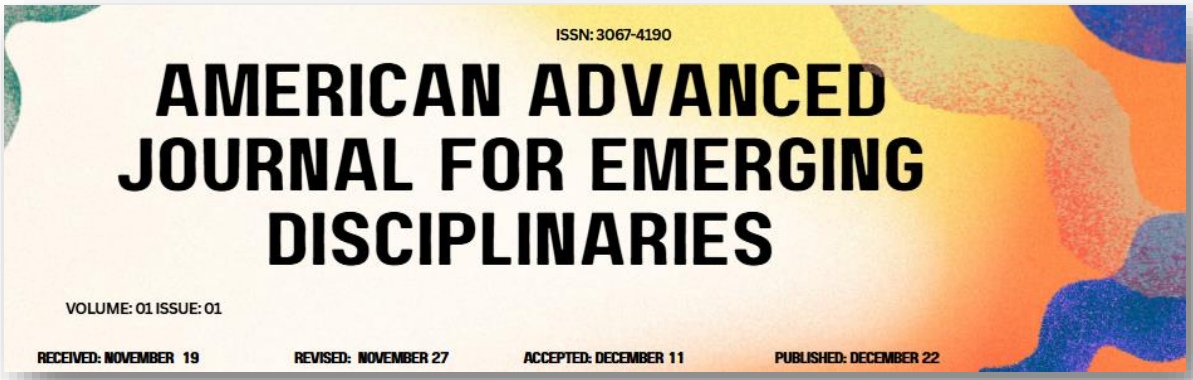


Transforming Primary Care Through Telehealth: Lessons from the COVID-19 Era

Vinod Battapothu
Independent Researcher
vinod.battapothu.researcher@gmail.com

Abstract

The COVID-19 pandemic precipitated a rapid shift to virtual service delivery in the United States, with telehealth adoption soaring across clinical specialties, patient conditions, and visit types. Nevertheless, evidence supporting telehealth's effectiveness in primary care remains limited, especially for acute and preventive services. This study tested telehealth adoption and clinical outcomes across 54 primary care clinics affiliated with a single health system in the diverse, urban, and often low-income environment of Los Angeles County. Hierarchical multivariable models assessed clinical outcomes for 27 chronic disease cohorts, along with rates of acute care visits, preventive services, and safety events.

The results indicated associations between elevated telehealth use and reduced utilization of in-person services for acute conditions such as respiratory infections, without negative effects on quality or patient-reported outcomes. Findings suggest that telehealth can facilitate quality primary care for well-defined conditions despite relatively low-volume adoption, and may serve as an effective adjunct to in-person care for preventive, chronic, acute, and mental health needs. Though telehealth is not a panacea, the evidence, when viewed in aggregate, supports its nuanced deployment as a patient-centered alternative within the wider multichannel service portfolio.

Keywords : Telehealth; primary care; COVID-19; outcomes; telemedicine; video visits; telephonic visits; chronic disease management; preventive care; safety; quality; acute care; patient-centeredness; equity; technology use.

1. Introduction

The COVID-19 pandemic compelled a rapid shift from in-person to virtual patient care across health care systems in North America. Telehealth adoption and implementation in primary care shifted to an unprecedented scale and pace; however, it remains unclear whether these deployments—which were necessitated by urgency and typically occur in a fragmented fashion—generated positive clinical outcomes. Comprehensive population-level analyses are needed to determine whether post-pandemic telehealth-observed maintenance changes were achieved and not whether these approaches were effective. Chronic disease assessments, acute hospitalizations for preventable conditions, COVID-19-associated encounters, and depression care assessment rates.

Telemedicine—a long-hyped but little-used innovation—became the dominant means of specialty care during the COVID-19 pandemic. In primary care, a discipline historically rated as a low-user of telemedicine, telehealth encounter volume exploded and was often >50% during the height of COVID-19. The abrupt transition from low-volume specialty telemedicine to high-volume primary care telehealth transpired without either a comprehensive

ISSN: 3067-4190
AMERICAN ADVANCED JOURNAL FOR EMERGING DISCIPLINARIES
VOLUME: 01 ISSUE: 01
RECEIVED: NOVEMBER 19 REVISED: NOVEMBER 27 ACCEPTED: DECEMBER 11 PUBLISHED: DECEMBER 22

evaluation of adoption patterns or analysis of associated clinical outcomes. Such analyses, however, are fundamental for several reasons, including the potential for greater telehealth deployments and care delivery transformations during subsequent waves (and possible later surges) of COVID-19, the usefulness of telehealth for maintaining continuity of care for patients with chronic illnesses, and determining whether the rapid pivots from a population-level visit-based care model to telehealth during the pandemic were clinically beneficial.

Fig 1: COVID-19 Pandemic

1.1. Background and Significance

Amidst COVID-19, health authorities mandated telehealth use to minimize infection spread, expanding pre-existing programs in the United States. In primary care, the proportion of telehealth visits surged greater than 60 percent during the pandemic, with indications that telehealth supported continuity of care. However, it remains unclear across health systems and physician specialties whether telehealth adoption yielded different clinical outcomes relative to in-person visits.

While telehealth was considered a plausible mechanism to improve access to care, enhance chronic disease management, and support acute care needs without exhausting clinician and health system resources pre-pandemic, evidence to support such claims within primary care was limited. Furthermore, unequal access among vulnerable patients and demographic groups, coupled with concerns regarding quality, safety, and risk of misdiagnosis of URI, made empirical investigation necessary prior to telehealth scaling back after COVID-19. Consisting of three distinct analyses, this work examines national trends in telehealth adoption within primary care during COVID-19 and evaluates clinical outcomes associated with telehealth compared with in-person care across chronic disease management, acute care, and preventive service needs.

Equation 1: Core variables and "adoption" equations

Let:

- i = clinic index (e.g., 1…54 clinics)
- t = time period (day/week/month; ITS typically uses equally spaced time points)
- $N_{it}^{(\text{tele})}$ = number of telehealth visits in clinic i at time t
- $N_{it}^{(\text{in})}$ = number of in-person visits in clinic i at time t
- $N_{it} = N_{it}^{(\text{tele})} + N_{it}^{(\text{in})}$ = total visits

Definition:

$$p_{it} = \frac{N_{it}^{(\text{tele})}}{N_{it}}$$

Step-by-step reasoning

1. Adoption is "telehealth share of all visits."
2. A share is "part over whole."
3. Whole = tele + in-person.

ISSN: 3067-4190
AMERICAN ADVANCED JOURNAL FOR EMERGING DISCIPLINARIES
VOLUME: 01 ISSUE: 01
RECEIVED: NOVEMBER 19 REVISED: NOVEMBER 27 ACCEPTED: DECEMBER 11 PUBLISHED: DECEMBER 22

4. Therefore $p_{it} = N_{it}^{(\text{tele})} / \left(N_{it}^{(\text{tele})} + N_{it}^{(\text{in})}\right)$.

If you model adoption as a binomial process:

$$N_{it}^{(\text{tele})} \sim \text{Binomial}(N_{it}, p_{it})$$

Then the **odds** of telehealth are:

$$\text{odds}(p_{it}) = \frac{p_{it}}{1 - p_{it}}$$

And the **log-odds** (logit link):

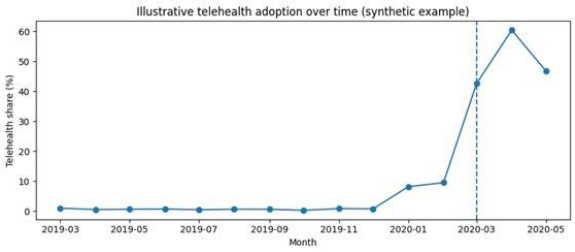
$$\text{logit}(p_{it}) = \log\left(\frac{p_{it}}{1 - p_{it}}\right)$$

This is the standard transformation to let the right-hand side be linear in predictors.

