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ORIGINAL ARTICLE

Determinants of telemedicine adoption among financially distressed patients with cancer during the COVID-19 pandemic: insights from a nationwide study

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Abstract

Purpose Telemedicine use during the COVID-19 pandemic among financially distressed patients with cancer, with respect to the determinants of adoption and patterns of utilization, has yet to be delineated. We sought to systematically characterize telemedicine utilization in financially distressed patients with cancer during the COVID-19 pandemic.

Methods We conducted a cross-sectional analysis of nationwide survey data assessing telemedicine use in patients with cancer during the COVID-19 pandemic collected by Patient Advocate Foundation (PAF) in December 2020. Patients were characterized as financially distressed by self-reporting limited financial resources to manage out-of-pocket costs, psychological distress, and/or adaptive coping behaviors. Primary study outcome was telemedicine utilization during the pandemic. Secondary outcomes were telemedicine utilization volume and modality preferences. Multivariable and Poisson regression analyses were used to identify factors associated with telemedicine use.

Results A convenience sample of 627 patients with cancer responded to the PAF survey. Telemedicine adoption during the pandemic was reported by 67% of patients, with most (63%) preferring video visits. Younger age (19–35 age compared to ≥ 75 age) (OR, 6.07; 95% CI, 1.47–25.1) and more comorbidities (≥ 3 comorbidities compared to cancer only) (OR, 1.79; 95% CI, 1.13–2.65) were factors associated with telemedicine adoption. Younger age (19–35 years) (incidence rate ratios [IRR], 1.78; 95% CI, 24–115%) and higher comorbidities (≥ 3) (IRR; 1.36; 95% CI, 20–55%) were factors associated with higher utilization volume. As area deprivation index increased by 10 units, the number of visits decreased by 3% (IRR 1.03, 95% CI, 1.03–1.05).

Conclusions The rapid adoption of telemedicine may exacerbate existing inequities, particularly among vulnerable financially distressed patients with cancer. Policy-level interventions are needed for the equitable and efficient provision of this service.

Keywords Telemedicine · Telehealth · Cancer · Financial distress · Toxicity · COVID-19 · Pandemic · Adoption · Utilization

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Introduction

Telemedicine employs audiovisual telecommunications technology to engage with or monitor individuals for health-related purposes and to provide health care to populations with restricted access to care [1]. The anticipated shortage of oncologists in the USA, as well as the low availability of oncologic care in geographically rural locations, provides compelling justification for the adoption and expansion of telemedicine services in cancer [2, 3]. Telemedicine services, deployed synchronously or asynchronously, can help strategically redistribute the oncology workforce and reduce the disruption cancer can bring to patients' lives [4].

Prior to the pandemic, telemedicine was associated with comparable efficacy to in-person care management at lower costs and high satisfaction levels among patients with cancer and health professionals [1]. Telemedicine can also facilitate remote symptom management, chemotherapeutic supervision, palliative care, and psychological support [4–6]. As the SARS-CoV-2 (COVID-19) pandemic spread across the globe, patients with cancer suffered compromised care, including delays in treatment, cancer screening tests [7], and referrals to specialists [8], because of concerns about treatment-related complications and facility-based exposure to COVID-19 [9, 10]. To circumvent the crisis, telemedicine use was recommended to limit the risk of facility-based viral transmission, protect patients with chronic diseases who require ongoing medical treatment, and conserve personal protective equipment [11]. It has also measurably reduced the need for immunocompromised patients with cancer to visit the hospital at a time when they are at high risk of death due to COVID-19 [12].

Expansion of telemedicine has been proposed as an innovative strategy for reducing healthcare expenditures and out-of-pocket patients' expenses and thus relieving some of the burden of financial toxicity [13]. Financial toxicity denotes the economic harm and accompanying psychological distress to patients and their families brought about by the high direct and indirect costs associated with care for a medical condition [14]. Patients with cancer are a population characterized by a high prevalence of financial toxicity owing to high costs of therapeutics, utilization of high-deductible health plans, guideline-recommended multi-modal treatments in advanced disease, as well as treatment-related employment changes or loss [15, 16]. Accordingly, 45–73% of cancer survivors report some manifestation of financial toxicity according to subjective and material conditions measures [16, 17]. The thoughtful deployment of virtual encounters might engender reductions in patient medical and nonmedical out-of-pocket costs, avoidance of unnecessary hospital visits, and minimization of employment disruption [18, 19].

However, to the best of our knowledge, telemedicine adoption rates among financially distressed patients with cancer have not been described during the pandemic, and no study has assessed the determinants of telemedicine adoption and utilization within this vulnerable population. The present study leverages a cross-sectional national survey to investigate patterns and drivers of telemedicine utilization in financially under-resourced patients with cancer during the COVID-19 pandemic. We hypothesized that certain demographic characteristics such as socioeconomic status, age, and number of comorbidities are differentially associated with telemedicine adoption and utilization.

Methods

Study design

The Patient Advocate Foundation (PAF) distributed nationwide surveys at two time points: (1) May 20 to July 11, 2020, and (2) December 2 to December 23, 2020, via email to recipients of PAF services from July 2019 through April 2020. Only the second survey "wave" (i.e., December 2–23, 2020) contained questions that comprehensively addressed the use of telemedicine services during the pandemic. The present study is a cross-sectional analysis of the convenience sample of patients with cancer who responded to the second survey wave ($N = 627$). Non-response generated up to three reminder emails and participation was completely voluntary. Survey incentivization entailed random drawings for multiple $50 gift cards. The survey contained questions that focused on individual experiences with telemedicine adoption, utilization, preferences, perceived advantages, and barriers to utilization (supplementary materials). This study was approved by The University of Texas MD Anderson Cancer Center Institutional Review Board, and the reporting of our results is consistent with Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations [20].

