Practice-level variation in telemedicine use in a pediatric primary care network during COVID-19

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Abstract

Background: Telehealth, the delivery of health care through telecommunication technology, has the potential to address multiple health system concerns. Despite this potential, only 15% of pediatric primary care clinicians reported using telemedicine as of 2016, with the majority identifying inadequate payment for these services as the largest barrier. The COVID-19 pandemic led to rapid changes in payment and regulations surrounding telehealth, allowing for integration into primary care pediatrics.

Objective: Due to limited use of telemedicine in primary care pediatrics prior to COVID-19, much is unknown about the role of telehealth in pediatric primary care. To address this gap in knowledge, we examined the association between practice-level telemedicine use within a large pediatric primary care network and practice characteristics, telemedicine visit diagnoses, in-person visit volume, child-level variation in telemedicine use and clinician attitudes towards telemedicine.

Methods: We analyzed electronic health record data from 45 primary care practices. Practices were stratified into tertiles based on rates of telemedicine use (low, intermediate, and high) per 1000 patients per week during a two-week period (4/19-5/2/2020). By practice tertile, we compared (1) practice characteristics, (2) telemedicine visit diagnoses, (3) in-person visit rates to office, urgent care and emergency department, (4) child-level variation in telemedicine use and (5) clinician attitudes towards telemedicine across these practices.

Results: Across pediatric primary care practices, telemedicine visit rates ranged from 5 to 23 telemedicine visits per 1000 patients per week. Across all tertiles, the most frequent telemedicine visit diagnoses were mental health (28-36% of visits) and dermatologic (15-28%). Compared to low telemedicine use practices, high telemedicine use practices had fewer in-person office visits (10 vs. 16 visits per 1000 patients per week, P=0.005), but overall more total encounters (in-office and telemedicine: 28 vs. 22 visits per 1000 patients per week, P=0.006). Telemedicine use varied with child age, race and ethnicity, and recent well child care, but no significant interactions existed between these characteristics and practice-level telemedicine use. Finally, clinician attitudes regarding the usability, usefulness, or impact of telemedicine did not vary significantly across tertiles.

Conclusions: Across a network of pediatric practices, we identified significant practice-level variation in telemedicine use, with increased use associated with more varied telemedicine diagnoses, fewer in-person office visits, and increased overall primary care encounter volume. Thus in the context of the pandemic when underutilization of primary care was prevalent, higher practice-level telemedicine use supported pediatric primary care encounter volume closer to usual rates. Child-level telemedicine use differed by child age, race/ethnicity, and recent well child care, building upon prior concerns about differences in access to telehealth care. However, increased practice-level use of telemedicine services was not associated with reduced nor worsened differences in utilization, suggesting further work is needed to promote equitable access to primary care telemedicine.

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Original Manuscript

Practice-level variation in telemedicine use in a pediatric primary care network during COVID-19

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Contributors' Statement:
Drs Schweiberger and Ray conceptualized and designed the study, completed all statistical analyses, drafted the initial manuscript, reviewed and revised the manuscript.
Drs Hoberman, Wolfson, Schoemer, and Iagnemma conceptualized the study, coordinated data collection, reviewed and revised the manuscript.
Ms. Taormina and Mr. Squire collected data, reviewed and revised the manuscript.
All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

ABSTRACT

Background
Telehealth, the delivery of health care through telecommunication technology, has the potential to address multiple health system concerns. Despite this potential, only 15% of pediatric primary care clinicians reported using telemedicine as of 2016, with the majority identifying inadequate payment for these services as the largest barrier. The COVID-19 pandemic led to rapid changes in payment and regulations surrounding telehealth, allowing for integration into primary care pediatrics.

Objectives
Due to limited use of telemedicine in primary care pediatrics prior to COVID-19, much is unknown about the role of telemedicine in pediatric primary care. To address this gap in knowledge, we examined the association between practice-level telemedicine use within a large pediatric primary care network and practice characteristics, telemedicine visit diagnoses, in-person visit volume, child-level variation in telemedicine use and clinician attitudes towards telemedicine.

Methods
We analyzed electronic health record data from 45 primary care practices and administered a clinician survey to practice clinicians. Practices were stratified into tertiles based on rates of telemedicine use (low, intermediate, high) per 1000 patients per week during a two-week period (4/19-5/2/2020). By practice tertile, we compared (1) practice characteristics, (2) telemedicine visit diagnoses, (3) in-person visit rates to office, urgent care and emergency department, (4) child-level variation in telemedicine use and (5) clinician attitudes towards telemedicine across these practices.

Results
Across pediatric primary care practices, telemedicine visit rates ranged from 5 to 23 telemedicine visits per 1000 patients per week. Across all tertiles, the most frequent telemedicine visit diagnoses were mental health (28-36% of visits) and dermatologic (15-28%). Compared to low telemedicine use practices, high telemedicine use practices had fewer in-person office visits (10 vs. 16 visits per 1000 patients per week, P=0.005), but overall more total encounters (in-office and telemedicine: 28 vs. 22 visits per 1000 patients per week, P=0.006). Telemedicine use varied with child age, race and ethnicity, and recent preventive care, but no significant interactions existed between these characteristics and practice-level telemedicine use. Finally, clinician attitudes regarding the usability and impact of telemedicine did not vary significantly across tertiles.