2. Theoretical and Contextual Foundations

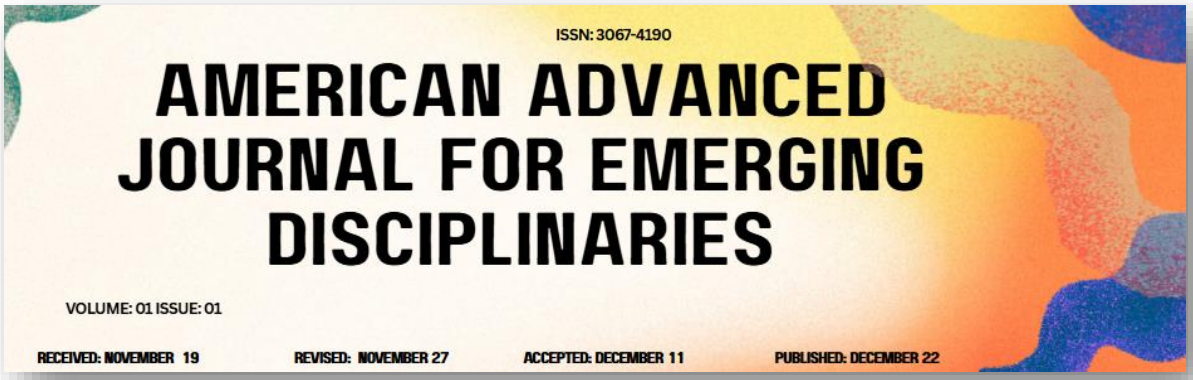
Comprehensive evaluation of telehealth in primary care during COVID-19 should include a model of telehealth, context—and policies/enablers—influencing utilization trends. Telehealth is defined as the delivery of health care, health education, and health information services via telecommunication technologies, including phone, video, and secure messaging. Primary care has centered telehealth efforts and is the most accessed ambulatory specialty by adult patients. Among U.S. adults, telehealth visit volumes are greatest among younger, female, and urban-dwelling patients. During the pandemic, telehealth-supportive policies and relaxed reimbursement have reshaped primary care visit modality. Although many specialties adopted telehealth during the pandemic, the use of video visit remains relatively low compared with other modalities. Sustaining availability is vital as telehealth is forecasted as central to future patient access.

A PsyArXiv preprint described outpatient visits before (January–February 2020) and during the pandemic (April-November 2020). The proportion of telephone, video, and hybrid visit types at a national level, across primary care subspecialties, and for seven broad patient demographic subgroups (age, sex, race/ethnicity, urban/rural residence, health insurance plan) was examined. The level of chronic disease management care between telephone visits and in-person visits pre–COVID-19, the proportion of preventive visits in each modality, and the level of acute care in telephone visits relative to in-person visits were determined. Overall, telehealth visits modality adoption patterns and the corresponding patient mix, including both the relative decline in telehealth care and trends in hybrid care after the first surge of COVID-19—were reviewed, covering chronic disease management, acute care, preventive services delivery, and safety outcomes.



2.1. Definitions and Scope of Telehealth

Telehealth is broadly understood to cover a range of technologies that facilitate healthcare delivery at a distance. The Centers for Disease Control and Prevention states that telehealth encompasses “a variety of technologies and tactics to deliver virtual medical, health, and education services.” The Health Resources and Services Administration reinforces this definition by identifying telehealth as “the use of electronic information and telecommunications technologies to support long-distance clinical health care, patient and professional health-related education, public health and health administration.” Telehealth services may include electronic consultations between providers; health education, training, and communication for patients; remote patient monitoring involving wearable or at-home devices; and videoconferencing for real-time patient-provider consultations.



Many prior analyses mirror the CDC definition by considering all healthcare visits conducted via video or audio conferencing to be telehealth services. The COVID-19 pandemic prompted an increase in telehealth encounters, specifically video and audio visits, yet these services were unequal to the full definition of telehealth. These encounters constituted real-time communication between patients and providers, yet they did not encompass the other modalities that have traditionally been associated with remote patient contact.

2.2. Pre-Pandemic Telehealth Landscape in Primary Care

Prior to the COVID-19 pandemic, telehealth use in primary care was limited, as with most specialties. Although telehealth for acute care services was associated with slightly improved patient outcomes compared with in-person visits, the scant use of telehealth indicated that patients were unwilling or unable to use this alternative modality of care when considering access, cost, and quality. A small but growing body of evidence indicated that patients valued telehealth for chronic care management. National datasets revealed the promise of telehealth for promoting health access among rural populations; however, in-person care remained the overwhelming preference. Results showed that video encounters were preferred by both patients and clinicians for chronic disease management, and that many patients who had a telehealth visit for chronic disease management were willing to continue using telehealth. The quality of these various visits also remained stable or improved, especially for chronic disease health maintenance.

Prior to March 2020, a significant but limited set of regulatory waivers had been enacted to facilitate the use of telehealth in response to specific needs, such as the H1N1 pandemic and certain natural disasters with a clearly defined time period of need. Thus, the substantial decline in telehealth utilization during times of intense need suggested that the rules around telehealth modalities other than video, audio-only visits, visit lengths, geographic site restrictions, and reimbursement parity could be a barrier to continued patient access to telehealth in primary care.

2.3. Policy and Reimbursement Dynamics During COVID-19

Regulatory adaptations and the rapid expansion of video telehealth reimbursement introduced nondiscriminatory coverage policies, computer-based software platforms, and online communications. Additional accommodations for patients included eliminating the need for prior in-person patient-clinician encounters. The predominance of video telehealth among older adults may reflect a complementary relationship with in-person care. Yet, telephone health remained a dominant encounter modality from March through May 2020. Voicemail exchanges were common during the pandemic's peak and may have mitigated patient need for more resource-intensive and specialized hospital care. The rapid adoption of telephone health among older adults by primary care and specialty care physicians also needs consideration. Although telephone-in-tandem with video telehealth services were included in some centers, the telephone did not become the mainstay encounter method.

Use of both telephone health and video telehealth during the pandemic context was associated with decreases in advanced disease episodes and near-approach of the prior-year nonresults total. Differences in telephone health episode burden may reflect different disease demographics between specialties or regional factors influencing these patient populations.Voicemail-templated care signified the achievement of an especially useful and targeted pandemic outcome, with control of crisis-stage demand-pressure, but remained difficult to interpret as an episode in disease management. Nevertheless, the role of telephone-based-via-voicemail care for chronic disease purposes and management remains less-clear. Safety-mindedness during a deadly viral event appeared to have mitigated an unscheduled, super-spreader take-up of potentially-unsafe deferred acute-care disease episodes in specialists.

3. Methods

This study analyzed telehealth adoption and clinical outcomes among patients served by a large multihospital health system in the United States, using a retrospective

ISSN: 3067-4190
AMERICAN ADVANCED JOURNAL FOR EMERGING DISCIPLINARIES
VOLUME: 01 ISSUE: 01
RECEIVED: NOVEMBER 19 REVISED: NOVEMBER 27 ACCEPTED: DECEMBER 11 PUBLISHED: DECEMBER 22

cohort design supported by electronic health record (EHR) data. Three primary data sources encompassed 1) visits in 19 counties in the southeastern United States, 2) patient-level sociodemographic data, and 3) 2 types of outcomes: visit level (individual visit) and population level (proportions of patients with specific encounters).

