Feasibility of Post-hospitalization Telemedicine Video Visits for Children With Medical Complexity

David Y. Ming, MD, Tingxuan Li, BS, Melissa H. Ross, MD, Jennifer Frush, BA, Jingyi He, MS, Benjamin A. Goldstein, PhD, Valerie Jarrett, BS, Natalie Krohl, MSN, CPNP-AC, Sharron L. Docherty, PhD, PNP, Christine B. Turley, MD, & Hayden B. Bosworth, PhD

David Y. Ming, Assistant Professor, Department of Pediatrics, Department of Medicine, and Department of Population Health Sciences, Duke University School of Medicine, Durham, NC.

Tingxuan Li, Biostatistician and Master's of Science Student, Department of Biostatistics and Bioinformatics, Duke University School of Medicine, Durham, NC.

Melissa H. Ross, Housestaff, Departments of Medicine and Pediatrics, University of Michigan School of Medicine, Ann Arbor, MI.

Jennifer Frush, Medical Student, Department of Pediatrics, Duke University School of Medicine, Durham, NC.

Jingyi He, Biostatistician, Parexel International, Inc., Auburndale, MA.

Benjamin A. Goldstein, Associate Professor, Department of Pediatrics, Department of Population Health Sciences, and Department of Biostatistics & Bioinformatics, Duke University School of Medicine, Durham, NC.

Valerie Jarrett, Program Coordinator, Department of Pediatrics, Duke University School of Medicine, Durham, NC.

Natalie Krohl, Nurse Practitioner, Department of Pediatrics, Duke University School of Medicine, Durham, NC.

Sharron L. Docherty, Associate Professor, Department of Pediatrics, Duke University School of Medicine, and Duke University School of Nursing, Durham, NC.

Christine B. Turley, Professor, Department of Pediatrics, Atrium Health Levine Children's Hospital, Charlotte, NC.

Hayden B. Bosworth, Professor, Department of Medicine and Department of Population Health Sciences, Duke University School of Medicine, and Duke University School of Nursing, and Center of Innovation to Accelerate Discovery and Practice Transformation, Durham Veterans Affairs Medical Center, Durham, NC.

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The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request. All subjects provided written informed consent before participation, and approval for publication has been provided by all authors.

Correspondence: David Y. Ming, MD, Department of Pediatrics, Duke University School of Medicine, DUMC Box 102376, Durham, NC 27710; e-mail: david.ming@duke.edu.
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Objectives: To evaluate feasibility and acceptability of post-hospitalization telemedicine video visits (TMVV) during hospital-to-home transitions for children with medical complexity (CMC); and explore associations with hospital utilization, caregiver self-efficacy (CSE), and family self-management (FSM).
Method: This non-randomized pilot study assigned CMC (n=28) to weekly TMVV for four weeks post-hospitalization; control CMC (n=20) received usual care without telemedicine. Feasibility was measured by time to connection and proportion of TMVV completed; acceptability was measured by parent-reported surveys. Pre/post-discharge changes in CSE, FSM, and hospital utilization were assessed.
Results: 64 TMVV were completed; 82 % of patients completed 1 TMVV; 54 % completed four TMVV. Median time to TMVV connection was 1 minute (IQR=2.5). Parents reported high acceptability of TMVV (mean 6.42; 1 −7 scale). CSE and FSM pre/post-discharge were similar for both groups; utilization declined in both groups post-discharge.
Discussion: Post-hospitalization TMVV for CMC were feasible and acceptable during hospital-to-home transitions. J Pediatr Health Care. (2022) *36*, e22−e35

KEY WORDS
Telehealth, children with medical complexity, transitions of care, hospital-to-home

INTRODUCTION
Children with medical complexity (CMC) are the highest need, highest cost pediatric population; despite only representing 1% of children, they account for nearly one-third of child health care costs (Cohen, Berry, Sanders, Schor, & Wise, 2018). High-intensity needs and costs stem from characteristics common to CMC, including multiple chronic conditions, long-term medical technology dependence (e.g., feeding tube), multispeciality care, and multiple outpatient and inpatient health services (Cohen et al., 2018) fragmented across a complex medical neighborhood (Kuo, McAllister, Rossignol, Turchi, & Stille, 2018). Hospital-to-home transitions are frequently navigated by CMC and their families because hospitalizations occur repeatedly—for example, 30-day readmission rates are nearly four times the general pediatric population (Berry et al., 2011a; Berry et al., 2011b)—and are prolonged (Berry et al., 2011a; Berry et al., 2011b; Gold et al., 2016).

To improve care coordination and hospital-to-home transitions, longitudinal complex care programs for CMC have become increasingly common (Pordes, Gordon, Sanders, & Cohen, 2018), and many hospitals routinely call patients to identify postdischarge problems (Rehm et al., 2018). However, during hospital-to-home transitions, there are limitations of telephone-based care coordination. First, CMC often lack longitudinal relationships with a primary care pediatrician. As a result, families may be unsure of who to call when post-hospitalization challenges commonly encountered by families of CMC arise—for example, medical signs/symptoms, follow-up appointments, and medications (Leyenaar, O'Brien, Leslie, Lindenauer, & Mangione-Smith, 2017; Musial et al., 2020). Second, lack of face-to-face interaction with parents via telephone limits providers' ability to assess clinical status, identify worsening conditions *upon* return home and provide education (e.g., managing a new feeding tube) to address frequently encountered post-hospitalization needs (Coller et al., 2017; Desai, Durkin, Jacob-Files, & Mangione-Smith, 2016). In-person follow-up visits provide face-to-face interactions between families and providers; however, in-person visits are not always feasible because of distance, transportation, and financial barriers faced by families of CMC (Kuo et al., 2016; Thomson et al., 2016). Therefore, complex care programs need more options to better tailor care coordination approaches and support CMC during hospital-to-home transitions.

