travel distance from patients' home residence to the scheduled clinic and main clinic using Geocodio and the R package Geosphere.<sup>24,25</sup> Home addresses were also used to identify Federal Information Processing Standard codes to determine a neighborhood-level measure of socioeconomic status called Area Deprivation Index (ADI) and rural/urban designation for patients' home residence. ADI ranks socioeconomic status at neighborhood-level through 17 factors including employment, education level, housing quality, and income.<sup>26,27</sup> The measure is reported as deciles 1 through 10, with decile 1 representing the least disadvantaged neighborhoods and decile 10 representing the most disadvantaged neighborhoods.<sup>26,27</sup> The 2019 state-specific ADI for Wisconsin was used. Rural-urban designation was defined by rural-urban commuting area codes, which classify U.S. census tracts into metropolitan, micropolitan, small town, and rural areas.<sup>28</sup> Metropolitan areas were considered urban, and the remaining classifications were designated as rural. Patients' home addresses could not be linked to an ADI or rural-urban commuting area code in 13.1% and 10.4% of records, respectively. These patients were included in the study but excluded from comparisons specifically examining ADI and rurality.

### Statistical analysis

Chi-squared tests were used for analysis of categorical variables and t-tests or Wilcoxon signed-rank tests for analysis of continuous variables. A sub-group analysis was performed on basic PO visits after appendectomies (for both complicated and uncomplicated appendicitis) and inguinal, epigastric, and umbilical hernias given that this population was most consistently offered video visits in a standardized fashion. All statistical tests were two-sided with statistical significance considered to be  $\alpha = 0.05$ . All statistical analyses were performed using the R Studio (version 1.4.1717).<sup>29</sup>

## Results

### Study population

A total of 9970 outpatient pediatric surgery encounters were scheduled during the study period, of which 821 were excluded due to patient age or the encounters being nurse visits or prenatal consultations (Fig. 1). Of the remaining 9149 included encounters, 8042 (87.9%) were scheduled as IP visits, and 1107 (12.1%) as TM visits. New, established, and PO visit

types were similarly represented (32.2% versus 34.4% versus 33.4%, respectively) (Table 1). Most encounters (87.2%) were scheduled at the main pediatric surgery clinic, while the remainder were scheduled at one of the six regional pediatric surgery clinics. No-shows occurred in 8.5% of encounters, and 35.9% of encounters were canceled.