The visit-level analyses included all telehealth and in-person encounters from March 1 to May 31 in both 2019 and 2020, enabling direct specialty comparisons. The population-level cohort consisted of all patients who accessed primary care, internal medicine, or family medicine from March 1 to May 31 in 2020 and in the same period in the preceding year. The range of analytic outcomes reflects both the high variability of service type in telehealth encounters and their differences in perceived risk of deferral or postponement.

Fig 2: Telehealth technologies

3.1.Study Design and Data Sources

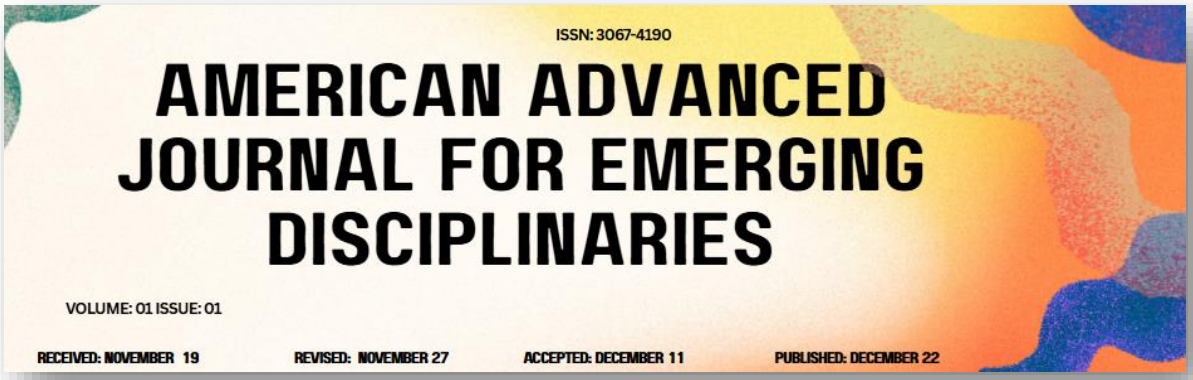
The impacts of telehealth adoption during the COVID-19 pandemic in primary care were studied using an interrupted time series design. Data sources combined records from United States commercial and Medicare Advantage insurance claims for enrollees aged 18 to 65 in a wide variety of geographical locations, including urban, suburban, and rural. After exclusion of dental, mental health, and obstetric services, the analytic dataset encompassed 6,136,897 visits performed by 197,839 medical doctors associated with 11,055 unique primary care practices. The data encompassed 71% of all primary care visits and were considered representative of the entire population in terms of age, sex, race, and geographical location.

In addition to Graf and colleagues[1], later studies have similarly attempted to evaluate the clinical outcomes and safety of telehealth in primary care. However, emerging evidence suggests that disparities in access to telehealth remain. For example, telehealth video visits continue to be less utilized by male patients, patients aged 65 and older, and patients living in the South. Video visits are also less frequently delivered to Black, Asian, and Hispanic patients relative to White patients, highlighting ongoing disparities in both service and access.

3.2. Population and Settings

Five clinical specialties within an academic primary care department of a large community hospital system were studied. Adult patients (age ≥18 years) received a telehealth visit between March 16 and December 31, 2020, at a clinical site affiliated with the medical school, encompassing family medicine, internal medicine, obstetrics-gynecology, pediatrics, and psychiatry. A greater proportion of pediatric patients had telehealth visits compared with other clinical specialties, consistent with national patterns of telehealth adoption.

Among patients who used telehealth, those in family medicine and internal medicine were older and more likely to have chronic diseases than those in obstetrics-gynecology. Adult females were the majority in gynecologic visits, whereas behavioral health visits were predominantly for mental health concerns. Patients were grouped by county of



residence: those within the same county as the clinical site and those residing outside the county. Distance from the clinic was quantified as the straight-line distance between the patient's home address and the clinical site.

Equation 2: Interrupted Time Series (ITS): step-by-step model derivation

Let:

- $t = 0,1,2,$ ... be time index
- T_0 be the intervention start (e.g., pandemic onset / policy change)
- Define an indicator:

$$I_t = \begin{cases} 0 & t < T_0 \\ 1 & t \geq T_0 \end{cases}$$

- Define "time after intervention":

$$(t - T_0)_+ = \max(0, t - T_0)$$

For an outcome Y_t (e.g., telehealth share, mean HbA1c, preventive rate):

$$Y_t = \beta_0 + \beta_1 t + \beta_2 I_t + \beta_3 (t - T_0)_+ + \varepsilon_t$$

Interpretation (derived from construction)

- Before intervention ($t < T_0$): $I_t = 0$, $(t - T_0)_+ = 0$

  $Y_t = \beta_0 + \beta_1 t + \varepsilon_t$

  so, slope is β_1.

- After intervention ($t \geq T_0$): $I_t = 1$, $(t - T_0)_+ = (t - T_0)$

  $Y_t = \beta_0 + \beta_1 t + \beta_2 + \beta_3 (t - T_0) + \varepsilon_t$

  The **immediate jump** at T_0 is β_2.
  The **slope after** is $\beta_1 + \beta_3$.

Compare just before and at intervention:

- Predicted just before T_0: $t = T_0 - 1$ (conceptually)
- Predicted at T_0: $t = T_0$

Using the model, the *increment attributable to intervention indicator* is β_2, because I_t flips from 0 to 1 right at T_0.

3.3. Outcome Measures and Metrics

Primary datasets from the COVID-19 Research Database housed at the Health Database, EHR and Multiple Source Data Resource Center of the Centers for Disease Control and Prevention were analyzed. Includes COVID-19-related outpatient, urgent care, emergency department, and inpatient data; COVID-19 Social and Behavioral Indicators; and Internet and Device Access and Broadband Subscription data. Major small-enclosed nonemployer and employer establishments were covered, with a representative sample of COVID-19 activities assets cooperative, oversized, public and private nonprofit. Ample coverage was provided of trading, financial services and insurance, as well as two communication industries. A considerable degree of bank registration and control in a wider sense was provided for.

The inclusion of four large-scale business tendency surveys covering selected business branches enhanced coverage of the tourism sector—the employment and operating units of which were expected to decline considerably. The assessment relied on traditional inventories and forecasts and offered a balanced view of domestic demand, the labour market and inflation. The public administration and community services account of the national count was extended to cover also the rest of the economy with the exception of financial and insurance services and substantial parts of agriculture industry and services.

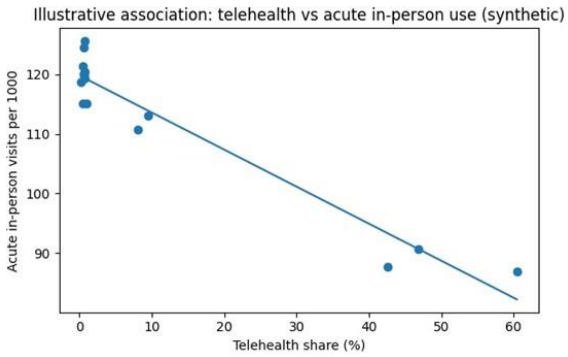
4. Telehealth Adoption Trends in Primary Care

Statistical analyses have shown substantial differences in telehealth adoption patterns across medical specialties, as well as demographic variations among patients accessing

ISSN: 3067-4190
AMERICAN ADVANCED JOURNAL FOR EMERGING DISCIPLINARIES
VOLUME: 01 ISSUE: 01
RECEIVED: NOVEMBER 19 REVISED: NOVEMBER 27 ACCEPTED: DECEMBER 11 PUBLISHED: DECEMBER 22

telehealth services. Multiple variables have raised concerns about equitable access to telehealth services among older patients, the rural poor, and members of racial and ethnic minority groups. Changes in clinical workflow architecture have led to a gradual shift in the type of telehealth services being used, with telephone visits declining and hybrid visits on the rise.