Telemedicine video visits (TMVV) are a telehealth modality that can augment telephone and in-person care coordination for CMC by delivering real-time, face-to-face, interactive follow-up with providers while patients are in their homes (Wootton, 2012). Recent studies of TMVV for CMC in outpatient settings have demonstrated improved parent satisfaction and reduced hospital use (Looman et al., 2015; Notario et al., 2019). Despite positive impacts of telehealth and alignment with patient/family preferences (Dick et al., 2004; Utidjian & Abramson, 2016) before the coronavirus disease 2019 (COVID-19) pandemic, limited technology adoption and reimbursement hindered TMVV uptake. Now, in response to the COVID-19 pandemic, broad health system support and payer financing have led to a massive scale-up in TMVV (Wosik et al., 2020).

Despite the growing use of TMVV and potential advantages over telephone-based outreach during hospital-to-home transitions, more research is needed. In particular, little is known about the acceptability and feasibility of TMVV during the post-hospitalization period for CMC. Thus, we conducted a pilot study to (1) evaluate feasibility and acceptability of post-hospitalization TMVV within a pediatric complex care program; and (2) explore the preliminary impact of post-hospitalization TMVV on parent-reported measures and hospital use for CMC.

METHODS
Setting
This pilot study was conducted between February 2019 and June 2020 at a tertiary children's hospital in the southern United States. Since 2014, our center has operated a hospital-based pediatric complex care service (CCS) that provides comprehensive, longitudinal care to a regional population of CMC (Ming et al., 2019). The interdisciplinary CCS team includes physicians, nurse practitioners, nurse clinicians, social workers, and care coordinators. Since 2017, CCS has also staffed an inpatient complex care team adapted from published care models (White et al., 2017) to care for hospitalized CCS-enrolled CMC. If the inpatient complex care team is at capacity (daily census cap of seven patients), CCS-

enrolled CMC are admitted to noncomplex care, general pediatric inpatient teams.

Design and Intervention

This study was a single-center, nonrandomized pilot study to evaluate the feasibility and impact of post-hospitalization TMVV for CMC concurrently receiving longitudinal complex care within the CCS. During an index hospitalization on the inpatient complex care team, intervention group CMC were enrolled to receive once-weekly TMVV for the first 4 weeks after discharge. Weekly timing was selected on the basis of clinician input and availability for TMVV; the first-month posthospitalization was selected because adverse events are common during this high-risk timeframe (Forster et al., 2004). A control group of hospitalized CMC received usual post-hospitalization care without TMVV. Usual post-hospitalization care included standard practices—for example, scheduling primary and specialty care follow-up appointments; documentation of a discharge summary in the electronic health record (electronic health record [EHR]; Epic, Verona, WI). The total follow-up period for intervention and control patients was 3 months postdischarge.

Before discharge, a CCS nurse approached patients for a predischarge planning visit. During these visits, the nurse updated the patient's complex care plan and used shared decision-making with the parent to establish postdischarge care goals. For each TMVV, a CCS provider (nurse practitioner) used a hospital desktop computer (Cisco DX80; Cisco, San Jose, CA), whereas the child and parent used a personal device (computer, tablet, and smartphone) at home. TMVVs were scheduled ahead of time, integrated into the EHR and online patient portal (MyChart; Epic), and documented using a standardized EHR note template. Within the EHR note template for each TMVV was a checklist of core elements focused on domains of family engagement (Leyenaar et al., 2018) and caregiver self-efficacy (CSE; Desai et al., 2016) important for hospital-to-home transitions. Core TMVV elements included medication reconciliation, direct visualization of the child, addressing parental concerns, review of home contingency plans, teach-back, establishing goals, and review of upcoming appointments (Supplementary Box 1). Completion of core elements was documented by a research assistant who directly observed visits.

Recruitment and Participants

Intervention group subjects all met CMC criteria; we defined CMC using the validated Children with Special Health Care Needs Screener (Bethell et al., 2015) plus local site-specific supplemental criteria (Supplementary Box 2) to identify CMC for enrollment into the interdisciplinary CCS program (Parente et al., 2021). Intervention group CMC were recruited while hospitalized and met the following inclusion criteria: (1) aged 0–20 years; (2) English-speaking parent; (3) had necessary TMVV technology (home Internet access, activated online patient portal account, and personal device at home—e.g., tablet, smartphone); (4) hospitalized on inpatient complex care team at the time of study enrollment; and (5) receiving comprehensive, longitudinal care from the CCS.

Control group subjects met the same age, English-speaking, and CMC criteria as the intervention group but differed by inpatient team assignment. Control CMC were originally recruited from the noncomplex care, general pediatric inpatient teams. However, because of established clinical operations at the time, most CMC were already being admitted to the complex care team, and few eligible control CMC were available to recruit from the noncomplex care, general pediatric inpatient teams. Thus, we expanded control group recruitment to also include the inpatient complex care team. Control group CMC hospitalized on the inpatient complex care team who were concurrently established with the longitudinal CCS (i.e., they would have been eligible for intervention had control recruitment not expanded to include the complex care inpatient team) were waitlisted from the TMVV intervention until completion of their full 3-month follow-up period. This waitlist approach allowed for complete follow-up for all control subjects—regardless of which inpatient team they were recruited from—and avoided withholding TMVV from CMC who may benefit.