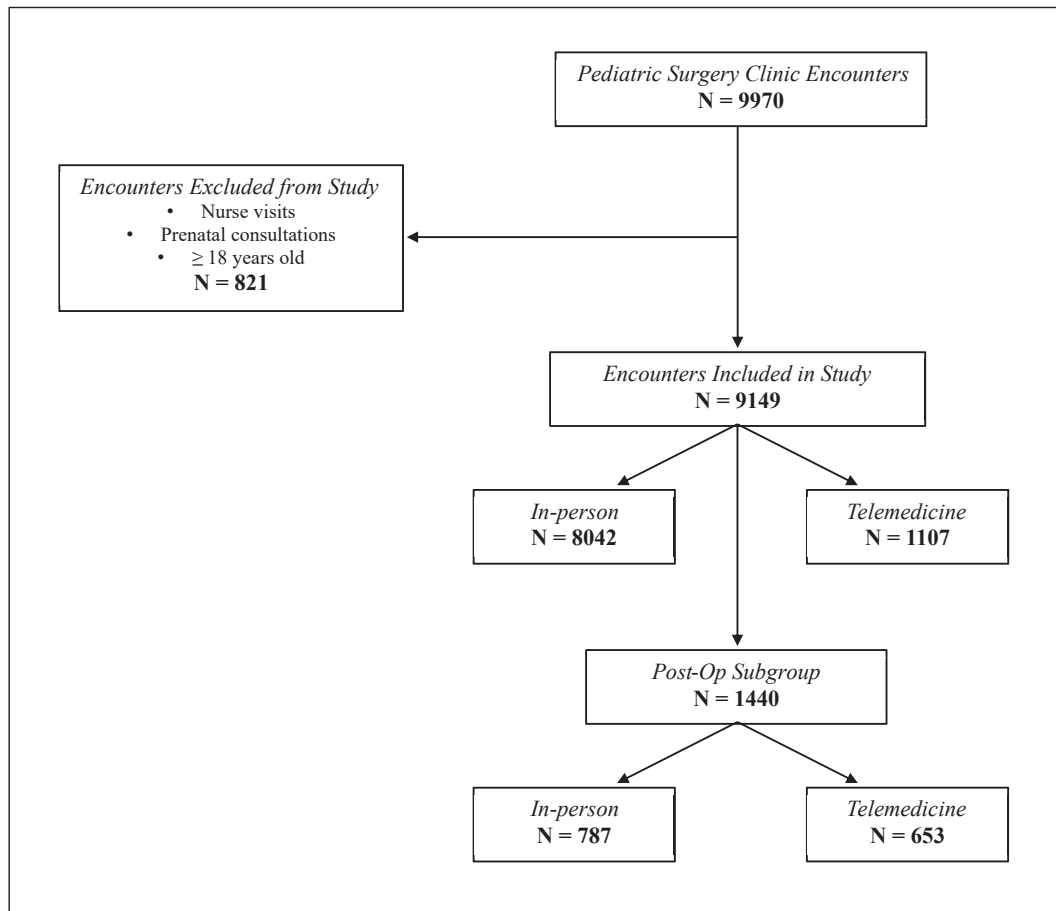
Patients most commonly lived in urban areas (91.2%); 43.6% lived in the most disadvantaged neighborhoods (ADI deciles 8-10). Rural/urban residence was associated with ADI ( $P < 0.001$ ), with rural patients generally living more frequently in mid-ADI neighborhoods and urban patients living more frequently in the extreme high- or low-ADI neighborhoods. Specifically, among rural patients, 46.4% lived in neighborhoods of ADI deciles 5-7. In contrast, among urban patients, 37.2% lived in neighborhoods of ADI deciles 1-4 and 45.0% lived in neighborhoods of ADI deciles 8-10.

### Use of telemedicine

TM visits increased after the pandemic onset in March 2020 and peaked in April 2020, with 33% of all completed visits and 75% of completed basic PO visits being accomplished via TM (Fig. 2). Utilization of TM was considerably lower in subsequent months but remained higher for basic PO visits. TM visits were predominately used for PO visits (76.9%) and less commonly for new (7.1%) and established (16.0%) visits (Table 1). Of the completed TM visits, 462 (97.9%) were video visits and 10 (2.1%) were telephone visits. TM visits were more frequently canceled (43.2% versus 34.9%,  $P < 0.001$ ) or no-shows (14.2% versus 7.7%,  $P < 0.001$ ) compared to IP visits.

Patients scheduled for TM visits were older (median age 6.7 y versus 5.1 y,  $P < 0.001$ ) and more frequently of white race (61.5% versus 50.8,  $P < 0.001$ ) and covered by private insurance (61.5% versus 46.7%,  $P < 0.001$ ) compared to those with IP visits (Table 1). Patients scheduled for TM visits were also more commonly from the less disadvantaged neighborhoods (44.1% versus 35.0% in ADI deciles 1-4,  $P < 0.001$ ) and less commonly from the more disadvantaged neighborhoods (32.6% versus 45.1% in ADI deciles 8-10,  $P < 0.001$ ). As expected, families utilizing TM were almost universally English-speaking. Patients scheduled for TM visits more frequently lived in rural areas (11.5% versus 8.4%,  $P = 0.002$ ) and lived further from the surgery clinic (median distance 13.0 versus 9.4 miles from the main clinic,  $P < 0.001$ ).

Overall, 14.3% of the scheduled pediatric surgery encounters for white patients were scheduled as TM visits, compared to 9.3% and 9.8% of encounters for black and Hispanic patients, respectively. Those with private insurance were scheduled for TM visits in 15.3% of encounters, in contrast to 9.0% of those with public insurance. With regard to residential location, 15.7% of encounters for rural patients were scheduled as TM visits compared to 11.6% for urban patients. In addition, 14.5% and 13.7% of encounters for patients in ADI deciles 1-4 and 5-7 neighborhoods were scheduled as TM visits, compared to 8.9% for patients in the most disadvantaged neighborhoods (ADI deciles 8-10). Among rural patients living in the most disadvantaged neighborhoods, 16.5% of scheduled encounters were TM visits compared to 8.4% of encounters for urban patients in the most disadvantaged neighborhoods.