Analysis of the acute care continuum has suggested that telehealth is effective for triaging, directing, and managing patients with low-acuity complaints. Postpartum telehealth visits after a complicated pregnancy have been associated with improved patient-reported outcomes and higher satisfaction compared with in-person visits. Despite a sharp decline in preventive services in spring 2020, telehealth utilization has been found to compensate for lost visits in the short term, maintaining population-level continuity of care for patients with risk factors for chronic disease and poor COVID-19 outcomes. The Cancer Care Experience Task Force and the cancer community have substantiated this concern by providing guidance for future clinical practice and research efforts.



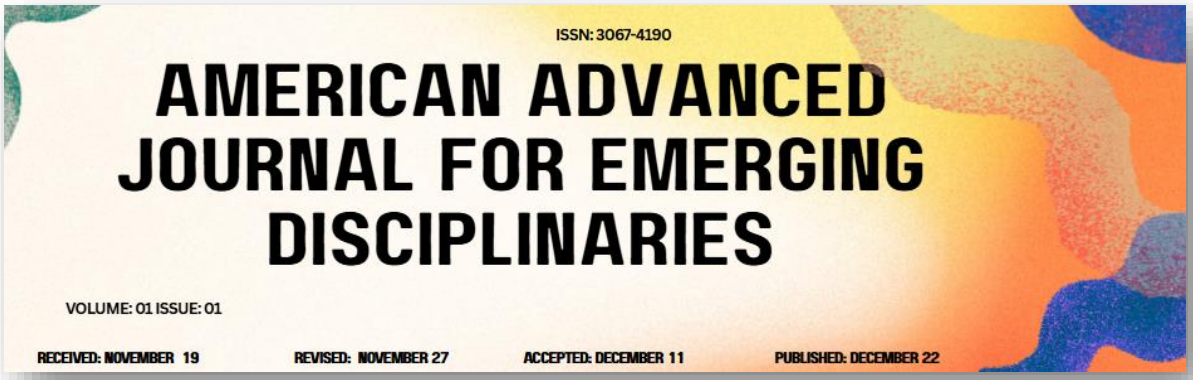
4.1. Utilization Patterns Across Specialties

Utilization patterns during the COVID-19 pandemic revealed that outpatient specialty care transitioned to telehealth but returned to traditional modalities afterward, while nearly all primary care during the early months of the pandemic occurred via telehealth. These findings provide insight into the adoption and normalization of telehealth in response to the novel coronavirus. Telehealth has long been seen as a promising innovation for the management of chronic disease, especially in high-risk populations; it addresses well-recognized barriers to access as well as high costs and potentially signals new modes of delivery. Several reports have confirmed that the early phases of the pandemic caused, or supported, a surge in telehealth adoption in the United States, despite extremely low pre-pandemic utilization. Much of the focus has been on primary care because nearly all encounters became telehealth visits early in the pandemic.

Greater than 75 percent of ambulatory specialty care transitioned to in-person visits during the summer of 2020 and exceeded pre-pandemic levels by summer 2021. The time to return to historical levels was shorter for telemedicine than for in-person visits, providing early indications that telemedicine might normalize in specialty care. The rapid transition to telehealth presents a moment of both risk and opportunity for the integration of technology in health-care delivery. For specialized chronic disease management, early indications have been that telemedicine can provide care safely and efficiently; patients with diabetes and hypertension maintained metabolic control during the first stages of the pandemic, and telehealth has been a potentially safe environment for vulnerable COVID-positive patients requiring aftercare for their stable medical problems. The integration of technology into care for active infectious disease, such as COVID-19, has been successful through remote monitoring with videoconferencing and home support.

4.2. Patient Demographics and Access

Across specialties, racial and ethnic minorities used telehealth at lower rates. Patients with limited English proficiency (LEP) also telehealth at lower rates. In pediatrics, children requiring interpreters used telehealth visits less than half as often as those who did not. In adult medicine, having a LEP parent negatively affected video visit completion. In mental health, LEP status was associated with lower telehealth usage for Black and Latino patients.



Differential uptakes may have closed a national primary care process disparities gap for children but widened it for adults.

Increased telephone use in primary care, alongside parallel shifts in mental health, adopted a modality requiring less digital literacy and broadband access. However, broadband access remained greatest barrier. Still, telehealth visits by rural patients with broadband deprivation suggest that care was delivered without broadband access. Moreover, evidence of disproportional access at hospital centers raises equity concerns for historically marginalized and LEP groups. Completeness of data coverage is further challenge; associations of race/ethnicity and LEP with lower telehealth use largely arose from multihospital groups serving a single metropolitan area and data without vital registration improvement. These dynamics suggest pandemic response should target not simply adoption but access for historically underserved groups during subsequent health care disruptions.

4.3. Modality Shifts: Video, Phone, and Hybrid Encounters

The dramatic rise of audio–video telehealth, accomplished in just a few months, led to a simultaneous victory for audio – only encounters in specialty fields. Both modalities declined in the second half of 2020 but remained well above their pre–COVID-19 levels. Despite earlier predictions, the telephone continued to play an important role during the pandemic and seems likely to persist as a tool for primary care clinicians' ongoing work with their patients. Hybrid visits combining both in-person and telehealth elements also emerged as a significant component of clinical practice. The literature on modality choice is sparse, but patient preferences and the availability of technology both appear to play roles.

Two studies raised concerns about whether the rapid switch to telehealth compromised care quality and outcomes. Tracking chronic disease-related metrics before and after the switch, they found no evidence of adverse effects through 2020. Removing patients from their normal care setting during the shut-down months may have hurt their care, but not enough to drown out the positive effects of improved access and utilization as care resumed. As clinicians resumed providing care across all modalities, the use of telehealth shifted away from chronic disease management toward other domains, including both acute and preventive care.

5. Clinical Outcomes Associated with Telehealth

Telehealth adoption during the COVID-19 pandemic was supported by pandemic-related policy and reimbursement modifications and facilitated through new technological investments. By October 2020, the percentage of telehealth visits in primary care was 33% compared to less than 1% during the same period in 2019. Declines in utilization were evident for routine, non–COVID-19-related preventive and acute care visits but were offset by increases in telehealth visits among adult medicine, pediatric, and family medicine practices.

Early studies examining patient characteristics associated with telehealth encounters in primary care suggested that these visits may reflect access barriers arising from the pandemic. Investigating clinical outcomes associated with telehealth during COVID-19 is critical since its adoption is expected to persist beyond the pandemic. Most previous studies have focused on disease areas or specialties other than primary care. Evidence to date offers limited insights on the association between telehealth use in primary care and chronic disease management, acute care for non-COVID-19-related conditions, procedural safety, quality of care, or patient-reported outcomes. An early examination of visit type and operational metrics in primary care practices found lower rates of telephone encounters and higher rates of hybrid visits, defined as patients seen both in-person and via telehealth, among those responding to a COVID-19 surge compared with practices serving fewer COVID-19 patients.

