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Virtual Diabetes and Hypertension Care in Community Health Centers:  
Use, Quality, and Patient Preferences

by

Aaron Alexander Tierney

A dissertation submitted in partial satisfaction of the  
requirements for the degree of  
Doctor of Philosophy  
in  
Health Policy  
in the  
Graduate Division  
of the  
University of California, Berkeley

Committee in charge:  
Professor Hector P. Rodriguez, Chair  
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## **Abstract**

Virtual Diabetes and Hypertension Care in Community Health Centers:  
Use, Quality, and Patient Preferences

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Aaron Alexander Tierney

Doctor of Philosophy in Health Policy

University of California, Berkeley

Professor Hector P. Rodriguez, Chair

In response to the COVID-19 pandemic, telehealth was rapidly implemented to make remote care possible. While pre-pandemic levels of telehealth utilization were low generally, community health centers (CHCs) had particularly low adoption due to policy barriers and limited access for low-income populations. One major challenge in understanding telehealth utilization among patients of CHCs is disentangling patient preferences and barriers to use. For instance, low-income populations may prefer in-person care, but this option may be constrained by structural barriers, including employer flexibility for time off and financial considerations. Despite lingering volatility in the policy landscape, unclear patient preferences, and unique barriers to implementation, many CHCs accelerated telehealth implementation.

In order to address barriers relevant to CHCs, this dissertation examines factors that impact telehealth implementation. Chapter 1 is a systematic review conducted to understand factors that influence organizational adoption of telehealth in safety net settings and how to overcome barriers. Chapter 2 examines the association of care continuity with telehealth use and quality of diabetes and hypertension care in CHCs before and during the COVID-19 pandemic. Finally, Chapter 3, utilizes a conjoint experiment with a latent class analysis to unpack preferences and needs of underserved patients that impact patient adoption and acceptance of telehealth. The three analyses together advance evidence about successful telehealth implementation for underserved patient populations.

# Table of Contents

<b>Background, Conceptual Model, and Aims</b> .....	<b>iv</b>
Background .....	iv
Conceptual Model .....	v
Outer Setting .....	v
The Organization .....	vi
Care Teams .....	vii
Patients .....	ix
Overall Conceptual Model .....	x
Hypotheses and Unique Contributions.....	xi
<b>Chapter 1. Telehealth Implementation for Safety Net Populations: A Systematic Review</b> ....	<b>1</b>
Background .....	1
Methods .....	1
Results .....	2
Quality of telehealth-based care and patient and clinician satisfaction .....	2
Grounding in implementation science theories, models, frameworks, and concepts .....	3
Diversity, equity, and inclusion of telehealth implementation in safety net settings .....	4
Discussion .....	5
Conclusion.....	8
Figures and tables.....	10
<b>Chapter 2. Telehealth Use, Care Continuity, and Quality Diabetes and Hypertension Care in Community Health Centers Before and During the Coronavirus Disease 2019 Pandemic</b> .....	<b>20</b>
Background .....	20
Methods .....	21
Data .....	21
Sample.....	21
Outcomes .....	21
Main independent variables .....	22
Control variables .....	22
Statistical analyses .....	22
Results .....	23
COVID-19 pandemic impact on care continuity .....	24

Telehealth use and care continuity during the pandemic.....	24
Care continuity, telehealth use, monitoring, and health outcomes .....	24
Mediating role of telehealth in the care continuity and quality relationship .....	24
Discussion .....	24
Conclusion.....	26
Figures and tables.....	27
<b>Chapter 3. Conjoint Analysis of Remote Care Preferences for Hypertension Management Among Adult Patients.....</b>	<b>32</b>
Background .....	32
Methods.....	33
Data.....	33
Measures .....	33
Statistical analyses .....	35
Sensitivity analyses.....	36
Results .....	36
Discussion .....	38
Conclusion.....	40
Figures and tables.....	41
<b>Conclusion .....</b>	<b>48</b>
<b>References .....</b>	<b>50</b>
<b>Appendices.....</b>	<b>70</b>

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## Background, Conceptual Model, and Aims

### Background

In response to COVID-19, health care delivery systems have quickly implemented telehealth systems to make remote care possible for the safety of their patient populations.<sup>1</sup> While pre-pandemic levels of telehealth utilization were low across the board, community health centers (CHCs) had particularly low adoption of the modality due to policy issues and barriers to access among their patient population. Before the pandemic, the Centers for Medicare and Medicaid Services (CMS) did not reimburse most telehealth appointments, making it near impossible for FQHCs to implement this visit modality since a majority of their patient population is covered by Medicare or Medicaid. In response to the pandemic, CMS has changed its policy so now video and telephone visits are reimbursable under emergency policies that are looking increasingly like they will be lasting changes beyond the pandemic.<sup>2</sup> Despite lingering volatility in the policy landscape, many FQHCs have accelerated telehealth implementation since the services have become reimbursable. However, many barriers to accessing telehealth, particularly video-based telehealth, still remain.<sup>3,4</sup>

One potential facilitator to effective telehealth implementation is strong interpersonal relationships between clinicians and patients. Despite telehealth existing for decades, it is only recently that it has surfaced as a priority for most health systems and physician organizations, and it is vastly understudied in the literature. Prior studies have looked at communication in electronic health records (EHRs) and other health information technologies (HIT) to study care team membership and structure to go beyond traditional research surveying team members for information on membership and structure or using continuity of care to measure team boundedness.<sup>5-7</sup> The literature shows the benefit of having bounded care teams (team with clear boundaries regarding individual responsibilities and who is on the team) on various outcomes such as quality of care and patient satisfaction.<sup>8,9</sup> There is also evidence that team scaffolding, or teams that have established set of roles but have fluid membership, can help more transient teams to improve their performance.<sup>10</sup> There is also evidence that teams tend to perform better and be more nimble when they are smaller (around 3 members as defined by the “teamlet” model of primary care proposed by Bodenheimer and Laing) or are less adaptable when they are too large.<sup>9,11</sup> Smaller teams have more opportunity to build trust among members, have smoother and more efficient communication, more accountability, higher engagement in work, and are easier to manage in general. However, little is known about how primary care team continuity impacts the effectiveness of telehealth implementation and its utilization (especially for certain modalities) during the COVID-19 pandemic.

Potential barriers to effective telehealth implementation include meeting patients’ preferences for their care modality of choice and ability to access telehealth service, which includes the ability of care teams to switch nimbly and effectively to providing care virtually. This is especially salient for CHCs which tend to serve socioeconomically vulnerable patient populations. Most care teams did not provide telehealth services prior to the COVID-19 pandemic and had to quickly develop and implement new workflows, innovative ideas, and strategies to provide quality care to patients. Issues of privacy, technological literacy, broadband access, and language barriers may decrease telehealth utilization at CHCs that have the capability to offer it.<sup>4</sup> In general, older population exhibit lower trust in HIT and feel less comfortable sharing sensitive information via digital modalities. Trust in digital platforms where one could be recorded could also be an issue



for undocumented populations, further decreasing utilization among populations traditionally served primarily by CHCs.

Non-English language speaking populations served by CHCs may also experience language barriers to telehealth utilization as most digital platforms currently on the market are designed primarily for population with English fluency or proficiency. Older and low-income populations also have lower rates of technological literacy and access to broadband services which may reduce telehealth utilization further.<sup>12</sup> All of these issues may be partially addressed by switching modalities to phone rather than video visits, but little is known about the comparative effectiveness between the two modalities and there are recent policy pushing away from offering telephonic care towards video visits in California that may be happening in other states as well.<sup>13</sup> Besides these barriers, patients of CHCs may have unique preferences that increase the acceptability of telehealth, such as elimination of travel and the need to leave work, which may make it easier for certain patients to access care, especially if they live in rural areas or have transportation or mobility barriers. There is also mixed evidence surrounding how team-based care may impact patient satisfaction with care.<sup>14</sup> In order to provide care that is acceptable to patients, it may be necessary to ensure individual physician, or at least care team continuity for the patient, even when providing care via telehealth. Patient satisfaction is highest when care is provided by a single physician, and minimal loss of satisfaction can be achieved on multidisciplinary care teams by providing on-team care from as few of members that the patient recognizes as part of the care team as possible (rather than a physician or member of a different care team).<sup>7</sup> In order to inform how CHCs can best leverage primary care team to support telehealth implementation for low-income populations, more research needs to be done to analyze the extent of barriers and the preferences of various patient populations CHCs may serve.

## **Conceptual Model**

To develop a conceptual model for effective telehealth adoption, 3 main stakeholders must be taken into consideration: the organization, care teams, and patients. These 3 stakeholders have unique barriers and facilitators to telehealth adoption that pose multiple levels of adoption that must all be successful individually in order to have a successful overall adoption. If just one of these levels is not aligned, telehealth adoption is likely to fail and/or will not have its intended impact on patient outcomes. Factors described in all three levels are derived from previous research and the following sections will go over each level in detail.

### Outer setting

Before going into the three levels of the model, it is important to briefly discuss the environment or outer setting in which telehealth adoption was taking place during the period of interest to this research. The outer setting of an implementation effort is a key factor in facilitating its success.<sup>15-</sup><sup>17</sup> Due to the nature of the COVID-19 pandemic, other outside factors were largely crowded out and telehealth was the only option to ensure care continuity during shelter-in-place orders that began on March 16, 2020. Further, policy, although some of it temporary, heavily supported telehealth adoption and allowed for reimbursement of phone and video visits for the first time ever in many settings. The main outside factor that could negatively impact telehealth adoption was a scarcity of electronic devices at the start of the pandemic, especially computers, tablets, and webcams. Even if organizations and patients were able to afford the purchase of such

equipment if they did not already have it, there may not have been enough stock in the market for everyone to acquire the necessary equipment for telehealth adoption until much after telehealth became reimbursable and a desirable option in the face of the pandemic.

### The Organization

Telehealth adoption is largely understudied, and while there are studies and frameworks of what facilitates successful adoption of health care innovation and new health information technologies, there are none that specifically address key factors for telehealth adoption at an organizational level. In order to make informed predictions about key facilitators and barriers for telehealth adoption at the organizational level, important considerations were extrapolated from the “inner setting” level of the Consolidated Framework for Implementation Research (CFIR).<sup>15</sup> The CFIR is a commonly used framework to inform the development and implementation of a myriad of health care innovations ranging from interpersonal interventions to health information technologies. The CFIR’s “inner setting” provides guidance on key organizational considerations for successful adoption of any innovation. Key factors relevant to telehealth adoption include structural characteristics of the organization, networks and communications within the organization, the organizational culture, the implementation climate of the organization, and the organization’s readiness for implementation of telehealth.

Structural factors such as social structure, age, maturity, and size can interplay with the ability of an organization to adopt new innovations successfully. Organizations with more interconnected teams and departments that are well differentiated and specialized, likely due to greater ease of coordination and diversified knowledge, have greater success with adoption of new innovations. Larger and more mature organizations are associated with increased success in implementation, due to their enhanced resources. Damschroder and colleagues also include team stability as a structural factor when describing the CFIR. However, since this factor is more specific to a specific team, as various teams in a singular organization can have large variance in stability, this factor will be touched on in the next level of the conceptual model.

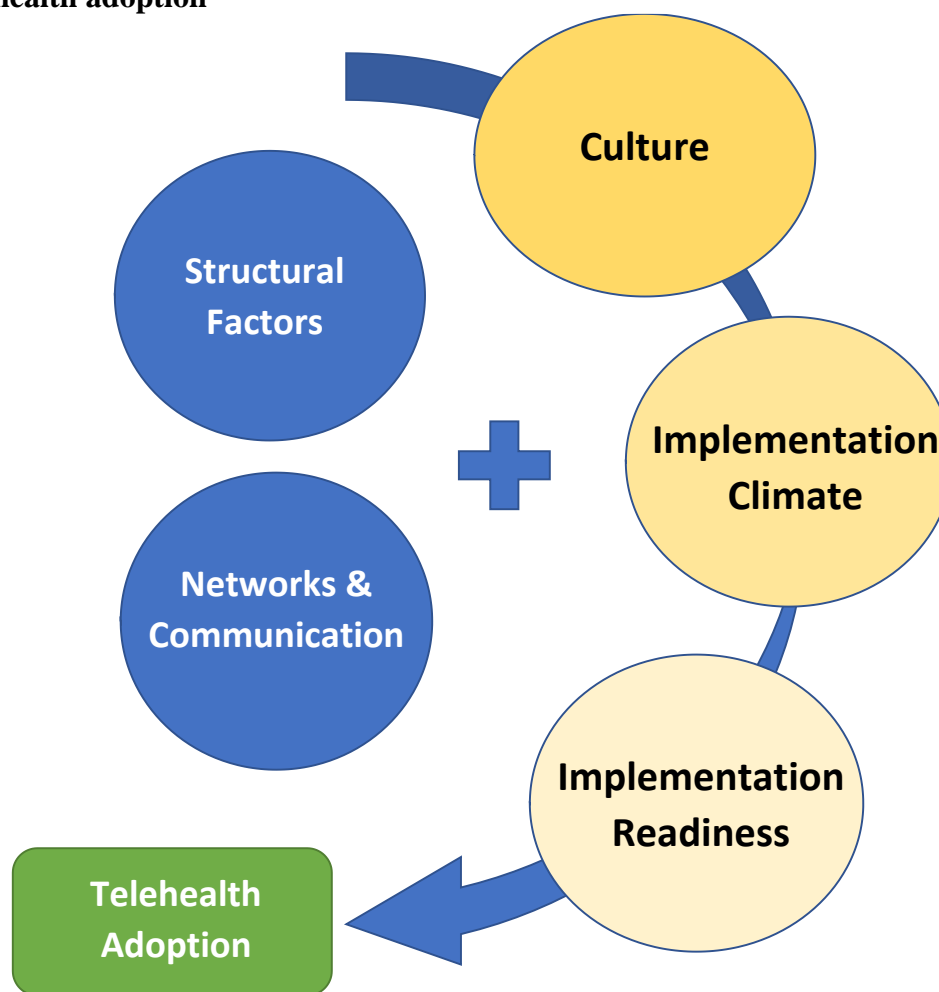
In addition, networks and communication within the organization can impact the ability of an organization to adopt health care innovations. Without a robust network and communication methods, there can be low fidelity of implementation and/or teams within the organization may receive fewer or unclear instructions on what is being implemented and how it should be implemented. This can impact stakeholder buy-in as well as effective implementation of the innovation. Once the innovation is implemented, organizations with fewer or weaker ties between networks are more fragmented and finding support outside of the care team if the team lacks the relevant knowledge, skills, abilities or other characteristics (KSAOs) to successfully implement the innovation can be extremely difficult, leading to an increased likelihood of failure of adoption.

Furthermore, if the organization’s culture does not support the innovation, this can lead to a failure of adoption. For instance, in the case of telehealth, if the organizational culture is one where there is a reluctance to change or there is a culture of sticking with older, established, and more heavily tested methods of care delivery, telehealth may face increased barriers to adoption. This ties in with the importance of the implementation climate, which may be influenced by the organizational culture.<sup>18</sup>

Implementation climate might also be impacted by individuals in the organization's perceptions of the level of support the organization gives to encourage, cultivate, and reward innovation use.<sup>19</sup> If the organization does not have needed supports in place for telehealth adoption such as training, IT staff, avenues for staff to provide feedback, or other elements of a supportive context, adoption is likely to fail. Many of these supportive items are also a piece of an organization's readiness for change, which predicts the likelihood of a successful implementation of an innovation.<sup>20</sup> There is a recent history of a link and overlap established between organizational culture, implementation climate, and implementation readiness for change and how they all influence the probability of successful implementation of health care innovations.<sup>17,21-23</sup>

A full diagram of the organizational conceptual model is illustrated below in **Figure 1**.

**Figure 1. Conceptual model of organizational factors involved in the facilitation of organizational telehealth adoption**



Care Teams

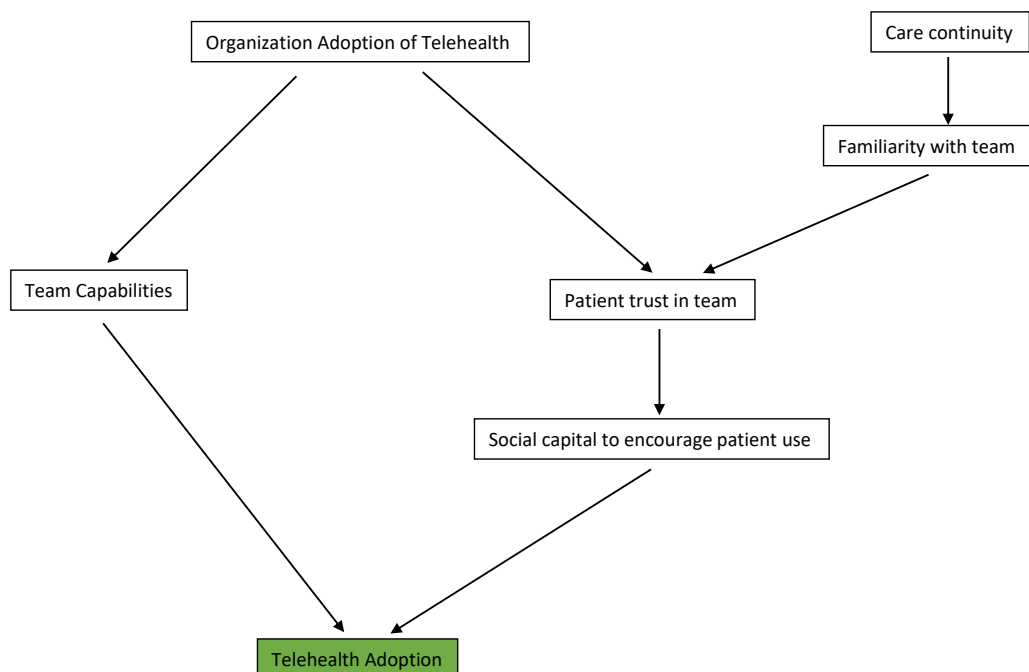
The research outlined in this document focuses on the impact of care team continuity on patient hypertension and diabetes process and outcome measures. While continuity of care, or care that is more concentrated among clinicians rather than dispersed, is associated with improved quality

of care and patients' experiences, it is unclear how this might impact telehealth adoption.<sup>24-26</sup> This research aims to determine the association between care continuity and telehealth adoption and improved intermediate outcomes of hypertension and diabetes care mediated by telehealth use.

The role of social networks and established relationships in trust building was established by foundational works in social capital theory.<sup>27-30</sup> Social capital is a central component of society and has predicted human behavior not just in individual relationships, but in various facets of life including politics, economics, and organizations.<sup>29-33</sup> Healthcare is no exception and trust has been established as a key determinant of patient experience.<sup>34-36</sup> Not only does trust built between patients and providers predict patient outcomes, it also has shown that it can influence patient behavior including use of unreliable health information garnered from the internet and patient adoption of health technology innovations.<sup>37-41</sup> The culmination of the interplay between social capital theory and health technology adoption is the framework presented by Tsai that uses concepts from social capital theory as a predictors of key drivers of adoption in the Technology Acceptance Model (TAM), an established framework in implementation science, user experience, and design.<sup>39,42</sup> This framework established a pipeline from trust to perceived use to usage intention. Care teams serve as an important mediator between the medical organization and patients.

Given the importance of patient trust in their providers as explained above, it is important to understand how to create, build, and maintain that trust. Psychology and sociology have found that the main way to build trust between individuals is through longevity of relationships.<sup>27-31,33</sup> In medicine, this is predominantly created through care continuity, which has been linked directly to trust in previous studies.<sup>43-47</sup>

**Figure 2. Conceptual model of the impact of care team continuity on team effectiveness and care team telehealth adoption**



## Patients

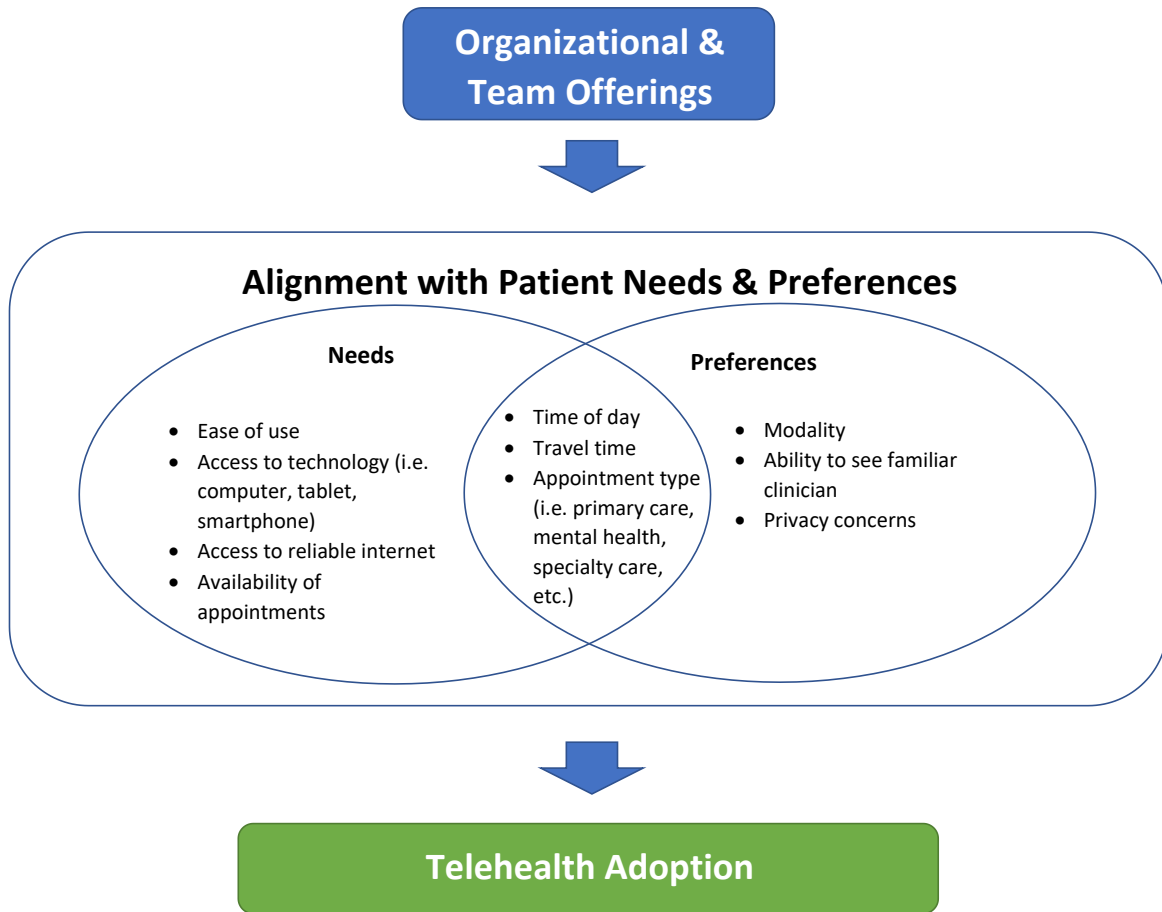
The final level of the conceptual model is informed by qualitative research and policy analyses that have explored factors that may impact patient adoption of telehealth.<sup>48-50</sup> Even if an organization provides perfect support and is fully resourced to adopt telehealth, with individual care teams fully onboard and engaged in implementation, telehealth adoption is bound to fail if there is no demand for it among patients in the marketplace.