Participants

This study included adults with a cancer diagnosis who had previously reported financial distress and received social needs navigation or financial assistance from PAF. PAF is a 501(c)(3) non-profit organization that provides social needs navigation and various forms of financial assistance to patients with a diagnosis of a chronic illness within the USA. PAF beneficiaries, including those with a cancer diagnosis, may be characterized by the presence of one or more of the following multidimensional consequences of financial toxicity: limited financial resources to manage out-of-pocket costs, psychological distress, and adaptive coping behaviors

[21]. Study inclusion criteria included a valid email address, participant age of 18 years or older, prior consent to receive survey communication from PAF, and the ability to complete the survey in English.

Outcome and covariables

Our primary outcome was telemedicine utilization during the pandemic. A telemedicine visit is defined as a self-reported synchronous live face-to-face encounter via a computer or smartphone with a videoconferencing platform (e.g., Skype, FaceTime, Zoom, Google chat, etc.) or visit that was conducted over the phone with a provider. To facilitate our analysis, patients were a priori categorized into the following three groups: "telemedicine naïve" (i.e., have never used telemedicine), "early telemedicine users" (i.e., used telemedicine prior to the pandemic), and "pandemic adopters" (i.e., began using telemedicine during the COVID-19 pandemic). Secondary outcomes were telemedicine utilization volume and preferences (video only, audio only, or no format preference). Pandemic telemedicine adopters were grouped into three categories: low volume utilizers (one visit), modest volume utilizers (2–5 visits), and high-volume utilizers (> 5 visits).

The following patient-level information was abstracted from the PAF database and linked to survey responses: age, race and ethnicity, sex, area deprivation index scores (ADI), annual household income, and marital status. Current insurance coverage, employment status, education level, and self-reported rural–urban status were collected directly within the survey tool. ADI is a validated composite area–level description of socioeconomic disadvantage that reflects education, poverty, housing, and employment [22]. Scores are based on census tract FIPS (Federal Information Processing Standard) codes and range from 1 to 100, with higher scores indicating greater disadvantage. Respondents self-reported comorbidities from a list for which they are currently or should be receiving treatment; comorbidities were classified as 0 (cancer only), 1–2, or 3 + number of comorbidities.

Statistical analysis

Descriptive statistics such as means, standard deviations, medians, and interquartile ranges (IQR) were used to summarize continuous variables. Categorical variables were presented using frequencies and percentages. Chi-squared or Fisher's exact tests were used to assess the association between categorical variables and study groups. The Kruskal–Wallis test was used to compare continuous variables among study groups, followed by Dunn's test for pairwise comparison when a significant difference was detected. We adjusted for multiple comparisons using Holm's sequential Bonferroni procedure. The Cochran-Armitage trend test was applied to assess the trend of probability of outcomes among ordinal categories. Multivariable logistic regression models were used to estimate the odds of adopting telemedicine during the pandemic using odds ratios (OR) and corresponding 95% confidence intervals (CI). Univariate and multivariable Poisson regression models estimated the incidence rate ratios (IRRs) of the number of telemedicine visits during the pandemic among patient groups. All models were adjusted for age, sex, race and ethnicity, region, annual household income, household size, marital status, employment status, ADI score, cancer type, and number of comorbidities. The stepwise model selection method was used to fit the most parsimonious statistical models, using the Akaike selection criterion. Missing values were imputed using single imputation. Normal distribution was used to impute the interval variables, and multinomial distribution was used for categorical variables. Spearman's rank correlation was computed to assess the relationship between worsening ADI status and telemedicine utilization volume. Two-tailed p-values < 0.05 were considered statistically significant, and all analyses were performed using SAS Enterprise Guide version 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

Patient demographics

Of the 627 survey respondents that comprise the analytic sample, 63% ($n = 395$) of patients were White, and 70% ($n = 439$) were female. The majority of patients (57.8%, $n = 362$) were between the ages of 56 and 75, 33.8% ($n = 212$) were between the ages of 36 and 55, 5.4% ($n = 34$) were over the age of 75, and 3.0% ($n = 19$) were between the ages of 19 and 35. The mean ADI was 47.1 ± 27.2, and the plurality of patients had hematologic cancers (33%; $n = 209$), followed by breast cancer (32.7%; $n = 205$), genitourinary/gynecological cancers (8.8%, 55), gastrointestinal cancer (6.2%, $n = 39$), thoracic cancer (2.1%, $n = 13$), and others (16.9%, $n = 106$). The largest percentages of patients were from suburban (48%; $n = 301$) or urban (27%; $n = 169$) areas, and the Southern USA (48%, $n = 299$). For the largest percentage of patients, annual household income range was $24,000–$47,999 (41%, $n = 254$) and the highest level of educational attainment was some college (38%, $n = 224$). The majority of patients (51%) were insured by Medicare, followed by private insurance (19%). Complete patient demographic information is provided in Table 1.