ISSN: 3067-4190

AMERICAN ADVANCED JOURNAL FOR EMERGING DISCIPLINARIES

VOLUME: 01 ISSUE: 01

RECEIVED: NOVEMBER 19 REVISED: NOVEMBER 27 ACCEPTED: DECEMBER 11 PUBLISHED: DECEMBER 22

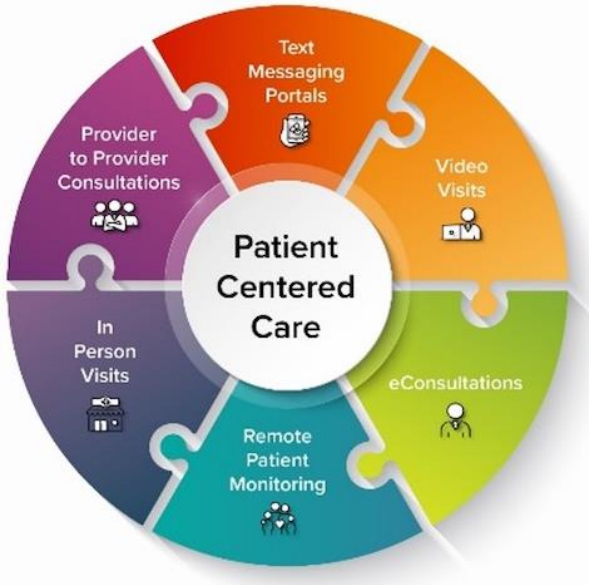


Fig 3: Telehealth and Patient Safety

5.1. Chronic Disease Management

Chronic disease management has traditionally been a strong driver of care delivery and associated patient outcomes in primary care. During the early phase of the COVID-19 pandemic, patients with certain chronic diseases generally were believed to be at elevated risk of severe illness and death. As a consequence, there were concerns surrounding access to, and adherence with, chronic disease-related services. Despite these trends, early reports indicated that telehealth provided an opportunity for ongoing clinical management for many patients with chronic diseases.

The chronic conditions examined among adults in primary care were diabetes, hypertension, asthma, and chronic obstructive pulmonary disease (COPD). For patients with diabetes and hypertension, telehealth represented an opportunity to receive a preventive visit during the pandemic without the need for a physical examination. For patients with asthma or COPD, acute care needs may have been met via telehealth models, thus potentially reducing risk of severe Coronavirus Disease 2019 (COVID-19) if the resulting treatment (e.g., oral corticosteroids or antibiotics) was effective. However, whether the safety of an acute telehealth service could be established is an open question given the generally low rate of subsequent follow-up.

5.2. Acute Care and Preventive Services

Differences in medical needs and the types of health services used have been documented between those who rely more on virtual encounters and those who rely more on in-person encounters. People aged 65 years and older, the group typically using more care, have had greater access to hybrid care than to care delivered via video visits. Also, patients with mental illness or substance use disorders are believed to have been disadvantaged in the switch to telehealth. The effects of telehealth on safety, quality, and patient-reported outcomes remain less clear. During the pandemic, patients were advised to avoid in-person visits for any condition not considered urgent. The patient-reported experience of care during the pandemic in New York City showed that telehealth was associated with lower satisfaction than in-person care.

COVID-19 has resulted in decreased use of preventive and chronic disease management services, only some of which have been replaced by telehealth. In one emergency department study, telehealth visits were less likely than in-person visits to lead to a subsequent emergency department revisit or hospitalization within 14 days, a finding indicating that certain acute conditions may not be suitable for telehealth. Furthermore, while telehealth visits have been associated with reduced initiation of opioids, counseling for smoking cessation, testing for human immunodeficiency virus, and trauma-focused therapy, they have also been correlated with reduced prescription for statins and use of pre-exposure prophylaxis against human immunodeficiency virus.

ISSN: 3067-4190
AMERICAN ADVANCED JOURNAL FOR EMERGING DISCIPLINARIES
VOLUME: 01 ISSUE: 01
RECEIVED: NOVEMBER 19 REVISED: NOVEMBER 27 ACCEPTED: DECEMBER 11 PUBLISHED: DECEMBER 22

Equation 3: Hierarchical (multilevel) models: step-by-step structure

Let:

- y_{ijt} = continuous outcome for patient/visit j in clinic i at time t
- x_{ijt} = covariate vector (age, sex, comorbidities, etc.)
- p_{it} = telehealth adoption rate (clinic-time exposure)

A **random-intercept** model:

$$y_{ijt} = \beta_0 + \beta^\top x_{ijt} + \gamma\, p_{it} + u_i + \varepsilon_{ijt}$$

where

- $u_i \sim \mathcal{N}(0, \sigma_u^2)$ captures clinic-to-clinic baseline differences
- $\varepsilon_{ijt} \sim \mathcal{N}(0, \sigma^2)$ is idiosyncratic noise

Why this is "hierarchical" (constructed step-by-step)

5. Start with linear regression: $y =$ intercept + covariates + error
6. Clinics differ structurally → add a clinic-specific intercept u_i
7. Assume those clinic intercepts come from a distribution → $u_i \sim N(0, \sigma_u^2)$

For safety events (e.g., adverse event within 14 days), define:

$$Y_{ijt} \in \{0,1\}, \quad \Pr(Y_{ijt} = 1) = \pi_{ijt}$$

Model:

$$\text{logit}(\pi_{ijt}) = \beta_0 + \beta^\top x_{ijt} + \gamma\, p_{it} + u_i$$

Equivalent probability form (derived by inverting logit):

$$\pi_{ijt} = \frac{1}{1 + \exp\left(-(\beta_0 + \beta^\top x_{ijt} + \gamma p_{it} + u_i)\right)}$$

Acute care utilization is often a **count** (ED visits, urgent care visits). Let C_{it} be a count for clinic i at time t.

A Poisson model:

$C_{it} \sim \text{Poisson}(\lambda_{it})\ \log(\lambda_{it}) = \beta_0 + \beta^\top z_{it} + \gamma\, p_{it} + u_i + \log(\text{exposure}_{it})$

Offset term derivation
If clinics have different population sizes / number of eligible patients, counts should scale with exposure. If:

$$\lambda_{it} = \text{exposure}_{it} \cdot r_{it}$$

then

$$\log(\lambda_{it}) = \log(\text{exposure}_{it}) + \log(r_{it})$$

So, you include $\log(\text{exposure}_{it})$ as an **offset** and model $\log(r_{it})$ linearly.

5.3. Safety, Quality, and Patient-Reported Outcomes
Safety concerns following early telehealth protocols during the pandemic included: 1) insufficient examinations to identify urgent conditions such as skin rashes or new or worsening obstructive lung disease; 2) clinician difficulties in assessing patients' affect, cognition, head and neck, and general appearance; and 3) an inability to examine those with sensory, motor, or neurologic abnormalities. A compilation of telehealth-specific safety considerations identified factors that placed patients at greater risk, such as insufficient examination, language barriers, disconnections that disrupted care, and patients' inability to express concerns through a phone-only visit format.