Factors well beyond availability impact patient adoption of telehealth. Some of these factors include perceptions of privacy, travel time to in-person alternatives, ease of use, differences in copay, ability to see a person the patient perceives as being part of their care team, the time of day of telehealth vs in-person offerings (especially for individuals that work), and perceptions of equivalent quality with in-person care. Some patients may also be more comfortable doing certain types of appointments over telehealth. For instance, there is a history of success with telehealth for mental health appointment in regard to patient satisfaction, but some patients may be more reluctant to have primary care appointments via telehealth or have appointments for specific concerns such as dermatology or acute conditions.

Patients in safety net settings may have additional concerns, such as access to fast and reliable internet necessary for video visits and access to phones, computers, and tablets that are necessary for telehealth. Safety net patients may also have enhanced sensitivity to factors that matter to a more general patient population, such as time of day concerns and travel time, as safety net patients may have multiple jobs or jobs with stricter schedules and an inability to realistically take time off from work to have an appointment.

In accordance with concepts already evidenced in implementation literature, the ability of telehealth offerings to align with patient needs and preferences outlined above, will determine patient adoption of telehealth services.<sup>15,51,52</sup>

**Figure 3. Conceptual model of the impact of patient needs and preferences on patient telehealth adoption**

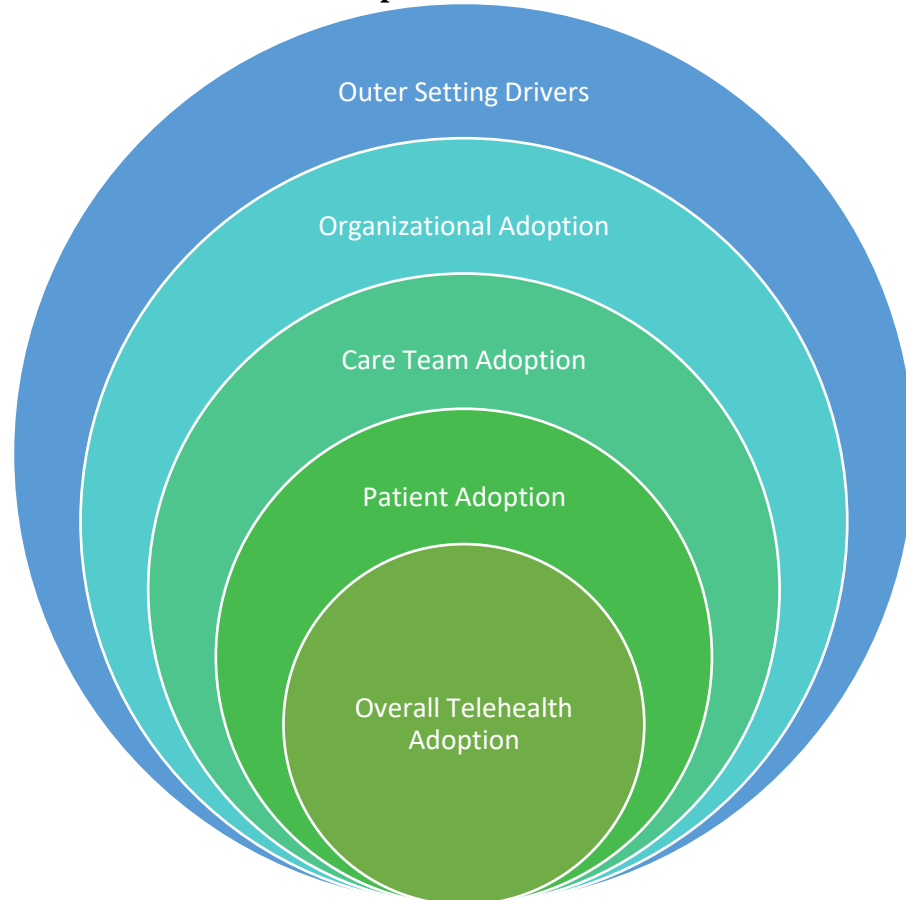


Overall Conceptual Model

With a model outlined for each level of stakeholder in the telehealth adoption pipeline, it is important to recognize some key factors in the overall picture. First, the outer setting discussed above will have an influence on all levels of stakeholders.<sup>15</sup> The COVID-19 pandemic was a driver to increase telehealth adoption at all levels out of concerns for safety of care teams and patients alike and was often the only way to give and receive care in the United States during shelter-in-place periods. Second, due to the novelty, complexity, and expense of telehealth implementation, factors that require large amounts of organizational support to overcome, telehealth adoption was largely a top-down process. The direction of telehealth adoption in reaction to COVID-19 made it so that each level of stakeholder adoption impacted the level below. Care teams could only adopt telehealth in a fashion that was supported and resourced by the organization, and patients could only adopt telehealth in ways offered by their care teams. There is also a potential “gatekeeping effect” between patients and organizational adoption if an organization were to adopt telehealth capabilities that were incongruent with care team abilities or perceptions of efficacy. In this scenario an organization may adopt telehealth, but patients are never presented with the offer of telehealth appointments (thus making patient level adoption impossible) because care teams are unable to or choose not to adopt telehealth. Finally, this results in the overall conceptual model presented in **Figure 4**, that combines the outer setting, the

organization, care teams, and patients and acknowledges the cascade effect present in telehealth adoption where each of the previous levels of stakeholder and outer setting serve as a backdrop and direct influence on whether the subsequent level has the choice of adoption. Successful overall telehealth adoption for a singular patient entails successful adoption at the level of the organization, care team, and patient.

**Figure 4: Conceptual framework to understand the flow from unique considerations from different levels of stakeholders to telehealth implementation**



### **Hypotheses and Unique Contribution**

In order to address the gaps detailed above, I conducted a project with 3 primary aims guided by each level of the previously presented conceptual model. The presented model stratified by stakeholder level will help frame understanding of factors that may impact the perceived usefulness of telehealth that has downstream effects on telehealth implementation by impacting people’s attitudes towards using and behavioral intention to use telehealth. One major challenge in understanding factors that influence telehealth utilization among patients of CHCs is disentangling patient preferences and barriers to use. For instance, in lower income populations time of day and travel time of an appointment may be a preference, but in many cases, if not more, time of day and travel time may be restrictive structural barriers due to employer demands, financial considerations, etc. Following the conceptual model, in **Aim 1** I conduct a systematic review to understand factors that influence organizational adoption of telehealth and how to overcome barriers. In **Aim 2** I perform a cross-sectional analysis of the impact of care continuity

on telehealth adoption using administrative data from community health centers. Finally, in **Aim 3** I perform a conjoint analysis with a latent class analysis to unpack patient preferences and needs by groups present in the data that impact patient adoption of telehealth. The three aims together illustrate a complete narrative for successful overall telehealth adoption in community health centers at each stakeholder level.



## **Chapter 1. Telehealth Implementation for Safety Net Populations: A Systematic Review**

### **Background**

In response to COVID-19, health care delivery systems have quickly implemented telehealth systems to make remote care possible for the safety of their patient populations.<sup>53-56</sup> This resulted in a multi-fold increase in telehealth adoption for care of patients across diagnoses and demographic groups.<sup>57-61</sup> Patients also exhibit high levels of satisfaction with virtual care.<sup>57,61</sup> Policies that support telehealth use and reimbursement are looking increasingly like they will be long-lasting into a post-pandemic world for certain patient populations and there is a push to expand this permanent coverage. There is also growing evidence that clinics and clinicians want telehealth to remain an offering in the post-pandemic world.<sup>62-64</sup>

However, little is known about telehealth effectiveness and barriers and facilitators to adoption and sustainability of telehealth programs. Understanding an innovation prior to implementation, including the resources it will require, how it will meet user needs, and planning to overcome known obstacles, is key to a sustained and effective implementation.<sup>15,65,66</sup> This is especially true in Federally Qualified Health Centers (FQHCs) and other safety net settings, which are key resources in ensuring equity in healthcare that serve patients with unique needs and preferences who are more likely to be at risk to being left behind by the “digital divide” – a division between people who have access to and use of digital media and those who do not.<sup>67</sup> Widespread telehealth adoption has the risk of exacerbating existing health care inequities if it is not adequately made available in a format tailored for underserved populations and communities.<sup>56,68-71</sup>

In order to address this gap, we aimed to compile evidence around primary care telehealth implementation and effectiveness in safety net settings. We conducted a systematic review focused on telehealth interventions aimed at patients in FQHCs, rural health centers (RHCs), community health centers (CHCs), and academic medical centers. Our aim was to garner information on addressable barriers and facilitators at the organizational level for synchronous phone or video visits in primary care, including behavioral and mental health, and pharmacy, as this is often patients’ first and/or only method of interaction with the health care system. This study aims to synthesize current knowledge that could ensure disadvantaged populations are not left behind as telehealth is sustained and expanded.

### **Methods**

In June 2021 through December 2021, a systematic review was conducted of peer-reviewed articles published in 2013 and after describing and analyzing the implementation of synchronous phone or video appointments in health care systems that predominantly serve low income and/or rural populations in the United States. Studies had to primarily focus on federally qualified health centers (FQHCs), rural health centers (RHCs) or community health centers (CHCs). Studies that took place in academic medical centers and safety net hospitals that focused on populations of interest were also included. Studies that took place in VA hospitals and clinics were excluded due to the limited external validity of findings of studies in these settings to other settings. Studies focusing on behavioral and mental health as well as pharmacy appointment

were included but we excluded all studies regarding non-reimbursable appointment types as defined by the Centers for Medicaid and Medicare Services (CMS), peer-to-peer educator appointments, and dental appointments. Relevant articles were identified in PubMed using search terms developed by the research team in June 2021 and then underwent title and abstract screening followed by full text screening for articles identified as potentially relevant. Some potentially relevant outside articles were identified and included in the screening process. All screening, extraction, and quality assessments were performed using Covidence, software designed to aid in conducting systematic reviews. Articles were only included for final analysis if two reviewers agreed that they met inclusion and exclusion criteria at each stage. Each included article underwent extraction and quality assessment using relevant Critical Appraisal Skills Programme (CASP) Checklists<sup>72</sup> by two reviewers. Disagreements between reviewers at all stages were resolved by a senior consensus reviewer. The extraction phase was used to pull out information about the design and results of each study, any barriers or facilitators to implementation of each study, and specific focus on a subset of further marginalized or at-risk populations (e.g. non-White, elderly, rural, specific comorbidities). Information of when and where the study took place, the details of the intervention, the modality of the telehealth appointments (phone, video, or both) were also collected.

## Results

After the full screening process, we were left with n=45 studies in our final sample that met our inclusion criteria for extraction and quality assessment.<sup>56,73-116</sup> A PRISMA flow diagram<sup>117-120</sup> detailing the review process is presented in **Figure 1**. N=36 (80%) studies were observational in nature<sup>56,73-79,81-96,98,99,101,103,104,106,108,109,112-115</sup> and n=9 (20%) were randomized controlled trials<sup>80,97,100,102,105,107,110,111,116</sup>. Most studies focused on video (n=35, 78%)<sup>56,73,75-79,81-90,93,94,96-98,100-102,104,106-111,113-115</sup> or audio (n=24, 53%)<sup>56,73,76-78,81-90,95,99-101,105-107,110,116</sup> based telehealth. Details of the study designs and telehealth modality included in **Table 1**.

All studies met the CASP Checklist requirements for being methodologically sound and being relevant to the intended purpose of our systematic review to provide insights to community health centers about previous work examining telehealth implementation to provide quality and effective care for their patient population.

### Quality of telehealth-based care and patient and clinician satisfaction

When performing analysis of the quality of care and patient outcomes provided by telehealth, n=21 (47%) studies found positive results<sup>73,75,78,82-84,86,90-92,99-101,104,106-111,113</sup>, n=1 (2%) study had null results<sup>116</sup>, n=13 (29%) studies had mixed results<sup>74,76,77,80,81,85,87,95-97,102,105,115</sup>, and n=10 (22%) studies were descriptive only in nature<sup>56,79,88,89,93,94,98,103,112,114</sup>. A brief summary and valance of the conclusions of each study are presented in **Table 2**.

These studies show that telehealth is acceptable to safety net patients and there is high interest in engaging in telehealth-based care delivery.<sup>78,83,85,106,111,113,114</sup> From an administrative standpoint, telehealth can also be successfully implemented in these traditionally resource constrained settings for primary care delivery and can also enhance team coordination and increase efficiency.<sup>73,77,80,82-85,87,89-92,95-97,99,100,104-107,109-111,113,115</sup> There is also some preliminary evidence

that telehealth implementation may have an impact on reducing clinician burnout through increased workflow efficiency while providing care to underserved patients.<sup>90</sup> Mills and colleagues performed a pre-post comparison that found that the same clinicians had an average on point 2 point reduction on an abbreviated Maslach Burnout Inventory post-telehealth implementation compared to before implementation, with reductions in burnout being associated with less emotional exhaustion and depersonalization.<sup>90</sup> Telehealth also helped bridge gaps between urban and rural patients, where rural patients generally have lower care utilization and more missed appointments than their urban counterparts.<sup>87,97,98,100,107,110</sup> However, results also showed that telehealth may not be an appropriate substitute for in-person care in all scenarios and with all patient populations.<sup>56,74,79,87,95,105</sup> For example, older patients have lower interest in and satisfaction with telehealth appointments, although there may be a stable minority open to its use.<sup>79,87</sup> Studies with this finding were both conducted among rural populations, which overall, still tended to have higher preference to telehealth than their urban dwelling counterparts, with increased preference correlated with increased distance from the nearest urban center. Studies also found parity between telehealth and in-person patient outcomes,<sup>99,101,104,105,110,116</sup> with a singular exception by Rosal and colleagues that found a telehealth intervention improved A1c control and depression reduction compared to baseline, but less so than an in-person intervention for inner city African American women.<sup>80</sup>

Initial results also show high acceptance and belief in the ability of telehealth to provide quality care beyond the COVID-19 pandemic.<sup>78,101</sup> In particular Mammen, et. al, found that smartphone-based telehealth for asthma care had high acceptability among clinicians<sup>101</sup> and a national survey analyzed by Nies and colleagues found 80% of surveyed clinicians in federally qualified health centers believed in the efficacy of telehealth to deliver quality care beyond the pandemic as either a supplement to or substitute for in-person care for certain patient populations (i.e. patients with mobility issues who would not be able to make it to the clinic otherwise).<sup>78</sup>

### Grounding in implementation science theories, model, frameworks, and concepts

Only n=3 (7%) studies grounded their research in a previously published implementation theory, model, or framework, using a total of 4 frameworks and models.<sup>89,110,111</sup> The four frameworks and models utilized were the Exploration, Preparation, Implementation, and Sustainment (EPIS) Framework<sup>121</sup>, the Donabedian Model<sup>122</sup>, and the Health Belief Model<sup>123</sup>, and the Transtheoretical Model<sup>124</sup>. All three studies utilized the frameworks to guide intervention development to maximize the potential for patient behavior change and empowerment and to analyze aspects of the settings that facilitate adequate supports and resources for successful intervention. While one study was descriptive in nature and used the EPIS framework to guide thinking about clinic categorization for opioid use disorder treatment,<sup>89</sup> the other two studies had successful implementation that improved diabetes outcomes<sup>110</sup> and access for patients of community mental health clinics.<sup>111</sup>

Twenty (44%) studies examined the implementation of a telehealth program longer than 3 months.<sup>74,80,87,92,93,97,98,100-102,104-111,115,116</sup> 16 (36%) studies gave the same intervention to all patients<sup>73,74,76-79,90,93,96,99,101,104,106,108,113,114</sup> and 20 (44%) had inconsistent interventions across patients and/or sites<sup>56,75,80,83-85,89,94,95,97,98,100,102,105,107,109-111,115,116</sup>, and 9 (20%) had

unclear/missing descriptions of the studied telehealth program<sup>81,82,86–88,91,92,103,112</sup>. 34 (76%) studies examined a long-lasting intervention<sup>56,73–79,81–96,98,99,103,104,108,109,112–115</sup> and 11 (24%) implemented telehealth as a trial only lasting the study period<sup>80,97,100–102,105–107,110,111,116</sup>. Details of the implementation and sustainability of interventions in included studies are presented in **Table 3**.

While examining the various implementations of telehealth, n=15 (33%) studies explicitly mentioned barriers to implementation<sup>56,73,79,86,87,94,96,99,103,104,107,111,113–115</sup> and n=8 (18%) mentioned facilitators<sup>75,76,83,89,104,106,111,115</sup>. Captured barriers included: billing/administrative workflow disruption (n=9, 20%)<sup>56,87,94,96,99,103,104,107,115</sup>, broadband access/quality (n=5, 11%)<sup>56,96,103,113,115</sup>, patient acceptance/preference for in-person (n=4, 9%)<sup>56,79,94,96</sup>, clinical workflow disruption (n=4, 9%)<sup>94,96,113,114</sup>, lack of technical/implementation expertise (n=4, 9%)<sup>56,103,114,115</sup>, language access/interpretation (n=3, 7%)<sup>56,87,99</sup>, regulatory support (n=3, 7%)<sup>94,103,113</sup>, patient digital literacy (n=2, 4%)<sup>56,73</sup>, clinician/staff training and resource requirements (n=2, 4%)<sup>114,115</sup>, privacy concerns (n=2, 4%)<sup>96,114</sup>, safety/quality of care concerns (n=2, 4%)<sup>56,96</sup>, and appointment availability (n=1, 2%)<sup>111</sup>. Uscher-Pines and colleagues performed a qualitative analysis of community health centers and federally qualified health centers in 14 states and their telehealth capacity for mental health services in 2020.<sup>96</sup> This analysis highlighted many of the most common barriers seen in the studies in our review. Specific barriers highlighted were difficulty sharing information, assessing the physical state of patients, and establishing rapport with patients via a virtual medium, especially with “warm hand-offs” that are central to mental health care. Captured facilitators to telehealth implementation included: efficiency gains (n=6, 13%)<sup>83,89,104,106,111,115</sup>, patient acceptance (n=3, 7%)<sup>83,106,111</sup>, enhanced patient access (n=3, 7%)<sup>83,106,115</sup>, telehealth being inexpensive/more cost-effective compared to in-person appointments (n=2, 4%)<sup>106,115</sup>, availability of training for clinicians and/or staff (n=1, 2%)<sup>75</sup>, and the ability to get reimbursement/payment for telehealth appointments (n=1, 2%)<sup>76</sup>. Patton et. al, 2021 highlighted some facilitators that are essential to enhancing digital health equity in their analysis of substance use and prenatal care delivery during the COVID-19 pandemic.<sup>83</sup> The authors described the elimination of the need for transportation and childcare through virtual care, which reduced missed appointment rates and facilitated the treatment of pregnant and postpartum patients diagnosed with opioid use disorder.

#### Diversity, equity, and inclusion of telehealth implementation in safety net settings

While examining these studies for diversity, equity, and inclusion (DEI) considerations, we found that in the demographics sections of these studies only n=17 (38%) included African American/Black patients<sup>73,75–77,80,83,85,87,90,92,100,101,105–107,110,111</sup>, n=13 (29%) included LatinX/Hispanic patients<sup>73,75–77,83,85,87,90–92,97,101,111</sup>, n=3 (7%) Asian patients<sup>85,92,101</sup>, n=3 (7%) patients aged 65 years or older<sup>85,103,113</sup>, and n=3 (7%) patients with limited English proficiency<sup>85,91,116</sup>. While extracting data on subgroup analyses of groups of special interest, n=8 (18%) included special analyses for African American/Black patients<sup>74,76,77,85,90,91,95,103</sup>, n=8 (18%) LatinX/Hispanic patients<sup>74,76,77,85,90,91,95,103</sup>, n=3 (7%) Asian patients<sup>74,85,103</sup>, n=5 (11%) patients aged 65 or older<sup>85,87,90,103,113</sup>, n=4 (9%) patients with limited English proficiency<sup>85,87,103,116</sup>, n=4 (9%) patients without private insurance<sup>74,76,102,109</sup>, n=2 (4%) patient

with varying levels of education<sup>102,116</sup>, and n=7 (16%) for other subgroups which included n=1 (2%) study each examining gender<sup>105</sup>, veteran status<sup>105</sup>, homelessness<sup>95</sup>, social vulnerability<sup>56</sup>, low income<sup>102</sup>, distance from nearest clinic<sup>109</sup>, and patients with depression<sup>116</sup>. Analyses of these subgroup yielded group-specific barriers and facilitators, such as enhanced interest in video visits thorough smartphone applications by non-English speaking patients, technology use barriers for older, non-English speaking, Black, or LatinX patients, and low interest and satisfaction in telehealth for rural older adults, despite high telehealth adoption and satisfaction among rural patients overall.<sup>85,87,103</sup>

## **Discussion**

Telehealth has the potential to have a positive impact on patient outcomes and quality of care through enhanced efficiency and ease of access to care. While current research primarily consists of studies conducted in the past couple of years, trends have begun to emerge. Despite gaps that exist in form of health disparities and the “digital divide”,<sup>67</sup> studies in this review have exemplified the utility of telehealth in serving the needs of a safety net population. Discovering ways to successfully integrate telehealth into administrative and clinical workflows and finding ways to support patients who have limited access to broadband and limited English proficiency in using telehealth through policy or organizational level interventions could address many barriers to telehealth adoption and sustainability in safety net settings. For instance, Khoong, et. al, 2021 found that non-English speakers in an urban safety net setting were more interested in video visits than English speakers and perceived language barriers as easier to overcome with visual cues.<sup>85</sup> Clinics that use interpretation services for visits with non-English speaking patients may find it useful to explore directing these patients to video-based telehealth services and offer video interpreters, helping to overcome barriers to telephone-based interpretation also observed in Parnell, et. al, 2020.<sup>99</sup> However, as with a few other studies in our review, such as Barney, et. al, 2020, privacy concerns over the ability to create a quiet and isolated location for appointments as well as data security were a barrier to patient acceptance of telehealth.<sup>114</sup>

Furthermore, there are additional studies included in our review that show that telehealth is an acceptable and effective method of providing healthcare to traditionally marginalized and disadvantaged groups. Adams, et. al, 2021 studied the implementation of a telehealth clinic in an urban setting for patients experiencing homelessness.<sup>75</sup> This clinic allowed for remote assessment of patients by a group of 10 rotating family medicine resident physicians with medical students staffed the sites withing the community. The medical students helped with logistics such as entering data into patient records, obtaining vital signs, and assisting patients with the remote stethoscope, ophthalmoscope, and dermatoscope offered at the remote site. Through this established drop-in telehealth clinic and training for staff, the drop-in center was able to meet patient needs while reducing ED utilization and providing patients needing a referral with appointments time within 24 hours of their visit to the drop-in clinic regardless of the condition they were presenting with. This set up maintained flexibility for clinicians, while helping to overcome barriers to access such as lack of housing and broadband access and maintaining high levels of satisfaction for both clinicians and patients. High rates of clinician acceptance of telehealth in safety net settings was also exhibited in two studies previously

mentioned,<sup>78,101</sup> as well as an association between reduced burnout among residents and telehealth adoption.<sup>90</sup> Clinician buy-in to telehealth is a key facilitator of overall telehealth adoption and another factor that points to the potential longevity of telehealth offerings in safety net settings.