Among survey respondents, 27% identified as telemedicine-naïve, 6% were early telemedicine users, and 67% were pandemic adopters. Of the patients who had used telemedicine, 49% ($n = 197$) received video visits, 24% ($n = 99$) received audio visits, and 27% ($n = 108$) received both. Patients with

Table 1 Respondent demographic and clinical characteristics ($N=627$)

Number of patients	All $N=627$ *n* (%)	Early telemedicine users $n=38$ *n* (%)	Pandemic adopters $n=422$ *n* (%)	Telemedicine naïve $n=167$ *n* (%)	*p*-value
Age group					**0.002**
19 to 35	19 (3.0)	3 (7.9)	16 (3.8)	0 (0)	
36 to 55	212 (33.8)	18 (47.4)	137 (32.5)	57 (34.1)	
56 to 75	362 (57.7)	16 (42.1)	252 (59.7)	94 (56.3)	
Over 75	34 (5.4)	1 (2.6)	17 (4)	16 (9.6)	
Gender					0.989
Female	439 (70.0)	27 (71.1)	295 (69.9)	117 (70.1)	
Male	188 (30.0)	11 (28.9)	127 (30.1)	50 (29.9)	
Race/ethnicity					0.777
White	395 (63.0)	24 (63.2)	272 (64.5)	99 (59.3)	
Black	130 (20.7)	7 (18.4)	86 (20.4)	37 (22.2)	
Hispanic/Latino	43 (6.9)	4 (10.5)	26 (6.2)	13 (7.8)	
Other	37 (5.9)	1 (2.6)	24 (5.7)	12 (7.2)	
Unknown	22 (3.5)	2 (5.3)	14 (3.3)	6 (3.6)	
Region					0.217
Midwest	112 (17.9)	4 (10.5)	73 (17.3)	35 (21)	
Northeast	104 (16.6)	4 (10.5)	74 (17.5)	26 (15.6)	
South	299 (47.7)	18 (47.4)	205 (48.6)	76 (45.5)	
West	109 (17.4)	12 (31.6)	68 (16.1)	29 (17.4)	
Unknown	3 (0.5)	0 (0)	2 (0.5)	1 (0.6)	
Annual household income					**0.047**
≤$23,999	191 (30.5)	9 (23.7)	125 (29.6)	57 (34.1)	
$24,000–$47,999	254 (40.5)	19 (50)	169 (40)	66 (39.5)	
$48,000–$71,999	106 (16.9)	4 (10.5)	77 (18.2)	25 (15)	
$72,000–$95,999	39 (6.2)	0 (0)	29 (6.9)	10 (6)	
$96,000–$119,999	32 (5.1)	6 (15.8)	18 (4.3)	8 (4.8)	
Unknown	5 (0.8)	0 (0)	4 (0.9)	1 (0.6)	
Household size					0.699
1	178 (28.4)	8 (21.1)	116 (27.5)	54 (32.3)	
2	229 (36.5)	13 (34.2)	155 (36.7)	61 (36.5)	
3	101 (16.1)	7 (18.4)	70 (16.6)	24 (14.4)	
4+	119 (19.0)	10 (26.3)	81 (19.2)	28 (16.8)	
Marital status					0.475
Married, or living as married	280 (44.7)	16 (42.1)	196 (46.4)	68 (40.7)	
Divorced/separated/widow	164 (26.2)	8 (21.1)	109 (25.8)	47 (28.1)	
Single	165 (26.3)	14 (36.8)	105 (24.9)	46 (27.5)	
Unknown	18 (2.9)	0 (0)	12 (2.8)	6 (3.6)	
Employment status					0.580
Employed	338 (53.9)	26 (68.4)	227 (53.8)	85 (50.9)	
Disabled	3 (0.5)	0 (0)	2 (0.5)	1 (0.6)	
Retired	187 (29.8)	8 (21.1)	123 (29.1)	56 (33.5)	
Unemployed/other	99 (15.8)	4 (10.5)	70 (16.6)	25 (15)	
Education level					0.374
Advanced degree	103 (16.4)	7 (18.4)	70 (16.6)	26 (15.6)	
Bachelor's degree	165 (26.3)	14 (36.8)	115 (27.3)	36 (21.6)	
Some college	224 (35.7)	10 (26.3)	144 (34.1)	70 (41.9)	
High school or less	131 (29.9)	7 (18.4)	89 (21.1)	35 (21)	

Table 1 (continued)

Number of patients	All $N=627$ *n* (%)	Early telemedicine users $n=38$ *n* (%)	Pandemic adopters $n=422$ *n* (%)	Telemedicine naïve $n=167$ *n* (%)	*p*-value
Unknown	4 (0.6)	0 (0)	4 (0.9)	0 (0)	
Insurance					**0.002**
Medicare	317 (50.6)	16 (42.1)	215 (50.9)	86 (51.5)	
ACA Exchange	37 (5.9)	2 (5.3)	25 (5.9)	10 (6)	
COBRA	20 (3.2)	5 (13.2)	15 (3.6)	0 (0)	
Medicaid	62 (9.9)	1 (2.6)	46 (10.9)	15 (9)	
None	16 (2.6)	1 (2.6)	6 (1.4)	9 (5.4)	
Private employer	120 (19.1)	11 (28.9)	78 (18.5)	31 (18.6)	
Unknown	55 (8.8)	2 (5.3)	37 (8.8)	16 (9.6)	
Rural–urban commuting area					0.330
Rural	132 (21.1)	7 (18.4)	93 (22)	32 (19.2)	
Suburban	301 (48)	20 (52.6)	208 (49.3)	73 (43.7)	
Urban	169 (27.0)	10 (26.3)	104 (24.6)	55 (32.9)	
Unknown	25 (4.0)	1 (2.6)	17 (4)	7 (4.2)	
Area deprivation index					0.189
Mean ± SD	47.07 ± 27.22	40.53 ± 27.89	46.58 ± 26.58	49.81 ± 28.51	
Median (IQR)	46 (25, 69)	33 (17.5, 66)	46 (26, 66)	51.5 (26, 74)	
Cancer type					0.616
Breast	205 (32.7)	10 (26.3)	140 (33.2)	55 (32.9)	
Gastrointestinal	39 (6.2)	1 (2.6)	29 (6.9)	9 (5.4)	
GU/Gyn	55 (8.8)	2 (5.3)	32 (7.6)	21 (12.6)	
Hematologic	209 (33.3)	15 (39.5)	140 (33.2)	54 (32.3)	
Thoracic	13 (2.1)	1 (2.6)	8 (1.9)	4 (2.4)	
Other	106 (16.9)	9 (23.7)	73 (17.3)	24 (14.4)	
Number of comorbidities					**0.035**
0 (cancer only)	239 (38.1)	16 (42.1)	147 (34.8)	76 (45.5)	
1–2	215 (34.3)	17 (44.7)	148 (35.1)	50 (29.9)	
3+	173 (27.6)	5 (13.2)	127 (30.1)	41 (24.6)	