**Fig. 1 – Flowchart demonstrating scheduled pediatric surgery encounters, exclusions, and distribution of encounters included in the final study population.**

### Telemedicine outcomes and adequacy

While 84.8% and 75.1% of the scheduled TM visits for new and established patients were completed, respectively, just 32.0% of PO TM visits were completed, with a higher frequency of both cancellations (50.8%) and no-shows (17.3%) ( $P < 0.001$ ) (Table 2). Of those canceled PO TM visits, 59.8% had communication with the surgical team, of which 41.7% were approved for cancellation because the visit was not needed and 18.1% were rescheduled to a new time. In addition, although new and established TM visits were more likely to be canceled, 54.6% of canceled new patients and 60.0% of canceled established patients were rescheduled. Most TM no-shows had no further communication with the surgical team and were not rescheduled.

The vast majority of the completed TM visits were adequate for accomplishing the visit goals — 95.5% of new patient visits, 96.2% of established patient visits, and 98.2% of PO visits (Table 2). Overall, nine (1.9%) of the 1107 completed TM visits were inadequate and required an IP visit for some aspect of the care, including just one (0.4%) among the PO TM visits. Four (0.9%) of the TM visits had technical challenges that required a video visit to be converted to a telephone visit.

### Basic post-operative subgroup analysis: patient characteristics

Among the 518 patients who completed basic PO visits, the patient population in whom TM was most uniformly offered and encouraged, 268 (51.7%) had undergone appendectomy and 250 (48.3%) had undergone hernia repairs (Table 3). These basic PO visits were scheduled as IP visits in 67.4% and TM visits in 32.6%, with 168 (99.4%) of the TM visits scheduled as video visits and one (0.6%) scheduled as a telephone visit. TM utilization was similar between patients who had undergone appendectomy and hernia repairs. Those patients utilizing TM and IP visits were also similar with regard to age, sex, and frequency of rural residence.

Similar to the overall study population, patients who utilized TM for basic PO visits were more likely to be white (59.8% versus 44.1%) and less likely to be black (16.6% versus 19.5%) or Hispanic (16.6% versus 28.7%) compared to those who utilized IP visits ( $P = 0.005$ ) (Table 3). Patients who utilized TM were again more frequently covered by private insurance (66.3% versus 48.4%,  $P < 0.001$ ), more commonly lived in the least disadvantaged neighborhoods (52.4% versus 34.6% in ADI deciles 1-4,  $P < 0.001$ ), and less commonly lived in the most

**Table 1 – Patient characteristics for all scheduled pediatric surgery clinic encounters, stratified by in-person versus telemedicine visits.**

	Total (n = 9149)	In-person (n = 8042)	Telemedicine (n = 1107)	P-value
	N (%)	N (%)	N (%)	
<b>Visit type</b>				<0.001
New	2943 (32.2)	2864 (35.6)	79 (7.1)	
Established	3149 (34.4)	2972 (37.0)	177 (16.0)	
Post-op	3057 (33.4)	2206 (27.4)	851 (76.9)	
<b>Appointment status</b>				<0.001
Arrived/completed	5092 (55.7)	4620 (57.5)	472 (42.6)	
Canceled	3281 (35.9)	2803 (34.9)	478 (43.2)	
No-show	776 (8.5)	619 (7.7)	157 (14.2)	
<b>Median age (IQR), y</b>	5.3 (1.6-13.2)	5.1 (1.6-13.2)	6.7 (3.1-12.9)	<0.001
<b>Race/ethnicity</b>				<0.001
White	4766 (52.1)	4085 (50.8)	681 (61.5)	
Black	2357 (25.8)	2138 (26.6)	219 (19.8)	
Hispanic	1373 (15.0)	1239 (15.4)	134 (12.1)	
Other/unknown	653 (7.1)	580 (7.2)	73 (6.6)	
<b>Sex</b>				0.9
Male	5233 (57.2)	4601 (57.2)	632 (57.1)	
Female	3916 (42.8)	3441 (42.8)	475 (42.9)	
<b>Primary language</b>				<0.001
English	8471 (92.6)	7371 (91.7)	1100 (99.4)	
Spanish	487 (5.3)	481 (6.0)	6 (0.5)	
Other	191 (2.1)	190 (2.4)	1 (0.1)	
<b>Median travel distance to main clinic (IQR), miles</b>	10.7 (5.8-33.2)	9.4 (5.8-32.7)	13.0 (6.9-35.8)	<0.001
<b>Median travel distance to scheduled clinic (IQR), miles</b>	8.8 (5.8-26.7)	8.4 (5.7-26.7)	12.6 (6.3-32.2)	<0.001
<b>Residence</b>				0.002
Rural	722 (8.8)	609 (8.4)	113 (11.5)	
Urban	7478 (91.2)	6608 (91.6)	870 (88.5)	
<b>ADI</b>				<0.001
1-4	2872 (36.1)	2455 (35.0)	417 (44.1)	
5-7	1611 (20.3)	1390 (19.8)	221 (23.4)	
8-10	3469 (43.6)	3161 (45.1)	308 (32.6)	
<b>Insurance</b>				<0.001
Private	4439 (48.5)	3758 (46.7)	681 (61.5)	
Public	4608 (50.4)	4192 (52.1)	416 (37.6)	
Self-Pay	102 (1.1)	92 (1.1)	10 (0.9)	