Conclusions
Across a network of pediatric practices, we identified significant practice-level variation in telemedicine use, with increased use associated with more varied telemedicine diagnoses, fewer in-person office visits, and increased overall primary care encounter volume. Thus in the context of the pandemic when underutilization of primary care was prevalent, higher practice-level telemedicine use supported pediatric primary care encounter volume closer to usual rates. Child-level telemedicine use differed by child age, race/ethnicity, and recent preventive care, building upon prior concerns about differences in access to telemedicine. However, increased practice-level use of telemedicine services was not associated with reduced nor worsened differences in utilization, suggesting further work is needed to promote equitable access to primary care telemedicine.

Keywords: Telehealth; Telemedicine; Ambulatory Pediatrics; Health Services Research

INTRODUCTION

Telehealth, the delivery of health care through telecommunication technology, has potential to address multiple health system concerns, such as physician workforce shortages, improving access to care, mitigating disparities in healthcare, controlling costs, and enhancing communication between clinicians[1-3]. Despite this potential, telehealth's uptake among pediatric clinicians has largely remained outside of primary care pediatrics, with growth instead observed in mental health, subspecialty care, and direct-to-consumer telemedicine provided by clinicians outside of the medical home[4, 5]. The American Academy of Pediatrics (AAP) cautions against pediatric telemedicine provided outside of the primary care office due to concerns about fragmentation of care, suboptimal care quality, and lack of integrated follow up, but supports integration of telehealth into primary care pediatrics within the patient-centered medical home[1, 6].

Despite the AAP endorsement of telehealth within primary care, only 15% of pediatric primary care clinicians reported using telemedicine as of 2016, with the majority identifying inadequate payment for these services as the largest barrier[7]. As of February 2020, all state Medicaid programs had payment provisions for live video telehealth services, however only 19 states paid for telehealth services while the patient was located in their home, and only 5 states mandated payment parity with in-person visits[8]. This was reflected in similar stipulations by commercial payers. With limited options for telehealth service payment, especially with patients located at home, the adoption of telemedicine was not financially viable for most pediatric primary care offices outside of integrated care delivery systems before March 2020[7, 9].

In March 2020, the COVID-19 pandemic precipitated a rapid need for increased telehealth services to safely deliver care while limiting the risk of exposure to contagion that is inherent in an in-person setting[10]. The need for telehealth services nationally led to rapid changes in payment and regulations surrounding telehealth delivery. Specifically, updated policies allowed patients to be

located in their homes during a telemedicine visit and allowed use of widely available technology platforms to deliver telehealth by waiving penalties for HIPAA violations[11, 12]. These policy changes, and shifting perceptions of risk versus benefit of in-person and virtual care allowed for a sudden adoption of telemedicine within primary care practices across the country[13-16].

Thus, we are witnessing an acute surge in telemedicine use within pediatric primary care, but much unknown about the potential uses and impact of telehealth in pediatric primary care, given the prior rarity of this model of care. We describe the experience of a large pediatric primary care network within the first two months of telemedicine use during the COVID-19 pandemic. Specifically, we aimed to identify high versus low telemedicine-using primary care practices and compare (1) practice characteristics, (2) telemedicine visit diagnoses, (3) in-person visit rates to office, urgent care and emergency department, (4) child-level variation in telemedicine use, and (5) clinician attitudes towards telemedicine across these practices.

METHODS

Context and Study population

We performed a retrospective analysis of electronic health record (EHR) data from 45 practices within a large pediatric primary care network. These practices are certified as patient-centered medical homes by The Joint Commission, and together provide care for approximately 315,000 children throughout Western Pennsylvania across 13 counties. All practices shared one EHR, which offered embedded video visits through a patient portal. Some of these practices had briefly trialed a model of acute care telemedicine in 2015, but none of the practices were offering telemedicine services at the start of the pandemic.

Telemedicine implementation

Local payers offered payment for telemedicine while the patient is at home on 3/17/2020 [17].

On 3/23/2020, the first county-specific stay-at-home order was issued in Pennsylvania[17, 18]. Several practice leads trialed multiple telemedicine platforms and workflows from 3/18-3/20/2020, with implementation strategies shared with all practices via videoconference on 3/23/2020. The network quality and safety leaders led collaborative learning videoconferences two to three times a week for the next two months with all physicians, advance practice providers (APPs), and practice managers, sharing telemedicine best practices and discussing other COVID-19 related topics. Initial relaxation of the stay-at-home order for the largest metropolitan county occurred on 5/15/2020 with transition to the state's "yellow phase."