Chi-squared tests were used to calculate the *p*-values for categorical variables. The Kruskal Wallis tests were used to calculate the *p*-values for area deprivation index

ACA Affordable Care Act, *COBRA* Consolidated Omnibus Budget Reconciliation Act, *S.D.* standard deviation, *IQR* interquartile range, *G.U.* genitourinary, *Gyn* gynecological

*bold values indicate statistical significance

a household income of $23,999 or less, as well as uninsured patients, had a higher proportion of telemedicine naive patients than early telemedicine users and pandemic adopters (34.1% vs. 29.6, and 32.3 vs. 27.5, respectively). Among the pandemic telemedicine adopters, 19% were low volume utilizers, 57% were modest volume utilizers, and 24% were high-volume utilizers. Table 2 provides an outline of patient demographics according to frequency of telemedicine use.

Telemedicine utilization preferences across modalities

Sixty-three percent of pandemic adopters preferred live face-to-face video, 15% preferred audio only, and 21% had no preference. Twenty-eight percent of patients reported that their provider did not inquire about their preference for telemedicine. No association was detected between demographic variables and patients' preferences.

Patient perception of telemedicine advantages

When asked about the advantages of telemedicine visits over in-person care, patients who had received telemedicine reported that it was more affordable (29%), more convenient (28%), allowed them to access care sooner (17%), gave them access to expert care outside their immediate area (8%), and did not interfere with their ability to work (5%). 13% however, reported no perceived benefits.

Table 2 Respondent demographic and clinical characteristics by telemedicine utilization volume (*N* = 455)

Number of patients	Low volume utilizers *n* = 84 *n* (%)	Modest volume utilizers *N* = 260 *n* (%)	High-volume utilizers *n* = 111 *n* (%)	*p*-value
Age group				0.131
Over 75	5 (6)	10 (3.8)	3 (2.7)	
56 to 75	55 (65.5)	156 (60)	55 (49.5)	
36 to 55	23 (27.4)	83 (31.9)	46 (41.4)	
19 to 35	1 (1.2)	11 (4.2)	7 (6.3)	
Gender				0.634
Female	56 (66.7)	182 (70)	81 (73)	
Male	28 (33.3)	78 (30)	30 (27)	
Race/ethnicity				0.312
White	62 (73.8)	161 (61.9)	71 (64)	
Black	14 (16.7)	57 (21.9)	21 (18.9)	
Hispanic/Latino	4 (4.8)	16 (6.2)	10 (9)	
Other	2 (2.4)	18 (6.9)	4 (3.6)	
Unknown	2 (2.4)	8 (3.1)	5 (4.5)	
Region				0.233
Midwest	22 (26.2)	40 (15.4)	15 (13.5)	
Northeast	13 (15.5)	44 (16.9)	21 (18.9)	
South	34 (40.5)	134 (51.5)	51 (45.9)	
West	15 (17.9)	42 (16.2)	22 (19.8)	
Unknown	0 (0)	0 (0)	2 (1.8)	
Annual household income				0.499
≤ $23,999	20 (23.8)	72 (27.7)	42 (37.8)	
$24,000–$47,999	41 (48.8)	103 (39.6)	41 (36.9)	
$48,000–$71,999	13 (15.5)	50 (19.2)	17 (15.3)	
$72,000–$95,999	5 (6)	17 (6.5)	7 (6.3)	
$96,000–$119,999	5 (6)	15 (5.8)	4 (3.6)	
Unknown	0 (0)	3 (1.2)	0 (0)	
Household size				**0.021**
1	32 (38.1)	65 (25)	26 (23.4)	
2	28 (33.3)	104 (40)	35 (31.5)	
3	13 (15.5)	45 (17.3)	17 (15.3)	
4 +	11 (13.1)	46 (17.7)	33 (29.7)	
Marital status				0.684
Married, or living as married	44 (52.4)	116 (44.6)	50 (45)	
Divorced/separated/widow	19 (22.6)	65 (25)	32 (28.8)	
Single	19 (22.6)	71 (27.3)	27 (24.3)	
Unknown	2 (2.4)	8 (3.1)	2 (1.8)	
Employment status				0.351
Employed	41 (48.8)	140 (53.8)	70 (63.1)	
Disabled	0 (0)	2 (0.8)	0 (0)	
Retired	27 (32.1)	79 (30.4)	24 (21.6)	
Unemployed/other	16 (19)	39 (15)	17 (15.3)	
Education level				0.195
Advanced degree	12 (14.3)	38 (14.6)	25 (22.5)	
Bachelor's degree	22 (26.2)	69 (26.5)	36 (32.4)	
Some college	30 (35.7)	90 (34.6)	34 (30.6)	
High school or less	19 (22.6)	61 (23.5)	15 (13.5)	

Table 2 (continued)