Similarly to many of the studies included in our review that discuss barriers or facilitators of implementation, previous systematic reviews of health information technology (HIT)-based interventions also revealed that consideration of and adaptation to existing workflows is an important factor that influenced the success of implementation.<sup>125,126</sup> Previous reviews of HIT implementation also highlight the importance of policy support at both the organizational (i.e. training, management support, resource availability, supporting infrastructure) and government level (i.e. reimbursement, incentives, supportive policy).<sup>126-130</sup> This highlights the importance of continuing support for telehealth reimbursement and policy that allows for flexibility. This support includes the outer context of telehealth implementation, which includes ensuring patient access to broadband internet and digital devices capable of video and telephone-based care. The Lifeline Program for Low-Income Consumers,<sup>131</sup> a federal program that subsidizes internet bills and payments for electronic devices is a key example of policy that provides a supportive outer context for telehealth implementation. We see the importance of these supports echoed in the studies included in our review that describe facilitators and barriers to implementation.<sup>56,73,75,76,79,83,86,87,89,94,96,99,103,104,106,107,111,113-115</sup> Childs, et. al, 2021 mentions changes to Centers for Medicare and Medicaid reimbursement policies during the pandemic as a key support for providing telehealth to vulnerable and high-risk populations.<sup>76</sup> Armstrong, et. al, 2011 also cited lack of reimbursement and inability to incorporate telehealth into a sustainable business model as a major barrier to sustainable teledermatology as reported by interviewed dermatologists.<sup>115</sup> One of the greatest advantages of telehealth that could facilitate its use is what it helps eliminate rather than add, such as factors mention by Patton and colleagues.<sup>83</sup> Patients who have limited time in their schedules to seek healthcare such as individuals working multiple jobs, who are parents or caregivers, or may live in rural areas far away from the nearest healthcare facility may see enhanced value from no longer needing to travel or pay for childcare to have a visit with a clinician.

Very few studies assessed the idea of sustainability, and all but one of the reviewed studies that assessed sustainability were published after the start of 2020. Given recent developments in policy, telehealth is likely to remain an option for patients moving into the future. It is important that the sustainability of various types of telehealth implementations are understood in order to conserve resources and maximize impact for health systems, care teams, and patients. Similarly, it is important to understand how the use of these systems may differentially impact patients of color, older patients, and other patients belonging to vulnerable populations. Coupled with the low proportion of studies that included patients of color, patients with limited English proficiency, and other at-risk groups, if research and publication continue in a similar manner it may have important and potentially dangerous implications for marginalized populations. Even if telehealth use is sustained and is shown to be efficacious, it is tantamount that health care systems do not further exacerbate already existing health disparities through the implementation of novel forms of care delivery. Rigorous DEI research in academic medicine is central to

creating the knowledge base needed to meaningfully address systemic gaps in health services administration and medicine at large.<sup>132</sup>

In addition, few studies reported on barriers and facilitators to telehealth implementation. Reporting on these factors could help consumers of research to better extract lessons in how to optimize telehealth implementation to reduce wasteful uses of resources while maximizing impact to patient outcomes. The low level of reporting on barriers and facilitators limits the ability to translate research findings into practice and spread the use of evidence-based practices, a central aim of implementation science.<sup>133</sup>

Given the small percentage of studies that were grounded in implementation frameworks, models, or theories, this may be an important next step in improving implementation research in telehealth. Implementation frameworks, models, and theories can be useful for providing context, standardization, while reducing the research-practice gap and moving the field towards an integrated body of knowledge.<sup>134</sup> This could be especially useful when trying to address inconsistencies and gaps in use and effectiveness of telehealth systems by race/ethnicity, socioeconomic status, age, disability status, and other characteristics of traditionally marginalized groups. Key implementation frameworks such as the Consolidated Framework for Implementation Research (CFIR) and others also help frame thinking around important considerations discussed in our reviewed studies such as creating a supportive outer context, having proper information technology infrastructure for implementation, and engaging with and adapting to stakeholder needs and preferences.<sup>15</sup> More specialized frameworks such as the Nonadoption, Abandonment, and Challenges to the Scale-Up, Spread, and Sustainability of Health and Care Technologies (NASSS), can help developers of novel telehealth technologies better consider how these technologies can better fit into workflows and the overall health care organization while assessing potential aspects of the technology that could lead to inequalities in access, uptake, and use by different demographic groups and addressing them in early stages.<sup>135</sup>

Only a fifth of included studies were randomized controlled trials which are often seen as the “gold standard” of research. However, given the expense and complexity of implementing changes to telehealth for experimental purposes and the need to rapidly respond to COVID-19 in the past (as n=30, 66.7% of the studies included were published during the pandemic), performing randomized controlled trials is often infeasible in this setting. In addition, observational studies benefit from their pragmatism and enhanced generalizability.<sup>136</sup> N=34 (76%) of included studies also analyzed a routine implementation of telehealth, rather than a trial with a set start and end date, providing enhanced learnings about adaptations and practical uses and design considerations.

Limitations of this study include the use of a singular database to gather studies for analysis. However, the risk of missing relevant studies published in the literature is low given the comprehensive nature of PubMed on the topic of medicine and health services research. As with all systematic reviews, publication bias<sup>137</sup> has the potential to impact the findings of this study. Research with statistically significant positive findings is more likely to be published than studies with null or negative findings. The prevalence of studies with positive findings may still be an indicator of the potential promise of telehealth, but also the shortcomings of telehealth

implementation in community health centers may not be accurately reflected by the available literature.

This systematic review also only analyzed studies published through 2021, so studies published in 2022 and the beginning of 2023 were not considered in our analysis. In 2022 through February 2023, n=12 studies examined disparities in telehealth use.<sup>138-149</sup> Of these, n=6 studies examined telehealth's interaction with racial and ethnic disparities,<sup>138-141,148,149</sup> n=1 study examined disparities between limited English proficient patients and English-speaking patients,<sup>146</sup> n=4 examined disparities between rural and urban populations,<sup>140,141,144,147</sup> and n=3 examined disparities within vulnerable safety net populations in general.<sup>142,143,145</sup> By racial/ethnic divisions, these studies continued to highlight disparities in telehealth adoption with non-Hispanic White patients much more likely to adopt telehealth. However, similar to the findings in this review, patients who did use telehealth missed fewer appointments regardless of race/ethnicity. One study also highlighted the importance of audio-only visits for Asian-American patients of FQHCs.<sup>149</sup> These studies also had mixed results when examining rural-urban disparities, finding that rural patients had lower telehealth adoption and higher rates of missed appointments, but also finding a dose-response between rurality and telehealth adoption, with increased likelihood of telehealth adoption being associated with increased distance from the nearest urban center regardless of race/ethnicity of the patient. These studies also found that when rural patients did adopt telehealth, it helped mitigate rural-urban disparities in missed appointments. In 2022 to February 2023, only n=1 study appeared to be rooted in an implementation science framework.<sup>150</sup> N=5 studies in this time period also found that established relationships between clinicians and patients is a key facilitator of telehealth adoption.<sup>139,151-154</sup> Of the n=39 studies found in a brief review of the literature published on telehealth implementation for safety net populations in the United States in 2022 through February 2023,<sup>138,140-177</sup> all studies found at least one major positive finding regarding telehealth's ability to increase patient satisfaction, decrease missed appointments, and potentially mitigate disparities for vulnerable and marginalized patients. Of particular note, however, is n=1 study that found high satisfaction across racial/ethnic groups with telehealth also found low satisfaction among Hispanic patients specifically.<sup>148</sup> In a positive trend, n=18 of these studies examined a telehealth implementation for at least 9 months,<sup>138,140-145,148,150,152,156,162,163,167,173,175-177</sup> giving us more insight into the sustainability of telehealth interventions. These studies reinforce many of the findings of this review that show the potential promise of telehealth in helping to mitigate disparities in healthcare and highlight the utility of capitalizing on established relationships to facilitate telehealth adoption. They also help address some of our concerns regarding the lack of studies looking at sustainability of telehealth published in 2013 to 2021. These studies also reinforce the need to ground more work in implementation science frameworks and do more studies on how to bridge gaps in utilization, especially between racial/ethnic groups in the United States.

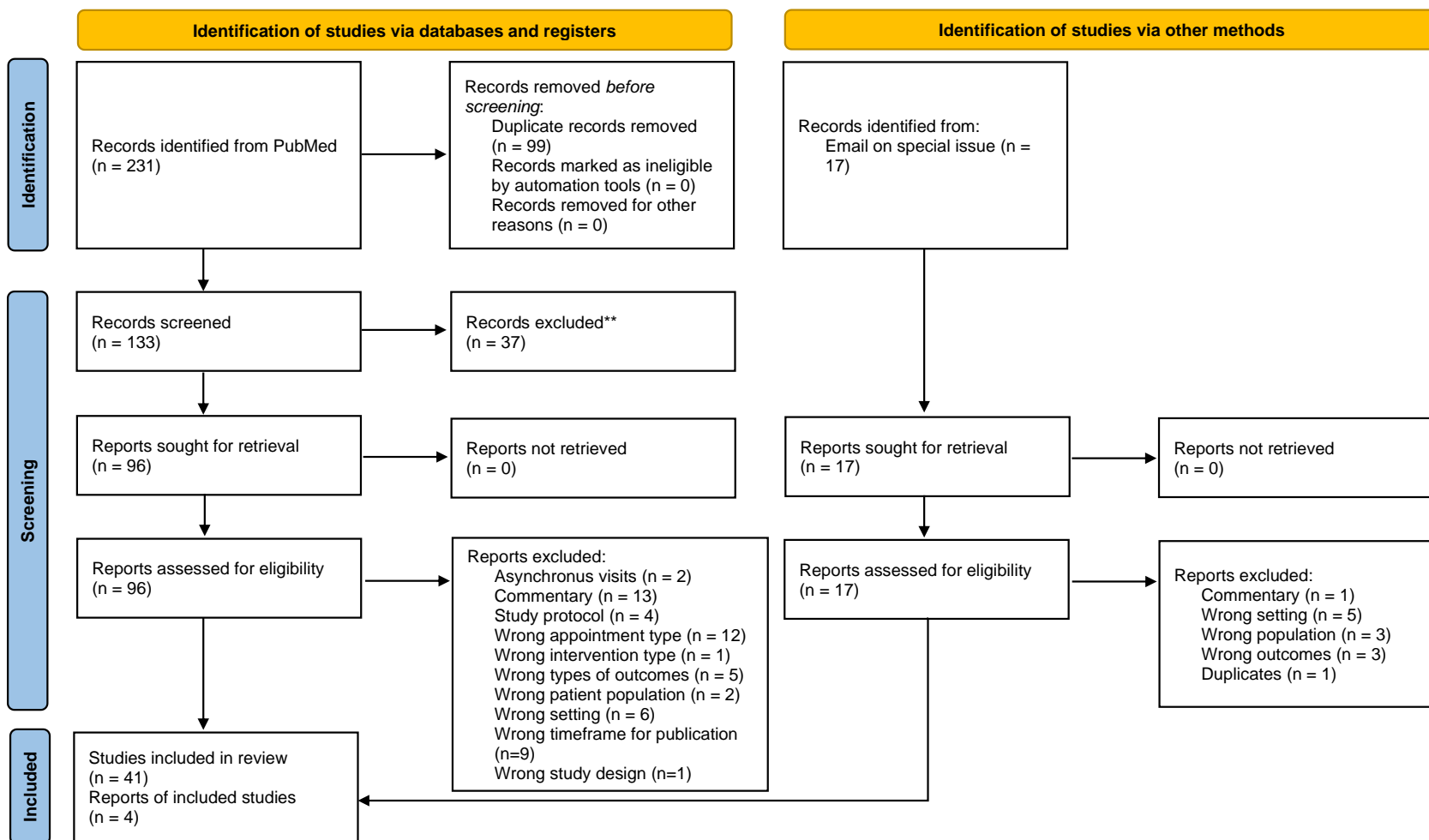
## **Conclusion**

Telehealth is a potentially promising avenue to providing healthcare to patients in safety net settings, especially for younger, rural populations. Initial positive results presented in this systematic review suggest telehealth could provide quality primary care that is potentially more



accessible and affordable by adding more flexibility necessary for patients that have tight constraints on their time and resources, such as eliminating the need for travel or childcare. Studies also show high rates of adoption and acceptability among low-income and minoritized patients, as well as high acceptance and perceived usefulness among clinicians providing care to these patients. However, a lack of studies with negative and/or null results should be taken with caution, as this is likely the result of publication bias. Future studies exploring trial-based/comparative evidence between telehealth and in-person quality of care and effective telehealth implementation in underserved and at-risk communities are needed. Future studies should also address the gap in satisfaction with care provided via telehealth between non-Hispanic White patients and patients of other racial/ethnic backgrounds. Since policy supporting the continual use of telehealth beyond the COVID-19 pandemic are gaining support and are being implemented across the nation, it is key that we understand how to best serve all patients to ensure we do not further exacerbate gaps in care quality and accessibility for vulnerable and underserved populations.

**Figure 1. PRISMA Flow Diagram**



\*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).

\*\*If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71. doi: 10.1136/bmj.n71. For more information, visit: <http://www.prisma-statement.org/>

**Table 1.** Study designs and modalities of telehealth examined in included studies

Study	Study Design		What did implementation consist of?						
	Observational	Randomized Controlled Trial	Video	Audio	Remote Monitoring	Training	Not Clear	Other	Other details
Adams 2021	X		X		X				
Anderson 2010		X		X					
Armstrong 2011	X		X						
Barney 2020	X		X						
Caton 2021	X		X	X			X		
Chang 2021	X		X	X			X		
Childs 2021	X		X	X					
Clifton 2003	X		X						
Coffman 2016	X						X		
Coker 2019		X	X						
Davis 2010		X	X	X					
Dayal 2019 (Neurology)	X		X						
Dayal 2019 (JAMA)	X		X						
Dunham 2021	X		X	X					
Fortney 2013		X	X	X					
Franciosi 2021	X						X		
Friesen 2015	X		X	X					
Futterman 2020	X						X		
Grubbs 2018		X		X					
Hernandez 2016	X		X		X				
Howren 2021	X		X						
Khoong 2021	X		X	X					
Lin 2018	X						X		
Mammen 2020	X		X	X	X				

Mills 2021 (AHA)	X		X	X					
Mills 2021 (Telemedicine)	X		X	X					
Mittal 2014		X	X				X		Medication management
Nguyen 2021	X		X	X					
Nies 2021	X		X	X					
Parnell 2020	X			X					
Patton 2021	X		X	X					
Phenicie 2021	X		X	X					
Pyne 2015		X	X	X	X				
Richter 2015		X	X						
Rosal 2014		X					X		Meetings in a "virtual world"
Shin 2014	X		X				X		Asynchronous care- "upload & wait"
Simon 2021	X		X	X					
Spinelli 2020	X			X					
Tolou-Shams 2021	X		X	X		X			
Uscher-Pines 2020 (Psychiatric)	X		X						
Uscher-Pines 2020 (Substance Abuse)	X		X						
Uscher-Pines 2021	X		X	X					
Vilendrer 2020	X		X		X				
Volcy 2021	X		X	X					
Zakaria 2019	X				X				

**Table 2.** Implementation and sustainability of intervention in included studies

Study	Duration of the intervention		Was the description of the intervention clear?			Sustainability/Follow-up				Fidelity/Even Implementation		
	Routine	Temporary	Very Clear	Somewhat Clear	Not Clear	<3 months	≥3 but <6 months	≥6 months	Not clear	Same Across All Groups	Different Across Groups	Unclear
Adams 2021	X		X						X		X	
Anderson 2010		X	X					X			X	
Armstrong 2011	X		X					X			X	
Barney 2020	X				X	X				X		
Caton 2021	X			X		X					X	
Chang 2021	X				X						X	
Childs 2021	X		X						X	X		
Clifton 2003	X		X			X				X		
Coffman 2016	X				X				X			X
Coker 2019		X	X					X			X	
Davis 2010		X		X				X			X	
Dayal 2019 (Neurology)	X		X					X			X	
Dayal 2019 (JAMA)	X		X					X		X		
Dunham 2021	X		X			X				X		
Fortney 2013		X	X					X			X	
Franciosi 2021	X		X					X		X		
Friesen 2015		X	X					X		X		
Futterman 2020	X				X	X						X
Grubbs 2018		X	X					X			X	
Hernandez 2016	X		X					X		X		
Howren 2021	X				X				X	X		
Khoong 2021	X			X		X					X	

Lin 2018	X			X					X			X
Mammen 2020		X	X				X			X		
Mills 2021 (AHA)	X				X	X					X	
Mills 2021 (Telemedicine)	X			X					X	X		
Mittal 2014		X	X					X			X	
Nguyen 2021	X			X		X				X		
Nies 2021	X			X		X				X		
Parnell 2020	X		X						X	X		
Patton 2021	X		X			X					X	
Phenicie 2021	X				X		X					X
Pyne 2015		X	X					X			X	
Richter 2015		X	X					X			X	
Rosal 2014		X	X				X				X	
Shin 2014	X		X					X			X	
Simon 2021	X				X	X						X
Spinelli 2020	X			X		X					X	
Tolou-Shams 2021	X				X	X						X
Uscher-Pines 2020 (Psychiatric)	X			X					X	X		
Uscher-Pines 2020 (Substance Abuse)	X			X					X		X	
Uscher-Pines 2021	X				X	X						X
Vilendrer 2020	X		X					X		X		
Volcy 2021	X			X		X						X
Zakaria 2019	X		X					X				X

**Table 3.** Summary and valance of conclusions by study

Study	Valence of conclusions				Summary of telehealth related conclusions
	Positive	Null	Mixed	N/A	
Adams 2021	X				Telehealth increased access and provided similar patient satisfaction to in-person visits for psychiatric care
Anderson 2010		X			Telephonic disease management support did not improve clinical or behavioral outcomes compared to usual care
Armstrong 2011			X		Teledermatology increases access for patients, but improvements in reimbursement, design, communication, and training are needed to sustain virtual services
Barney 2020				X	Telehealth was feasible and acceptable to patients, but future analysis is needed to analyze concerns about privacy, quality of care, and health disparities
Caton 2021				X	There was high adoption of telehealth for treatment in opioid use disorder in California, but impact on patient outcomes remains unclear
Chang 2021				X	Telehealth adoption was high during the COVID-19 pandemic in New York City, but was less likely to be adopted and faced more barriers to implementation in communities with high social vulnerability
Childs 2021			X		Telehealth increased appointment attendance rates compared to in-person services, but these effects were observed differentially across racial/ethnic groups, potentially exacerbating disparities
Clifton 2003	X				Telepharmacy had high acceptance among patients of CHCs and increased access to medications and pharmacy services
Coffman 2016				X	In 2014, a nation survey found only 15% of family physicians reported using telehealth with users more likely to be employed in federally designated "safety net" clinics and HMOs
Coker 2019	X				Children in a telehealth-enabled referral process in community mental health clinics were 3 times more likely to complete initial screening visits than usual care with higher satisfaction scores

Davis 2010	X				Diabetes self-management education delivered via telehealth was effective in improving metabolic control and reducing cardiovascular risk in a population that was primarily rural and composed of racial/ethnic minorities
Dayal 2019 (Neurology)	X				Compared with in-person visits, telehealth increased attendance of outpatient pediatric neurology and was more likely to be used by patients with non-private insurance, lower education, and lower household income
Dayal 2019 (JAMA)	X				Telehealth reduced hospital utilization for pediatric neurology compared with in-person care
Dunham 2021	X				Telehealth allowed the respectful and Equitable Access to Comprehensive Healthcare (REACH) Program to maintain uninterrupted care to patients during the COVID-19 pandemic with a hybrid of telehealth and in-person appointments
Fortney 2013	X				Telehealth patients of rural FQHCs had better outcomes across multiple aspects of collaborative care for depression than patients receiving practice-based care
Franciosi 2021			X		Telehealth reduced no-show rates, but increased the proportion of younger, English-speaking patients in many specialties. Some specialties also saw an increase in the percentage of white patients with telehealth, and primary care and adult non-surgical providers saw an increase in Medicare patients
Friesen 2015	X				Qualitative interviews with key participants at CHCs showed tele-lactation sessions were easy to implement, widened the client base, increased access, and reduced mothers' anxiety about the birthing process and hospital experience
Futterman 2020	X				Telehealth allowed for appropriate continuation of satisfactory prenatal care with no impact on patient perceived satisfaction of care during the COVID-19 pandemic
Grubbs 2018			X		Despite telehealth being more effective than usual care overall, telehealth was a less effective avenue for veterans receiving care for depression in the VA compared to a FQHC patient populations receiving similar care, putting veterans at higher risk of non-response than FQHC patients