ADI = area deprivation index, with decile 1 being least deprived and 10 most deprived; IQR = inter-quartile range.

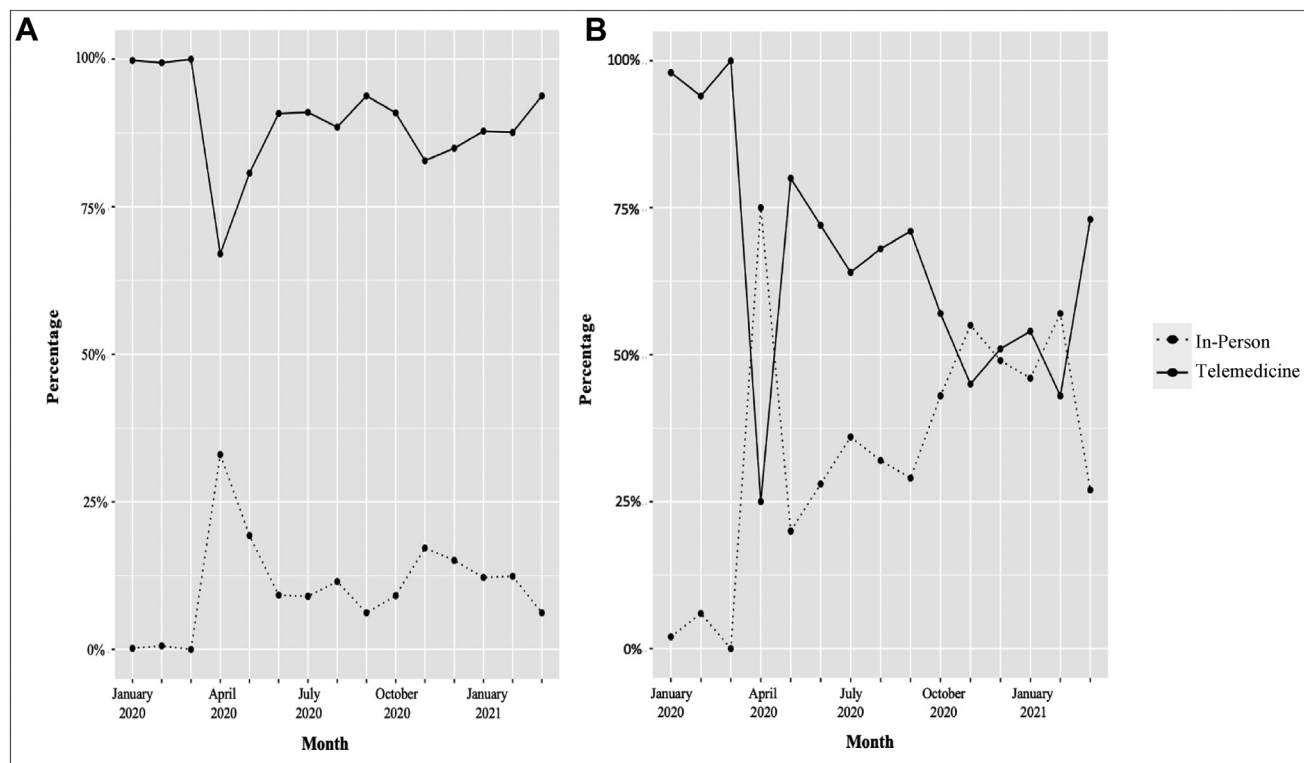
disadvantaged neighborhoods (24.5% versus 44.3% in ADI deciles 8-10,  $P < 0.001$ ). Patients utilizing TM for basic PO care also lived farther from the surgery clinic (median distance 12.4 versus 8.2 miles from the main clinic,  $P < 0.001$ ).