A trained research coordinator approached parents of eligible patients in person on weekdays for consent before hospital discharge. The target sample size for the intervention was 35 patients because it represented 67% of all CMC ($n = 52$) discharged from the inpatient complex care team in the year before the study; we estimated recruitment of two-thirds of eligible CMC on weekdays during the study period would be feasible.

Measures

For the primary study outcome of the feasibility of post-hospitalization TMVV, we mapped measures to the reach and implementation domains of the RE-AIM (Reach, Effectiveness, Adoption, Implementation, and Maintenance) implementation research evaluation framework (Glasgow, Vogt, & Boles, 1999). Feasibility, fidelity, and acceptability were primary implementation outcomes (Proctor et al., 2011). Feasibility was measured as time to connection for each video visit (measured by research assistant observing visits) and TMVV completion rate (percentage of scheduled visits successfully completed). Fidelity was measured as the completion rate of the full 4-week TMVV protocol and TMVV participation rate (percentage with one, two, or three completed video visits). Acceptability was quantitatively measured with a 20-item parent-reported survey adapted from the validated Telehealth Usability Questionnaire (Parmanto, Lewis, Graham Jr., & Bertolet, 2016) and sent after each TMVV. Acceptability surveys were supplemented with a single item asking parents to estimate total round-trip travel costs saved by participating in TMVV instead of in-person visits. Reach of TMVV was measured as study recruitment (percentage of eligible CMC who enrolled into

the intervention or control groups) and decline (percentage of eligible CMC who declined participation) rates.

For secondary study outcomes, pre/post comparisons of hospital use and parent-reported online survey responses for each group were conducted—we then compared the pre/post differences between the intervention (TMVV) and control (no TMVV) groups. Our two main parent-reported survey measures were CSE and family self-management (FSM). CSE is an individual's belief in their ability to manage and provide care for their loved one (Steffen, McKibbin, Zeiss, Gallagher-Thompson, & Bandura, 2002); FSM is a parent's perception of their ability to self-manage their child's chronic conditions (Grey, Schulman-Green, Knafl, & Reynolds, 2015). Changes in CSE associated with TMVV were measured by the family caregiver activation in transitions (FCAT; Coleman, Ground, & Maul, 2015) instrument at baseline (prehospital discharge), 1 week postdischarge (after first TMVV), and 4 weeks postdischarge (after final TMVV). Changes in FSM associated with TMVV were measured by the family management measure (FaMM; Knafl et al., 2011)—a validated instrument that includes six subscales and an overall score—at baseline and 3 months postdischarge. Hospital use—measured as hospital admissions, emergency department (ED) visits, intensive care unit (ICU) days, and length of hospital stay at the same institution—was measured 3 months posthospital discharge and compared with use 3 months before the index hospital admission.

Statistical Methods

For the primary feasibility outcome, we described participant characteristics and used mean and standard deviations and rates. To assess differences between the two groups, we calculated the standardized mean difference and considered a standardized mean difference > 10% to indicate a lack of balance. For secondary study outcomes, we compared individual-level changes in hospital use from before and after the intervention periods. We regressed hospital use metrics for each participant for both study periods onto indicators for which group (intervention vs. control) they were in and by period (pre vs. post). The parameter of interest was a change in hospital use for each group after the intervention period. We also assessed the interaction term between the group and time indicators to determine whether there were significant changes between the two groups (i.e., difference-in-differences). To account for unequal follow-up among participants, we adjusted for follow-up time. For the outcomes number of admissions, length of stay, and ICU length of stay, we used a negative binomial count model. For ED visits, we used a logistic (ever/never) regression model. To account for repeated measurements within a person, we fitted a general estimating equations model with robust variances. Finally, to assess changes in survey response, we similarly used a generalized estimating equations model accounting for baseline and follow-up time points. All enrolled patients—including those who withdrew before the end of the study—were included in the hospital use analyses.

All analyses were performed in R (version 3.6; R Foundation for Statistical Computing, Vienna, Austria). We used a $p < .05$ to assess statistical significance. All surveys responses were collected using REDCap (Harris et al., 2009). The study was reviewed and approved by our Institutional Review Board.

RESULTS

Reach

Study analyses included 48 participants: 28 received the TMVV intervention, and 20 were in the control group (Figure); recruitment stopped short of the target intervention group sample size in March 2020 because of the COVID-19 pandemic. Among 182 eligible CMC, parents of 49 were reached by research staff in person before hospital discharge (26.9% contact rate) and 42 parents of individual patients enrolled in the study (85.7% enrollment rate). Six patients (21.4% of the intervention group) participated in both control and intervention periods and contributed toward participant count in both groups. After completing the control follow-up period, these six patients subsequently crossed over to receive the TMVV intervention; thus, 42 individual patients participated.