Hernandez 2016	X				Telehealth was feasible to implement for children presenting to non-children's hospital Eds and allowed for effective collaboration between physicians to provide adequate and timely treatment
Howren 2021				X	A brief quality improvement study concluded that older, rural adults showed a low willingness to use telehealth to access mental health services
Khoong 2021			X		Safety net patients are interested and able to complete video visits, although many face barriers related to internet and mobile data access
Lin 2018				X	A study that outlines common policy-level facilitators and barriers to telehealth adoption
Mammen 2020	X				Smartphone based telehealth improved clinical asthma management, adherence to guidelines, and patient outcomes with high levels of patient and clinician acceptability
Mills 2021 (AHA)	X				A survey among 587 predominantly low-income and minority patients with hypertension in Louisiana and Mississippi found that the COVID-19 pandemic reported high rates of protective practices to prevent the spread of COVID-19 and of access to quality health care during the pandemic either in-person or by telehealth. In addition, patients are willing to return to their clinics for health care.
Mills 2021 (Telemedicine)	X				Telehealth provided an efficient way to screen for and provide education on COVID-19, as well as providing a secure alternative to in-person care. Increased telehealth use was also associated with decreased burnout among primary care residents
Mittal 2014			X		Telehealth was not differentially associated with outcomes of a depression treatment intervention in an underserved population compared to in-person care, but the intervention yielded low treatment response rates for both in-person and virtual interventions
Nguyen 2021			X		Implementation of telehealth in free clinics may be feasible, but more solutions for patients with smartphone-only internet access are needed
Nies 2021	X				The majority of surveyed clinicians in FQHC settings believed telehealth would be useful for providing care after the COVID-19 pandemic is over

Parnell 2020	X				Through the implementation of virtual post-operative visits for laparoscopic cholecystectomy patients, clinic efficiency improved by increasing new patient encounters, decreasing post-operative volume, and trending towards increased operations scheduled without compromising patient safety
Patton 2021	X				Hybrid telehealth provided many benefits to pregnant patients diagnosed with substance use disorder and yielded overwhelmingly positive responses to implementation
Phenicie 2021			X		Telehealth helped overcome access barriers for rural patients without compromising patient satisfaction. However, older patients were less satisfied with telehealth than their younger counterparts
Pyne 2015	X				Telehealth based collaborative care for depression in rural FQHCs was found to be more cost-effective than a similar in-person model
Richter 2015			X		Compared to telephone counseling to help rural patients quit smoking, integrated telemedicine increased utilization of cessation pharmacotherapy and produced higher participant satisfaction, but phone counseling was significantly less expensive
Rosal 2014			X		It was feasible to deliver diabetes self-management interventions to inner city African American women via virtual worlds with outcomes comparable to in-person interventions, but the virtual intervention was more expensive and was slightly less effective at A1c and depression reduction
Shin 2014				X	37% of respondents to a national survey of FQHCs found 37% provided some type of telehealth service. FQHCs that provide at least one telehealth service are more likely to be located in rural areas and FQHCs that provide two or more telehealth services are more likely to have generous state and local funding
Simon 2021			X		Despite increasing volume of telehealth visits, FQHCs saw a drop in services provided and delays of routine care during the COVID-19 pandemic

Spinelli 2020			X		Despite higher-than-expected telemedicine utilization in San Francisco, the odds of viral non-suppression after the start of COVID-19 was 31% higher than pre-pandemic, with homeless individuals facing the highest odds of negative impact
Tolou-Shams 2021	X				At an urban safety net hospital providing child mental health services during the COVID-19 pandemic, no-show rates significantly declined after the implementation of telehealth and service delivery volume was unchanged compared to pre-COVID-19 in-person visits
Uscher-Pines 2020 (Psychiatric)			X		Among community mental health centers, most used telehealth in adjunct with in-person care. Most health centers planned to continue using telehealth, but noted less patient engagement, challenges sharing information within care teams, and greater inefficiency
Uscher-Pines 2020 (Substance Abuse)				X	8 out of 22 health centers in 14 states reported offering tele-opioid use disorder treatment, with medication management as the most commonly cited use. Usually, telehealth was only offered after an in-person consultation and leading barriers included regulations on the prescribing of controlled substances, including buprenorphine, and difficulties in sending lab results to distant (prescribing) providers
Uscher-Pines 2021				X	Despite primary care visit volume declining in FQHCs during the COVID-19 pandemic, behavioral health visit volume remained stable primarily because telehealth replaced in-person visits (particularly by telephone)
Vilendrer 2020				X	In an analysis of three institutions during the beginning of the COVID-19 pandemic, all were able to adopt inpatient video calls. Rapid deployment was facilitated by direction from executive leadership, leveraging off-the-shelf hardware, vendor engagement, and clinical workflow integration
Volcy 2021	X				A majority of patients, faculty, and residents in internal and family medicine reported positive perceptions of telehealth in a survey conducted after the start of COVID-19
Zakaria 2019	X				An urban safety net hospital found an increase in access and efficiency of dermatology after the implementation of teledermatology

## **Chapter 2. Telehealth Use, Care Continuity, and Quality Diabetes and Hypertension Care in Community Health Centers Before and During the Coronavirus Disease 2019 Pandemic**

### **Background**

The COVID-19 pandemic led to a rapid uptake in telehealth use beginning in March 2020<sup>53-55</sup> to provide safer care to patients and reduce their exposure to the virus. While telehealth was lauded as a flexible and safe means of maintaining health care access for patients during the pandemic, care continuity's effect on telehealth use and telehealth's impact on quality of care is not well understood. Vulnerable populations, such as low-income patients, minoritized patients, and patients with complex care needs, patient populations often served by community health centers, may not have experienced the same improvements as other more advantaged populations.<sup>178</sup> Care continuity has previously been associated with improved quality of care and patient care experiences.<sup>46,179</sup> While there is some evidence that telehealth supported care continuity during the pandemic,<sup>180</sup> it is unclear how telehealth use impacted the relationship between care continuity and quality of care.<sup>178</sup>

Care continuity or the extent to which patient care is dispersed or concentrated among clinicians,<sup>181,182</sup> is a key factor in providing evidence-based care to adults with diabetes and/or hypertension.<sup>183-189</sup> Care continuity has previously been linked directly to trust in clinicians<sup>43-47,190</sup>—a key determinant of high quality patient care experiences.<sup>35,36,43,47</sup> The link between care continuity and trust in clinicians may have important implications for telehealth adoption. Patients with limited English proficiency and trusted care team members to help with interpretation and/or deliver care can improve patient-clinician communication during a telemedicine encounter.<sup>191</sup> In general, high levels of trust in clinicians can be especially useful in the face of external shocks when new innovations into care delivery need to be introduced.<sup>39</sup> Limited research has been conducted on care continuity for patients with chronic conditions in community health centers (CHCs). CHCs face rigorous continuous improvement expectations, and data collection and monitoring that may impact care continuity.<sup>190</sup> CHCs also faced greater workforce loss during the pandemic compared to other healthcare organizations, which may have negatively impacted patient-clinician relationships for CHC patients.<sup>192</sup>

As a result of shelter-in-place ordinances, adults with diabetes and/or hypertension were vulnerable because their routine care involves close monitoring and medication management. These patients are not only likely to be at higher risk of COVID-19-related complications,<sup>193</sup> but are at risk for exacerbations due to reduced access to, and utilization of, care.<sup>194</sup> We analyze data from before and during COVID-19 pandemic to assess the relationship between care continuity, telehealth use, and quality of care for patients with type II diabetes and hypertension. To our knowledge, this is the first study to examine the association of care continuity and telehealth use among adult CHC patients with chronic conditions.

Recent evidence about the association of telehealth use and diabetes and hypertension care indicates telehealth helped alleviate disruptions and decreases in quality of care during the COVID-19 pandemic, although there were disparities in age, race, and income in likelihood to utilize telehealth.<sup>195-197</sup> Based on these findings and evidence about the impact of care continuity on quality of care,<sup>184</sup> we hypothesize that care during the COVID-19 pandemic will be associated with lower continuity of care (Hypothesis 1) due the disruption of clinician-patient relationships

in CHCs and that telehealth use will be positively associated with patients with greater care continuity during the pandemic (Hypothesis 2). We also hypothesize that care continuity will be positively associated with processes and outcomes of diabetes and hypertension care during the pandemic (Hypothesis 3), and that the association between care continuity and process measures of quality will be mediated by telehealth use (Hypothesis 4).

## Methods

### Data

We analyzed 2019 and 2020 data from California CHC members of the Oregon Community Health Information Network (OCHIN) Accelerating Data Value Across a National Community Health Center Network (ADVANCE) Collaborative.<sup>198</sup> The goal of ADVANCE is to create a data network of CHCs to inform and disseminate research targeted at improving access, engagement, equity, and quality of care for patients of CHCs.<sup>198</sup>

### Sample

The study population are CHC clinicians and adult patients from a cohort of patients with diabetes and/or hypertension (n=20,792) with  $\geq 2$  encounters/year from 2019 (March-December 2019) to 2020 (March-December 2020) among 166 California CHC sites in the OCHIN ADVANCE Collaborative's electronic health record (EHR) data.<sup>198</sup> We restricted the sample to adults with at least two encounters during each year of the study because the assessment of continuity requires multiple encounters.

### Outcomes

For Hypothesis 1, the outcome measure is care continuity by year (pre- vs. during-COVID-19) by the modified modified continuity index (MMCI), a measure of care dispersion, calculated using equation (1):

$$MMCI = \frac{1 - \frac{k}{N + 0.1}}{1 - \frac{1}{N + 0.1}} \quad (1)$$

where  $k$  = number of clinicians seen in a period and  $N$  = total number of encounters to all clinicians in a period. MMCI is an established measure of care continuity used commonly in published studies of care continuity;<sup>199–205</sup> scores range from 0 to 1, where 1 is perfect continuity with all encounters to a singular provider and 0 is all encounters to different clinicians.

For Hypothesis 2, the outcome measure is telehealth use, defined as at least one telehealth encounter by a patient in each year as established through data collected from the EHR.

For Hypothesis 3, processes of care are measured by annual blood pressure and/or A1c testing. The relationship between MMCI and the final annual systolic and diastolic blood pressure level and A1c value of patients is examined to analyze if processes of care translate to improved intermediate outcomes of care. For Hypothesis 4, we conducted mediation analysis to examine the proportion of the relationship that is mediated by telehealth use between MMCI and the outcomes that have a significant relationship with both MMCI and telehealth use.

### Main Independent Variables

For Hypothesis 1, the main independent variable is the year (2019 vs 2020) of encounter. For Hypothesis 2, 3, & 4, the main independent variable is care continuity, measured by MMCI (range: 0-1).

### Control Variables

Regression models controlled for patients' sociodemographic characteristics, health status, encounters, and clinician types seen by patients during each year, categorized based on past research,<sup>5</sup> which include single physician only, physician and nurse practitioner/physician's assistant or registered nurse/medical assistant, combination of physician and a nurse practitioner/physician's assistant and registered nurse/medical assistant, 2 different physicians, and 3 or more unique physicians. Comorbidities were determined from the EHR problem list and included body mass index (BMI), congestive heart failure, cardiovascular disease, coronary heart disease, depression, anxiety/PTSD, general presence of a mental health condition, diabetic retinopathy, substance abuse, alcohol abuse, tobacco use, mobility impairments.<sup>206</sup> The Charlson comorbidity index (range: 1-12), a validated, weighted index of comorbidities that considers the number and severity of each condition resulting in an integer starting from zero that represents risk of mortality, was constructed and also included as a control variable.

### Statistical Analysis

First, a paired t-test compared average levels of care continuity (MMCI) across periods defined as before (2019) and during (2020) the COVID-19 pandemic. Next, logistic regression models estimated the association of care continuity (MMCI) with 1) telehealth use and 2) processes of care (blood pressure, hemoglobin A1c testing), net of control variables.<sup>33</sup> Generalized linear regression models estimated the association of MMCI and intermediate outcomes (blood pressure, A1c control). Robust standard errors accounted for patients clustering within CHC sites. Models were estimated separately for 2019 and 2020. The regression model of telehealth adoption by care continuity is presented in equation (2):

$$Y = \beta_0 + \beta_1 \text{Period} + \beta_2 \text{MMCI} + \beta_3 \text{Care team composition} + \beta_4 \text{number of visits} + \beta_5 \text{patient characteristics} + \varepsilon \quad (2)$$

Where  $\beta_0$  is an intercept term,  $\beta_1$  is a term indicating the period of the analysis as described above and  $\beta_1=0$  for analysis in the pre-period (2019) and  $\beta_1=1$  for analysis in the during-period (2020),  $\beta_2$  is the coefficient of care continuity,  $\beta_3$  is the coefficient for the **clinician** types seen in each period,  $\beta_4$  is the coefficient for the control variable for the number of encounters a patient had in a given period,  $\beta_5$  is the coefficient for control variables related to patient characteristics, which include Charlson score, income measured by percentage of federal poverty line, body mass index, sex, and age and  $\varepsilon$  is an error term.

Equation (3) exhibits the regression model for pre- and during-COVID-19 analysis of the association of care continuity and diabetes/hypertension management and the mediating impact of telehealth use is:

$$Y = \beta_0 + \beta_1 \text{Period} + \beta_2 \text{MMCI} + \beta_3 \text{clinician type} + \beta_4 \text{TH use} + \beta_5 \text{patient characteristics} + \beta_6 \text{2019 baseline value} + \varepsilon$$

(3)

Where  $\beta_0$  is an intercept term,  $\beta_1$  is a term indicating the period of the analysis and  $\beta_1=0$  for analysis in the pre-period and  $\beta_1=1$  for analysis in the during-period,  $\beta_2$  is the coefficient of care continuity,  $\beta_3$  is the coefficient for the control variable that controls for the different configurations of **clinician** types that a patient saw in each period,  $\beta_4$  is the coefficient indicating telehealth use in a period,  $\beta_4=0$  for no telehealth use, and  $\beta_4=1$  for patients with at least one telehealth encounter in the period,  $\beta_5$  is the coefficient for control variables related to patient characteristics, which include the Charlson score, income measured by percentage of federal poverty line, body mass index, sex, and age,  $\beta_6$  is the coefficient for 2019 baseline values of intermediate outcomes in 2020 regressions, and  $\varepsilon$  is an error term.

We conducted a formal mediation analysis<sup>207</sup> to examine telehealth as a mediator, or variables that explains the relationship between care continuity and quality of care. We only examined the association of MMCI with the A1c testing during the pandemic, as it was the only significant association between telehealth use and study outcomes found in adjusted analyses. We chose this approach to enable estimation of effects described by non-linear relationships. “PARAMED” package in STATA was used,<sup>208,209</sup> which uses parametric regression models to estimate causal mediation effects. Percent mediation is then calculated by equation (4) using natural indirect and direct effects:<sup>210,211</sup>

$$\left( \frac{\text{Indirect effect}}{\text{Direct effect} + \text{Indirect effect}} \right) * 100\%$$

(4)

Mediation analyses were conducted for 2020 study outcomes for which the relationships between MMCI and the study outcome were statistically significant in adjusted analyses. Mediation analysis was not conducted for 2019 due to low uptake of telehealth during the period. All statistical analyses were performed using Stata 17.0<sup>209</sup>

## Results

The analytic sample is predominantly female (58.1%) and identified as Hispanic/Latinx (52.7%). A plurality (43.5%) of the population preferred Spanish as their spoken language, 52.7% English, and 3.3% another language (**Table 1**). Homelessness (0.45%) were a small minority, and most patients had an assigned primary care physician (98.8%). Most (58.66%) of the sample was diagnosed with type II diabetes and 85.22% had hypertension. The average Charlson comorbidity score was 3.19 (standard deviation, SD=1.63).

Overall, encounters declined during the COVID-19 pandemic with 263,633 encounters in 2019 and 103,634 in 2020. The types of clinicians that patients had encounters with changed from 2019 to 2020, with a larger proportion of patients seeing a single physician (2019: 21.7%, 2020: 25.4%), a physician and a nurse practitioner/physician’s assistant or registered nurse/medical assistant (2019: 7.0%, 2020: 8.7%), a combination of a physician and a nurse practitioner/physician’s assistant and registered nurse/medical assistant (2019: 4.7%, 2020: 5.7%), and 2 different physicians (2019: 31.4%, 2020: 39.5%) in 2020 compared to 2019. There was a reduction in the proportion of patients seeing 3 or more unique physicians in 2020 (2019: 35.3%, 2020: 20.8%).

### COVID-19 pandemic impact on care continuity

Supporting hypothesis 1, patients experienced reduced continuity of care in 2020 (MMCI=0.63, SD=0.36) compared to 2019 (MMCI=0.71, SD=0.28,  $p<0.001$ ). Almost all patients (2019: 99.99% vs 2020: 99.75%) had their blood pressure screened annually but only 69.78% vs 63.32% of adults with diabetes had their A1c tested in 2019 vs 2020.

### Telehealth use and care continuity during the pandemic

Telehealth accounted for 0.33% of encounters in 2019 and increased to 9.55% in 2020 (**Figure 1**). In our sample, 14.1% of clinicians used telehealth to provide care in 2020 out of  $n=16,597$  clinicians represented in our analytic sample (data not shown). In adjusted analyses, higher MMCI scores were associated with higher odds of telehealth use in 2020 (OR=1.94, marginal effect=0.20,  $z=70.78$ ,  $p<0.001$ ), but not 2019, which partially supports hypothesis 2 (**Table 2**). Contrary to expectations, an inverse relationship was found between 2019 MMCI scores and telehealth use in 2020 (OR:0.82, marginal effect=0.20,  $z=70.73$ ,  $p=0.003$ ; **Table 2**).

### Care continuity, telehealth use, monitoring, and health outcomes

Care continuity (MMCI 2019: OR=1.98, marginal effect=0.69,  $z=165.50$ ,  $p<0.001$ ; 2020: OR=1.50, marginal effect=0.63,  $z=147.73$ ,  $p<0.001$ ) and telehealth use (2019: OR=1.50, marginal effect=0.85,  $z=122.87$ ,  $p<0.001$ ; 2020: OR=10.00, marginal effect=0.90,  $z=155.57$ ,  $p<0.001$ ) were significantly associated with more consistent A1c testing in both periods (**Table 2**), supporting the first part of hypothesis 3. Contrary to the second part of hypothesis 3, MMCI, but not telehealth use, was significantly associated with lower A1c values in 2019 ( $\beta= -0.57$ ,  $p=0.007$ ) and 2020 ( $\beta= -0.45$ ,  $p=0.008$ ). Higher care continuity (MMCI) was associated with lower systolic blood pressure ( $\beta= -2.90$ ,  $p<0.001$ ) and diastolic blood pressure values ( $\beta= -1.44$ ,  $p<0.001$ ) in 2020.

### Mediating role of telehealth in the care continuity and quality relationship

The mediation analyses found the pathway between care continuity and telehealth, telehealth and A1c testing, and care continuity and A1c testing to all be statistically significant (**Figure 2**). Care continuity partially mediated the care continuity and A1c testing relationship in 2020 based on the four steps used to assess mediation effects.<sup>212</sup> In 2020, 38.7% of the relationship between MMCI and A1c testing was mediated by telehealth use (direct effect:  $\beta=1.76$  [95% CI: 1.45-2.12] indirect effect:  $\beta=1.11$  [95% CI: 1.05-1.12]), but telehealth use did not mediate the association of care continuity and other study outcomes, offering only partial support for hypothesis 4.

## **Discussion**

Our analyses of care continuity, telehealth use, and quality of care among adults with diabetes and/or hypertension in CHCs before and during the pandemic reveals that care continuity and telehealth use are associated with quality of care in complex ways. Consistent with hypothesis 1, care continuity for adults with diabetes and/or hypertension receiving care in CHCs during the early COVID-19 pandemic (2020) declined compared to pre-pandemic period (2019). Higher care continuity in 2020 was associated with higher telehealth use and A1c testing, as well as lower A1c scores and lower blood pressure in accordance with hypothesis 2. Although continuity of care is generally associated with better patient outcomes, the findings of this study are consistent with the mixed effects found in the literature analyzing the impact of care continuity



on quality of care for patients with diabetes and hypertension.<sup>183,184,186–188</sup> Our findings are consistent with past research that demonstrates that care continuity improves quality of care for patients with diabetes and/or hypertension, but that processes of care do not necessarily translate to improved intermediate outcomes.<sup>183,184,186–188</sup> However, care continuity can improve patients' experiences of care and quality of life for patients with diabetes.<sup>188,189</sup> Our findings that telehealth use was more common for patients that previously had low utilization of health care suggest telehealth could be a tool to enhance care continuity for patient populations that previously have low continuity of care. Further research is needed to examine how telehealth might be leveraged to enhance care continuity to improve patient outcomes to help better translate improved process outcomes into improved intermediate outcomes.

Contrary to hypothesis 3, more frequent A1c and blood pressure testing did not translate to better intermediate outcomes. Telehealth mediated the association of care continuity with consistent A1c and blood pressure testing, indicating that care continuity facilitates telehealth use and may enable resilient performance on high priority process measures, partially supporting our hypothesis 4. Moreover, evidence suggests there was a decline in physical activity during the COVID-19 pandemic increase in sedentary behavior that could not be addressed by care continuity and care management.<sup>213</sup> The finding that telehealth acts as a mediator for diabetes monitoring is consistent with another recent study on a non-safety net population highlighting the utility of telehealth in sustaining continuous care during COVID-19.<sup>54</sup> Despite a lack of translation of telehealth use into improved intermediate outcomes of care, the finding that telehealth facilitated continuous A1c monitoring during the pandemic suggest that telehealth may be a useful tool in maintaining care continuity and processes of care during a crisis.