Number of patients	Low volume utilizers $n=84$ *n* (%)	Modest volume utilizers $N=260$ *n* (%)	High-volume utilizers $n=111$ *n* (%)	*p*-value
Unknown	1 (1.2)	2 (0.8)	1 (0.9)	
Insurance				0.732
Medicare	45 (53.6)	131 (50.4)	53 (47.7)	
ACA Exchange	5 (6)	18 (6.9)	4 (3.6)	
COBRA	3 (3.6)	10 (3.8)	6 (5.4)	
Medicaid	7 (8.3)	23 (8.8)	17 (15.3)	
None	2 (2.4)	5 (1.9)	0 (0)	
Private employer	14 (16.7)	51 (19.6)	22 (19.8)	
Other/unknown	8 (9.5)	22 (8.5)	9 (8.1)	
Rural–urban commuting area				0.429
Rural	23 (27.4)	57 (21.9)	19 (17.1)	
Suburban	35 (41.7)	132 (50.8)	59 (53.2)	
Urban	22 (26.2)	64 (24.6)	26 (23.4)	
Unknown	4 (4.8)	7 (2.7)	7 (6.3)	
Area Deprivation Index				0.28
Mean ± SD	50 ± 28.13	45.71 ± 26.33	42.96 ± 25.77	
Median (IQR)	53 (26, 74)	44.5 (23.5, 66)	40.5 (25, 63)	
Cancer type				0.359
Breast	23 (27.4)	88 (33.8)	38 (34.2)	
Gastrointestinal	7 (8.3)	18 (6.9)	5 (4.5)	
GU/Gyn	6 (7.1)	22 (8.5)	4 (3.6)	
Hematologic	26 (31)	87 (33.5)	41 (36.9)	
Thoracic	1 (1.2)	7 (2.7)	1 (0.9)	
Other	21 (25)	38 (14.6)	22 (19.8)	
Number of comorbidities				**0.002**
0	44 (52.4)	90 (34.6)	29 (26.1)	
1–2	25 (29.8)	98 (37.7)	40 (36)	
3 +	15 (17.9)	72 (27.7)	42 (37.8)	

Chi-squared tests were used to calculate the *p*-values for categorical variables. The Kruskal Wallis tests were used to calculate the *p*-values for ADI

ACA Affordable Care Act, *COBRA* Consolidated Omnibus Budget Reconciliation Act, *S.D.* standard deviation, *IQR* interquartile range, *G.U.* genitourinary, *Gyn* gynecological

*bold values indicate statistical significance

Barriers to telemedicine utilization

Fifty-five percent of telemedicine naive patients stated that they had no reason to use telemedicine, while 36% stated that they would only use it for common health issues or questions. Of the patients who reported barriers to telemedicine use during the pandemic ($n=199$), 65% reported poor internet connectivity, 19% reported a lack of access to devices, and 16% reported discomfort or embarrassment with being on video. Patients who expressed concerns about using telemedicine during the pandemic ($n=200$) were concerned about the quality of care provided (46%), were concerned that telemedicine was a poor substitute for an in-person office visit (25%), were concerned that they lacked the necessary skills or training to use the technology (18%), and were concerned about the security and privacy of the information provided during the encounter (13%).

Factors associated with pandemic telemedicine utilization

Pandemic adopters were noted to be older and had more comorbidities than telemedicine naïve and early telemedicine users (Table 1). Adoption of telehealth was correlated with increasing numbers of comorbidities ($p=0.0097$). In adjusted models, telemedicine adoption was associated with 19–35 age compared to ≥ 75 age (OR, 6.07; 95% CI, 1.47–25.1), and ≥ 3 comorbidities compared to cancer only

(OR, 1.79; 95% CI, 1.13–2.65; Table 3). *Factors associated with utilization volume.*

High-volume utilizers had larger households, and more comorbidities (Table 2). A trend test demonstrated that the probability of high-volume telemedicine utilization increased as household size and the number of comorbidities increased. There was a negative correlation between ADI status and telemedicine utilization volume; as ADI increased, telemedicine utilization volume decreased ($r = -0.12$, $p = 0.022$). Patients aged 36 to 55 had 52% more telemedicine visits (IRR 1.52, 95% CI 1.13–2.05) than patients over the age of 75, and patients age 19 and 35 had 78% more visits (IRR 1.75, 95% CI, 1.24–2.55) than patients over the age of 75 (Table 4). Patients with 1–2 comorbidities had 21% more visits (IRR 1.21, 95% CI, 1.07–1.36) than those with cancer only, and patients with 3 or more comorbidities had 36% more visits (IRR 1.36, 95% CI, 1.20–1.55) than those with cancer only. As ADI increased by 10 units, the number of visits decreased by 3% (IRR 1.03, 95%CI, 1.03–1.05; Table 4).

Discussion

The onset of the COVID-19 pandemic radically transformed the provision of routine ambulatory care services by catalyzing a rapid increase in telemedicine adoption to preserve personal protective equipment and dampen viral transmission, particularly among immunocompromised patients with cancer [23]. The present study leveraged a large nationwide survey on the use of telemedicine in financially distressed patients with cancer, defined by the receipt of services from the PAF, during the COVID-19 pandemic. Our results indicate that telemedicine was adopted by 67% of patients, compared to 6% who were already using telemedicine pre-pandemic, representing an 11-fold increase. When faced with a choice between video and audio visits, most patients (63%) preferred video visits. In adjusted models, we found that younger age and having multiple comorbidities were associated with pandemic-related telemedicine adoption, increasing it by roughly six and two-fold, respectively. Among patients who adopted the technology, older patients and those with fewer comorbidities and higher ADI scores demonstrated lower telemedicine utilization rates.