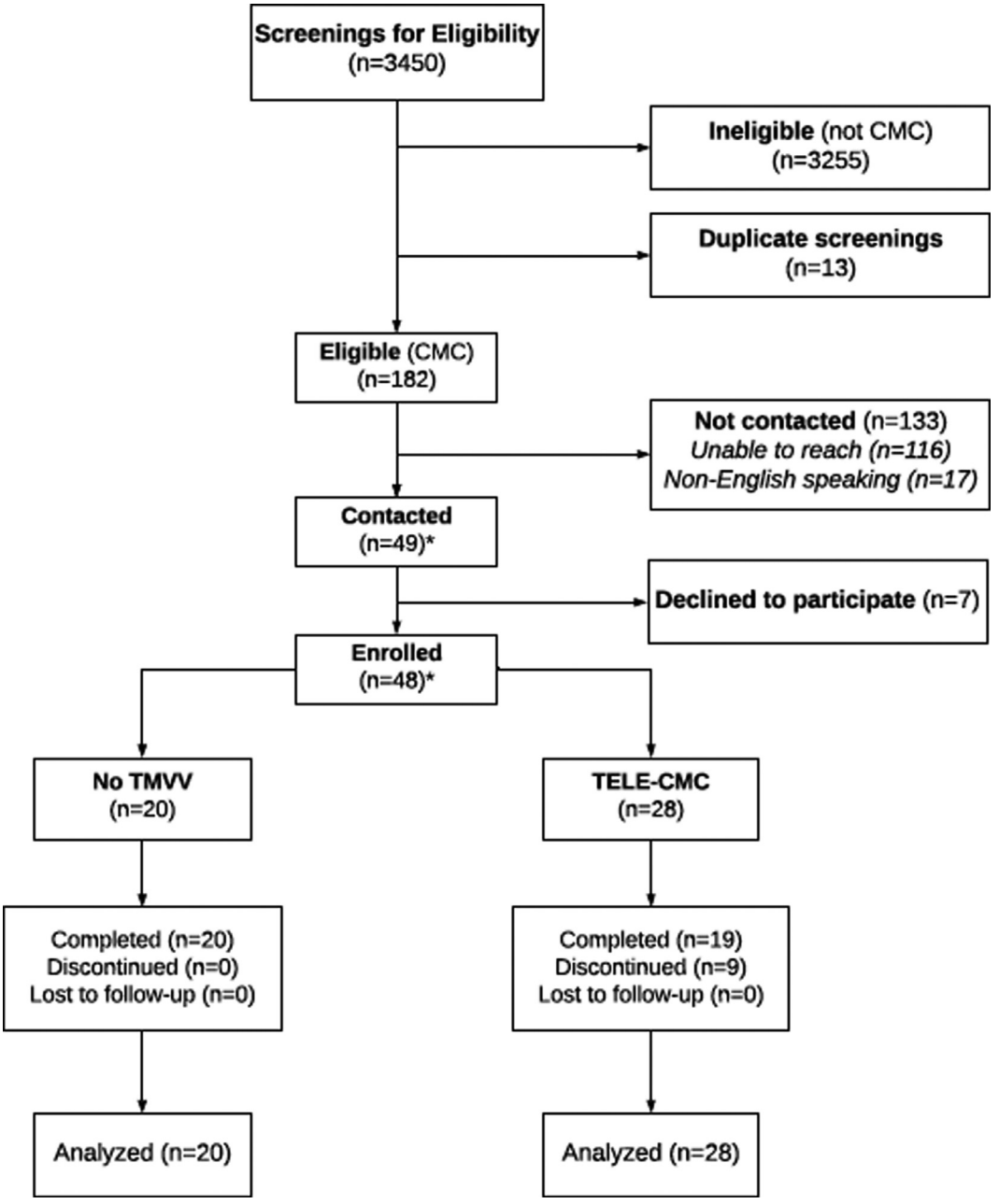
Most eligible, noncontacted parents of CMC were unable to be reached by study staff (n = 116; 86.6%) primarily because of patients being discharged before study staff could meet with parents in person. Parents of seven patients (14.3% of contacted CMC) declined to participate after an in-person discussion with research staff. Among 28 intervention patients, nine (32%) parents withdrew before the end of the study; the most commonly reported reason for withdrawal was parents' inability to accommodate TMVV during weekdays because of school schedules (n = 4; 44%). One withdrawn patient died during the study period, and two other patients died following completion of the study; no deaths nor any other adverse events were related to the TMVV intervention. No patients were lost to follow-up.

Baseline participant characteristics are summarized in Table 1. Intervention group (TMVV) participants tended to be younger; a higher percentage identified as male, Black race, or Hispanic ethnicity; a higher percentage were publicly insured and with annual household income < $50,000, and a lower percentage of caregivers had college or graduate degrees. Both groups had similar medical needs (e.g., long-term use of medical technology devices, hospital use, and the number of specialists seen), distance from home to a tertiary care center, and household size.

Implementation: Feasibility, Fidelity, Acceptability

A total of 64 TMVV were conducted during the study period; 75% of scheduled visits were completed. Half of all video visits successfully connected in 1 min (median time to connection = 1 min; interquartile range = 2.5). Smartphones (63%) and tablets (28%) were the most frequently used devices by parents; high-speed wireless (80%) and cell phone data (15%) were the most commonly reported methods for

FIGURE. Consolidated Standards of Reporting Trials (CONSORT) study flow diagram. CMC, children with medical complexity; TMVV, telemedicine video visits; TELE-CMC post-hospitalization telemedicine visits for children with medical complexity, telemedicine video visits for children with medical complexity. *Because n=6 individuals participated in control (no TMVV) and then subsequently enrolled in intervention (TELE-CMC) after completion of control period follow-up, the 48 participants total analyzed between the two groups included 42 unique patients.



Internet connection. The average TMVV duration was 40 min (range = 7–88).