Long-term investment in telehealth infrastructure and information technology departments may be needed to support the resilience of CHCs during times of crises. Our result that patients experiencing lower care continuity in 2019 were more likely to use telehealth during the pandemic compared to patients with higher care continuity suggests that telehealth can support monitoring of diabetes and hypertension when in-person care is less safe. By continuing support for telehealth, policymakers can help ensure that patients are able to maintain continuous chronic care treatment and monitoring even during major shocks such as the COVID-19 pandemic. Tailoring of telehealth services to meet CHC patient needs could also increase telehealth use and support improved quality of care for adults with diabetes and/or hypertension, including ensuring that patient portals and other platforms are available in Spanish and other Medicaid threshold languages.<sup>191</sup> Supporting audio-only telemedicine appointments may also be a key factor in meeting the needs of CHC patients,<sup>191</sup> but more research is needed to assess whether quality of care disparities exists between audio-only and video telemedicine encounters.<sup>214</sup>

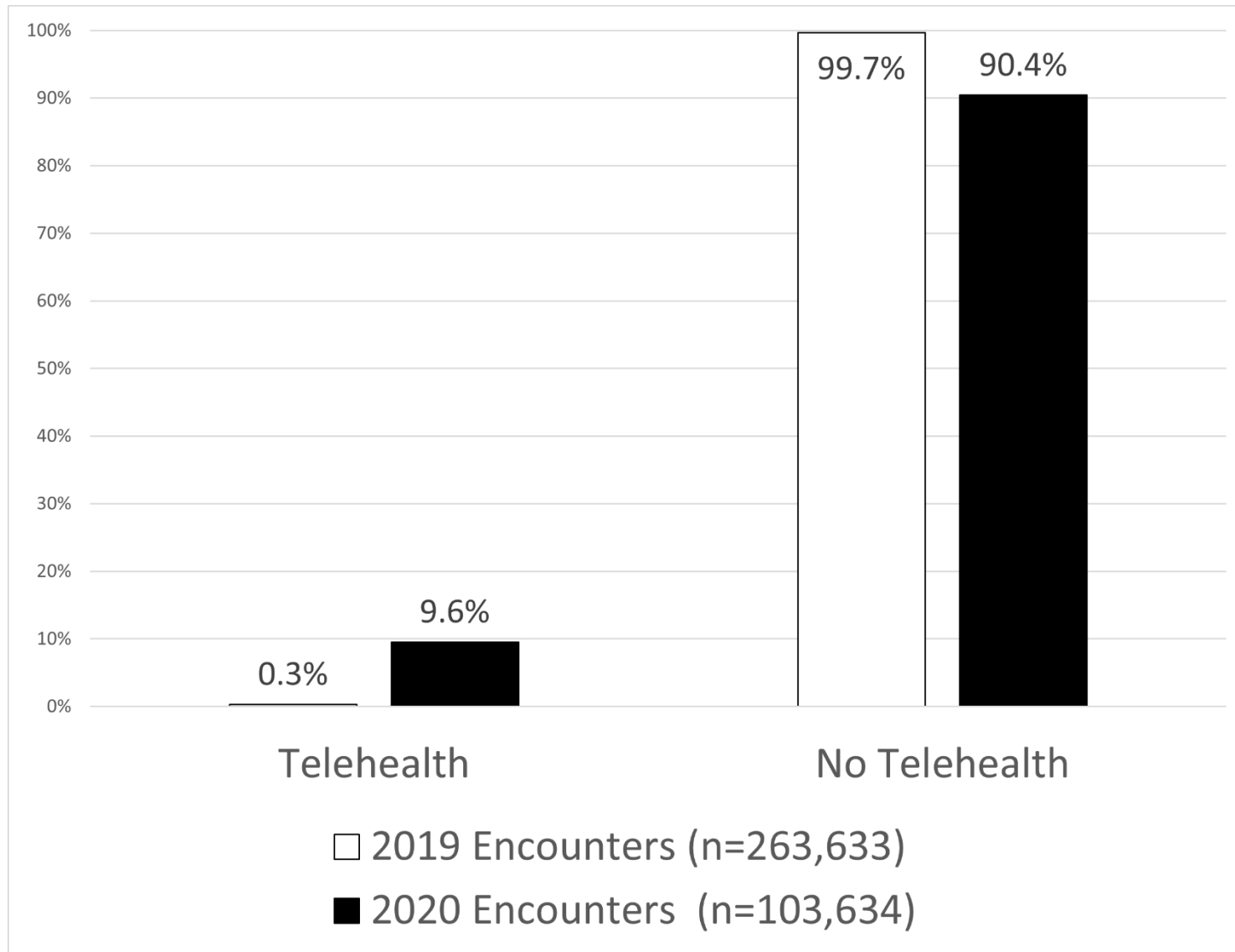
Our results should be considered in light of some limitations. First, our findings may not be reflective for all patients with diabetes and/or hypertension and may not generalize to lower utilizing patients. We could not track utilization outside of the CHCs and patients may have sought care elsewhere, but these data are not captured if they are not a member of the OCHIN ADVANCE collaborative. Another limitation is that the nature of the data used does not allow for direct measurement of team membership and collaboration. Social network analysis could be used in the future to elucidate team structure and communication patterns and to examine the relationship between care coordination and telehealth use.<sup>5</sup> Only 1.21% of patients in our sample

did not have an assigned primary care clinician, so we were unable to adequately analyze the unique effects of care continuity on this population who may be at especially high risk of exacerbations due to diabetes and/or hypertension. There were also telehealth documentation challenges for CHCs during the early pandemic and some telehealth encounters may be misclassified as “in-person” encounters in the OCHIN data. National data indicate that the proportion of overall encounters that were telehealth in outpatient settings during the study period were 30.1%,<sup>215</sup> greater than the 14.1% documented in our analytic sample. Misclassification of telehealth encounters in our data could bias the study results. Finally, we were not able to distinguish between audio and video encounters in our data set. The modalities may differentially impact quality of care and more evidence examining heterogenous quality effects by modality are needed.<sup>214</sup> Given increased stress, reduced activity due to shelter-in-place, and greater isolation, care continuity and monitoring blood pressure and A1c may have been necessary, but insufficient to improve intermediate outcomes.

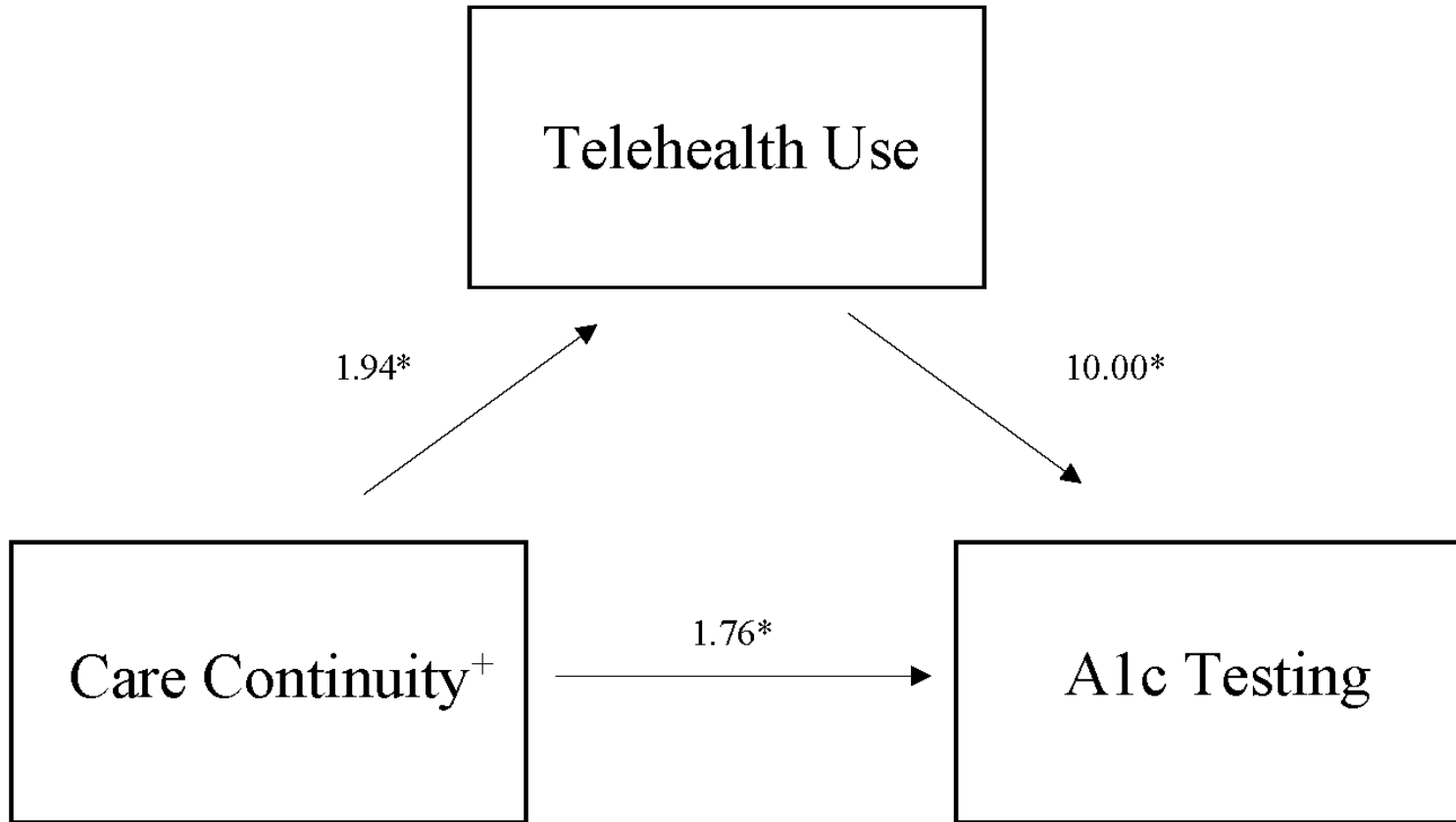
### **Conclusions**

Care continuity helped maintain quality of care for adult CHC patients during the COVID-19 pandemic and may support resilient performance on high priority process measures like A1c testing during times of crises. Examining the mechanisms that connect continuity of care to increased telehealth use, including through primary care team learning, may provide additional insights about how best to implement disruptive patient-centered innovations.

**Figure 1.** Proportion of encounters conducted via telehealth by year



**Figure 2.** Results of causal mediation analysis with bootstrap SEs of the role of telehealth in the relationship between continuity of care and hemoglobin A1c testing



\*Significant at  $p < 0.001$

▲Analyses consider the types of clinicians seen by the patient, the number of visits by the patient in each year, age, sex, annual income as a percentage of federal poverty line, body mass index (BMI), and the Charlson Comorbidity index.

+Care continuity is measured using the Modified Modified Continuity Index (MMCI).

**Table 1.** Patient Demographics and Clinical Characteristics of the Analytic Sample, by Telehealth Exposure

Patient Demographics	n (%)	Telehealth, n (%)	No Telehealth, n (%)	p-value
Number of patients <sup>+</sup>	20,792 (100%)	4,251 (20.45%)	16,541 (79.55%)	
<i>Sex</i>				<b>0.021*</b>
Female	12,069 (58.05%)	2,534 (59.61%)	9,535 (57.64%)	
Male	8,723 (41.95%)	1,717 (40.39%)	7,006 (42.36%)	
<i>Race/Ethnicity</i>				0.08
Hispanic/Latino	10,955 (52.69%)	2,258 (53.12%)	8,697 (52.58%)	
White	6,021 (28.96%)	1,191 (28.02%)	4,830 (29.20%)	
Asian	1,374 (6.61%)	288 (6.77%)	1,086 (6.57%)	
Black or African American	1,345 (6.47%)	290 (6.82%)	1,055 (6.38%)	
Native Hawaiian or Other Pacific Islander	128 (0.66%)	20 (0.47%)	108 (0.65%)	
American Indian or Alaskan Native	90 (0.43%)	15 (0.35%)	75 (0.45%)	
Multiple races	73 (0.35%)	15 (0.35%)	58 (0.35%)	
Unknown	806 (3.88%)	174 (4.09%)	632 (3.82%)	
<i>Patient Preferred Spoken Language</i>				0.132
English	10,960 (52.71%)	2,191 (51.54%)	8,769 (53.01%)	
Spanish	9,139 (43.95%)	1,904 (44.79%)	7,235 (43.74%)	
Other	693 (3.33%)	156 (3.67%)	537 (3.25%)	
<i>Marital Status</i>				<b>&lt;0.001*</b>
Single	5,034 (24.21%)	864 (20.32%)	4,170 (25.21%)	
Married/Domestic Partner	4,934 (23.73%)	887 (20.87%)	4,047 (24.47%)	
Significant other	352 (1.69%)	64 (1.51%)	288 (1.74%)	
Separated/Divorced	1,172 (5.64%)	202 (4.75%)	970 (5.86%)	
Widowed	855 (4.11%)	163 (3.83%)	692 (4.18%)	
Unknown	8,445 (40.62%)	2,071 (48.72%)	6,374 (38.53%)	
<i>Homelessness status</i>				0.072
Yes	94 (0.45%)	23 (0.54%)	71 (0.43%)	
<i>Insurance</i>				<b>&lt;0.001*</b>
Private	1,816 (8.73%)	376 (8.84%)	1,440 (8.71%)	
Medicaid	7,374 (35.47%)	1,525 (35.87%)	5,849 (35.36%)	
Medicare	6,562 (31.56%)	1,375 (32.35%)	5,187 (31.36%)	
Other Public	1,734 (8.34%)	248 (5.83%)	1,486 (8.98%)	
Uninsured	3,306 (15.90%)	727 (17.10%)	2,579 (15.59%)	
<i>Assigned primary care physician</i>				<b>0.043*</b>
Yes	20,541 (98.79%)	4,201 (98.82%)	16,340 (98.78%)	
No	251 (1.21%)	50 (1.18%)	201 (1.22%)	
<i>Comorbidities</i>				
Type II diabetes	12,197 (58.66%)	2,887 (67.91%)	9,310 (56.28%)	<b>&lt;0.001*</b>
Hypertension	17,718 (85.22%)	3,567 (83.91%)	14,151 (85.55%)	<b>0.007*</b>
Congestive heart failure	1,000 (4.81%)	231 (5.43%)	769 (4.65%)	<b>0.033*</b>
Cardiovascular disease	1,297 (6.24%)	308 (7.25%)	989 (5.98%)	<b>0.002*</b>
Congenital heart disease	1,885 (9.07%)	452 (10.63%)	1,433 (8.66%)	<b>&lt;0.001*</b>
Diabetic retinopathy	1,295 (6.23%)	336 (7.90%)	959 (5.80%)	<b>&lt;0.001*</b>
Secondary diabetes	1,011 (4.86%)	273 (6.42%)	738 (4.46%)	<b>&lt;0.001*</b>
Mobility impairment	239 (1.15%)	49 (1.15%)	190 (1.15%)	0.983

Substance abuse	2,031 (9.77%)	404 (9.50%)	1627 (9.84%)	0.515
Alcohol use	1,068 (5.14%)	202 (4.75%)	866 (5.24%)	0.203
Tobacco use	1,836 (8.83%)	361 (8.49%)	1,475 (8.92%)	0.384
Depression	5,251 (25.25%)	1,169 (27.50%)	4,082 (24.68%)	<b>&lt;0.001*</b>
Anxiety/Post-traumatic stress disorder	4,050 (19.48%)	854 (20.09%)	3,196 (19.32%)	0.260
Other mental health condition	3,199 (15.39%)	687 (16.16%)	2,512 (15.19%)	0.116
	<i>Mean (SD)</i>	<i>Mean (SD)</i>	<i>Mean (SD)</i>	
Age	57.8 (11.9)	57.8 (11.8)	57.8 (11.9)	<b>0.703</b>
Charlson score	3.19 (1.63)	3.46 (1.65)	3.12 (1.62)	<b>&lt;0.001*</b>
Body mass index	31.76 (7.45)	32.16 (7.44)	31.66 (7.44)	<b>&lt;0.001*</b>
*Significant at p<0.05 level				
†Percentages displayed for “number of patients” are row percentages. All other percentages presented above reflect column percentages.				

**Table 2.** Multivariable Regression Analyses: The Association of Care Continuity and Telehealth with Quality of Hypertension and Diabetes Care

		Telehealth Use (2019 n= 19,385; 2020 n=19,385)		Hemoglobin A1c Process (2019 n= 11,373; 2020 n=11,373)		Hemoglobin A1c Value (2019 n= 3,384; 2020 n=3,625)		Systolic Blood Pressure (2019 n= 19,360; 2020 n=17,738)		Diastolic Blood Pressure (2019 n= 19,360; 2020 n=17,738)	
		OR	95% CI	OR	95% CI	Coef.	95% CI	Coef.	95% CI	Coef.	95% CI
2019	Care Continuity <sup>+</sup>	0.84	0.6-1.06	1.98***	1.55-2.53	-0.57**	-0.99- -0.15	-1.58	-3.17- -0.01	-0.67	-1.57-0.23
	Telehealth	---	---	2.72***	1.99-3.72	-0.15	-0.54-0.24	-0.44	-2.31-1.42	-0.88	-1.88-0.11
2020	Care continuity <sup>+</sup>	1.94***	1.55-2.43	1.50***	1.23-1.82	-0.45**	-0.78- -0.12	-2.90***	-4.16- -1.63	-1.44***	-2.16- -0.72
	Telehealth	---	---	10.00***	7.30-13.70	0.03	-0.24-0.30	-0.08	-2.06-1.89	0.84	-0.27-1.94

\*p<0.05, \*\*p<0.01, \*\*\*p<0.001  
<sup>▲</sup>Regression results control for the types of clinicians seen by the patient, the number of visits by the patient in each year, age, sex, annual income as a percentage of federal poverty line, body mass index (BMI), and the Charlson Comorbidity index. 2020 regressions also control for 2019 baseline values of their respective dependent variables. All regression models were estimated using robust standard errors.  
<sup>+</sup>Care continuity is measured using the Modified Modified Continuity Index (MMCI).

## Chapter 3. Conjoint Analysis of Remote Care Preferences for Hypertension Management Among Adult Patients

### Background

Despite a large uptake in telehealth to maintain access to healthcare in the wake of COVID-19,<sup>53–55</sup> telehealth was differentially utilized based on socioeconomic status (SES), race/ethnicity, gender, and English proficiency, with those who already face more difficulties and worse health outcomes using telehealth to a lesser extent.<sup>216,217</sup> These differences in utilization further exacerbate inequities in healthcare. However, telehealth also has the potential to reduce health disparities in the United States. Prior studies have shown telehealth appointments may provide additional flexibility, reduced missed appointment rates<sup>87,97,98,100,107,110,218</sup> and opportunities for patients to pay lower copays,<sup>219</sup> which may increase access for the lowest income patients.

Despite early evidence indicating high acceptability of telehealth, even among low-income, rural, and patients of various racial/ethnic backgrounds,<sup>78,83,85,106,111,113,114,149</sup> telehealth may not always be the most effective or acceptable avenue to providing care to all groups, including older patients and potentially veterans.<sup>79,87,105</sup> These findings highlight the need to develop methods that health care organizations can use to efficiently identify patient preferences for telehealth and tailor offerings to the needs and preferences of various patient groups, especially racial and ethnic minority patients, low-income patients, and patients that live in rural areas that are often not included or have low participation in scientific studies.<sup>220–222</sup> Compared to traditional survey methods, conjoint surveys allow for more realistic scenarios that increase the external validity of the collected data, as well as providing a more detailed analysis with rank-ordering and direct comparison of attributes.<sup>223</sup> When paired with a latent class analysis, the utility of this method is further enhanced over traditional survey methods by allowing for segmentation without a priori assumptions of the participant population to avoid generating a “one-size-fits-all” approach that could not adequately capture the needs of vulnerable populations.<sup>223,224</sup>

Conjoint analysis is a market research method but has potential applications to assist health care systems in better understanding and serving patients and their unique needs.<sup>225,226</sup> Conjoint analysis is commonly used in medical decision making, but to our knowledge has not been used to address the various needs and equity concerns of patients regarding telehealth services. Latent class analysis is a statistical method that uses the dataset from a conjoint analysis to find categories or groups of responders that share similar characteristics that the analyst does not define a priori.<sup>223</sup> The analysis assesses the typical characteristics of each group, which are then named according to the preferences and characteristics of typical members of that group.

This work focuses on adults with hypertension due to its prevalence and disproportionate impact on community health center (CHC) patient populations.<sup>227–232</sup> Hypertension has also been linked to an increased risk for a variety of comorbidities and adverse events, such as stroke, heart attack, and heart failure.<sup>229</sup> Hypertension is also addressable through continuous monitoring, regular interactions with clinicians and other healthcare personnel, and quality of care improvement efforts, making it a condition that telehealth has a high appropriateness to treat.<sup>229,233</sup> A systematic review by Xu and colleagues exhibits the importance of addressing a variety of care preferences when managing hypertension, as well as incorporating patient-centered decision-making into hypertension care to maximize patient outcomes and adherence to



treatment.<sup>234</sup> Conjoint and latent class analyses can elicit preferences and segmentation in preferences so that healthcare organizations and clinicians can better provide patient-centered care.<sup>226</sup>

To understand factors that impact telehealth acceptability for hypertension management, a conjoint and latent class analysis were conducted to identify preferences of adults with hypertension in the United States typically served by CHCs.

## Methods

### Data

All conjoint and latent class analyses were conducted using Lighthouse Studio 9.14.2 (Sawtooth Software, Inc.). Participants were recruited through a service offered by Dynata, LLC from a pool of participants that had already expressed interest in participating in surveys for research. To be eligible for participation in the conjoint study, participants had to be at least 18 years old and be able to speak English. Participants from households that earned less than \$50K per year (77.2%) and speak a language other than English at home (68.8%) were oversampled. To ensure adequate power in our analyses, we followed the rule for sample size put forth by Johnson in 1996<sup>235</sup> presented in equation (5):

$$n \geq \frac{1000c}{ta} \tag{5}$$

Where  $n$  is the number of respondents,  $c$  is the maximum number of levels for any one attribute,  $t$  is the number of tasks, and  $a$  is the number of alternatives per task (not including any “none” options)

As further detailed below, our conjoint survey had a maximum of 4 levels per attribute, 12 tasks, and 2 alternatives per task, yielding a desired sample size of  $n=167$  individuals.

### Measures

After reviewing an informational form describing the study and consent for participation, participants were asked to complete a survey that contained demographics questions to determine eligibility and framing for other survey questions (language spoken at home, English proficiency, age, hypertension status), 12 conjoint tasks, and additional demographics questions (gender, race/ethnicity, annual household income, employment status, parent/caregiver status, whether they had a regular place where they sought healthcare, their number of healthcare visits in 2022, home internet access, health conditions).

Six individual attributes of interest (ability to see a clinician with whom there is an established relationship, profession of available clinician, copayment, appointment type, time of available appointment, earliest available appointment) were established for the conjoint tasks. Attributes for the conjoint task were determined from prior qualitative research eliciting barriers and facilitators of telehealth adoption from interviews with clinicians and patients of federally qualified health centers.<sup>153</sup> For each task, two options for a primary care appointment were presented simultaneously with varying levels of each attribute. Each task was presented alongside a scenario about ongoing hypertension management for those with hypertension

(46.3%) and a simulated scenario if they had not been diagnosed with hypertension (34.7%). A sample conjoint task is presented in **Figure 1** and the full survey is presented in **Appendix 7**.