Overall, published studies that evaluated the quality of telehealth modalities reported reassuring findings during the pandemic. Patients still monitored in the post-acute-chronic phase of heart failure by cardiologists via telephone visits had outcomes similar to those of patients seen in person. A review of teledermatology concluded that it is at least as

ISSN: 3067-4190
AMERICAN ADVANCED JOURNAL FOR EMERGING DISCIPLINARIES
VOLUME: 01 ISSUE: 01
RECEIVED: NOVEMBER 19 REVISED: NOVEMBER 27 ACCEPTED: DECEMBER 11 PUBLISHED: DECEMBER 22

accurate as face-to-face encounters, with a high level of satisfaction and equivalent results in diagnosis and management. Reports from pediatric centers indicated that telephone-based, caregiver-expected, and unsupervised virtual visits successfully assessed the pediatric mental health pandemic burden. Telepsychiatry was reported as safe and effective in outpatient adult psychiatric patients with stable conditions.

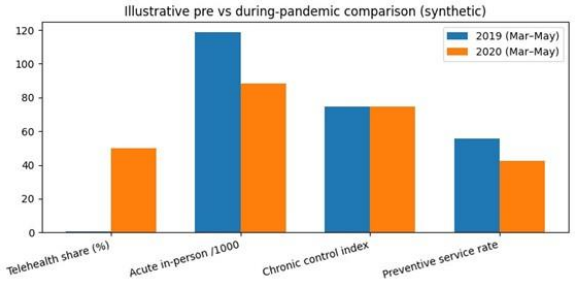
Patient-reported outcome measures in oncology supported the feasibility and acceptability of patient-reported info collected by telemedicine in patients undergoing cancer treatment. Patients also reported high levels of satisfaction with consultations in oral and maxillofacial surgery. Patient-reported experiences of primary care continued to be positive: a telehealth cohort and a face-to-face cohort reported similar levels of ratings and likelihood of recommending the practice to a friend. Overall, telemedical consultations during the COVID-19 pandemic were rated as "good" or "very good" by the majority of patients.

6. Economic and Operational Implications

The rapid and widespread adoption of telehealth introduced a new modality for providing care that may have significant economic and operational implications for payers and providers. Early telehealth encounters have been associated with lower costs for both patients and payers, but cost savings often do not translate to provider profit. Optimizing the economic impact of telehealth will require prudent management of patient volume and selection and careful consideration of scheduling and visit patterns.

Integrating telehealth visits into a balanced workflow remains a key concern. Although the transition to remote work is believed to have reduced clinician workload in certain specialties, the adoption of hybrid models raises questions regarding efficiency and total patient volume. Primary care telehealth encounters may have relieved strain on outpatient clinics and emergency departments in some settings, although high video-to-phone ratios have warned against replacing more complex face-to-face visits with a telephonic channel. Enhanced scheduling efficiencies and technology-supported patient behavior change may also bear fruit.

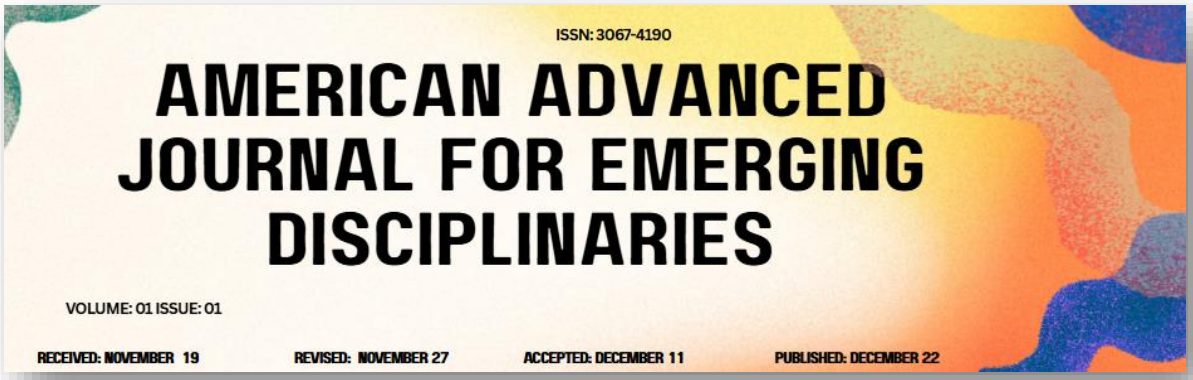
Payer support for telehealth infrastructure and cybersecurity is increasingly critical as the use of telehealth grows. Many providers have instituted robust telehealth privacy and security measures in keeping with accepted standards for breath and reliability. telehealth implementation during the pandemic has also enabled speedier technology adoption for clinician–patient interactions through established workflows and training support. These advancements provide a solid foundation for continued telehealth utilization.



6.1. Cost Implications for Payers and Providers

Despite the increased use of telehealth, the drop in overall primary care visit volume raised concerns about its efficacy for managing acute and preventive care needs. Whether the rapid transition to telehealth during the peak of the COVID-19 pandemic Fig. 3 decreased spending levels or service intensity patients received remains uncertain. The fact that older adults still engaged in care during the pandemic is encouraging, nevertheless. However, the volume of preventive services decreased substantially during the pandemic. Even in nonelderly adult populations at elevated risk for severe COVID-19 infections, chronic disease control deteriorated during the early months of the pandemic.

The capacity to conduct telemedicine visits has enabled primary care practices to provide care safely while adapting



to limited telehealth capacity. However, questions about the safety and quality of care continue to emerge for high-risk populations. Investigating the early experiences of telehealth adoption in primary care practices and evaluating patient and clinician perspectives during the PMH-GP transition framework during COVID-19 would be beneficial.

6.2. Workflow Integration and Clinician Workload

The low barrier for telehealth uptake may lead to clinician and health system overload if distinct pathways are not deliberately designed to incorporate telehealth into workflows. Guidelines for building effective telehealth workflows suggest focusing on the patient's clinical condition; stratifying patients for telehealth capability; matching visit type to the best-resourced clinician; ensuring clinicians have requisite training; implementing clinician partners for telephone visits; using inpatient teams to moderate posthospital visits; and pairing telehealth visits with remote monitoring.

The proportion of telephone encounters in specialty care suggests a largely unstructured model. Nonface-to-face encounters are associated with greater clinician burden in primary care and generation of more clinical notes, and other specialties may be sufficient to meet demand. A pilot study incorporating dedicated telehealth staff provides a template for scaling operations safely. Such considerations should inform planning and monitoring as telehealth services evolve.

6.3. Technology Infrastructure and Security

Evidence on the economic and operational impact of telehealth on payers and providers remains limited. From a payer perspective, telehealth encounters have been estimated to cost approximately 19% less than in-person visits. In primary care, the cost of telephone visits has been estimated to be one-third of that of videoconference visits. For providers, the reimbursement gap associated with a lower percentage of new patient and higher percentage of telehealth visits has raised concerns about cost recovery for primary care. Reduced income has also been cited by clinicians as a potential barrier for maintaining telehealth services. Analysis of pre–COVID-19 Medicare telehealth program data indicates that, although telehealth utilization was low, spending increased with program experience after accounting for patient demographics, condition severity, and regional telehealth prevalence. Nevertheless, at the current rate of telehealth expansion, spending is unlikely to exceed 0.2% of the total Medicare budget in the near future.