#### Basic post-operative subgroup analysis: outcomes and adequacy

For basic PO care, TM visits were again more likely than IP visits to be canceled (56.0% versus 44.9%) or no-shows (18.2% versus 10.8%) ( $P < 0.001$ ) (Table 4). Of the canceled basic PO TM visits, 60.3% had communication with the surgical team, of which 43.3% were approved for cancellation because the visit

was not needed and 17.0% were rescheduled to a new time. IP visits for basic PO care were less likely to be approved for cancellation but more likely to be rescheduled when canceled compared to TM visits (38.2% versus 17.0%,  $P < 0.001$ ). Most basic PO visit no-shows, for both IP and TM appointments, had no further communication with the surgical team and were not rescheduled.

The completed basic PO TM visits were adequate for accomplishing the visit goals in the vast majority (97.6%) of patients. No basic PO TM visits required an IP visit given inadequacy of the TM visit; four patients (2.4%) required conversion of a video visit to a telephone visit given technical challenges. In total, 27.7% of all scheduled basic PO visits,



**Fig. 2 – Percentage of all completed visits stratified by in-person versus telemedicine per month for (A) the entire cohort, and (B) the subgroup of basic post-operative patients.**

including those that were eventually canceled or were no-shows, were successfully completed via TM (11.5%) or were canceled via electronic communication after confirming the absence of any PO concerns (16.2%).

## Discussion

This study measuring the utilization and adequacy of TM in pediatric surgery during the COVID-19 pandemic found that TM use increased and was adequate for accomplishing the visit goals in nearly all of the encounters in which TM was used. However, cancellations and no-shows were unexpectedly higher for TM than for IP visits. In addition, racial, socioeconomic, and geographic disparities in the utilization of TM among pediatric surgical patients were identified, with TM being used more frequently by those who were white, privately insured, from less disadvantaged neighborhoods, and living a greater distance from the clinic.

For basic PO visits after appendectomy and hernia repairs, in particular, this study demonstrated the success of a hybrid option in which 1) a PO appointment was made initially and encouraged to occur via TM, and 2) families were provided a means to electronically communicate with the surgical team and thereby cancel the previously scheduled appointment when deemed unnecessary. This approach was developed given increasing evidence that routine IP PO clinic visits may

be unnecessary for many common pediatric surgical procedures, consuming families' time and resources with little clinical value.<sup>30-33</sup> In addition, it builds upon the telephone follow-up that many institutions have found to be helpful for PO visits.<sup>34-40</sup> Importantly, the approach is family-centered, allowing for variability not only based upon clinical need but also based upon families' varying preferences between IP, TM, and no PO visits.

TM was utilized more frequently by families traveling greater distances to clinic and from rural locations. TM was used less by minority races, those covered by public insurance, and patients from more disadvantaged neighborhoods. Similar disparities have been previously identified for IP pediatric surgery clinic visits at CW.<sup>17</sup> These findings are in line with prior studies suggesting that TM may have an unintended role in further exacerbating underlying health disparities in both adult and pediatric populations, including among those who are of minority race, non-English speaking, unemployed, with less education, and with disabilities.<sup>41-43</sup>

TM may be an excellent option for accessing care for those who live farther from specialized centers and may have otherwise found an IP visit challenging because of time or travel expenses.<sup>6,8,44-46</sup> Indeed, rural children generally live greater distances from children's hospitals and more frequently live in economically disadvantaged areas.<sup>47</sup> The extent to which rural patients utilize TM may be limited by a lack of resources, however, including the technology