Finally, participants that endorsed having been diagnosed with hypertension were also asked five questions on a 10-point Likert scale (with 1 being “Not confident at all” to 10 being “Totally confident”) about their confidence in managing their high blood pressure previously used by Warren-Findlow and colleagues to study hypertension self-care and self-efficacy among African American adults<sup>236</sup> (How confident are you that you can do all the things necessary to manage your high blood pressure on a regular basis?; How confident are you that you can judge when changes in your high blood pressure mean you should visit a doctor?; How confident are you that you can do the different tasks and activities needed to manage your high blood pressure so as to reduce your need to see a doctor?; How confident are you that you can reduce the emotional distress caused by your high blood pressure so that it does not affect your everyday life?; How confident are you that you can do things other than just taking medication to reduce how much your high blood pressure affects your everyday life?).

**Figure 1.** Sample Conjoint Task

	Option 1	Option 2
Ability to see a clinician with whom you have an established relationship	No	Yes
Profession of available clinician	Nurse practitioner or Physician's assistant	MD
Copayment	\$10	\$20
Appointment type	Video through Zoom or other widely available platform	Audio-only
Time of available appointment	After 5pm	1-5pm
Earliest available appointment	Same day or next day	14 days
	<input type="button" value="Select"/>	<input type="button" value="Select"/>
<b>Option 3</b>		
NONE: I wouldn't choose any of these.		
<input type="button" value="Select"/>		

## Statistical Analyses

Through 12 repetitions of the conjoint task with randomized levels of each attribute, individual utilities for hypertension management appointments across attributes were constructed using logit estimation, allowing for aggregate utility estimations for the entire sample population. equation (6) presents how each utility term will be estimated.

$$P_n(1) = \frac{1}{1 + e^{-\mu\beta'(x_{1n}-x_{2n})}} \quad (6)$$

Where:  $P_n(1)$  is the probability person n will choose alternative 1, telehealth

$\mu$  indicates a recursive term in the data

$\beta'$  is the coefficient of each attribute included in the model

$x_{1n}$  are the scenarios where person n chose alternative 1 (telehealth)

$x_{2n}$  are the scenarios where person n chose alternative 2 (in-person visits)

Predictive validity was examined through asymptotic t-tests to test for validity of individual attributes and likelihood ratio tests for the overall validity of models to ensure they are useful for predicting whether a patient will choose telehealth or in-person visits under various levels of the attributes included in the model presented in equation (7):

$$L^* = \prod_{n=1}^N P_n(\text{telehealth})^{y_{\text{telehealth},n}} P_n(\text{in-person visit})^{(1-y_{\text{telehealth},n})}$$

Where  $y_{\text{telehealth},n} = \begin{cases} 1, & \text{if person } n \text{ chose telehealth} \\ 0, & \text{if person } n \text{ chose in-person visit} \end{cases}$  (7)

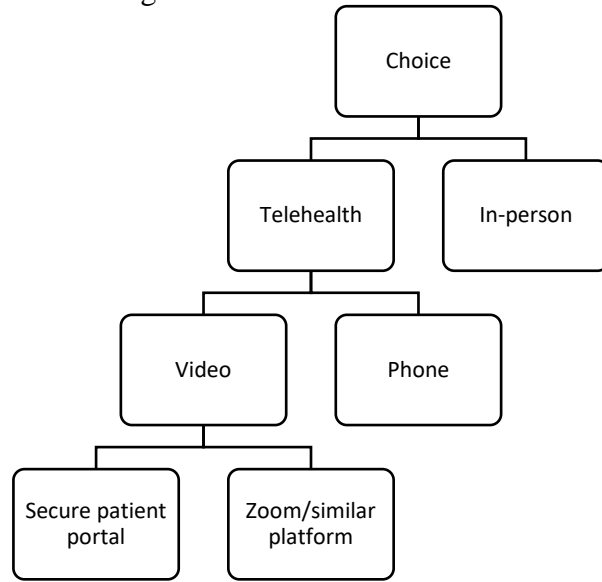
Predictions were then used to estimate general values of coefficients that are most likely to result in the observed model by taking the natural log of the likelihood function to create a maximum likelihood estimator presented in equation (8).

$$L(\beta_1, \beta_2, \dots, \beta_K) = \ln L^*(\beta_1, \beta_2, \dots, \beta_K)$$

Maximum Likelihood Estimator:  $\hat{\beta} = \text{argmax}_{\beta} L(\beta_1, \beta_2, \dots, \beta_K)$  (8)

There were also multiple sub-modalities of telehealth so a nested logit model was used as illustrated in **Figure 2**. The goodness-of-fit for models, including the Bayesian information criterion, were assessed to determine the number of latent classes.

**Figure 2.** Diagram of nested logit model



The resulting latent classes were compared for differences in demographic composition using chi-square tests for both overall demographic distribution and using dummies for each level of every measured demographic characteristic. Any groups that did not contain large enough counts to maintain statistical power were either combined with other groups or dropped from sub-analyses.<sup>237</sup> The final model specification is presented in equation (9):

$$V_T = \beta_1 \text{familiar clinician} + \beta_2 \text{profession of clinician} + \beta_3 \text{copay} + \beta_4 \text{appointment type} + \beta_6 \text{time of appointment} + \beta_7 \text{availability}$$

$$V_I = \beta_0 + \beta_1 \text{familiar clinician} + \beta_2 \text{profession of clinician} + \beta_3 \text{copay} + \beta_4 \text{appointment type} + \beta_6 \text{time of appointment} + \beta_7 \text{availability} \quad (9)$$

Where  $V_T$  is the systematic utility of telehealth and  $V_I$  is the systematic utility of in-person visits

### Sensitivity Analyses

To examine if there were differential preferences for participants with and without a current hypertension diagnosis, we stratified the sample by those with and without hypertension and conducted independent conjoint analyses (using logit models), comparing the zero-centered utilities for each attribute between the two groups. Also, using the groups elicited by the latent class analysis, we used linear regressions to examine the relationship between self-efficacy in managing hypertension and telehealth preferences.

Statistical analyses were conducted using Stata 17.0 (StataCorp, LLC). The University of California, Berkeley’s institutional review board approved the study protocol.

### **Results**

A total of 435 adults participated in the conjoint survey. For the analyses, the participant pool was restricted to participants with complete survey responses and with at least 150 seconds logged for survey completion. Participants who did not complete the survey (n=85, 19.5%) and those that spent less than 150 seconds completing the survey (n=30, 6.9%) were excluded, resulting in a final analytical sample of 320 adults of which n=148 (46.3%) had been diagnosed with hypertension. Most (n=247, 77.2%) participants belonged to households making less than \$50K per year, 95.9% (n=306) of participants reported having access to broadband internet at home and had an average of 2 chronic conditions (average: 1.9, SD=2.3, range: 0-12) (**Table 1**). Some groups elicited by the survey did not contain enough individuals to be adequately powered for analyses. For analyses, individuals in the 75-84 years old (n=6) and the 85+ years old (n=5) age groups were combined into a new 75+ years old age group. Those reporting contract or temporary employment (n=8) were combined with those reporting part-time employment (n=64). Those who reported speaking English “not well” (n=2) were combined with those reporting “well” (n=36). Those reporting having the VA as their regular place where they sought healthcare (n=3) were combined into the “some other place” category (n=13). These changes are reflected in **Table 1**, which reports our final analytical sample. The individual reporting “other” as their gender (n=1) and the n=4 individuals reporting “other” as their race/ethnicity were also excluded from gender- and race/ethnicity-based analyses, although they are still present in the overall analytical sample.

Overall, respondents had positive zero-centered utility for in-person visits (0.353, SE=0.039) and video appointments conducted through a secure patient portal (0.002, SE=0.040), meaning that patient preferred these appointment types over audio-only visits or visits through a popular consumer video call platform (**Table 2**). Respondents preferred visits before 5pm (8-11 am: 0.010, SE=0.040; 11am-1pm: 0.034, SE=0.040; 1-5pm: 0.006, SE=0.040) and appointment options that had availability within the next 7 days (Same day or next day: 0.375, SE=0.039; within 7 days: 0.094, SE=0.040). Respondents also preferred seeing a clinician with whom they have an established relationship (0.168, SE=0.021) and visits with a physician (0.111, SE=0.032). Participants had positive zero-centered utility for copays \$10 or less (\$0: 0.330, SE=0.039; \$10: 0.091, SE=0.040), meaning, in general, patients were willing to pay a small copay for other aspects of their visit to meet their preferences.

Latent class analysis yielded four major groups of participants based on their priorities when selecting an appointment for hypertension management. While major test-of-fit statistics showed improvement in statistical fit with more fragmented grouping, results for the five-group analysis yielded two groups with overlap in preference characteristics (similar ranking of attribute importance with different magnitudes of measured utility for each attribute) so we proceeded with the four-group model (**Table 3**). We categorized these groups as the “in-person” group (26.5% of participants), “cost conscious” group (8.1%), “expedited” group (19.7%), and “comprehensive” group (45.6%). The “in-person” group strongly weighted in-person appointments, the “cost conscious” group prioritized the lowest copay, “expedited” group prioritized getting the earliest appointment possible and “comprehensive” group had multiple high priority preferences, including appointment type (with a preference for in-person or video visit via secure patient portal), copay, (with a preference for \$0-\$10 copays) and the ability to see a familiar physician to prioritize appointment selection. Detailed results of the latent class analysis and relative importance of each attribute are presented in **Tables 3 & 4**.

Participants in the “in-person” group tended to be older than those in other groups and participants in the “comprehensive” group tended to be the youngest ( $X^2=48.396$ ,  $p<0.001$ ). Those in the “cost conscious” group were more likely to have low household annual incomes (<25K/year: 50.0%; \$25K-\$49,999/year: 38.5%) and participants in the “comprehensive” group had the lowest percentage (27.4%) of participants making less than \$25K/year and the highest percentage (14.4%) making over \$100K/year ( $X^2=37.615$ ,  $p<0.001$ ). Those in the “comprehensive” group were also the most likely to have full-time employment ( $X^2=50.874$ ,  $p<0.001$ ). The “cost conscious” group were also the least likely to be a parent or caregiver or have an established place of care and the “comprehensive” group were the most likely to be a parent or caregiver and have an established place of care (parent/caregiver:  $X^2= 11.078$ ,  $p=0.011$ ; established place of care:  $X^2= 11.080$ ,  $p=0.011$ ). The “expedited” group reported the most appointments in the past year and those in the “cost conscious” group reported the least number of visits in the past year ( $X^2= 20.880$ ,  $p=0.013$ ). The groups did not significantly differ on other demographic characteristics, including race/ethnicity or whether the participant had diagnosed hypertension. Full demographics comparisons of the groups are presented in **Table 5**.

When participants with and without a hypertension diagnosis are examined separately, logit analysis revealed participants with hypertension exhibited a positive utility for in-person appointments (0.338, SE=0.057) and video telehealth appointments through a secure patient portal (0.036, SE=0.058), while participants without a diagnosis only exhibited positive utility for in-person appointments (0.372, SE=0.054). Participants with hypertension also exhibited a positive utility for appointments from 8am-1pm (8-11 am: 0.076, SE=0.058; 11am-1pm: 0.021, SE=0.058), while those without hypertension exhibited a positive utility for appointments from 11am-5pm (11am-1pm: 0.040, SE=0.055; 1-5pm: 0.051, SE=0.055). Results of the analyses separated by hypertension status are presented in **Appendix 8**. There were also no differences in latent class distribution for participants with hypertension based on their confidence in managing their hypertension (**Appendix 9**).

## Discussion

While telehealth will never replace in-person hypertension care for most patients, our results highlight that telehealth is an important modality for routine hypertension management, especially video appointments through secure patient portals. We found that video-based telehealth through a secure patient portal had a positive zero-centered utility for adults adds to evidence about the sustained preference for telehealth beyond the end of shelter-in-place ordinances during the COVID-19 pandemic. Preferences for video encounters through secure patient portals rather than widely used platforms underscore the need for health care organizations to invest in telehealth infrastructure, especially patient portals that support secure, encrypted, and Health Insurance Portability and Accountability Act of 1996 (HIPAA)<sup>238</sup> compliant video chat services, is a worthwhile investment for healthcare organizations providing care to patients with hypertension.

Telehealth appointments also provide opportunities for patients to have lower copayments,<sup>219</sup> which may increase utilization for the lowest income patients and help meet the needs and priorities of all patients, as low copays had a positive zero-centered utility for all patients regardless of their priorities when selecting appointments. Our results related to co-payments are consistent with evidence that telehealth can also increase cost-effectiveness of mental health treatment at the organizational level that could translate to hypertension care,<sup>97,100</sup> creating a

scenario where both patients and hypertension care providing institutions can simultaneously save on care-associated costs.

There was a strong preference for the ability to see a familiar clinician by patients across the board, which is consistent with recent literature on telehealth adoption that has found the existence of an established relationship between clinician and patient is a major facilitator of successful telehealth adoption.<sup>151–154,176</sup> The “in-person” group was composed of individuals that tended to be older also matches literature that points to potentially low interest in telehealth and less satisfaction with telehealth appointments among older patients.<sup>79,87</sup> Also, our findings of positive zero-centered utilities for in-person and video visits and negative zero-centered utility for telephone visits is supported by previous evidence that found high interest in video visit among various demographics groups, including patients typically served in safety net settings.<sup>78,83,85,106,111,113,114,149</sup>

Finally, our finding that telehealth preferences for hypertension care did not differ by race/ethnicity further support the idea that telehealth could provide an avenue to equitable care.<sup>67</sup> Marginalized patients from have a documented interest in telehealth beyond this study and telehealth can help marginalized patients overcome barriers to seeking healthcare present for in-person appointments such as travel time or a need for childcare, which could be key considerations for marginalized patients in our “comprehensive” group who are more likely to be parents or caregivers or our “cost conscious” group who may have less flexibility in their schedules or enhanced barriers to attending in-person appointments.<sup>75,83,85,87,99,103,138,141,176,218</sup>

The study results should be considered in light of limitations. First, participants were recruited through a service with an established participant pool and the survey was distributed and administered through a digital interface. The results may not generalize to adults with lower technology literacy and without broadband internet at home. Second, while there are many strengths of conjoint and latent class analysis in maximizing resources and efficiency, as well as predicting the best offerings in general for different patients, results of this and similar studies should not be taken as a replacement for working with patients on an individual level to develop a care plan. Third, we do not have data on some demographics of our participants that may influence patient preferences outside the ones measured in this study. Participants’ perceptions of the quality of the relationship they have with their primary care provider may influence preferences for the ability to see a familiar clinician. Their previous experience with receiving care from non-physician clinicians may influence their utility for the profession of the available clinician. Also, the details of participants’ insurance coverage and benefits, such as deductibles may influence preferences around copay. Finally, for our conjoint analysis we also assume that introducing a new alternative would not significantly impact the choice between the two presented alternatives in each conjoint task. However, our methodology has shown to be successful in predicting choice and utilities despite this limitation.<sup>239</sup>

Latent class analyses of patient preferences for remote care help guide and serve as a starting place for clinicians and staff responsible for scheduling hypertension care appointments in offering different modalities for patients in settings where there are multiple offerings. For instance, older patients presenting with hypertension could be offered in-person appointments first followed by a discussion of what works best for them. In contrast, patients with a history of high utilization could be initially offered a telehealth appointment that occurs sooner than the next more traditional in-person offering, that could be maximize patient satisfaction and cost-

effectiveness. In addition, telehealth may also allow more flexibility of appointment times for care teams which may help address the needs of large groups of patients, including patient who fall into the “expedited” and “comprehensive” groups.<sup>78,101</sup>

Future research should expand the participant population of conjoint and latent class analyses beyond the convenience sample used in this study and use these methods to determine patient utility for different modalities of appointments for conditions beyond hypertension. These methods could also be used internally in health systems and provider organizations to increase access to care and improve the quality of care in guiding telehealth adoption, adaptation, or sustainability. Finally, clinical decision support tools and related tools could be developed to quickly determine whether an in-person, video, or telephone visit might be the best offering for different patients seeking care for hypertension or other conditions.

## **Conclusions**

Our conjoint and latent class analyses of appointment preferences for hypertension management indicate that participant preferences can be segmented into 4 groups with different preference orderings that prioritize: 1) in-person care, 2) low copayments, 3) expedited care and 4) balanced preferences for in-person and telehealth appointments through a secure portal, low copayments, and the ability to see a familiar clinician. Given that the majority of participants exhibited complex preferences for telehealth (“comprehensive” group), evidence is needed to clarify whether aligning appointment offerings with patients’ preferences can aid with reducing no-show rates and improving treatment adherence, quality of care, equity in patient outcomes, and efficient allocation of resources.



**Table 1.** Demographics of the analytical sample

<b>Demographics (n=320)</b>	<b>N</b>	<b>%</b>
<i>Age</i>		
18-24 years old	49	15.3
25-34 years old	67	21
35-44 years old	64	20
45-54 years old	47	14.7
55-64 years old	46	14.4
65-74 years old	36	11.3
75+ years old	11	3.4
<i>Gender (n=318)*</i>		
Male	145	45.5
Female	173	54.2
Other	1	0.3
<i>Race/Ethnicity</i>		
White	138	43.1
Hispanic or Latino	114	35.6
Black or African American	34	10.6
Asian/Pacific Islander	30	9.4
Other	4	1.3
<i>Household Income</i>		
Less than \$25,000	104	32.5
\$25,000 to \$49,999	143	44.7
\$50,000 to \$74,999	30	9.4
\$75,000 to \$99,999	18	5.6
\$100,000+	25	7.8
<i>Employment Status</i>		
Full-time	125	39.1
Part-time/Contract/Temporary	72	22.5
Unemployed	60	18.8
Unable to work	26	8.1
Other	37	11.6
<i>Parent/Caregiver Status</i>		
Yes	154	48.3
<i>Speak a language other than English at home</i>		
Yes	220	68.8
<i>English proficiency (n=260)*</i>		
Native speaker	122	38.1
Very well	100	31.3
Well/Not well	38	14.6
<i>Have a regular place for healthcare (n=317)*</i>		

Yes	250	78.1
<i>Details of place where healthcare is typically sought (n=253)*</i>		
Community health center	68	21.3
Kaiser Permanente	17	5.3
Private doctor	130	40.6
Emergency room	22	6.9
Some other place	16	6.3
<i>Number of healthcare visits in 2022 (n=253)*</i>		
None	35	10.9
1 visit	64	20.0
2 visits	58	18.1
3 or more visits	96	30.0
<i>Home internet access (n=319)*</i>		
Yes	306	95.6
<i>Hypertension</i>		
Yes	148	46.3
<i>Other comorbidities</i>		
Heart disease	47	14.7
Lung disease	21	6.6
Diabetes	68	21.3
Ulcer or stomach disease	35	10.9
Kidney disease	27	8.4
Liver disease	17	5.3
Anemia or other blood disease	50	15.6
Cancer	31	9.7
Depression	118	36.9
Osteoarthritis, degenerative arthritis	42	13.1
Back pain	109	34.1
Rheumatoid arthritis	31	9.7
*For questions where not all participants answered, counts of the number of participants that answered are presented with percentage of the total sample (n=320)		

**Table 2.** Results of logit analysis for overall sample (zero-centered differences)

Attributes	Utility	SE	t Ratio
Ability to see a clinician with whom you have an established relationship			
Yes	0.168	0.021	8.055
No	-0.168	0.021	-8.055
Profession of available clinician			
MD	0.111	0.032	3.514

Nurse practitioner or Physician's assistant	-0.042	0.032	-1.309
Nurse care manager	-0.069	0.032	-2.155
<b>Copayment</b>			
\$0	0.330	0.039	8.418
\$10	0.091	0.040	2.279
\$20	-0.105	0.040	-2.618
\$30	-0.315	0.042	-7.581
<b>Appointment type</b>			
In-person	0.353	0.039	9.039
Video through a secure patient portal	0.002	0.040	0.047
Video through Zoom or other widely available platform	-0.100	0.040	-2.479
Audio-only	-0.255	0.041	-6.170
<b>Time of available appointment</b>			
8-11am	0.010	0.040	0.249
11am-1pm	0.034	0.040	0.844
1-5pm	0.006	0.040	0.146
After 5pm	-0.049	0.040	-1.225
<b>Earliest available appointment</b>			
Same day or next day	0.375	0.039	9.650
7 days	0.094	0.040	2.363
14 days	-0.121	0.041	-2.968
30 days	-0.347	0.042	-8.312
None of the above options	-0.284	0.037	-7.646
Log-likelihood for model : -3975.13; Log-likelihood for null model: -4218.67			

**Table 3.** Latent class analysis of hypertension management care preferences

<b>Decision point</b>	<b>Two-latent class model</b>	<b>Three-latent class model</b>	<b>Four-latent class model</b>	<b>Five-latent class model</b>
Percent Certainty	20.589	22.894	24.732	26.832
Akaike Info Criterion	6766.148	6605.690	6484.659	6341.438
Consistent Akaike Info Criterion	7005.505	6968.352	6970.625	6950.709
Bayesian Information Criterion	6972.505	6918.352	6903.625	6866.709
Adjusted Bayesian Info Criterion	6867.646	6759.475	6690.731	6599.796
Chi-Square	1737.194	1931.652	2086.683	2263.905
Relative Chi-Square	52.642	38.633	31.145	26.951

**Table 4.** Results of latent class analysis in zero-centered differences in utility

<b>Groups</b>	<b>In-person (n=85, 26.5%)</b>	<b>Cost conscious (n=26, 8.1%)</b>	<b>Expedited (n=63, 19.7%)</b>	<b>Comprehensive (n=146, 45.6%)</b>
<i>Ability to see a clinician with whom you have an established relationship</i>				
Yes	40.857	0.730	27.684	72.655
No	-40.857	-0.730	-27.684	-72.655
<i>Profession of available clinician</i>				
MD	34.968	1.365	19.257	45.151
Nurse practitioner or Physician's assistant	-24.049	9.899	8.527	-29.456
Nurse care manager	-10.919	-11.264	-27.784	-15.695
<i>Copayment</i>				
\$0	40.304	234.364	47.573	24.440
\$10	-0.491	41.578	15.543	63.443
\$20	1.291	-69.305	-18.282	-5.895
\$30	-41.104	-206.637	-44.834	-81.988
<i>Appointment type</i>				
In-person	157.053	27.425	43.960	75.732
Video through a secure patient portal	-32.585	-12.889	-23.701	46.192
Video through Zoom or other widely available platform	-36.086	11.703	6.930	-54.743
Audio-only	-88.381	-26.239	-27.189	-67.181
<i>Time of available appointment</i>				
8-11am	3.888	9.744	5.519	-13.211
11am-1pm	-4.817	15.336	-1.908	21.251
1-5pm	9.531	-3.370	2.495	0.735
After 5pm	-8.602	-21.710	-6.106	-8.775
<i>Earliest available appointment</i>				
Same day or next day	56.557	13.927	165.398	31.522
7 days	8.355	-1.155	57.809	-13.536