These findings are consistent with prior studies that have associated older age (≥ 65 years) with lower rates of internet access and technology adoption [24]. Additionally, older patients have also been characterized by lower rates of digital health literacy, less online portal use, and pervasive privacy concerns about digital health technologies compared to younger patients [23, 25]. In our study, 18% of patients reported that they lacked the necessary skills or training to use telemedicine, and 13% were concerned about

Table 3 Univariable and multivariable logistic regression model of probability of telemedicine adoption ($N = 627$)

	Univariable model	Multivariable model
	OR (95%CI)	OR (95%CI)
Age group		
Over 75	Ref	Ref
56 to 75	2.29 (1.13–4.65)	2.28 (1.11–4.68)
36 to 55	1.83 (0.88–3.79)	2.01 (0.96–4.23)
19 to 35	5.33 (1.31–21.7)	6.07 (1.47–25.1)
Gender		
Female	Ref	
Male	1.02 (0.71–1.46)	
Race/ethnicity		
White	Ref	
Black	0.88 (0.58–1.35)	
Hispanic/Latino	0.69 (0.36–1.32)	
Other	0.83 (0.41–1.69)	
Region		
Midwest	Ref	
Northeast	1.32 (0.74–2.34)	
South	1.17 (0.74–1.84)	
West	0.89 (0.51–1.53)	
Annual household income		
≤ $23,999	Ref	
$24,000–$47,999	1.05 (0.71–1.56)	
$48,000–$71,999	1.40 (0.83–2.36)	
$72,000–$95,999	1.53 (0.70–3.33)	
$96,000–$119,999	0.68 (0.32–1.45)	
Area deprivation index (by 10-unit increase)	0.98 (0.92–1.05)	
Household size		
1	Ref	
2	1.12 (0.74–1.69)	
3	1.21 (0.72–2.04)	
4 +	1.14 (0.70–1.87)	
Marital status		
Married, or living as married	Ref	
Divorced/separated/widow	0.85 (0.56–1.28)	
Single	0.75 (0.50–1.13)	
Employment status		
Employed	Ref	
Disabled	0.98 (0.09–10.9)	
Retired	0.94 (0.64–1.37)	
Unemployed/other	1.18 (0.72–1.92)	
Education level		
Advanced degree	Ref	
Bachelor's degree	1.08 (0.64–1.84)	
Some college	0.85 (0.52–1.39)	
High school or less	1.00 (0.57–1.74)	
Insurance		

Table 3 (continued)

	Univariable model	Multivariable model
Medicare	Ref	
ACA Exchange	0.99 (0.48–2.05)	
COBRA	1.42 (0.50–4.02)	
Medicaid	1.36 (0.74–2.52)	
None	0.28 (0.10–0.80)	
Other/unknown	0.98 (0.53–1.80)	
Private employer	0.88 (0.57–1.37)	
Rural–urban commuting area		
Rural	Ref	Ref
Suburban	0.94 (0.60–1.47)	0.89 (0.57–1.39)
Urban	0.67 (0.41–1.09)	0.62 (0.38–1.01)
Cancer type		
Breast	Ref	
Gastrointestinal	1.35 (0.62–2.93)	
GU/Gyn	0.65 (0.35–1.19)	
Hematologic	0.94 (0.62–1.42)	
Thoracic	0.74 (0.23–2.36)	
Other	1.03 (0.62–1.70)	
Number of comorbidities		
0	Ref	Ref
1–2	1.38 (0.94–2.04)	1.41 (0.95–2.09)
3+	1.73 (1.13–2.65)	1.79 (1.15–2.76)

OR odds ratio, *ACA* Affordable Care Act, *COBRA* Consolidated Omnibus Budget Reconciliation Act, *G.U.* genitourinary, *Gyn* gynecological

the security and privacy of the information provided during the encounter. Therefore, future work is needed to delineate an implementation framework for the deployment of digital health technologies among older adults, one that ideally includes culturally competent communication practices and addresses prevailing concerns about data privacy. This implementation framework should also reflect the preference hierarchy for the various telemedicine modalities across patient demographic categories and address the barriers to telemedicine visits, such as lack of digital literacy, and broadband access and lack of smartphone utilization.

These disparities in both the use and willingness to leverage telemedicine have been cited in prior studies [26], and are highly salient in the context of financial toxicity because proponents of telemedicine cite its ability to mitigate travel burden, and employment disruptions, and increase access to health care and financial counseling. These benefits are supported by our findings that when compared to in-person visits, telemedicine was perceived as less expensive and more convenient, allowed patients to access care sooner and outside of their network, and did not interfere with work.

In our study, we found a higher proportion of telemedicine naïve patients among patients with low household income (< $23,999) and those who were uninsured. Additionally, we found that patients with smaller household sizes and higher ADI had lower telemedicine utilization rates. The financial difficulties that patients with cancer face might also serve to limit their access to telemedicine as evidenced by the considerable overlap between correlative factors for financial toxicity and low telemedicine adoption namely lower socioeconomic status, and ethnic/racial minority groups [23, 27]. Our findings suggest that the rapid adoption of telemedicine may exacerbate existing inequities, particularly among the vulnerable cancer population (i.e., elderly, residents of neighborhoods with high deprivation). Policy-level interventions such as maintaining coverage and payment parity in access to various telemedicine modalities [28], creating a reimbursement framework for digital health navigators [29], and increasing levels of investment towards the diffusion of broadband access will help mitigate the entrenchment of inequities in access to digital care ("digital divide") [30, 31]. Payment parity is critical as Medicare has announced that it will not compensate audio-only telehealth visits for evaluation and management after the declaration of the public health emergency period [28], creating potential inequities for patients without access to broadband or videoconferencing equipment. Policy interventions must ensure that telemedicine services are covered and reimbursed at the same level as in-person visits, regardless of insurance coverage status.