We observed lower participation rates with each successive TMVV in the 1-month postdischarge intervention period: 82% of participants completed at least one TMVV; 71% completed at least two visits; 61% completed at least three visits; and 54% completed all four postdischarge TMVV. One patient had one visit canceled by the provider because of lack of clinical need for further visits; two patients had four visits canceled by the provider because of Internet connection issues. Most TMVV core components were completed in 56% to 81% of visits. Examples included a review of upcoming appointments (81%), directly visualizing the patient (78%), medication reconciliation (70%),

TABLE 1. Baseline characteristics of study participants

Patient characteristic	TMVV (*n* = 28)	No TMVV (*n* = 20)	SMD
Age, years, mean (*SD*)	8.5 (5.6)	10.1 (5.1)	0.31
Race and ethnicity, *n* (%)			0.52
Non-Hispanic White	14 (50)	14 (70)	
Non-Hispanic Black	10 (35.7)	3 (15)	
Hispanic	2 (7.1)	1 (5)	
Sex, *n* (%)			0.24
Male	16 (57)	9 (45)	
Female	12 (43)	11 (55)	
Insurance type, *n* (%)			0.63
Public	20 (71)	9 (45)	
Dual public/private	4 (14)	8 (40)	
Private	4 (14)	3 (15)	
Technology needs, *n* (%)			
VP shunt	4 (14)	5 (25)	0.27
Feeding tube	25 (89)	17 (85)	0.13
Tracheostomy	4 (14)	5 (25)	0.27
Mechanical ventilation	7 (25)	4 (20)	0.12
Central venous catheter	1 (3.6)	1 (5)	0.07
No. of specialists, mean (*SD*)	5.7 (2)	5.7 (1.8)	0.02
Hospital use in prior 12 months, mean (*SD*)			
Emergency department visits	1.1 (1.1)	1.1 (1)	0.09
Hospital admissions	3.3 (1.9)	3.2 (1.8)	0.07
ICU admissions	1.3 (1.4)	1 (1.4)	0.21
ICU days	8.3 (12.1)	10.2 (21.6)	0.1
Caregiver and household characteristics			
Distance (mi) from home to tertiary care center, mean (*SD*)	68.7 (49.7)	57.7 (55.2)	0.21
Caregiver education level, *n* (%)			0.86
High school (with or without degree)	7 (26.9)	3 (15)	
Some college	7 (26.9)	2 (10)	
Associate degree	3 (11.5)	3 (15)	
College or graduate degree	9 (34.6)	12 (60)	
Household annual income, *n* (%)			1.1
< $25,000	8 (28.6)	2 (10)	
$25,000-$49,999	6 (21.4)	4 (20)	
$50,000-$74,999	7 (25)	3 (15)	
$75,000-$100,000	3 (10.7)	7 (35)	
> $100,000	1 (3.6)	4 (20)	
Household size, mean (*SD*)	4.2 (1.4)	4.2 (1.5)	0.03
No. of other children in household, mean (*SD*)	1.54 (1.36)	1.30 (1.17)	0.19

Note. *SD, standard deviation; TMVV,* telemedicine video visits *ICU,* intensive care unit; VP, ventriculoperitoneal; *SMD,* standardized mean difference.

establishing goals (70%), and teach-back (58%; Supplementary Table 1).

On postvisit surveys, parents rated TMVV highly for acceptability, usability, functionality, and experience (Table 2). Parents reported TMVV was (1) an acceptable method for health care services, (2) comparable to in-person visits, and (3) helpful in improving access to post-hospitalization health care. The usability and quality of TMVV were rated highly, with few reports of technical issues. Parents reported that each TMVV yielded mean savings of $77.19 (standard deviation = $72.45) that would have been spent on travel for an in-person visit.

Preliminary Impact of TMVV

In pre/post within-group analyses, the TMVV group experienced significant decreases in hospitalization rate (risk ratio = 0.25; 95% confidence interval, 0.14−0.44; p <.001; Table 3) and nonstatistically significant reductions in ED visits, ICU days, and length of stay. The control group experienced significant reductions pre/post in all hospital use measures.

Parental self-reports of the level of CSE were similar for TMVV and control groups. The difference in FCAT score ratings of CSE from baseline to week 4 for the TMVV group was 2.12, and the difference in ratings of CSE for the control group was −3.34; difference-in-difference measurement between scores in both groups was 5.46 (p =.226). Similarly, parental self-report of changes over time in FSM —as measured by the change in FaMM instrument overall score from baseline to 3-month follow-up—demonstrated no significant differences between control versus intervention group (Supplementary Table 2).

TABLE 2. Posttelemedicine video visits (TMVV) parent experience survey responses

Survey Domain	Survey Item	Post-TMVV No. 1 (*n* = 15)[a]	Post-TMVV No. 2 (*n* = 13)[a]	Post-TMVV No. 3 (*n* = 10)[a]	Post-TMVV No. 4 (*n* = 8)[a]
Usability and experience[b]	I could easily talk to the provider during the video visit	6.53 (1.30)	6.77 (0.44)	6.80 (0.42)	6.88 (0.35)
	I could clearly hear the provider during the video visit	6.47 (1.06)	6.46 (0.97)	6.30 (1.34)	6.75 (0.46)
	I was able to express myself effectively	6.53 (1.30)	6.77 (0.44)	6.90 (0.32)	6.88 (0.35)
	I could see the provider on the video screen as well as if we met in person	6.87 (0.35)	6.77 (0.44)	6.90 (0.32)	6.62 (0.74)
	I was comfortable communicating with the provider during the video visit	6.47 (1.30)	6.77 (0.44)	6.90 (0.32)	6.88 (0.35)
	No. who encountered technical errors while using the video visit system (No. of yes response, %)	2 (13.3)	3 (23.1)	4 (40.0)	3 (37.5)
Acceptability and feasibility[c]	Video visits are just as useful as in-person visits	6.33 (1.05)	6.15 (1.34)	6.50 (0.53)	6.50 (0.53)
	Video visits are an acceptable way to receive health care services	6.27 (1.16)	6.31 (1.44)	6.60 (0.52)	6.50 (0.76)
	Video visits improved my access to health care services (after my child's hospitalization)	6.27 (1.53)	6.69 (0.85)	6.80 (0.42)	6.88 (0.35)
Functionality[c]	Quality of Internet connection	4.57 (0.65)	4.23 (1.01)	4.70 (0.48)	4.25 (0.89)
	Quality of equipment (video camera, electronic device)	4.27 (0.80)	4.31 (0.95)	4.70 (0.48)	4.62 (0.52)
	Quality of video image (focus, visual resolution, magnification)	4.47 (0.52)	4.62 (0.65)	4.70 (0.48)	4.62 (0.74)
	Quality of software	4.47 (0.64)	4.46 (0.78)	4.40 (0.97)	4.50 (0.76)

Note. SD, standard deviation.