Data Source

We obtained encounter data for all telemedicine and in-person visits between 3/18-5/2/2020 from the EHR, and identified patient panels for each practice defined as all patients with ≥1 encounter at the practice in the prior two years. For each practice's patient panel, patient demographics, date of last preventive visit, and counts of telemedicine, office, ED and urgent care visits were obtained from the EHR. To complement this EHR-based evaluation, we also surveyed the primary care clinicians across the practice network regarding the usability, usefulness, and perception of patient and clinician experience of telemedicine.

EHR Data and Variables

For each practice in the network, the number of practice clinicians (doctors and APPs) and practice site location were obtained from network records. Practice site counties were classified as rural or urban using the 2013 rural-urban continuum codes [19].

Telemedicine visits were identified using EHR encounter type codes. All completed telemedicine visits from 3/18-5/2/2020 were included. For each telemedicine visit, we extracted practice site, child age on the date of visit, and primary visit diagnosis.

Telemedicine visit primary diagnoses were categorized based on International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) diagnosis codes into 22 broad ICD-10-CM diagnostic categories corresponding to organ systems [20]. For non-specific categories (e.g., “symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified” (R00-R99)), we reviewed sub-categories and recategorized into the relevant organ system. For example, the sub-category of “symptoms and signs involving the skin and subcutaneous tissue” (R20-R23) was grouped with “Diseases of the skin and subcutaneous tissues” (L00-L99) into “Skin and subcutaneous tissue diagnoses.”

To compare volume of telemedicine visits with other modes of care delivery, we extracted from the EHR each practice’s volume including in-person office, urgent care and ED visits as well as telephone encounters (excluding those with a telemedicine or in-person visit on the same day) during a 2-week window during the pandemic (4/19-5/2/2020).

Finally, for each child identified as part of a practice’s panel, we extracted age, race and ethnicity, health insurance (Medicaid vs. commercial), and whether the child had a preventive visit within the prior 12 months. Child race and ethnicity were originally recorded in the EHR based on parent response during the child’s first visit with the practice. Across all practices, 82% of patients were identified as white non-Hispanic, such that analyses by patient race and ethnicity are limited to comparing children identified as white non-Hispanic to children identified as any other racial or ethnic identity, of which the majority identified as “other” (9%), non-Hispanic Black (8%) or Hispanic (1%).

Clinician Survey

To complement this primarily EHR-based analysis, clinicians in the primary care network were invited to participate in an online survey. Survey items examined usability and usefulness of telemedicine through items modified from the Technology Usability Questionnaire (TUQ), which is

a validated survey incorporating questions from the Technology Acceptance Model (TAM), Telemedicine Satisfaction Questionnaire (TSQ) and the post-study system usability questionnaire (PSSUQ) and encompasses five subscales: usefulness, ease of use, effectiveness, reliability and satisfaction, with items using Likert scales [21]. We added questions pertaining to the physician experience of telemedicine, including perceived impact on quality of care (informed by the Institute of Medicine's six domains of quality), impact on job satisfaction (informed by Self-determination theory), and perceived usefulness of telemedicine for different visit reasons [22, 23]. The survey included 37 questions, and is available in Appendix 1. Participants had the option to identify their practice, or leave this item blank.

Clinicians were invited to participate in the anonymous online survey between 4/28-5/14/2020 through a series of 4 emails. The timeframe was chosen to capture summative attitudes and experiences of clinicians coinciding with the end of the EHR-based analysis.

Identification of low, intermediate, and high telemedicine use practices

For each practice, in order to account for variation in practice size, we determined the total number of telemedicine visits completed per week and divided the number of visits by the number of active patients in that practice to provide a standardized rate of telemedicine visits per 1000 patients. To categorize high versus low telemedicine use practices, the rate of telemedicine visits per 1000 patients per week was averaged for the two-week period (4/19-5/2/2020) occurring after the first month of telemedicine implementation. This time frame was chosen to categorize practices at a time where telemedicine visit volume had stabilized, such that analysis could focus on practices with high versus low use (as opposed to early vs. late adopters). The 45 practices were categorized into tertiles based on their telemedicine visit rates, which we labeled as "low" "intermediate" or "high" telemedicine use practices.

Statistical Analysis

Analyses compared practice-level characteristics, telemedicine visit diagnoses, in-person visit volume, variation in volume by patient characteristics, and clinician attitudes across telemedicine use tertiles. Across practice-level telemedicine use tertiles, we compared practice-level characteristics and in-person visits per 1000 patients per week using Kruskal-Wallis tests. We compared percent of telemedicine visits within each individual diagnosis category across tertiles using logistic regression.

For patients in each practice's panel, we determined the percentage of children who had one or more telemedicine visits during the two-week period of focused analysis (4/19-5/2/2020) by specific child characteristics (age, race and ethnicity, insurance type, and receipt of a preventive visit in the prior year). First, to assess whether there was a significant difference in telemedicine use by child characteristics across all practices (regardless of practice-level telemedicine use) we used a child-level logistic regression model clustered by practice but with no tertile variable. To determine whether increased practice-level use of telemedicine altered the differences in telemedicine use by child characteristics, we assessed the significance of an interaction term between each child characteristic category and practice tertile within a series of child-level logistic regression models clustered by practice across all tertiles. We tested the significance of the interaction terms using Wald tests, and present results as adjusted percentages determined through these models.