**Table 2 – Outcomes and adequacy of scheduled pediatric surgery telemedicine encounters, stratified by visit type.**

	Total (n = 1107)	New (n = 79)	Established (n = 177)	Post-operative (n = 851)	P-value
	N (%)	N (%)	N (%)	N (%)	
<b>Appointment status</b>					<0.001
Arrived/completed	472 (42.6)	67 (84.8)	133 (75.1)	272 (32.0)	
Canceled	478 (43.2)	11 (13.9)	35 (19.8)	432 (50.8)	
No-show	157 (14.2)	1 (1.3)	9 (5.1)	147 (17.3)	
<b>Arrived/completed (n = 472)</b>					<0.001
Adequate	459 (97.2)	64 (95.5)	128 (96.2)	267 (98.2)	
Inadequate, need in-person visit	9 (1.9)	3 (4.5)	5 (3.8)	1 (0.4)	
Technical challenges, convert to phone	4 (0.8)	0 (0.0)	0 (0.0)	4 (1.5)	
<b>Canceled (n = 478)</b>					<0.001
Approved to cancel*	182 (38.1)	NA	2 (5.7)	180 (41.7)	
Canceled but rescheduled	105 (22.0)	6 (54.6)	21 (60.0)	78 (18.1)	
Canceled by family, not rescheduled	62 (13.0)	3 (27.3)	5 (14.3)	54 (12.5)	
Other cancellations	129 (27.0)	2 (18.2)	7 (20.0)	120 (27.8)	
<b>No-show (n = 157)</b>					1.0
Not seen again/no further communication	141 (89.8)	1 (100.0)	8 (89.0)	132 (89.8)	
Rescheduled and/or communication completed	16 (10.2)	0 (0.0)	1 (11.1)	15 (10.2)	

\* Families communicated with the surgical team electronically, providing wound photos as needed and confirming the absence of any concerns that would have still required a visit.

necessary to complete video visits. This study's finding of increased TM use among rural and remote patients could therefore underestimate what TM use may have been if adequate resources were available. Perhaps, if access to broadband internet and a technological device necessary to conduct a video visit was ubiquitous among rural and socioeconomically disadvantaged patients, even more patients may have utilized TM. Interestingly, however, the impact of socioeconomic status on TM use among rural patients specifically appears to be blunted in this study, with rural patients who live in the most disadvantaged neighborhoods still using TM at a rate similar to those in the least disadvantaged neighborhoods.

Reasons for the disparities in TM utilization that were identified in this study are unknown. One potential explanation is surgical team bias in not routinely offering or encouraging TM use to certain subsets of patients. This bias would not be expected, however, apart from limitations in offering TM video visits when language interpretation was necessary. Regardless, to exclude provider bias to the greatest extent possible, we examined closely the patient population in whom TM was most uniformly offered and encouraged – those requiring basic PO follow-up care and disparities remained within that subgroup.

Disparities could also develop through varying desire or ability to create a patient portal account through the electronic medical record, a necessary first step in using video visits at our institution. Lower TM use in these populations could also be due to hesitancy to use the TM platform because of inexperience, lack of private spaces in the home

to discuss personal information, or absence of a device and broadband internet access capable of completing a video visit. Although ownership of such technology has rapidly grown, a digital gap still remains for Americans of lower income levels and among those of minority race.<sup>43,48</sup> If the necessary technology were more widely available across the entire population, including for the most socioeconomically disadvantaged patients, a greater and more evenly distributed increase in TM utilization may be seen. Future work is necessary to investigate whether the identified disparities in TM use among children is due to provider bias, cultural preferences and expectations, or availability of and knowledge regarding the necessary technology and internet connectivity.