	14 days	-7.176	16.447	-66.194	7.769
	30 days	-57.736	-29.219	-157.012	-25.755
	<i>None of the above options</i>	223.200	80.197	-101.820	-974.163
	<b>Attribute Importances</b>				
	Ability to see a clinician with whom you have an established relationship	13.619	0.243	9.228	24.218
	Profession of available clinician	9.836	3.527	7.840	12.435
	Copayment	13.568	73.500	15.401	24.238
	Appointment type	40.906	8.944	11.858	23.819
	Time of available appointment	3.022	6.174	1.937	5.744
	Earliest available appointment	19.049	7.611	53.735	9.546

**Table 5.** Demographics comparison of latent classes

	In-person (n=85)	Cost conscious (n=26)	Expedited (n=63)	Comprehensive (n=146)		
	%	%	%	%	X <sup>2</sup>	p-value
<i>Age</i>					48.396	<0.001
18-24 years old	14.1	15.4	19.0	14.4	0.869	0.833
25-34 years old	14.1	15.4	23.8	24.7	4.407	0.221
35-44 years old	12.9	11.5	11.1	29.5	15.074	0.002
45-54 years old	14.1	23.1	20.6	11.0	4.881	0.181
55-64 years old	14.1	23.1	15.9	12.3	2.216	0.529
65-74 years old	21.2	11.5	4.8	8.2	12.390	0.006
75+ years old	9.4	0.0	4.8	0.0	15.596	0.001
<i>Gender (n=317)*</i>	<i>n=84</i>	<i>n=26</i>	<i>n=63</i>	<i>n=145</i>	2.707	0.439
Female	54.8	65.4	58.7	50.3	---	---
<i>Race/Ethnicity (n=316)*</i>	<i>n=84</i>	<i>n=26</i>	<i>n=61</i>	<i>n=145</i>	16.012	0.067
White	38.1	38.5	37.7	50.3	5.209	0.157
Hispanic or Latino	40.5	38.5	44.3	29.7	4.663	0.198
Black or African American	10.7	0.0	13.1	11.7	3.536	0.316
Asian/Pacific Islander	10.7	23.0	4.9	8.3	7.700	0.053
<i>Household Income</i>					37.615	<0.001
Less than \$25,000	38.8	50.0	28.6	27.4	7.355	0.061
\$25,000 to \$49,999	49.4	38.5	44.4	43.2	1.316	0.725
\$50,000 to \$74,999	7.1	7.7	20.6	6.2	11.796	0.008
\$75,000 to \$99,999	1.2	3.8	4.8	8.9	6.369	0.095
\$100,000+	3.5	0.0	1.6	14.4	16.511	0.001
<i>Employment Status</i>					50.874	<0.001
Full-time	27.1	15.4	44.4	47.9	16.875	0.001
Part-time/Contract/Temporary	18.8	15.4	22.2	26.0	2.458	0.483
Unemployed	21.2	26.9	22.2	14.4	3.794	0.285

Unable to work	7.1	26.9	7.9	5.5	13.809	0.003
Other	25.9	15.4	3.2	6.2	25.912	<0.001
<i>Parent/Caregiver Status</i>					11.078	0.011
Yes	40.0	26.9	49.2	56.2	---	---
<i>Speak a language other than English at home</i>					3.189	0.363
Yes	75.3	88.5	82.5	82.9	---	---
<i>English proficiency (n=260)*</i>	<i>n=64</i>	<i>n=23</i>	<i>n=121</i>	<i>n=52</i>	13.180	0.040
Native speaker	43.8	26.1	50.0	51.2	5.371	0.147
Very well	31.3	56.5	36.5	39.7	4.732	0.193
Well/Not well	25	17.4	13.5	9.1	8.687	0.034
<i>Have a regular place for healthcare (n=317)*</i>	<i>n=85</i>	<i>n=26</i>	<i>n=62</i>	<i>n=144</i>	11.080	0.011
Yes	71.8	61.5	80.6	85.4	---	---
<i>Details of place where healthcare is typically sought (n=253)*</i>	<i>n=61</i>	<i>n=16</i>	<i>n=51</i>	<i>n=125</i>	8.789	0.721
Community health center	27.9	31.3	19.6	28.8	1.793	0.617
Kaiser Permanente	1.6	0.0	7.8	9.6	5.422	0.143
Private doctor	54.1	50.0	60.8	46.4	3.239	0.356
Emergency room	9.8	12.5	5.9	8.8	0.902	0.825
Some other place	6.6	6.3	5.9	6.4	0.024	0.999
<i>Number of healthcare visits in 2022 (n=253)*</i>	<i>n=61</i>	<i>n=16</i>	<i>n=51</i>	<i>n=125</i>	20.880	0.013
None	21.3	31.3	9.8	9.6	9.507	0.023
1 visit	16.4	18.8	21.6	32.0	6.269	0.099
2 visits	14.8	18.8	21.6	28.0	4.338	0.227
3 or more visits	47.5	31.3	47.1	30.4	7.511	0.057
<i>Home internet access (n=319)*</i>	<i>n=85</i>	<i>n=25</i>	<i>n=63</i>	<i>n=146</i>	2.492	0.477
Yes	94.1	92.0	96.8	97.3	---	---
<i>Hypertension</i>					3.187	0.364
Yes	44.7	30.8	47.6	49.3	---	---
*For questions where not all participants answered, counts of the number of participants that answered are presented with percentage of the total sample (n=320)						

## Conclusion

Effectively innovating remote care services requires understanding the organizational, care team, and patient factors that facilitate and hamper adoption and quality of implementation. In addition, it is paramount to address the “digital divide” when designing these services so that care can be improved for all patients, not just those with the most resources or social advantage. One of the ways to ensure digital health equity is by tailoring innovations to community health centers and their patient populations. Through the three chapters presented above, we have summarized existing literature relevant to telehealth implementation for primary care in community health centers, examined the impact of care continuity on telehealth adoption and its effect on hypertension and diabetes care outcomes for patients of community health centers, and elicited the remote care preferences of patients for hypertension care, focusing on low and middle-income patients and patients that speak a language other than English at home.

The first chapter summarized the potential strengths of telehealth and its potential to be a way to increase access to quality primary care for patients of community health centers. It also highlighted some of the shortcomings of the existing literature and how future research could be improved, including grounding future work theories and/or frameworks, including more patients from marginalized populations in studies of telehealth, and including specific detailing of barriers and facilitators of telehealth implementation and how to sustain these services. Addressing these factors in future studies can help enhance the external validity and actionability of findings, as well as advance health equity.

Analyses in the second chapter displayed that higher care continuity is associated with telehealth use and A1c testing, and lower A1c and blood pressure in community health centers. Telehealth use mediated the association of care continuity and A1c testing during the COVID-19 pandemic. Care continuity may facilitate telehealth use and resilient performance on process measures for hypertension and diabetes care in community health centers. Telehealth may also be a way to ensure enhanced process outcomes for diabetes care for patients served by community health centers.

The third chapter utilized a conjoint and latent class analysis to reveal the preferences for remote hypertension care in the United States, primarily focusing on patients in households that make less than \$50K per year and speak a language other than English at home. Patients showed a preference for in-person care and telehealth through secure patient portals. Latent class analysis yielded four major groups of preferences: 1) in-person care, 2) low copayments, 3) expedited care, and 4) balanced preferences for in-person and telehealth appointments through a secure portal, low copayments, and the ability to see a familiar clinician.

Returning to the conceptual model presented in the introduction, Chapter 1 confirms the importance of policy support at the outer setting and organizational level. Key barriers and facilitators to telehealth adoption were related to reimbursement, creating sustainable business models, availability of telehealth or general health information technology expertise and training (care team KSAOs), and incorporation into existing workflows. At the care team level, in Chapter 2, we see a significant relationship between telehealth adoption and care continuity that highlights the importance of trust and established relationships in telehealth adoption. Support for this hypothesis is continued in Chapter 3 that shows that participants assigned high utility to the ability to see a familiar clinician. At the patient level, Chapter 3 supports the idea that factors



such as privacy concerns and copays have a large influence on telehealth acceptance and adoption for patients. However, these relationships were complex for a majority of individuals, with heterogeneity across patient groups, and need to be more nuanced than previously hypothesized as there may not be a best “one-size-fits-all” approach to tailoring telehealth services for community health centers.

Although this dissertation exhibits some of the early promise for telehealth implementation and use in community health centers, work in this area is still in its early stages. Further research is needed to assess parity of quality of care between telehealth and in-person care in various situations, which types of care telehealth may be appropriate or inappropriate for, and the impacts of telehealth utilization and tailoring on patient outcomes and satisfaction, care team workflows, and health care systems resources over time.

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**Appendix 1.** Extraction tool for systematic review of telehealth implementation in safety net settings

**Identification**

*ID:*

*Number of publications:*

*Author:*

*Publication Year:*

*Country:*

**1. Short description of telehealth implementation (make sure to describe the personnel involved, e.g., physicians, medical assistants, health coaches, etc.):**

*Note: For interventions with multiple facets, list the main components. If there is a control group, also briefly describe it.*

**2. Duration/frequency of implementation**

- Routine telehealth implementation (not a temporary intervention) .....
- Intervention study with a beginning and end .....
  - If so, indicate duration: \_\_\_\_\_

**3. Indicate any theories or conceptual frameworks are mentioned, otherwise write “none.”**

**4. Was telehealth implementation clearly described?**

- 0: No, not clear.....
- 1: Somewhat/mostly clear.....
- 2: Very clear.....

*Note: Score 1 if it was difficult to determine what intervention was; inconsistencies in intervention description, or specifics of intervention vaguely described*

**5. What did telehealth implementation consist of (check all that apply)?:**

- Video visits.....
- Audio only visits .....
- Remote monitoring of biometrics (blood pressure for ex.) .....
- Training of staff and clinicians on telehealth.....
- Patient assistance for broadband access.....
- Patient training on telehealth technology .....
- Language interpretation or telehealth services in multiple languages.....
- Not clear.....

List other intervention components not stated above\_\_\_\_\_

6. Implementation Barriers (**check all that apply to the results presented**)

- a. Broadband/ internet access/ internet quality .....
- b. Patient digital health literacy.....
- c. Language access/ interpretation.....
- d. Patient acceptance of telehealth/ preference for in-person visits.....
- e. Clinic workflow disruption.....
- f. **Billing/administrative workflow disruption/uncertainty (wording).....**
- g. Lack of technical / implementation expertise.....
- h. Clinician/staff training and resource requirements.....
- i. Other (describe: \_\_\_\_\_).....

7. Implementation Facilitators (**check all that apply to the results presented**)

- a. Reimbursement/ payment.....
- b. Training for patients .....
- c. Training for clinicians and/or staff.....
- d. Financial incentives.....
- e. Non-financial incentives (i.e., recognition) .....
- f. Patient acceptance of telehealth.....
- g. Efficiency gains for the clinic (i.e., lower no-show rates).....
- h. Other (describe: lower barriers to start and continue medications).....

8. Were any analyses of specific subgroups conducted? If so, which subgroups:

0: No, none.....

1: Yes.....

If yes, indicate which subgroups were analyzed separately:

- African-Americans .....
- Latinos/Hispanics.....
- Asian or Pacific Islander.....
- Older adults (age 65+).....
- Patients with limited English proficiency: .....
- Other (indicate subgroup: \_\_\_\_\_) .....

9. Authors' conclusions from abstract:

Positive results.....

Null results.....

Mixed results.....

N/A .....□

**10. Was the follow-up period to assess telehealth long enough to assess the impact of telehealth on outcomes?**

0: All or most outcomes assessed < 3 months after implementation.....□

1: All or most outcomes assessed at >= 3 months but < 6 months since implementation; or, unclear how long the implementation occurred .....□

2: All or most outcomes assessed for >= 6 months after implementation.....□

**11. Was telehealth implemented evenly across all patient groups in the study?**

0: Intervention /implementation different across groups.....□

1: Unclear, not enough info, or some subgroups of intervention.....□

2: No subgroups; same intervention; same measures .....□

**Methods**

**1. Study Design (check one)**

- Randomized controlled trial .....□
- Pretest-posttest study .....□
- Posttest study.....□
- Descriptive/Interview Study.....□
- Other \_\_\_\_\_

**2. Setting for Results:**

- Multiple clinic sites □ \_\_\_\_\_specify # of sites, if applicable
- One clinic site □

**3. Method of recruitment of participants**

- Not an intervention .....□
- Phone .....□
- Email.....□
- Mail.....□
- Clinic patients.....□
- Voluntary.....□
- Other \_\_\_\_\_

**4. Clarity of analysis and reporting of results:**

0: Very unclear and results doubtful.....□

1: P-value(s) not reported & not computable (e.g., due to missing sample size); □



2: Analysis and results clearly presented, p-values computable if not reported...

## Population

**1. Short description of safety net organizational setting (FQHC, small independent practice, etc.):**

**2. Short description of patient population studied** (include inclusion criteria description here, including any qualifying medical conditions) and geographic region:

**3. Indicate the number of patients included in the study for each of these categories (total for intervention and control, if applicable). If not reported, indicate “Not Reported”.**

- Total patients: \_\_\_\_\_
- African-Americans: \_\_\_\_\_
- Latinos/Hispanics: \_\_\_\_\_
- Asian or Pacific Islander: \_\_\_\_\_
- Non-Latino White Patients: \_\_\_\_\_
- Older adults (aged 65+): \_\_\_\_\_
- Patients with limited English proficiency: \_\_\_\_\_

## Interventions and Comparisons/Outcomes

### 1. Outcomes- Summary

Abstract all outcomes reported (processes, clinician-reported, cost, patient outcomes).

### 2. Types of outcomes measured:

- 0: Patient-reported measures (i.e., patient experience, functional status)
- 1: Clinical quality of care (i.e., blood pressure process, blood pressure control)
- 2. Cost and utilization outcomes (i.e. utilization, cost, cost effectiveness )

### 3. Outcomes- Detail (Users vs non-users of telehealth)

If (a) either the pre or post value is missing; or (b) baseline data (prior to intervention deployment) is not reported, do not report these details. If baseline and/or follow up data were collected over a range of time, record the last date of the baseline data collection (before intervention starts) and the data point that corresponds to the last date that the outcomes data were collected.

#### Outcome number 1:

- Description of outcome: Reported adaptations for medication visits
- Type of measure: Patient-----Process-----Other (*circle*)
- Date of Final Measurement \_\_\_\_\_
- P value: \_\_\_\_\_ or “Not stated”
- Overall effect: Better----Worse---No change-----Can’t tell----N/A (*circle*)

- Details of Outcome:

Outcome number 2:

- Description of outcome: Reported adaptations for medication visits
- Type of measure: Patient-----Process-----Other (*circle*)
- Date of Final Measurement \_\_\_\_\_
- P value: \_\_\_\_\_ or “Not stated”
- Overall effect: Better----Worse---No change-----Can’t tell----N/A (*circle*)
- Details of Outcome:

Outcome number 3:

- Description of outcome: Reported adaptations for medication visits
- Type of measure: Patient-----Process-----Other (*circle*)
- Date of Final Measurement \_\_\_\_\_
- P value: \_\_\_\_\_ or “Not stated”
- Overall effect: Better----Worse---No change-----Can’t tell----N/A (*circle*)
- Details of Outcome:

**Appendix 2.** Search terms used for the systematic review of telehealth implementation in safety net settings

("telehealth"[All Fields] OR "tele-health"[All Fields] OR "telemedicine"[All Fields] OR "telemedicine"[MeSH Terms] OR "virtual"[All Fields] OR "video appointments"[All Fields] OR "tele care"[All Fields] OR "telecare"[All Fields] OR "remote consultation"[All Fields] OR “teleconsultation”[All Fields])

AND

("safety-net"[All Fields] OR "Safety-net Providers"[All Fields] OR "Safety-net Providers"[MeSH Terms] OR "federally qualified health center"[All Fields] OR "federally qualified health centers"[All Fields] OR "fqhc"[All Fields] OR "fqhcs"[All Fields] OR "community health center"[All Fields] OR "community health centers"[All Fields] OR "chc"[All Fields] OR "chcs"[All Fields] OR "rural health center"[All Fields] OR "rural health centers"[All Fields] OR "rhc"[All Fields] OR "rhcs"[All Fields])

**Appendix 3.** Inclusion criteria for the systematic review of telehealth implementation in safety net settings

- *Setting & Population:* Health care systems that serve predominantly low income and/or rural (safety net) populations in the United States
  - FQHCs, RHCs, CHCs
  - Can include academic medical centers & safety net hospitals

- Do not include studies that are only VAs
- *Types of telehealth*: Only synchronous phone or video appointments
- *Type of appointment*: Provider-to-patient appointments
  - Can include behavioral/mental health
  - Does not include intervention appointments (unless they are reimbursable)
  - Does not include peer-to-peer educator appointments
  - Does not include dental telehealth
  - Can include pharmacy telehealth
- *Time frame*: Published 2013 or after
- *Type of article*: Must be peer-reviewed original research articles (exclude commentaries)
  - Must be focused on or describe one or more implementation science areas
  - The ones that don't have empirical data should be tagged

#### Appendix 4. Implementation details of interventions from included studies from consensus

Study	Implementation Barriers	Implementation Facilitators	Short description of telehealth implementation (make sure to describe the personnel involved, e.g., physicians, medical assistants, health coaches, etc.):	Were any analyses of specific subgroups conducted? If so, which subgroups:
Adams 2021	none described	Providers have telehealth training and experience	Telehealth clinic in an urban drop-in center that provides medical services for people experiencing homelessness. The clinic is staffed by 3 family medicine attendings from the Medical University of South Carolina. Providers see patients through internet-based 2-way audio/visual system.	0: No, none
Anderson 2010	none described	none described	Telephonic disease management for diabetes administered by trained specialized nurses to Community Health Center clinic patients suffering from type 2 diabetes. Management included clinical assessment, self-management, medication adherence, and glucose monitoring. High-quality usual diabetes care was provided for both intervention and control group	1: Yes: -Patients with depression -Spanish speakers -Patients with lower education attainment
Armstrong 2011	Clinician/staff training and resource requirements Broadband/ internet access/ internet quality Other: Technology-related issues Communicating with referring providers effectively Setting up operation with staff	Efficiency gains for the clinic Other: Increases patient access convenience Timely and cost effective care increase	Any teledermatology taking place in California, mainly consisting of live-interactive, store-and-forward, or a hybrid of both. Most clinics did not use any additional staff outside of the normal practice of dermatology (physicians, MA's, PA's , nurses, administrative assistants, and	No, none

			information technologists).	
Barney 2020	Clinic workflow disruption Lack of technical / implementation expertise Clinician/staff training and resource requirements Other (describe: privacy, quality of care, need for in-person visits for certain measurements and assessments)	-Training for clinicians and/or staff -Patient acceptance of telehealth - Ability to integrate medical interpreters - All patients have access to appropriate devices for telehealth - Less financial and time burdens for patients - Lower barriers to initiate prescription for opioid use disorder	Routine telehealth implementation involving all providers, clinical support staff, clerical support staff, social workers, and registered dietitians at UCSF's Adolescent and Young Adult Medicine Clinic	0: No, none
Caton 2021	-Clinic workflow disruption	-Efficiency gains for the clinic (i.e., lower no-show rates)	Virtual visits for medical and behavioral health appointments for those with opioid use disorder, surveyed prescribers, behavioral health personnel, and others	0: No, none
Chang 2021	Broadband/ internet access/ internet quality Patient digital health literacy Language access/ interpretation Billing/administrative workflow disruption/uncertainty Lack of technical / implementation expertise Other (describe: concerns about quality of care)  Patient acceptance of telehealth/ preference for in-person visits	N/A	Any telehealth rolled out in New York City by members of Bureau of Equitable Health Systems.	Other (indicate subgroup: providers belonging to practices in high vs. low Social Vulnerability Index)
Childs 2021	none described	Reimbursement/payment	Telephonic telehealth sessions and virtual IOP (intensive outpatient) psychotherapy (group-level and individual), crisis management, family involvement, psychiatric medication management, consultation, care management services etc...	Yes: African-Americans, Latinos/Hispanics, Payment type (Medicaid Commercial etc.), Type of IOP group (Mood disorder etc.)