Clinician survey responses were compared across tertiles using linear regression clustered by practice, excluding respondents who did not identify their practice. We also compared responses for those not identifying their practice versus those who did, again using linear regression, and found no significant differences.

All analyses were conducted in Stata version 16.1 with significance assessed using an alpha level of 0.05.

Approval/Ethical Considerations

This analysis was part of a quality improvement project aimed at improving pediatric primary care telemedicine delivery and was approved by the University of Pittsburgh Medical Center's Quality Review Committee. Projects approved by this committee do not meet the definition of human subjects research and therefore do not require formal approval by an institutional review board.

RESULTS

Starting 3/23/2020, the network underwent a rapid reduction of in-person office visit volume and simultaneous increase in telemedicine visit volume (Figure 1). Telemedicine visit volume reached a steady state 3-4 weeks after implementation.

Practice-level characteristics

High telemedicine use practices had more physicians in the practice (median 4) than low telemedicine use practices (median 3, P=0.04), but all other practice-level characteristics were similar (Table 1).

Table 1: Practice characteristics by high, intermediate or low telemedicine (TM) use

	Low TM use	Intermediate TM use	High TM use	P
Practices, No.				
	15	15	15	--
TM visits per 1000 patients per week, range				
	5-9.6	9.7-14	15-23	--
Practice characteristics				
Active patients in practice, range				
	1200-8300	2600-7800	2000-10400	0.08
Practice clinicians				
Physicians, median (IQR)	2 (1-6)	5 (2-10)	6 (4-10)	0.04
APPs, median (IQR)	2 (1-3)	2 (2-6)	2 (1-5)	0.7

Patient population insured by Medicaid, median (IQR)				
	61 (50-77)	62 (53-73)	79 (62-82)	0.07
Practice site (rural/urban)[a] Rural county, n (%)				
	4 (27)	4 (27)	3 (20)	0.9

[a]Based on USDA rural-urban continuum codes

TM, telemedicine; IQR, inter-quartile range; APPs, advanced practice providers

Telemedicine visit diagnoses

Across all tertiles, telemedicine visits were most common for mental health and skin/soft tissue-related diagnoses (Table 2). However, the percentage of visits in each of these diagnostic categories varied with practice-level telemedicine use. Visits with skin-related diagnoses, for example, comprised 18% of telemedicine visits at low telemedicine use practices, and 15% of visits at high telemedicine use practices (P<0.006). While visits for skin-related diagnoses represented a smaller percentage of telemedicine visits at high telemedicine use practices, the number of skin-related visits per 1000 patients per week was higher at high telemedicine use practices compared to low telemedicine use practices (median 14 vs. 7 telemedicine skin related visits per 1000 patients per week at high and low telemedicine use practices, respectively; P<0.001). High telemedicine use practices had a larger percentage of their telemedicine visits devoted to respiratory (P<0.001), ear/mastoid (P<0.001), and genitourinary (P=0.02) diagnoses than low telemedicine use practices (Table 2).

Table 2: Telemedicine (TM) visit diagnoses by practices with high, intermediate or low telemedicine use (3/18-5/2/2020)

	Low TM use	Intermediate TM use	High TM use	P[a]
TM visits per 1000 patients per week, range				
	5-9.6	9.7-14	15-23	--
Number of Practices				
	15	15	15	--
Visit diagnosis category (ICD-10 code), No. (% of total visits)				
Mental, Behavioral and Neurodevelopmental diagnoses (F01-F99)				
	969 (36)	1704 (32)	2724 (28)	<0.001
Skin and subcutaneous tissue diagnoses (L00-L99, R20-R29)				
	467 (18)	801 (15)	1435 (15)	0.006
Respiratory system diagnoses (J00-J99, R04-R07)				
	297 (11)	684 (13)	1395 (15)	<0.001
Digestive system diagnoses (K00-K95, R10-R19)				
	182 (7)	396 (7)	697 (7)	0.6
Infectious and parasitic diagnoses (A00-B99)				
	176 (7)	390 (7)	746 (8)	0.04
Injury/poisoning (S00-T88)				
	92 (4)	184 (3)	437 (5)	0.001
General symptoms and signs (R50, R52-R69)				
	77 (3)	241 (5)	416 (4)	0.01
Eye diagnoses (H00-H59)				
	77 (3)	147 (3)	255 (3)	0.5
Ear and mastoid process diagnoses (H60-H95)				
	45 (2)	230 (4)	395 (4)	<0.001
Genitourinary system diagnoses (N00-N99, R30-R39, R80-R82)				
	45 (2)	123 (2)	240 (3)	0.02
Other[b]				
	234 (9)	435 (8)	847 (9)	0.6

[a] p-values indicate significance of proportion of telemedicine visits within each individual diagnosis category compared across practice-level telemedicine use tertiles using logistic regression