TM in pediatric surgical outpatient care has not been widely researched, but this study's findings are consistent with other studies that suggest TM is a viable option for provision of care in the pediatric surgical population, with considerable potential for time and cost savings for families.<sup>3-9,11,12</sup> New consultations and established visits are especially amenable to TM when the visit's focus is on education and management options.<sup>6</sup> TM PO visits have also been successful in assessing incisions and discussing recovery.<sup>8,12</sup> Another study found no re-admissions, additional clinic visits, or emergency department visits for any group of patients with a PO TM visit.<sup>7</sup> Consistent with these prior findings, <1% of patients in the current study needed re-evaluation in clinic with an IP visit after a TM visit was completed. The pediatric urology field has seen similar success using TM compared to IP visits.<sup>10,14-16</sup>



**Table 3 – Patient characteristics for all completed basic post-operative pediatric surgery clinic encounters, stratified by in-person versus telemedicine visits.**

	Total (n = 518)	In-person (n = 349)	Telemedicine (n = 169)	P-value
	N (%)	N (%)	N (%)	
<b>Operation</b>				
Appendectomy	268 (51.7)	179 (51.3)	89 (52.7)	0.8
Hernia repair	250 (48.3)	170 (48.7)	80 (47.3)	
Inguinal hernia	95 (38.0)	68 (40.0)	27 (33.8)	0.1
Epigastric hernia	13 (5.2)	7 (4.1)	6 (7.5)	
Umbilical hernia	94 (37.6)	68 (40.0)	26 (32.5)	
Epigastric and umbilical	6 (2.4)	2 (1.2)	4 (5.0)	
Inguinal with epigastric and/or umbilical	42 (16.8)	25 (14.7)	17 (21.3)	
Median age (IQR), y	7.4 (3.4-12.4)	7.6 (3.5-12.6)	7.4 (3.4-11.7)	1.0
<b>Race/ethnicity</b>				
				0.005
White	255 (49.2)	154 (44.1)	101 (59.8)	
Black	96 (18.5)	68 (19.5)	28 (16.6)	
Hispanic	128 (24.7)	100 (28.7)	28 (16.6)	
Other/unknown	39 (7.5)	27 (7.7)	12 (7.1)	
<b>Sex</b>				
				0.5
Male	307 (59.3)	210 (60.2)	97 (57.4)	
Female	211 (40.7)	139 (39.8)	72 (42.6)	
<b>Primary language</b>				
				<0.001
English	446 (86.1)	278 (79.7)	168 (99.4)	
Spanish	63 (12.2)	62 (17.8)	1 (0.6)	
Other	9 (1.7)	9 (2.6)	0 (0.0)	
Median travel distance to main clinic (IQR), miles	8.4 (6.1-25.5)	8.2 (6.1-25.0)	12.4 (6.1-26.8)	<0.001
Median travel distance to scheduled clinic (IQR), miles	8.2 (6.1-23.1)	7.3 (5.6-18.9)	11.6 (6.1-25.5)	<0.001
<b>Residence</b>				
				0.7
Rural	34 (7.2)	22 (6.9)	12 (8.0)	
Urban	437 (92.8)	298 (93.1)	139 (92.1)	
<b>ADI</b>				
				<0.001
1-4	184 (40.4)	107 (34.6)	77 (52.4)	
5-7	99 (21.7)	65 (21.0)	34 (23.1)	
8-10	173 (37.9)	137 (44.3)	36 (24.5)	
<b>Insurance</b>				
				<0.001
Private	281 (54.3)	169 (48.4)	112 (66.3)	
Public	231 (44.6)	178 (51.0)	53 (31.4)	
Self-Pay	6 (1.2)	2 (0.6)	4 (2.4)	

ADI = area deprivation index, with decile 1 being least deprived and 10 most deprived; IQR = inter-quartile range.

Hesitancy to use TM may arise from families' desire to see a provider IP and doubt regarding a provider's competence over video.<sup>49</sup> In addition, families have been found to be more likely to agree to a TM visit with their primary care physician than for a routine PO visit, although 70% would still agree to a PO TM visit.<sup>49</sup> Despite some hesitancy, however, families have largely found value in TM encounters and that TM visits met expectations.<sup>3-6,8,9</sup>

Similar to prior work examining the use of TM in surgical specialties,<sup>2</sup> TM use in this study increased dramatically early during the COVID-19 pandemic before declining after IP visits were resumed, although TM use still remained higher than prior to the pandemic. While evaluation for some conditions is

likely not amenable to completion via TM, significant potential likely exists for additional expansion of TM use to other clinical scenarios when acceptable to families. For example, PO care for more complex surgical diseases such as esophageal and duodenal atresia has also been provided via TM.<sup>4</sup> Even for medically complex children, TM has been shown to reduce days of care in clinic, emergency department, and hospital visits, decrease rates of serious illness, increase treatment compliance, and enhance the ability of providers to reach patients.<sup>50</sup>