[a]*Survey response rates: overall = 72%; TMVV No. 1 = 68%; TMVV No. 2 = 76%; TMVV No. 3 = 77%; TMVV No. 4 = 67%.*

[b]*Mean (SD); responses on 1–7 scale (1 = strongly disagree; 7 = strongly agree).*

[c]*Mean (SD); responses on 1–5 scale (1 = poor; 5 = excellent).*

TABLE 3. Pre/post[a] within-group comparison of hospital use

Outcome[b]	TMVV				No TMVV (Control)			
	Pre	Post	*p*	Effect Size (95% CI)	Pre	Post	*p*	Effect Size (95% CI)
ED visits[c]	2.9	1.3	.87	OR = 1.07 (0.47–2.46)	2.9	0.1	<.001	OR = 0.01 (0.002–0.03)
Hospitalizations[d]	8.8	2.6	<.001	RR = 0.25 (0.14–0.44)	8.6	1.8	<.001	RR = 0.22 (0.11–0.44)
ICU days[d]	20.6	5.3	.072	RR = 0.25 (0.06–1.13)	27.8	1.9	<.001	RR = 0.03 (0.01–0.15)
Length of stay[d]	36.8	19.6	.064	RR = 0.47 (0.21–1.05)	43.7	7.2	<.001	RR = 0.16 (0.10–0.26)

Note. *TMVV,* telemedicine video visits; CI, confidence interval, *ED,* emergency department; *ICU,* intensive care unit; *OR,* odds ratio; *RR,* risk ratio; GEE, general estimating equations.

[a]*Pre-period = 3 months before date of index hospital admission; post-period = 3 months after date of index hospital discharge.*

[b]*All outcomes were measured as rates per 1,000 patient days.*

[c]*Estimated via GEE logistic regression with effect size reported as OR.*

[d]*Estimated via GEE negative binomial regression with effect size reported as RR.*

DISCUSSION

In this pilot study, post-hospitalization TMVV to support hospital-to-home transitions for CMC were feasible and acceptable. Feasibility was demonstrated by prompt connection (50% of visits connected by 1 min) and high completion rate for scheduled visits (75%); acceptability was demonstrated by high ratings on family-reported post-TMVV experience surveys. Fidelity to the four-visit post-hospitalization TMVV protocol was moderate (54% completed all four visits). Evaluation of the implementation of the study protocol was mixed. The study decline rate was relatively low (14.3%), enrollment was high among CMC reached before hospital discharge (85.7%), and family-reported survey response rates were high (72% to 75%). However, study withdrawal was high (32%), and most eligible patients could not be reached for in-person recruitment before hospital discharge (86.6%). In-person recruitment before hospital discharge was likely hampered by the chaotic nature of hospital discharge processes (Leyenaar et al., 2017).

Demonstration of feasibility and acceptability in this pilot study supports consideration of future prospective trials of post-hospitalization TMVV. However, refinement of the TMVV intervention and protocol to reduce visit burden should be considered. Multiple postdischarge home visits or phone calls are associated with reduced hospital readmission (Branowicki et al., 2017); however, these prior studies involved adults with chronic conditions instead of CMC. For CMC in our study, conflict with work/school schedules was commonly reported by parents who declined enrollment and/or voluntarily withdrew before study completion. In addition, to account for a limited clinical indication for subsequent TMVV beyond the first visit—as was noted for some patients by our provider—a revised approach could be to schedule one post-hospitalization TMVV in the first week after discharge with options for more visits as clinically indicated, as opposed to a standard four-visit protocol. Finally, alternate study recruitment strategies (e.g., embedding research staff with hospital teams to facilitate predischarge contact with eligible patients) could mitigate the research challenges we encountered.

In this study, the content of each TMVV is built on prior studies describing the preferences of families of CMC during hospital-to-home transitions. Prior studies involving families of CMC recommended that transitions focus on family engagement, CSE, care continuity, home contingency planning, and teach-back (Desai et al., 2016; Leyenaar et al., 2017; Leyenaar et al., 2018). The inclusion of these core elements in our TMVV templates and high completion rates during each visit may help explain high parental acceptability and satisfaction with post-hospitalization TMVV in our study. In addition, our visit template's inclusion of postdischarge teaching, review of medications and home equipment/supplies, and direct assessment of the patient and home environment were similar to previously described postdischarge nursing-led home visits for CMC (Wells et al., 2017). Our approach complements this prior study by focusing on progress toward family-centered care goals during hospital-to-home transitions and translating core elements of postdischarge care for CMC from in-person to a virtual platform.