[b]Diagnostic categories with less than 2% of visits are represented in this "other" category, these included neoplasms & hematologic diagnoses (C00-D89, R70-R79), endocrine, nutritional and metabolic diseases (E00- E89), nervous system diagnoses (G00-G99, R51), circulatory system diagnoses (I00-I99, R01-R03), musculoskeletal diagnoses (M00-M99), peripartum and perinatal diagnoses (O00-O9A, P00-P96), congenital anomalies (Q00-Q99), symptoms and signs not otherwise classified (R00-R03, R09, R25-R29, R40-R49, R83-R99) as well as codes for special purposes (U00-U85), injuries (V00-Y99), and contact with health services (Z00-Z99)
TM, telemedicine; ICD-10, International Classification of Diseases, Tenth Revision, Clinical Modification

In-person visit volume

Compared to low telemedicine use practices, practices with high telemedicine use had fewer

in-person office visits (median 10 vs. 16 in-person office visits per 1000 patients per week at high vs. low telemedicine use practices, respectively; P=0.005; Table 3). Practices with high telemedicine use also had slightly more ED visits (median 2 vs. 1 ED visits per 1000 patients per week at high and low telemedicine use practices, respectively; P=0.02) but similar urgent care visits. When accounting for both in-person and telemedicine office visits, high telemedicine use practices had more total primary care encounters per 1000 patients per week (median 28 vs. 22 encounters, P=0.006). Of note, among high telemedicine use practices, total primary care encounters (in-person and telemedicine) represented a median of 53% of 2019 weekly volume. In contrast, among low telemedicine use practices, total primary care encounters represented a median of 46% of 2019 weekly volume. Telephone encounters occurring separate from a visit were similar across tertiles.

Table 3: In-person visits by patients in practices with high, intermediate or low telemedicine (TM) use (4/19-5/2/2020)

	Low TM use	Intermediate TM use	High TM use	P[a]
Practices, n				
	15	15	15	--
Primary care patient visits, median (IQR)				
TM visits per 1000 patients per week, range				
	5-9.6	9.7-14	15-23	--
In-person office visits per 1000 patients per week				
	16 (12-18)	11 (7-14)	10 (8-12)	0.005
All primary care encounters per 1000 patients per week				
	22 (19-26)	23 (19-26)	28 (25-30)	0.006
In-Person patient visits outside of primary care, median (IQR)				
Urgent care visits per 1000 patients per week				
	0.4 (0-1)	1 (0.5-2)	1 (0.8-2)	0.1
ED visits per 1000 patients per week				
	1 (0.8-1)	2 (1-2)	2 (1-2)	0.02
Total encounters per 1000 patients per week outside of Primary Care				
	2 (1-3)	3 (2-4)	3 (2-4)	0.008
Total encounters per 1000 patients per week				
	25 (20-28)	25 (24-29)	30 (28-33)	0.003
Patient telephone calls to practice not associated with a visit, median (IQR)				
Telephone management without a visit per 1000 patients per week				
	17 (8-22)	14 (10-16)	15 (7-20)	0.8

[a]p-values indicate practice-level in-person visits per 1000 patients per week compared across practice-level telemedicine use tertiles using Kruskal-Wallis tests.

TM, telemedicine; IQR, inter-quartile range

Patient characteristics associated with telemedicine use

In logistic regression models without practice-level tertile designation, use of telemedicine varied significantly by child race and ethnicity (P<0.001), child age (P <0.001) and receipt of preventive care in the prior 12 months (P<0.001), but did not vary by child insurance category (P=0.4). However, interaction terms between practice tertile and each of these characteristics were not significant (Table 4). This indicates that while differences exist in the full sample for telemedicine use by child race and ethnicity, child age, and recency of a preventive visit, increasing practice-level use of telemedicine did not change the relationship between these patient characteristics and likelihood of a telemedicine visit.

Table 4: Variation in telemedicine (TM) visits by child characteristics across practices with low, intermediate, and high telemedicine use. Adjusted percentage of children in patient panel who had one or more telemedicine visits during study period using logistic regression clustered by practice. Bolded variables are significant in the entire population. P values indicate significance of interaction term between specified characteristic and practice tertile.