This study is limited by its retrospective nature and therefore limited ability to ascertain the reasons behind why TM was or was not chosen. Future efforts to increase TM

**Table 4 – Outcomes and adequacy of basic post-operative pediatric surgery clinic encounters, stratified by in-person versus telemedicine visits.**

	Total (n = 1440)	In-person (n = 787)	Telemedicine (n = 653)	P-value
	N (%)	N (%)	N (%)	
<b>Appointment status</b>				<0.001
Arrived/completed	518 (36.0)	349 (44.4)	169 (25.9)	
Canceled	718 (49.9)	353 (44.9)	365 (56.0)	
No-show	204 (14.2)	85 (10.8)	119 (18.2)	
<b>Arrived/completed (n = 518)</b>				<0.001
Adequate	514 (99.2)	349 (100)	165 (97.6)	
Inadequate, need in-person visit	0 (0.0)	NA	0 (0.0)	
Technical challenges, convert to phone	4 (0.8)	NA	4 (2.4)	
<b>Canceled (n = 718)</b>				<0.001
Approved to cancel <sup>*</sup>	234 (32.6)	76 (21.5)	158 (43.3)	
Canceled but rescheduled	197 (27.5)	135 (38.2)	62 (17.0)	
Canceled by family, not rescheduled	91 (12.7)	45 (12.8)	46 (12.6)	
Other cancellations	196 (27.3)	97 (27.5)	99 (27.1)	
<b>No-show (n = 204)</b>				0.3
Not seen again/no further communication	178 (87.3)	71 (83.5)	107 (89.9)	
Rescheduled and/or communication completed	26 (12.8)	14 (16.5)	12 (10.1)	

<sup>\*</sup>Families communicated with the surgical team electronically, providing wound photos as needed and confirming the absence of any concerns that would have still required a visit.

access will require a more detailed investigation regarding whether decisions surrounding TM use are based more on family preferences or a lack of infrastructure, equipment, and/or knowledge necessary to enable telemedicine use. With regard to TM use being lower among Hispanic patients, this finding is likely biased by the fact that TM was generally offered only to English-speaking families in this early phase of TM introduction at our institution. As our TM use continues to expand, we are eager to incorporate interpreter services into the video visits being offered. In addition, this study can provide only limited insight into the reasons underlying the higher frequency of no-shows and cancellations for TM visits. While we expected a lower rate, given the relative ease of logging onto a video visit compared to traveling to an IP visit, the opposite was found. While many canceled visits were rescheduled or had been canceled because they were deemed unnecessary, most no-shows had no further communication with the surgical team and were not rescheduled. Those scheduling TM visits may have a perception of less commitment or investment in following through with attending the visit. While this tendency may have little to no impact on patient outcomes, in particular for basic PO visits, this higher rate of no-shows does present a challenge in creating a reliable schedule for the surgical team.

In conclusion, this study adds to the growing support for incorporating TM into pediatric surgical outpatient care. TM provided effective and efficient care for nearly all of the encounters in which it was used and may have broader untapped applicability. In addition, TM combined with a simple system to enable families to communicate electronically with the surgical team to report PO recovery eliminated the need

for many IP visits for basic PO care. TM was utilized especially among patients with greater travel. However, TM utilization was limited among those of minority race, with public insurance, and from more disadvantaged neighborhoods. Future work is necessary to more fully investigate these disparities in TM utilization and ensure broad access to this useful tool for all children requiring surgical care.

### Author Contributions

K.G., C.G., M.F., L.C., D.G., and K.V.A. established the study concept and design. K.G., M.F., and K.V.A. performed data collection and statistical analysis. K.G., C.G., M.F., and K.V.A. drafted the manuscript. All authors performed critical revision of the manuscript and approved the final manuscript as submitted.

### Disclosure

None declared.

### Funding

The authors report no proprietary or commercial interest in any product mentioned or concept discussed in this article.

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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