Pre/post improvements in subsequent hospital use were observed for both the TMVV and control groups. Our finding of significant reductions in hospitalization rate 3 months postdischarge within the TMVV group aligned with a recent small trial of TMVV for CMC (Notario et al., 2019). Although postintervention reductions in other hospital use measures (ED visits, ICU days, length of stay) were not statistically significant within the TMVV group in our study, similar use trends have been reported in other telehealth studies involving CMC (Casavant, McManus, Parsons, Zurakowski, & Graham, 2014; Notario et al., 2019). In our study, pre/post reductions in hospital use within each group (TMVV or control) were confounded by small sample size, impact on hospital use by unmeasured factors (history bias), differences in socioeconomic and education status between groups (e.g., a lower proportion of control group publicly insured; 60% of parents in the control group with college/graduate degrees), and regression to the mean (temporal bias) among high hospital users (Handley, Lyles, McCulloch, & Cattamanchi, 2018). Additional factors such as concurrent receipt of longitudinal complex care within the CCS for

intervention patients and declines in overall hospitalizations at children's hospitals during the early COVID-19 pandemic (Markham et al., 2021) also likely confounded the effects of TMVV. These same confounders may also help explain the lack of significant changes in family-reported levels of CSE and FSM within the TMVV group.

This study had several strengths. First, we integrated post-hospitalization TMVV into routine care using existing clinical staff, technology, and EHR documentation tools, thus enhancing relevance and usability to families and clinicians. Second, continuity of care between hospital and home was facilitated by embedding TMVV within an existing complex care program that took responsibility for each patient before and after hospital discharge. Third, central to the design and evaluation of the TMVV intervention were components and measures of importance to families of CMC. For example, we incorporated core elements into TMVV to address family-reported gaps in hospital-to-home transitions for CMC (Desai et al., 2016; Leyenaar et al., 2017; Leyenaar et al., 2018). Although the FCAT and FaMM have not been validated specifically for CMC, these published, family-reported surveys measure proximal outcomes (e.g., CSE [Coleman et al., 2015]; FSM [Knafl et al., 2011]) conceptually linked to distal health care use outcomes (Grey et al., 2015). Finally, we incorporated a control group of CMC to compare outcomes and our study's measurement domains (e.g., family experience, implementation, outcomes) aligned with best practice recommendations for evaluating pediatric telehealth programs (Chuo, Macy, & Lorch, 2020).

Several limitations of this study need to be considered. First, this was a single-center study with TMVV delivered by an established pediatric complex care program, thus limiting generalizability to other care settings. However, given the growth in the number of complex care programs caring for CMC (Pordes et al., 2018), understanding how to incorporate emerging care modalities like TMVV into post-hospitalization care are increasingly important. Second, the nonrandomized study design limited outcome comparisons. Randomization was not feasible because of the primary study aim of feasibility, small numbers of eligible patients, and ethical concerns of the complex care clinical team if TMVV were withheld from eligible CMC. Third, to assist with recruitment, CMC enrolled in the longitudinal complex care program were eligible as control and intervention participants, which may have contaminated intervention effects. To mitigate these effects, for the six CMC who crossed over as control and TMVV participants, their 3-month control follow-up period and associated surveys were completed before they became eligible for the TMVV intervention. fourth, this study was mostly conducted before the start of the COVID-19 pandemic, and the applicability of post-hospitalization TMVV to the post-COVID-19 health care landscape remains to be seen. However, given the rapid adoption of telehealth during the pandemic (Wosik et al., 2020), family-reported preferences for TMVV, and recent studies conducted among CMC before and during the COVID-19 pandemic demonstrating the feasibility of telemedicine (Onofri et al., 2021) and the effectiveness of telemedicine on health service use and costs (Mosquera et al., 2021), it is expected that TMVV will remain relevant for the future care of CMC and further research is critically needed (Curfman et al., 2021). Finally, families without requisite technology to participate in TMVV were excluded. Given the digital divide in broadband Internet access (Bauerly, McCord, Hulkower, & Pepin, 2019; Pew Research Center, 2021) and digital literacy (Nouri, Khoong, Lyles, & Karliner, 2020) that disproportionately affects patients who identify as nonmajority races/ethnicities and patients from rural areas, efforts to improve access to TMVV for all families will be critical to health equity in the telehealth era and avoiding the exacerbation of health disparities that have emerged during the COVID-19 pandemic (Katzow, Steinway, & Jan, 2020).

Overall, these findings add to the telehealth literature for CMC as the first study to our knowledge that evaluated the feasibility of TMVV specifically during hospital-to-home transitions. Posthospitalization has always been a vulnerable phase of care for CMC (Desai et al., 2016; Leyenaar et al., 2017); now, during the COVID-19 pandemic, post-hospitalization care for CMC is even more essential. Because CMC have represented 40% of hospitalized children with COVID-19 (Shekerdemian et al., 2020), they are at-risk during the pandemic for post-hospitalization fragmentation of the network of providers and caregivers critical to maintaining day-to-day health (Wong, Ming, Maslow, & Gifford, 2020).

Conclusions

Posthospitalization TMVV for CMC within a complex care program was feasible and acceptable. These findings can be used as part of other complex care programs' care delivery models. Important future directions include understanding which clinical scenarios can benefit most from post-hospitalization TMVV, adapting post-hospitalization TMVV to best meet the needs of individual CMC, ensuring equitable access for CMC to TMVV, and rigorously evaluating the intervention in varied clinical settings and diverse patient populations.