	No TM Use Tertile Interaction Term	With TM Use Tertile Interaction Terms			
	All practices	Low TM Use Practices	Intermediate TM use Practices	High TM Use Practices	P for interaction term
Practices, n					
	45	15	15	15	--
TM visits per 1000 patients per week, range					
	5-23	5-9.6	9.7-14	15-23	--
Children, n					
	244,473	66,295	84,093	94,085	--
Adjusted percentage of children with one or more telemedicine visit, (95% CI)					
By child age[a]					0.25
0-2 years	2.3 (2-2.7)	1.6 (0.8-2.3)	2.2 (1.9-2.6)	3.1 (2.6-3.5)	
3-5 years	1.3 (1.1-1.5)	1 (0.7-1.4)	1 (0.9-1.2)	1.7 (1.4-2)	
6-11 years	1.6 (1.5-1.8)	1.2 (0.9-1.4)	1.6 (1.5-1.8)	2 (1.8-2.2)	
12-17 years	1.6 (1.4-1.7)	1.1 (0.9-1.3)	1.6 (1.3-1.9)	1.9 (1.7-2)	
By race/ethnicity					0.1
Non-Hispanic Black, Hispanic and other race/ethnicity categories	1.4 (1.2-1.6)	0.7 (0.3-1.1)	1.3 (1.2-1.5)	1.8 (1.6-2.1)	
Non-Hispanic white	1.7 (1.6-1.9)	1.2(1-1.5)	1.7 (1.5-1.8)	2.1 (2-2.3)	
By receipt of preventive care within last year					0.26
Received preventive care in last year	1.8 (1.7-2)	1.3 (1-1.6)	1.7 (1.6-1.9)	2.3 (2.1-2.5)	
No preventive care in last year	1.1 (0.9-1.2)	0.7 (0.6-0.8)	1.1 (1-1.2)	1.3 (1.1-1.5)	
By insurance type[b]					0.2
Medicaid insured children	1.7(1.5-1.9)	1.2 (0.9-1.6)	1.6 (1.4-1.8)	2.3 (2-2.6)	
Commercially insured children	1.6 (1.5-1.8)	1.1 (0.8-1.4)	1.6 (1.5-1.7)	2 (1.8-2.2)	

TM, telemedicine; CI, confidence interval

[a]Patients over 18 years old excluded (n=20,424)

[b]Children identified as self-pay excluded (n=9,258)

Clinicians attitudes towards telemedicine

The survey was completed by 121 clinicians including 88 who did and 33 who did not identify their practice (34% response rate). Clinician attitudes regarding the usability, usefulness for child health, usefulness for clinician experience, or impact of telemedicine did not vary significantly across tertiles (Table 5).

Table 5: Clinician perceptions of usability and usefulness of telemedicine (TM)

	Clinicians at Low TM use	Clinicians at Intermediate TM use	Clinicians at High TM use	P[a]
TM visits per 1000 patients per week, range				
	5-9.6	9.7-14	15-23	--
Clinicians, No.				
	21	35	32	--
Practices represented				
	12	14	13	--
Usability, mean (SD)[b]				
Ease of Use and Learnability				
	5.8 (0.8)	5.4 (1.2)	5.9 (0.9)	0.5
Effectiveness				
	4.9 (0.8)	4.4 (1.4)	4.5 (1.3)	0.3
Reliability				
	2.3 (1.4)	2.5 (1.6)	2.2 (1.3)	0.8
Satisfaction and Future Use				
	5 (1.1)	4.8 (1.7)	4.8 (1.3)	0.7
Usefulness – Child & Population Health, mean (SD)[c]				
Timeliness of care				
	3.8 (0.7)	3.7 (1)	3.8 (0.9)	0.98
Equity in access to care				
	4 (0.8)	3.9 (1)	3.8 (1.1)	0.5
Family-centeredness of care				
	3.4 (0.7)	3 (1)	3.1 (1.1)	0.3
Health of my patients				
	2.8 (0.7)	3 (0.9)	2.9 (0.9)	0.9
Continuity of care				
	3 (0.9)	3.1 (1.2)	3.1 (1)	0.8
Safety of my patients				
	2.6 (0.7)	3.1 (1.1)	3 (1)	0.2
Usefulness – Clinician Experience, mean (SD)[c]				
Financial health of my practice				
	2.8 (0.9)	2.8 (1)	2.6 (1.1)	0.3
Sense of accomplishment from my work				

	2.7 (0.8)	2.6 (1)	2.2 (1)	0.07
Satisfaction with how I spend my time				
	2.6 (1.1)	2.5 (1.1)	2.2 (1)	0.2
Sense of connectedness with patients				
	2.3 (0.9)	2.6 (1.2)	2.3 (1.2)	0.8
Suitability of telemedicine for specific reasons, mean (SD)[d]				
Acute Care				
	2.2 (0.5)	2.3 (0.5)	2.3 (0.5)	0.7
Chronic Disease Management				
	2.6 (0.7)	2.6 (0.7)	2.5 (0.7)	0.7
Preventive Care				
	1.9 (0.9)	1.8 (0.8)	1.8 (0.8)	0.8
Follow up Care				
	2.4 (0.5)	2.3 (0.7)	2.3 (0.6)	0.8
Care Coordination				
	3.1 (0.8)	3 (0.7)	2.8 (0.7)	0.3
Mental Health				
	3.2 (0.7)	3 (0.5)	3 (0.7)	0.3

[a] P-values reported from clinician survey responses compared across tertiles using linear regression clustered by practice

[b] Survey questions answered using a 7-point Likert scale where 1 indicates “Strongly Disagree,” and 7 indicates “Strongly Agree”

[c] Survey questions answered using a 5-point scale where 1indicates “Much worse,” 3 indicates “about the same,” and 5 indicates “Much better”

[d] Survey questions answered using a 4-point scale where 1indicates “Never” and 4 indicates “Always”

TM, telemedicine; SD, standard deviation

DISCUSSION

Among a network of pediatric practices, we examined practice-level variation in use of telemedicine during the COVID-19 pandemic, allowing us to explore ongoing questions about the relationship between telemedicine use, receipt of care, and equity in receipt of care. We found increased practice-level telemedicine use was associated with more physicians in the practice, more varied telemedicine encounter diagnoses, and fewer in-person office visits per 1000 patients per week.