Lower telemedicine adoption rates, during the pandemic, have been documented among rural patients within a general medical context [32]. Access to cancer care services is a well-recognized challenge for residents of rural communities in light of the considerable travel distances to major centers for care that can incur indirect costs (employment disruption, travel, and accommodation costs) [33, 34]. The use of telemedicine and other technology-based approaches has been shown to measurably improve health care access and quality, as well as the survival outcomes of patients with cancer in rural areas [34, 35]. Furthermore, adoption of telemedicine in rural areas may aid in resolving the disparity in survival and disease-related outcomes that exists between metropolitan and non-metropolitan patients [36, 37]. In our study, we identified no differences in telemedicine adoption in individuals residing in rural, suburban, or urban areas. These findings may be indicative of demand-side factors wherein there is no discernable difference in patient-level preferences for telemedicine, across rural, suburban, and urban settings. A recent systematic review showed that rural cancer survivors significantly valued digital approaches to the management of their care [38]. This coupled with the ubiquity of smartphone devices and significant apprehension about the adverse consequences of disruptions or delays in cancer care may have motivated pandemic-related use of telemedicine among patients with cancer [39]. However, as

Table 4 Univariate analysis and multivariable Poisson regression models for the number of telemedicine visits ($N = 455$)

	Univariate regression model		Multivariable Poisson regression model
	Number of visits Mean ± S.D	p	IRR (95%CI)
Age group			
Over 75	2.61 ± 1.75	0.005	Ref
56 to 75	3.23 ± 1.81		1.28 (0.96–1.72)
36 to 55	3.64 ± 1.85		1.52 (1.13–2.05)
19 to 35	4.21 ± 1.69		1.78 (1.24–2.55)
Gender		0.561	
Female	3.42 ± 1.84		
Male	3.3 ± 1.81		
Race/ethnicity		0.303	
White	3.29 ± 1.86		
Black	3.37 ± 1.78		
Hispanic/Latino	3.83 ± 1.91		
Other	3.75 ± 1.57		
Region		0.087	
Midwest	2.95 ± 1.83		
Northeast	3.54 ± 1.82		
South	3.38 ± 1.79		
West	3.62 ± 1.9		
Annual household income		0.331	
≤ $23,999	3.66 ± 1.9		
$24,000-$47,999	3.25 ± 1.84		
$48,000-$71,999	3.41 ± 1.78		
$72,000-$95,999	3.24 ± 1.81		
≥ $96,000-$119,999	3.04 ± 1.71		
Household size		0.023	
1	3.07 ± 1.86		
2	3.4 ± 1.75		
3	3.35 ± 1.83		
4 +	3.82 ± 1.88		
Marital status		0.598	
Married, or living as married	3.31 ± 1.85		
Divorced/separated/widow	3.53 ± 1.87		
Single	3.38 ± 1.8		
Employment status		0.468	
Employed	3.5 ± 1.87		
Disabled	4 ± 1.41		
Retired	3.18 ± 1.75		
Unemployed/other	3.33 ± 1.86		
Education level		0.106	
Advanced degree	3.65 ± 1.93		
Bachelor's degree	3.6 ± 1.89		
Some college	3.29 ± 1.81		
High school or less	3.03 ± 1.66		
Insurance		0.328	
Medicare	3.34 ± 1.83		
ACA Exchange	3.11 ± 1.67		
COBRA	3.42 ± 1.98		

Table 4 (continued)

	Univariate regression model		Multivariable Poisson regression model
	Number of visits Mean ± S.D	p	IRR (95%CI)
Medicaid	3.81 ± 1.93		
None	2 ± 0.82		
Other/unknown	3.54 ± 1.88		
Private employer	3.4 ± 1.83		
Rural-uirban commuting area		0.191	
Rural	3.08 ± 1.79		
Suburban	3.47 ± 1.83		
Urban	3.42 ± 1.83		
Area Deprivation Index			
Spearman *r*	− 0.118	0.022	0.97 (0.95–0.99) *
Cancer type		0.616	
Breast	3.46 ± 1.81		
Gastrointestinal	3.3 ± 1.82		
GU/Gyn	2.84 ± 1.55		
Hematologic	3.44 ± 1.87		
Thoracic	3.78 ± 1.48		
Other	3.35 ± 1.96		
Number of comorbidities		< 0.001	
0	2.97 ± 1.77		Ref
1–2	3.47 ± 1.79		1.21 (1.07–1.36)
3 +	3.81 ± 1.86		1.36 (1.20–1.55)

*Regression coefficient for ADI was calculated by increase of 10 units

IRR incidence rate ratio, *ACA* Affordable Care Act, *COBRA* Consolidated Omnibus Budget Reconciliation Act, *G.U.* genitourinary, *Gyn* gynecological

others have highlighted, understanding the role of digital health strategies in the organization and delivery of rural cancer care is a significant gap in the literature [38]. Consequently, the present study is one of the very few to report the relationship between rurality and pandemic-related telemedicine adoption among patients with cancer. Finally, although not uniquely available to cancer patients, it is plausible that recently enacted federal policy changes to incentivize the construction of network infrastructures and upgrading of existing internet services may have been a supply-side driver of our findings [40–42].