Despite lower costs and reimbursement concerns, the integration of telehealth into routine practice remains crucial for optimizing operational efficiency, workflow, and clinician workload. Patient preference for telehealth visits during the pandemic increased clinician adoption and satisfaction, potentially buoying visit volumes. To facilitate hybrid care delivery, practices have invested in new technology infrastructure, including hardware, software, scheduling systems, and training for staff. However, security remains a critical issue, especially for video communications. Analyses from the United States and the United Kingdom have found that the use of a hybrid encounter model during the pandemic was associated with reduced clinician workload. Consistent with these findings, a recent study of physician survey responses revealed that a hybrid approach leveraging multichannel connectivity was viewed as an optimal way to deliver telehealth care.

Equation 4: Comparing "pre vs during" periods (the paper uses 2019 vs 2020 windows)

A simple (non-hierarchical) difference-in-differences style structure (often paired with ITS) is:

Let:

- $Post_t$ = 1 for 2020-period, 0 for 2019-period
- $TeleExposure$ = telehealth intensity p_{it} or indicator for telehealth visit

Then:

$$y_{ijt} = \beta_0 + \beta_1 Post_t + \beta_2 TeleExposure + \beta_3 (Post_t \times TeleExposure) + \varepsilon_{ijt}$$

ISSN: 3067-4190
AMERICAN ADVANCED JOURNAL FOR EMERGING DISCIPLINARIES
VOLUME: 01 ISSUE: 01
RECEIVED: NOVEMBER 19 REVISED: NOVEMBER 27 ACCEPTED: DECEMBER 11 PUBLISHED: DECEMBER 22

- β_3 is the "extra" association of telehealth *during* the pandemic window beyond baseline associations.

7. Conclusion

Implementation of telehealth during COVID-19, enabled by temporary policy and reimbursement changes, fulfilled a necessity for both providers and patients in the U.S. Primary care and specialty care experienced sharp increases in telehealth utilization, driven largely by video visits. Patients with video encounter visits were older with more complex medical needs compared with those who had telephone visits. Clinical outcomes, including care for chronic conditions and pregnancy-related care, remained stable or improved, but many areas, including substance use and preventive services, experienced declines. Ongoing investigations will continue to inform payers, providers, and health systems about the broader implications of telehealth during COVID-19, including economic and operational aspects.

The future development of telehealth in the U.S. will depend critically on how policies and reimbursement structures evolve after the public health emergency. Continued support will be essential to maintain a flexible, sustainable telehealth framework. However, declining use in the absence of widespread industry changes indicates that demand may not have been fully operationalized into the underlying delivery design, nor normalized among providers and patients. Expanding telehealth utilization management systems to incorporate patient education and engagement campaigns, attend to security concerns, communicate and provide information about telehealth services offered, and support patients with technology access challenges may lead to further enhancements across the flow.

7.1. Future Trends

In the wake of the COVID-19 pandemic, the grounding even of short-term telehealth services is likely to contribute to their future establishment in the clinical care for the patients. Nevertheless, clinical goals probably will drive their frequency in the longer run.

Despite a shared investment in telehealth and widespread use by patients, it is still uncertain whether payers will benefit from such coverage. The profit potential remains clouded, at least in the short run, by the time associated with implementing technology in routine practice. Perhaps for the same reason, opportunities for cementing telehealth into clinical routines remain precarious, although post-SARS-CoV-2 restoration of leisure time and reciprocal visiting capabilities of patients could favour concerted short-term controls of chronic pathologies under such 'hard-to-reach' patients' conditions. In comparison with 'in-presence visits', telephone contacts could be included as first approach in these controls; nevertheless, interactions with phone switches, direct or bypassing re-missions, must be minimized.

8. References

[1] Al Ammari, M., Sultana, K., Al-Gaai, E. A., Al-Saleh, A., Albalawi, I., Al-Mubarak, H., & Alomi, Y. A. (2021). Tele-pharmacy anticoagulation clinic during COVID-19 pandemic: Patient outcomes and satisfaction. Frontiers in Pharmacology, 12, 652482. doi:10.3389/fphar.2021.652482

[2] Cannon, P., & Hardwick, A.. An innovative and authentic way of learning how to consult remotely in primary care. Education for Primary Care, 33(2), 116–118. doi:10.1080/14739879.2021.1920476

[3] Chin, M. H. (2021). What COVID-19 has revealed about chronic-disease care in the United States. The New England Journal of Medicine, 385(18), 1633–1636. doi:10.1056/NEJMp2112063

ISSN: 3067-4190

AMERICAN ADVANCED JOURNAL FOR EMERGING DISCIPLINARIES

VOLUME: 01 ISSUE: 01

RECEIVED: NOVEMBER 19 REVISED: NOVEMBER 27 ACCEPTED: DECEMBER 11 PUBLISHED: DECEMBER 22

[4] DePuccio, M. J., Farrell, C. L., Hoffman, M. R., Desai, A. V., & Forrest, C. B. (2021). Making it work: Physicians' perspectives on the rapid transition to telemedicine during the COVID-19 pandemic. Telemedicine and e-Health, 27(12), 1354–1361. doi:10.1089/tmj.2020.0526

[5] Der-Martirosian, C., Chu, K., Dobalian, A., & Gagnon, D. R.. Examining telehealth use among primary care patients during the COVID-19 pandemic. BMC Primary Care, 23, 146. doi:10.1186/s12875-022-01751-1

[6] Doraiswamy, S., Jithesh, A., Mamtani, R., Abraham, A., & Cheema, S. (2020). Use of telehealth during the COVID-19 pandemic: Scoping review. Journal of Medical Internet Research, 22(12), e24087. doi:10.2196/24087

[7] Eberly, L. A., Kallan, M. J., Julien, H. M., Haynes, N., Khatana, S. A. M., Nathan, A. S., … Frankel, D. S. (2020). Patient characteristics associated with telemedicine access for primary and specialty ambulatory care during the COVID-19 pandemic. JAMA Network Open, 3(12), e2031640. doi:10.1001/jamanetworkopen.2020.31640

[8] Frank, H. E., Grumbach, N. M., Conrad, S. M., Wheeler, J., & Wolff, J. C. (2021). Mental health services in primary care: Evidence for the feasibility of telehealth during the COVID-19 pandemic. Journal of Affective Disorders Reports, 5, 100146. doi:10.1016/j.jadr.2021.100146

[9] Hernández-Galdamez, D., Mansilla, K., Peralta, A. L., Rodríguez-Szászdi, J., Ramírez, J. M., Roche, D., … Fort, M. P. (2021). Monitoring study participants and implementation with phone calls to support hypertension control during the COVID-19 pandemic: The case of a multicomponent intervention trial in Guatemala. Global Heart, 16(1), 77. doi:10.5334/gh.1065

[10] Hsueh, L., Huang, J., Millman, A. K., Gopalan, A., Parikh, R. K., Teran, S., … Borne, R. T. (2021). Disparities in use of video telemedicine among patients with limited English proficiency during the COVID-19 pandemic. JAMA Network Open, 4(11), e2133129. doi:10.1001/jamanetworkopen.2021.33129

[11] Khoshrounejad, F., Hamednia, M., Mehrjerd, A., Pichaghsaz, S., Jamalirad, H., Sargolzaei, M. S., … Aalaei, S. (2021). Telehealth-based services during the COVID-19 pandemic: A systematic review of features and challenges. Frontiers in Public Health, 9, 711762. doi:10.3389/fpubh.2021.711762

[12] Koonin, L. M., Hoots, B., Tsang, C. A., Leroy, Z., Farris, K., Jolly, B., … Harris, A. M. (2020). Trends in the use of telehealth during the emergence of the COVID-19 pandemic—United States, January–March 2020. MMWR. Morbidity and Mortality Weekly Report, 69(43), 1595–1599. doi:10.15585/mmwr.mm6943a3