While concerns exist that telemedicine may promote overutilization, we found that in the context of the pandemic greater pediatric primary care practice-level telemedicine use resulted not in

overutilization but rather supported primary care encounter volume slightly closer to usual rates during a time when underutilization of primary care and other health care settings was prevalent[24-28]. We also found that high telemedicine use practices had slightly more ED visits than low telemedicine use practices during the study period. Again, this finding must be interpreted in the setting of overall decreased health care encounters during this time, such that the slight increase could represent either a greater ability of telemedicine to triage children to emergent care during COVID-19 or alternatively a slightly greater need for emergent care for patients in these practices. Another possibility is that high telemedicine use practices may have adhered more strictly to guidelines to reduce in-person office visits; that goal, rather than telemedicine itself, may have led to the slight increase in ED visits.

In addition to concerns about overutilization, concerns have also been raised about whether increased telemedicine utilization will improve equity of access to care, or whether it will exacerbate disparities in access due to the digital divide[2, 29, 30]. In our sample, children without a preventive visit in the past year and children who identified as races or ethnicities other than white non-Hispanic were less likely to have had a telemedicine visit, while telemedicine use did not vary by child insurance type. These differences in the overall population use of telemedicine build upon prior concerns about differences in access to broadband internet, patient portals and telemedicine [29, 31-34]. However, the non-significant interaction terms indicate that increased practice-level use of telemedicine services during this specific period neither reduced nor worsened these differences. In cases where telemedicine is intended to be a tool to improve equity in access to care, these results indicate that simply increasing the use of telemedicine may not be sufficient to ensure more equitable access. Indeed, telemedicine has the potential to exchange one set of barriers to care (transportation issues, time constraints, hidden costs of missing work) for another (need for internet access, device capability, computer literacy). For telemedicine to more effectively reduce disparities in access, telemedicine will need to be implemented in ways that more intentionally overcome barriers.

While increased use of telemedicine by practices did not translate into greater equity in telemedicine use for patients, it did translate into more varied telemedicine use based on visit diagnoses. Additionally, we observed an increase in proportion of visits related to respiratory and ear, nose and throat (ENT) symptoms. Concerns have been raised about assessments of ears in the absence of tele-otoscopy, which was not available for the studied visits [35]. Given that clinicians in low vs high telemedicine use tertiles reported similar views about the suitability of telemedicine for acute care, increased respiratory and ENT diagnoses at high telemedicine use practices may reflect a stronger practice-wide commitment to reducing in-person visits due to COVID-19 as opposed to increased comfort with caring for these diagnoses via telemedicine. All practices, no matter their use tertile, had the same most common telemedicine visit diagnosis categories: mental health and skin-related diagnoses. This differs from the most common diagnoses for visits by children to commercial direct-to-consumer telemedicine, where the most common visit diagnosis category was nose/sinus infections [4]. In contrast, the most common diagnosis group among these primary care telemedicine visits was mental health, accounting for about 30% of telemedicine visits across the full set of practices.

One key limitation of this EHR analysis is we cannot account for patient or parent preferences for or satisfaction with telemedicine use. Additionally, the racial/ethnic diversity within our sample was minimal, limiting analyses by race and ethnicity to a comparison of white non-Hispanic children and children identified as any other race or ethnicity. We also sought to compare visit volume by parental language, but had limited numbers of children with parental preference for non-English language identified in the relevant EHR field (0.5%). While systems are in place to integrate ED and urgent care visit information into the EHR, ED and urgent care visits outside of our health system may still have been missed. However, we do not anticipate this resulting in any systematic bias across practice tertiles given the large number of integrated ED and urgent care centers across the region. We also note that we focused this analysis on telemedicine visit diagnoses

and volume and did not examine quality of care or clinical outcomes. Finally, this analysis focused on telemedicine use within a specific context, such that generalizability of findings will need to be examined through other sources.

CONCLUSION

This study demonstrates that a large pediatric primary care network rapidly integrated use of telemedicine when given a favorable payment environment and public health mandates. The integration of telemedicine allowed continued contact with patients during the pandemic, largely for mental health care, with high practice-level telemedicine use allowing for more encounters with patients per week during a time where underutilization of primary care was common. Further work is needed to understand the sustainability of the pandemic-related surge in primary care telemedicine use and to identify ways to enhance the ability of telemedicine to improve access for those with access barriers.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest relevant to this article to disclose.