Additionally, in our study, we demonstrated that patients with cancer with more comorbidities had higher telemedicine adoption and utilization rates. The number of comorbidities was independently associated with higher telemedicine adoption and utilization rates; having ≥ 3 comorbidities increased the adoption odds nearly twofold and the utilization volume by 36%. These findings are divergent from the existing general medicine literature wherein lower rates of telemedicine utilization during the pandemic have been described among adult ambulatory patients with a higher comorbidity burden. Those with a Charlson comorbidity index of > 2 (compared with 0) were documented as having a lower telemedicine adoption rate [43]. One postulation for our results is the dissemination of reports early during the pandemic course that COVID-19 patients with cancer had a worse prognosis and a higher risk of complications, relative to patients without a cancer diagnosis [44–47]. Thus, the higher telemedicine adoption rates among comorbid patients with cancer might be indicative of heightened precautions to avoid COVID-19 exposure among those at high risk.

Although our study evaluated only English-speaking patients, non–English-speaking patients may face many barriers to engaging in telemedicine care. Prior studies have shown that even in non-virtual settings, non–English-speaking patients face significant challenges when navigating the health-care system, including poorer outcomes, higher complications rates, and lower satisfaction [48, 49]. Discordance in language between telemedicine providers and non-English speaking patients may lead to an increase in medical errors, costs, and lower quality of care. We posit that the widespread use of telemedicine has the potential to exacerbate inequities among non-English speaking patients, particularly those in financial distress, if an equity lens is not implemented. Non-English-speaking patients may find it difficult to access and navigate telemedicine platforms, as well as follow subsequent instructions related to primary or follow-up visits, due to language discordance and lack of cultural competency in patient engagement platforms. Furthermore, telemedicine vendors do not always provide interpreter services [50]. This is especially important for older patients, who we have shown to be at a higher risk of lower telemedicine utilization, because Medicare does not currently reimburse interpretation services. Future studies are needed to further evaluate telemedicine adoption and utilization among non–English-speaking patients with cancer. Furthermore, policies that ensure non-English speaking patients have equitable access to telemedicine services are needed.

Prior to the pandemic, Medicare reimbursement for telemedicine services was limited to rural areas with a provider facility [51]. As the COVID-19 pandemic evolved, changes in insurance policy that allowed for expanded reimbursement facilitated a rapid adoption of telemedicine services. The Centers for Medicare and Medicaid Services (CMS) has expanded the list of eligible services, providers, geographic locations, and mode of telemedicine coverage for Medicare beneficiaries to include both audio and video-based telemedicine services that do not require patients to visit a provider facility [52]. Telemedicine reimbursement policies for commercially insured patients and Medicaid beneficiaries, on the other hand, varied by state. As a result of the COVID-19 pandemic, Medicaid and private insurers in many states implemented policies to expand telemedicine service coverage for various modalities and geographic locations [53]. Of note, in the current study, we found no difference in telemedicine utilization based on the type of insurance coverage.

Our study should be viewed in light of limitations including the cross-sectional, observational design, which could lead to unmeasured confounding. We are also unable to determine causality. The study examined data from under-resourced, underserved patients with cancer, and may not be representative of the overall cancer population. Our sample may be skewed toward people who can navigate online and telephonic non-profit services and access web-based surveys. Only patients who could receive survey communication from PAF via email were included in our study. Those who did not meet this criterion, who are also likely to be telemedicine naïve, were excluded from the study, potentially resulting in selection bias. Furthermore, the present study used self-reported survey data, which can introduce recall bias and possibly imprecision. Moreover, while our study included a nationwide cohort of PAF service recipients, our findings may not be generalizable to all financially distressed patients with cancer. Lastly, due to our sampling frame, we were unable to conduct a non-responder analysis and as a result are unable to discern any major systematic differences between those who participated in our study and those who did not.

Conclusion

This study evaluated telemedicine utilization in financially distressed patients with cancer during the COVID-19 pandemic. Our results indicate that telemedicine was adopted at a high rate during the pandemic with most patients preferring video visits. We found that younger age and more comorbidities were factors associated with telemedicine adoption. Among patients who adopted the technology, older patients and those with fewer comorbidities and higher ADI scores demonstrated lower utilization rates. As telemedicine continues to play an important role in oncology care, we hope that the findings of this study will aid in the development of new solutions and the equitable delivery of this technology to patients with cancer.

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Author contribution Abbas M. Hassan: conceptualization, investigation, methodology, resources, writing—original draft, writing—review and editing. Carrie K. Chu: investigation, resources, writing—original draft, writing—review and editing. Jun Liu: data curation, formal analysis, methodology and validation. Rebecca Angove: investigation, resources, writing—original draft, writing—review and editing. Gabrielle Rocque: investigation, writing—original draft, writing—review and editing. Kathleen D. Gallagher: investigation, resources, writing—original draft, writing—review and editing. Adeyiza O. Momoh: investigation, writing—original draft, writing—review and editing. Nicole E. Caston: investigation, writing—original draft, writing—review and editing. Courtney P. Williams: investigation, resources, writing—original draft, writing—review and editing. Stephanie Wheeler: investigation, writing—original draft, writing—review and editing. Charles E Butler: conceptualization, investigation, methodology, writing—review and editing. Anaeze C. Offodile: conceptualization, investigation, methodology, resources, writing—original draft, writing—review and editing.

Data availability The datasets generated during and/or analyzed during the current study are not publicly available due to institutional policies but are available from the corresponding author on reasonable request.

Code availability Not applicable.

Declarations

Ethics approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent to participate This is an observational study and The University of Texas MD Anderson Cancer has waived informed consent.

Consent for publication Not applicable.

Conflict of interest Dr. Offodile reports research funding from Blue Cross Blue Shield, University Cancer Foundation, Rising Tide Foundation for Clinical Cancer Research, and the National Academy of Medicine. All are unrelated to the submitted work. Dr. Offodile also reports honorarium from the Indiana University and University of Tennessee Departments of Surgery. Dr. Rocque reports research funding from Genentech, Pfizer, and Carevive and consulting from Pfizer.

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