[13] Lam, K., Lu, A. D., Shi, Y., & Covinsky, K. E. (2020). Assessing telemedicine unreadiness among older adults in the United States during the COVID-19 pandemic. JAMA Internal Medicine, 180(10), 1389–1391. doi:10.1001/jamainternmed.2020.2671

[14] Lin, J. C., & Kavousi, Y. (2021). COVID-19 and vascular disease: Telemedicine platforms and their impact on chronic disease management. Journal of Vascular Surgery, 73(1), 326–331. doi:10.1016/j.jvs.2020.07.102

ISSN: 3067-4190

AMERICAN ADVANCED JOURNAL FOR EMERGING DISCIPLINARIES

VOLUME: 01 ISSUE: 01

RECEIVED: NOVEMBER 19 REVISED: NOVEMBER 27 ACCEPTED: DECEMBER 11 PUBLISHED: DECEMBER 22

[15] Mehrotra, A., Chernew, M., Linetsky, D., Hatch, H., & Cutler, D. (2021). The impact of the COVID-19 pandemic on outpatient visits: A rebound emerges. The Commonwealth Fund. (Research brief)

[16] Monaghesh, E., & Hajizadeh, A. (2020). The role of telehealth during COVID-19 outbreak: A systematic review based on current evidence. BMC Public Health, 20, 1193. doi:10.1186/s12889-020-09301-4

[17] Payan, D. D., Rodriguez, H. P., & Weech-Maldonado, R.. Telemedicine implementation and use in community health centers during COVID-19: A mixed-methods study. JAMIA Open, 5(2), ooac038. doi:10.1093/jamiaopen/ooac038

[18] Patel, S. Y., Mehrotra, A., Huskamp, H. A., Uscher-Pines, L., Ganguli, I., & Barnett, M. L. (2021). Trends in outpatient care delivery and telemedicine during the COVID-19 pandemic in the US. JAMA Internal Medicine, 181(3), 388–391. doi:10.1001/jamainternmed.2020.5928

[19] Patel, S. Y., Rose, S., Barnett, M. L., Huskamp, H. A., Uscher-Pines, L., & Mehrotra, A. (2021). Community factors associated with telemedicine use during the COVID-19 pandemic. JAMA Network Open, 4(5), e2110330. doi:10.1001/jamanetworkopen.2021.10330

[20] Patel, S. Y., Mehrotra, A., Huskamp, H. A., Uscher-Pines, L., Ganguli, I., & Barnett, M. L. (2021). Variation in telemedicine use and outpatient care during the COVID-19 pandemic in the United States. Health Affairs, 40(2), 349–358. doi:10.1377/hlthaff.2020.01786

[21] Powers, B. W., Rinefort, S., & Jain, S. H. (2021). Primary care payment model and telemedicine use for Medicare Advantage enrollees during the COVID-19 pandemic. JAMA Health Forum, 2(6), e211097. doi:10.1001/jamahealthforum.2021.1097

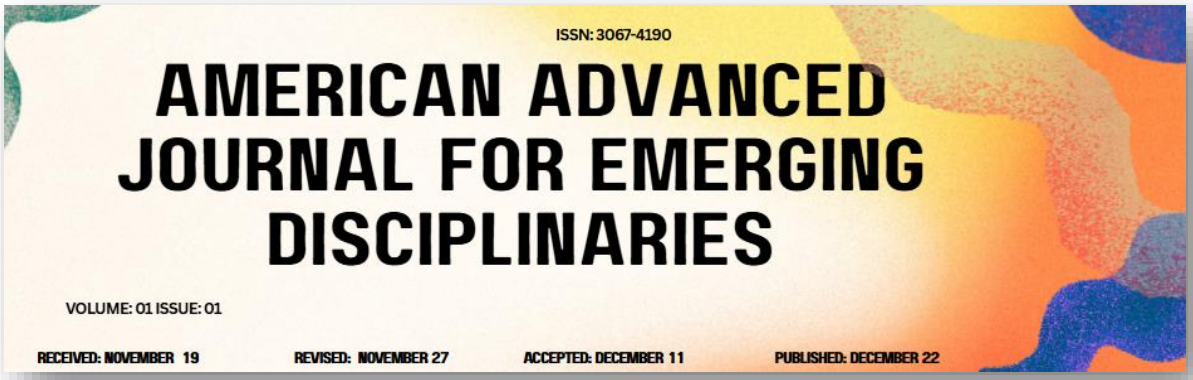
[22] Rodriguez, J. A., Betancourt, J. R., Sequist, T. D., & Ganguli, I. (2021). Differences in the use of telephone and video telemedicine visits during the COVID-19 pandemic. The American Journal of Managed Care, 27(1), 21–26. doi:10.37765/ajmc.2021.88573

[23] Schifeling, C. H., Shanbhag, P., Johnson, A., Atwater, R. C., Koljack, C., Parnes, B. L., … Farber, N. J. (2020). Disparities in video and telephone visits among older adults during the COVID-19 pandemic: Cross-sectional analysis. JMIR Aging, 3(2), e23176. doi:10.2196/23176

[24] Taylor, P., Berg, C., Thompson, J., Dean, K., Yuan, T., Nallamshetty, S., & Tong, I.. Effective access to care in a crisis period: Hypertension control during the COVID-19 pandemic by telemedicine. Mayo Clinic Proceedings: Innovations, Quality & Outcomes, 6(1), 19–26. doi:10.1016/j.mayocpiqo.2021.11.006

[25] Thomas-Jacques, T., Jamieson, T., & Shaw, J. (2021). Telephone, video, equity and access in virtual care. npj Digital Medicine, 4, 150. doi:10.1038/s41746-021-00528-y

[26] Uscher-Pines, L., Sousa, J., Raja, P., Mehrotra, A., Barnett, M. L., & Huskamp, H. A. (2021). Suddenly becoming a “virtual doctor”: Experiences of psychiatrists transitioning to telemedicine during the COVID-19 pandemic. Psychiatric Services, 72(10), 1143–1150. doi:10.1176/appi.ps.202000250



[27] Venkatesh, K. P., Mehrotra, A., & Huskamp, H. A.. Has increased telehealth access during COVID-19 led to overuse? npj Digital Medicine, 5, 177. doi:10.1038/s41746-022-00740-4

[28] Vogt, E. L., Welch, B. M., Bunnell, B. E., Barrera, J. F., Paige, S. R., & Kaphingst, K. A.. Quantifying the impact of COVID-19 on telemedicine utilization: Retrospective observational study. Interactive Journal of Medical Research, 11(1), e29880. doi:10.2196/29880

[29] Wosik, J., Fudim, M., Cameron, B., Gellad, Z. F., Cho, A., Phinney, D., … Katz, J. N. (2020). Telehealth transformation: COVID-19 and the rise of virtual care. Journal of the American Medical Informatics Association, 27(6), 957–962. doi:10.1093/jamia/ocaa067

[30] Ye, S., Kronish, I., Fleck, E., & Horowitz, C.. The impact of telemedicine visits on controlling high blood pressure: Retrospective cohort study. JMIR Formative Research, 6(3), e32403. doi:10.2196/32403

[31] Zhang, Y., Arora, P., Fu, J., & Zhang, Y.. Impact of telehealth on health care resource utilization during the COVID-19 pandemic: A real-world analysis. Journal of Comparative Effectiveness Research, 11(9), 677–687. doi:10.2217/cer-2021-0242