ABBREVIATIONS

AAP- American Academy of Pediatrics
APPs- Advanced Practice Providers

ED- Emergency Department
EHR- Electronic Health Record
ENT- Ear, Nose and Throat
ICD-10-CM - International Classification of Diseases, Tenth Revision, Clinical Modification
TM- Telemedicine
TUQ- Technology Usability Questionnaire

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FIGURE CAPTIONS:

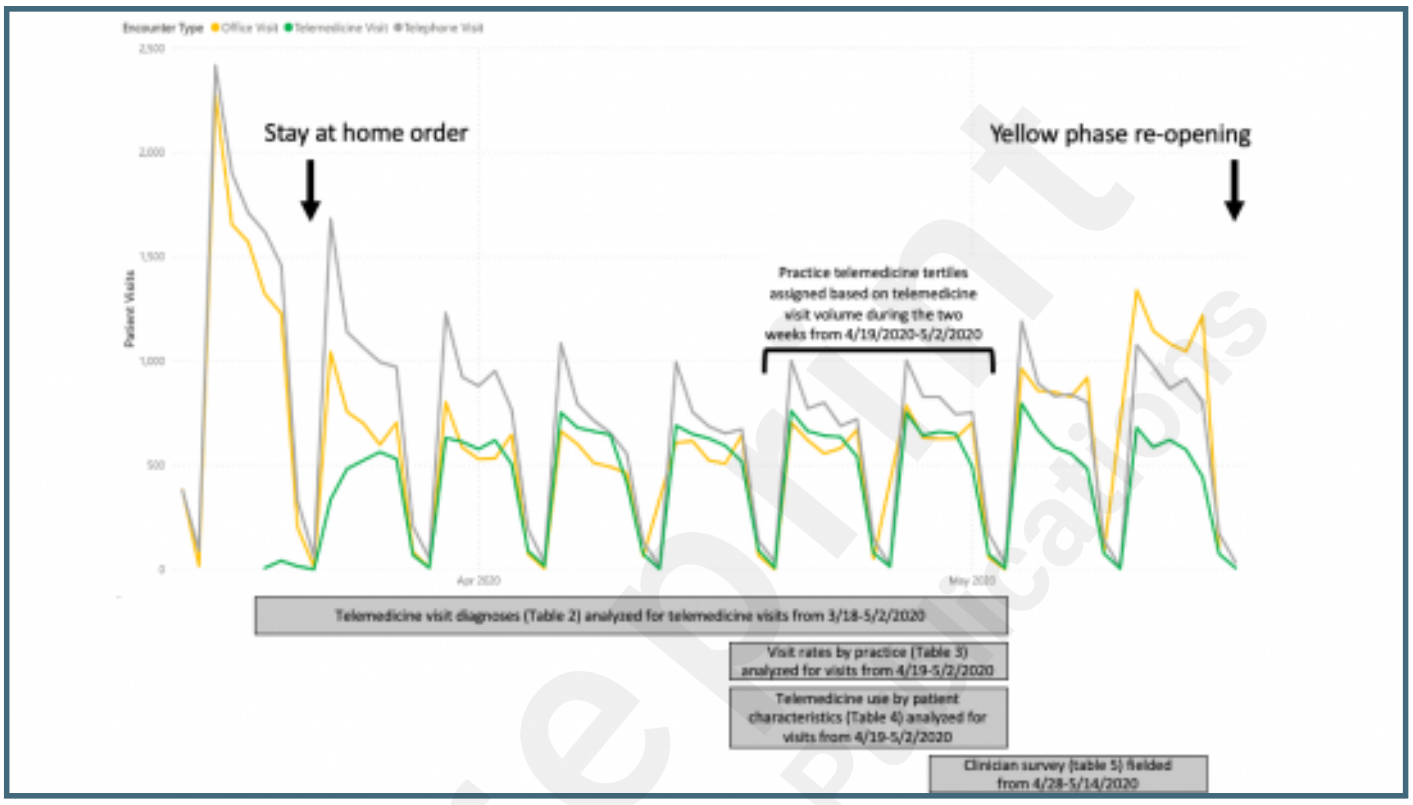
Figure 1: Encounters by telemedicine, in-person office, and care via telephone across 45 practices within a pediatric primary care network, March-May 2020

Figure 1 Legend: In this figure, we detail the timeline for the various analyses included in this study. Encounter volume across the network are shown for telemedicine (green), in-person office (yellow), and telephone (gray) encounters from March through May 2020. Telemedicine use tertiles were defined based on visit volume from 4/19-5/2/2020 (indicated by brackets) as this represented steady state telemedicine use. Yellow phase indicates the first relaxation of the stay-at-home order indicating the first phase of reopening in Pennsylvania.

Supplementary Files

Figures

Encounters by telemedicine, in-person office, and care via telephone across 45 practices within a pediatric primary care network, March-May 2020. In this figure, we detail the timeline for the various analyses included in this study. Encounter volume across the network are shown for telemedicine (green), in-person office (yellow), and telephone (gray) encounters from March through May 2020. Telemedicine use tertiles were defined based on visit volume from 4/19-5/2/2020 (indicated by brackets) as this represented steady state telemedicine use. Yellow phase indicates the first relaxation of the stay-at-home order indicating the first phase of reopening in Pennsylvania.



Multimedia Appendixes

Clinician Survey.
URL: https://asset.jmir.pub/assets/858d60eef3e851a993a3d16e3382a009.docx