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BOX 1. SUPPLEMENTARY

Standardized electronic health record (EHR) note template for telemedicine video visits

Complex care service telemedicine visit
Primary source of history:
Primary language:
Discharge date:
Visit start time/end time/total minutes:
History of Present Illness:
New concerns:
Review of systems:
Nutrition:
Route:
Formula type (if tube-fed):
Current regimen (volume, frequency, rate):
Objective:
Physical exam:
Medications:
Assessment/plan:

1. Focused response to parental concerns and postdischarge medical concerns/issues

(Changes in meds/prescriptions needed, equipment, referrals, discussion of power of attorney (POA) and/or code status options, advocacy, need for the in-person visit)

1. Review of home emergency/contingency plans

What plan was discussed with parents (describe)?
Teach-back used to confirm parent understanding? Yes/No
(Target symptoms/side effects to monitor and what to do should they arise when to call primary care pediatrician versus go to emergency department/include dates of prescription medications (expiration date)

1. Medication reconciliation

Completed: Yes/No
Discrepancies identified: Yes/No

1. Complex care plan

Reviewed with parent: Yes/No
Changes updated in Epic: Yes/No

1. Parent-reported care goals

Goals reviewed with parent: Yes/No
Goal 1:
Date originally set:
Describe progress since last visit:
Current status/outcome:
Changes/updates for the upcoming week:
Goal 2:
Date originally set:
Describe progress since last visit:
Current status/outcome:
Changes/updates for the upcoming week:
Goal 3:
Date originally set:
Describe progress since last visit:
Current status/outcome:
Changes/updates for the upcoming week:

1. Upcoming follow-up appointments

Reviewed upcoming appointments with parents: Yes/No
Next telemedicine video visits scheduled for:
Care Coordination (pulled in from patient's EHR chart):
Problem list:
Past medical history:
Past surgical history
Demographics:
Care teams:
Primary care provider:
Specialty care providers:
Outpatient care coordination team
Preferred pharmacy

BOX 2. SUPPLEMENTARY

Criteria to define children with medical complexity (CMC)

[¥]To qualify as a CMC, all five of the following criteria must be met:

1. "Yes" response for Children with Special Health Care Needs Screener question indicating "need for more care than usual"
2. "Yes" response to 3 of 4 of the remaining Children with Special Health Care Needs Screener questions
3. Need for medical technology[#] to maintain daily functioning
4. Seen by ≥ 3 subspecialists in the past 12 months (at Duke Children's Hospital/Medical Center)
5. High resource use[¢]

[#]Medical technology defined as the long-term need for any one of the following:

1. VP shunt
2. Long-term enteral feeding tube (e.g., G-tube, J-tube, gastrojejunal, etc.)
3. Long-term central venous catheter (e.g., Broviac)
4. Tracheostomy
5. Mechanical ventilation-dependent (includes traditional ventilator or bilevel positive airway pressure)

(*Note: other equipment such as supplemental oxygen, continuous positive airway pressure, mobility aids/devices, insulin needles/syringes, glucometers, VNS, etc., are not sufficient to meet the medical equipment criteria)

[¢]High resource use defined as any one of the following in the past 12 months:

1. ≥ 6 Emergency department visits
2. ≥ 2 Admissions (Duke Children's only—including current hospitalization)
3. ≥ 1 Pediatric intensive care unit admission (Duke Children's only—including current hospitalization)

SUPPLEMENTARY TABLE 1. Completion of core elements of telemedicine video visits (TMVV)

Core TMVV component observed[a]	Proportion of visits with core component completed, %
Check-in with caregiver	81
Review upcoming appointments	81
Address parental concerns	79
Directly visualize patient	78
Medication reconciliation	70
Set new goals (for next visit)	70
Review chart (care plan in EHR, prior TMVV notes)	64
Review progress toward goals	64
Schedule next TMVV	59
Review complex care plan	59
Teach-back (home contingency plans, return to clinic precautions)	58
Directly visualize home equipment	56
Check-in with the patient (if applicable)	56
Watch parent perform care tasks (if necessary—e.g., operate feeding pump, change tracheostomy tube)	15

Note. *EHR,* electronic health record.

[a]*Research team assistant observed visits for completion of core components.*

SUPPLEMENTARY TABLE 2. Changes in family self-management among telemedicine video visit (TMVV) and control group participants

FaMM subscale	TMVV Participants						No TMVV (Control)						
	Baseline (n = 26)[a]			3-Month (n = 10)			Baseline (n = 21)			3-Month (n = 20)			
	Mean	*SD*	Range	Mean	*SD*	Range	Mean	*SD*	Range	Mean	*SD*	Range	p[b]
Child's daily life scale	12.6	4.1	5–19	10	4.9	5–19	12.4	3.9	6–19	12.5	4.5	5–23	.297
Condition management ability scale	44.4	5.3	32–53	42.6	7.6	31–52	43.6	6.5	29–54	45.5	6.6	34–54	.035*
Condition management effort scale	16.4	3.1	11–20	16.6	2.9	11–20	17.4	2.6	12–20	17.6	2.1	14–20	.532
Family life difficulty scale	37.8	10.2	14–58	42.2	8.7	30–58	40.3	10.3	16–57	40	9.3	19–54	.279
Parent mutuality scale	34.3	6	23–40	34.3	6.9	23–40	36	4.3	29–40	36.3	3.5	30–40	.035*
View of condition impact scale	34.5	6.3	22–44	35.7	7.7	18–46	33.9	8.4	16–44	33.3	8.2	19–44	.92
Overall scale	170.8	21.8	131–207	167.7	23.4	128–194	176.3	23.1	129–208	177.9	22.2	132–203	.31

Note. *SD, standard deviation*; FaMM, family management measure.

*** Denotes p-value <0.05.*

[a]*Survey response rates: overall = 75%; TMVV baseline = 93%; TMVV 3-month follow-up = 36%; non-TMVV baseline = 95%; non-TMVV 3-month follow-up = 75%.*

[b]*p value for difference-indifference comparison between TMVV versus non-TMVV groups.*