Clifton 2003	Broadband/ internet access/ internet quality, clinic Workflow disruption, Other (describe: Cost of communication equipment, Regulatory)	N/A	Prescription is transmitted from remote clinic to pharmacy then a pharmacist enters any orders and the label is printed at the remote site where an authorized person (physician, NP) approves the prescription and has a two-way videoconference with the pharmacy to verify. After the pharmacist also visually verifies the label is on the correct bottle and has the correct directions, and is not broken or tampered with, a two-way videoconference between the patient and pharmacist is set up to provide counseling on medication use and to provide the patient with their prescription.	No subgroups; same intervention; same measures
Coffman 2016	N/A	N/A	Provision of primary care services, primary care, and subspecialists referral services, e-visits, and store and forward services	0: No, none
Coker 2019	- Appointments for visits for the telehealth care coordinator could only be scheduled on 1 selected day of the week	-Patient acceptance of telehealth -Efficiency gains for the clinic (i.e., lower no-show rates)	FQHC care coordinator along with patients (child and guardian) teaches and accompanies videoconferences with screening department at CMHC. CMHC case manager screens for mental health needs from patients, and then refers family to CMHC therapist for an in person visit	0: No, none

Davis 2010	N/A	<ul style="list-style-type: none"> <li>-Patient acceptance of telehealth</li> <li>- Modification of materials for cultural competence</li> <li>- Coordinating administrator for care centers</li> <li>- Successful personalized interactions with group education sessions through video conferencing</li> <li>- Reminders through telephone calls and mailings</li> </ul>	Virtual conferences between patients at a primary care clinic, and a nurse/CDE or dietitian at the academic health center. Care consists of 20 min diabetes education session.	0: No, none
Dayal 2019 (Neurology)	N/A	<ul style="list-style-type: none"> <li>-Efficiency gains for the clinic (higher appointment completion rates)</li> <li>- Less travel time for patients</li> </ul>	<p>Pediatric neurology telemedicine consultations between a specialist at UC Davis Hospital and patients at 15 remote sites.</p> <p>Videoconferencing was conducted over turnkey telemedicine codecs with full UCDH provider access to remote pan-tilt-zoom capabilities.</p>	<p>Yes:</p> <p>Type of insurance Private/Nonprivate Distance to UCDH</p>
Dayal 2019 (JAMA)	N/A	N/A	Remote clinic staff and primary care physicians conducted vitals, history, and physical examination then faxed, mailed or shared over picture archiving and communication systems to a pediatric neurologist who then conducted a consultation via videoconferencing.	0: No, none
Dunham 2021	Pateint digital health literacy	<ul style="list-style-type: none"> <li>-Training for patients</li> <li>-Efficiency gains for the clinic</li> <li>-Patients were provided with necessary technology (iPhones with unlimited data plans)</li> <li>-Technological help from medical student volunteers</li> </ul>	Telephone and video primary care appointments for new and continuing clinic patients receiving care for opioid and alcohol use disorder, and those suffering from hepatitis C virus. Online zoom meetings between doctors, nurse practitioners, and mental health professionals, social workers and patient navigators for coordinated care. Referral appointments for inpatient patients	0: No, none

			who tested positive for HCV at other programs.	
Fortney 2013	Billing/administrative workflow disruption/uncertainty	None described	Telemedicine-based collaborative care: FQHC on-site primary care providers and off-site depression care managers, pharmacists, psychologists, and psychiatrists. Care was provided through telephone and video call appointments.	0: No, none
Franciosi 2021	-Language access/ interpretation	-Efficiency gains for the clinic : lower no-show rates	Live appointments between physician providers and patients using Doximity or AmWell technology. Consultations were for the following categories: primary care, adult non-surgical, adult surgical, and pediatric surgical, and pediatric non-surgical.	1: Yes:-African-Americans-Latinos/Hispanics-Asian or Pacific Islander-Whites; by insurance
Friesen 2015	N/A	<ul style="list-style-type: none"> <li>- Efficiency gains for the clinic</li> <li>- Patient acceptance of telehealth</li> <li>- Increased access to lactation education for populations that otherwise wouldn't have access to</li> <li>- Cost savings</li> <li>- time savings</li> <li>- inexpensive equipment</li> </ul>	Virtual breastfeeding education appointment between an International Board Certified Lactation Consultant (IBCLC) at an Indiana university hospital and breastfeeding women at an inner-city community health center breastfeeding center. Appointments happened pre and postpartum at the same time as they had their regular clinic appointments.	0: No, none
Futterman 2020	N/A	-Patient acceptance of telehealth	Virtual prenatal visits during the COVID-19 pandemic (March 1 to May 1, 2020). Pregnancy monitored by a physician or midwife.	Yes:African-Americans Latinos/Hispanics



Grubbs 2018	N/A	N/A	Telephone-based depression care management delivered by primary care providers, off-site telepsychiatrist, and official clinical pharmacist. Also included counseling at the VA and a telepsychologist at FQHCs	1: Yes: - Veteran status - Male/Female
Hernandez 2016	Billing/administrative workflow disruption/uncertainty	Efficiency gains for the clinic	Audiovisual communications through Polycom between the UC Davis Children's Hospital pediatric critical care physician and the patient. Patient was accompanied with referring home ED physician or nurse practitioner, the bedside ED nurse, the respiratory therapist, and/or the parents/guardians.	0: No, none
Howren 2021	Patient acceptance of telehealth/ preference for in-person visits	none described	Video conferencing with healthcare team	0: No, none
Khoong 2021	-Broadband/ internet access/ internet quality - Patient digital health literacy - Security/privacy concerns - No access to device for video visits - Trouble downloading video call platform	- Caller provided instructions on how to download video call platform	Patients were called by research analysts or medical student volunteers before their telephone appointment to see if they were interested in a video visit instead. All patients scheduled with approx. 20 clinicians during a 2-week period. If they expressed interest the caller gave them instructions of how to download the platform and go through with the video call.	1: Yes [African-Americans, Latinos/Hispanics, Asian or Pacific Islander, Older adults (age 65+), Patients with limited English proficiency]

Lin 2018	Broadband/ internet access/ internet quality Cost and reimbursement Technical issues aside from broadband Miscellaneous technical issues Partners and providers (proved to complex care) Patients population Regulations, policies, or scope of work	N/A	FQHC health providers utilizing telehealth with their patients. Telehealth including live video, store & forward, remote patient monitoring, and transmission/ facility fee.	Yes: Minority group members (Includes African Americans, Hispanic/Latinos, American Indian or Alaskan Native, Asian, and Native Hawaiian); Adults older than 65;English as a second language
Mammen 2020	N/A	-Financial incentives -Patient acceptance of telehealth -Efficiency gains for the clinic -Increased engagement in care -Improved workflow -Easy access to care	TEAMS is an intervention to help with at-home asthma self-management in young urban adults. The telemedicine part of the intervention included smartphone-based telemedicine follow-up and self-management training via Zoom with a nurse. Follow-up happened every 2-6 weeks until asthma was well controlled. Once good control is achieved the follow-up was 2-3 months for assessment of symptoms, lung function, and recent medication use. Phone calls were also made to health care providers for urgent follow-up if needed.	0: No, none

Mills 2021 (AHA)	N/A	-Training for clinicians and/or staff	Telehealth appointments between patients and internal and family medicine residents. Residents were postgraduate years 1,2 and 3. Appointments included screening for COVID-19, outpatient follow-up, patient education on COVID-19, and referrals for other specialties.	0: No, none
Mills 2021 (Telemedicine)	n/a	-Patient acceptance of telehealth	Telehealth appointments through the IMPACTS-BP study including audio and video visits for patient with high BP	Yes: African Americans, Latinos/Hispanics, Older than 65
Mittal 2014	N/A	N/A	Telemedicine -based collaborative care for patients by Depression Care Managers (telephone nurse care manager) supervised by telemedicine care teams. Stepped care in which pharmacist are consulted by phone followed by a telepsychiatrist if needed.	Race, Income, Insurance, Education
Nguyen 2021	none	-high reported smartphone ownership -Clinic offers translation services	Audio-only by phone and video telephone appointments via Zoom between clinic patients and volunteer staff.	Yes: African Americans, Latinos/Hispanics

Nies 2021	-patient care -lack of physical patient interaction -technical issues	-Patient convenience	Online clinic appointments through 1 of 3 telemedicine modalities that are HIPAA compliant: Webex, Doximity , or MyChart. Providers did audio-video visits over audio-only if possible.	0: No, none
Parnell 2020	Billing/administrative workflow disruptions Language barriers compounding with telephone visits	-Efficiency gains for the clinic	Virtual post-op visits for uncomplicated laparoscopic cholecystectomy patients. A provider team that consisted of residents and advanced practice providers with faculty supervision conducted a virtual post-op clinic every week where they called patients 2 weeks after surgery. In these calls they followed a standardized questionnaire and referrals to in-person clinic appointments or the ER were given accordingly.	0: No, none
Patton 2021	-Broadband/ internet access/ internet quality - Unstable housing -Lack of consistent phone access - No private location for personal calls	-Patient acceptance of telehealth -Efficiency gains for the clinic (i.e., lower no-show rates) -No need for transportation -No need for childcare	Hybrid model of care where patients are receiving care delivery in person as well as through telehealth. Patients were receiving 6-8 telemedicine contacts per month including a weekly nurse call, an obstetrics MD call every other week, as well as psychiatry and social work calls. Telemedicine appointments were conducted using the hospital's approved platforms for video calls (Zoom or Doximity), or telephone calls alone. Clinicians on the call were in dedicated clinic rooms or in other private settings using hospital-approved equipment.	0: No, none

Phenicie 2021	Lack of health insurance coverage Logistical issues Transportation issues Language barriers	N/A	Telehealth by phone or video	1: Yes: -Age -Primary Language
Pyne 2015	none described	none described	Patient and depression care manager (usually a nurse) have phone appointments and DCM will meet weekly with a psychiatrist to discuss patients and prepare notes and recommendations for stepped care. Notes are faxed to FQHC to be implemented by PCP. If no response to initial antidepressant offsite pharmacist will conduct a medication history and provide recommendations for medication management. If no response to 2 trials, a psychiatry consult will be held through video call. All patients have access to cognitive-behavioral therapy through video calls.	0: No, none
Richter 2015	-Broadband/ internet access/ internet quality -Patient acceptance of telehealth/ preference for in-person visits -Costs of travel time to clinic site for appointment	- Phone call reminders by counselors to participants before their appointment - Sites received a computer and software to implement intervention -Training for clinicians and/or staff -Installing of internet	4 sessions of telehealth appointments integrated into patient's primary care in their home clinic examination room equipped with all necessary equipment for video calls. Patient can create a quit plan and/or start pharmacotherapy with help from health care providers.	0: No, none
Rosal 2014	-Broadband/ internet access/ internet quality -technical difficulties with sound/microphone	-Training for patients -Patients were provided with internet and laptops -Addressed troubleshooting problems	Sessions delivered through "virtual world environment" on curriculum developed to improve diabetes knowledge, optimize attitudes toward diabetes self-management, and facilitate behavioral changes. The first online session was individual followed by 8 weekly 90-minute group sessions with 8-	0: No, none

			9 other people. The intervention team consisted of a registered dietitian, a certified diabetes educator, and a nurse practitioner.	
Shin 2014	- Reimbursement and payment for urban FQHCs	-Reimbursement streams for rural FQHCs	Exchange of clinical information through electronic audiovisual media between providers or providers and patients. Audio-visual technology includes webinars and video conferencing. Telehealth can also be synchronous or asynchronous. An example of asynchronous telehealth could be email or document and image transferring.	0: No, none
Simon 2021	N/A	N/A	Video and telephone virtual visits for medical, substance use, dental, enabling services, and mental health for FQHC patients in 19 states.	0: No, none
Spinelli 2020	-Lack of technical / implementation expertise for older adults - insecure housing	N/A	Telephone appointments between clinicians and patients with HIV.	Yes: African Americans, Latinos, Asians, Homeless
Tolou-Shams 2021	-Broadband/ internet access/ internet quality -Lack of technical / implementation expertise -Clinician/staff training and resource requirements -Privacy concerns -Engaging younger children - Certain therapies require making direct observations which is not possible with some telehealth methodologies	-Training for clinicians and/or staff -Patient acceptance of telehealth	Telepsychiatry in the form of clinic and community base inpatient and outpatient direct care for children. Performed by licensed credentialed psychologist and MA-level providers and trainees, n=55.	0: No, none

Uscher-Pines 2020 (Psychiatric)	-Broadband/ internet access/ internet quality -Clinic workflow disruption -Billing/administrative workflow disruption/uncertainty (wording) -Hampers information sharing between sharing and communication among members of care team -Maintaining confidentiality and safety	-Efficiency gains for the clinic: Less wait time -Solution to workforce shortages	FQHCs and CMHCs offering in-person combined with tele-mental health. All offer telepsychiatry, 10 also offer therapy over video conferencing. Providers varied but most commonly psychiatrics nurse practitioner.	0: No, none
Uscher-Pines 2020 (Substance Abuse)	-Patient acceptance of telehealth/ preference for in-person visits- Billing/administrative workflow disruption/uncertainty (wording)- Regulatory barrier: Ryan Haight Act (requires an in-person visit prior to the prescribing of substances)-Difficulties in getting lab results - Reimbursement	-Patient acceptance of telehealth -Increases access and convenience for OUD care for patients -Increases capacity of the overall behavioral health system -Decreases stigma associated with seeking OUD treatment	Different models of tele-ODU offered by FQHCs and CMHCs. The most common service provided is medication management via video call. Other services included medication prescription, counseling, and psychotherapy. Some treatments are all telemedicine cased while others are a combination of telemedicine and in person.	0: No, none
Uscher-Pines 2021	Economic barriers for patients Lack of resources for FQHCs	N/A	Virtual telephone and video visits between for primary care and behavioral health between FQHC providers and patients pre and during the COVID-19 pandemic.	0: No, none
Vilendrer 2020	-Broadband/ internet access/ internet quality -Other: trouble with integrating translation services	-Other: Staff acceptance for telehealth -Other: Good relationships with vendors -Other: Weekly teleconferences to resolve challenges and share benefits and best practices across sites	Stanford Healthcare: use computer workstations with video capability or full-sized tablets. Patients engaged with computer or tablets and video conference with providers Stanford Children's Health: Engaged with patients and their families through video conferencing with providers elsewhere in the hospital County of Santa Clara Health System: also utilized device based telemedicine conference between	0: No, none

			provider and patient. Also monitoring of EHR records	
Volcy 2021	Patient acceptance of telehealth/ preference for in-person visits	none described	Phone and video call virtual visits between family medicine and internal medicine providers and patients who agreed to have a virtual visit.	0: No, none
Zakaria 2019	N/A	-Efficiency gains for the clinic -More dermatology cases evaluated -Increased access to dermatology -Decreased wait time for clinic appointments	Primary care providers upload images and consult questions through a web-based telemedicine platform. 4 dermatology residents and an attending create assessment and care plan in the same platform. Telemedicine platform also allows for scheduling appointments for patients who need in-person care.	0: No, none

#### Appendix 5. Description of study methods from included studies from consensus

<b>Study</b>	<b>Clarity of analysis and reporting of results:</b>	<b>Method of recruitment of participants</b>	<b>Setting for Results:</b>	<b>Types of outcomes measured:</b>
Adams 2021	2: Analysis and results clearly presented, p-values computable if not reported	-Not an intervention -Clinic patients	An urban drop in center that offers medical services for PEH	0: Patient-reported measures
Anderson 2010	Multiple clinic sites: 2 community health centers	-Phone -Mail	2: Analysis and results clearly presented, p-values	-0: Patient-reported measures



			computable if not reported	-1: Clinical quality of care
Armstrong 2011	Analysis and results clearly presented, p-values computable if not reported	Not an intervention	17 identified dermatologist practicing tele dermatology within California. 35% university based setting 24% private practice 18% County Hospitals 18% managed care organizations 6% Veterans Administration Hospital	Clinical quality of care
Barney 2020	1: P-value(s) not reported & not computable (e.g., due to missing sample size)	Not an intervention	One clinic site	2. Cost and utilization outcomes
Caton 2021	1: P-value(s) not reported & not computable (e.g., due to missing sample size)	Email	Multiple clinic sites: 57	-0: Patient-reported measures -2. Cost and utilization outcomes
Chang 2021	Analysis and results clearly presented, p-values computable if not reported	Not an intervention	Multiple clinic sites: Unclear (918 providers from clinics with <4 providers)	Patient-reported measures Clinical quality of care Cost and utilization outcomes
Childs 2021	2: Analysis and results clearly presented, p-values computable if not reported	Clinic patients	Yale Newhaven Psychiatric Hospital, a large metropolitan hospital based setting	2. Cost and utilization outcomes

Clifton 2003	Analysis and results clearly presented, p-values computable if not reported	Clinic patients	Multiple clinic sites: 6	Patient-reported measures (i.e., patient experience, functional status)
Coffman 2016	2: Analysis and results clearly presented, p-values computable if not reported	Not an intervention	FQHC, community health center, rural health clinic, or Indian health service. Academic health center Health maintenance organization Accountable care organization Patient-centered medical home	2. Cost and utilization outcomes
Coker 2019	Analysis and results clearly presented, p-values computable if not reported	Referral process: Parents of children who are referred to a community mental health clinic (CMHC) by their pcp at a FQHC watch a video of the CMHC and can schedule a telehealth eligibility screening visit with the FQHC's telehealth care coordinator. In this visit, the coordinator connects the parents via videoconference to the screening department at the CMHC to	1 FQHC with 6 clinics and 2 CMHCs	2. Cost and utilization outcomes

		determine child's eligibility.		
Davis 2010	2: Analysis and results clearly presented, p-values computable if not reported	Phone		GHb (%)
Dayal 2019 (Neurology)	2: Analysis and results clearly presented, p-values computable if not reported	-Not an intervention - Patients from EHR data	Multiple clinic sites: 15 remote clinic sites, 1 university hospital (UC Davis), mostly minority patients	2. Cost and utilization outcomes
Dayal 2019 (JAMA)	2: Analysis and results clearly presented, p-values computable if not reported	-Clinic patients -Other: data retrospectively collected and deidentified from electronic health records	Multiple clinic sites: 13 remote clinics	2. Cost and utilization outcomes
Dunham 2021	Analysis and results clearly presented, p-values computable if not reported	Clinic Patients	Primary care clinic: Respectful and Equitable Access to Comprehensive Healthcare (REACH) Program	2. Cost and utilization outcomes (mostly utilization outcomes)
Fortney 2013	2: Analysis and results clearly presented, p-values computable if not reported	-Phone - Clinic patients	Multiple clinic sites: 5	1: Clinical quality of care (i.e., blood pressure process, blood pressure control)

Franciosi 2021	2: Analysis and results clearly presented, p-values computable if not reported	Not an intervention	Multiple clinic sites: 3 UMass Memorial Health Center campuses	2. Cost and utilization outcomes
Friesen 2015	1: P-value(s) not reported & not computable	Clinic patients	A single inner-city community health center	0: Patient-reported measures 1: Clinical quality of care
Futterman 2020	2: Analysis and results clearly presented, p-values computable if not reported	Clinic patients	An East Harlem inner city safety net hospital	2. Cost and utilization outcomes
Grubbs 2018	2: Analysis and results clearly presented, p-values computable if not reported	Phone Clinic patients	Multiple clinic sites: 12 (5 FQHCs & 7 VA CBOCs)	1: Clinical quality of care
Hernandez 2016	1: P-value(s) not reported & not computable	Not an intervention	Multiple clinic sites: 18	2. Cost and utilization outcome
Howren 2021	1: P-value(s) not reported & not computable	-Email -Mail	One clinic affiliated with a network of rural southeastern federally qualified health centers.	0: Patient-reported measures
Khoong 2021	2: Analysis and results clearly presented, p-values computable if not reported	-Phone	Multiple clinic sites 2 [women's health or general medicine clinic in an urban safety-net hospital]	0: Patient-reported measures
Lin 2018	2: Analysis and results clearly	Not an intervention	Multiple clinic sites: 1,367 health centers	1: Clinical quality of care (i.e., blood

	presented, p-values computable if not reported			pressure process, blood pressure control)
Mammen 2020	2: Analysis and results clearly presented, p-values computable if not reported	-Phone -Email	1 safety net clinic located in urban New York	0: Patient-reported measures 1: Clinical quality of care
Mills 2021 (AHA)	2: Analysis and results clearly presented, p-values computable if not reported	Email	One medical school: Morehouse school of Medicine	2. Cost and utilization outcomes (i.e. utilization, cost, cost effectiveness )
Mills 2021 (Telemedicine)	Analysis and results clearly presented, p-values computable if not reported	Phone	36 primary clinic sites which are part of 8 FQHCs	0: Patient-reported measures
Mittal 2014	2: Analysis and results clearly presented, p-values computable if not reported	-Phone -Clinic patients	Multiple clinic sites: 9 FQHCs	0: Patient-reported measures (i.e., patient experience, functional status)
Nguyen 2021	2: Analysis and results clearly presented, p-values computable if not reported	Not an intervention	Multiple clinic sites: 4	2. Cost and utilization outcomes
Nies 2021	2: Analysis and results clearly presented, p-values computable if not reported	Email	Multiple clinic sites: 75 sites	n/a Provider-reported measures

Parnell 2020	2: Analysis and results clearly presented, p-values computable if not reported	Clinic patients	Single Safety-Net hospital system in Texas	1: Clinical quality of care 2. Cost and utilization outcomes
Patton 2021	1: P-value(s) not reported & not computable (e.g., due to missing sample size)	Not an intervention	1 Safety net hospital's Recovery, Empowerment, Social Services, Prenatal care, Education, Community and Treatment (RESPECT) clinic. This clinic integrates SUD and prenatal care.	2. Cost and utilization outcomes
Phenicie 2021	2: Analysis and results clearly presented, p-values computable if not reported	Clinic Patients	1 FQHC system with multiple clinic sites serving a large migrant worker community in Arizona	
Pyne 2015	2: Analysis and results clearly presented, p-values computable if not reported	-Clinic patients -Voluntary	Multiple clinic sites: 5 rural FQHCs	2. Cost and utilization outcomes
Richter 2015	2: Analysis and results clearly presented, p-values computable if not reported	- Mail - Clinic patients - Voluntary - Radio interviews - Health fairs - Community newsletters - Staff recruitment tables at worksites	Multiple clinic sites: 20 (3 FQHCs)	1: Clinical quality of care 2. Cost and utilization outcomes

Rosal 2014	2: Analysis and results clearly presented, p-values computable if not reported	-Phone -Mail	Boston medical center +affiliated clinics	1: Clinical quality of care (i.e., blood pressure process, blood pressure control) 2. Cost and utilization outcomes (i.e. utilization, cost, cost-effectiveness)
Shin 2014	2: Analysis and results clearly presented, p-values computable if not reported	- Survey administered to all FQHCs in the country - Voluntary	Multiple clinic sites: 625 FQHCs	1: Clinical quality of care (i.e., blood pressure process, blood pressure control)
Simon 2021	1: P-value(s) not reported & not computable (e.g., due to missing sample size)	Other: EHR data from a health center-controlled network's enterprise data warehouse	Multiple clinic sites: 36 FQHCs in 19 states	2. Cost and utilization outcomes (i.e. utilization, cost, cost effectiveness )
Spinelli 2020	Analysis and results clearly presented, p-values computable if not reported	Not an intervention	A single safety-net clinic in San Francisco	1: Clinical quality of care
Tolou-Shams 2021	1: P-value(s) not reported & not computable (e.g., due to missing sample size)	Email (for providers to answer survey)	A large safety-net hospital in San Francisco	0: Patient-reported measures (i.e., patient experience, functional status)
Uscher-Pines 2020 (Psychiatric)	Analysis and results clearly presented, p-values computable if not reported	Not an intervention	Multiple clinic sites: 20 health centers (9 FQHCs and 11 community mental health clinics) in 14 different US states	2. Cost and utilization outcomes (i.e. utilization, cost, cost effectiveness )

Uscher-Pines 2020 (Substance Abuse)	1: P-value(s) not reported & not computable (e.g., due to missing sample size)	SAMSHA 2018 Behavioral Health Treatment Services Locator database	Multiple clinic sites: 22 Health centers (11 FQHCs and 11 CMHCs)	2. Cost and utilization outcomes
Uscher-Pines 2021	Analysis and results clearly presented, p-values computable if not reported	-Not an intervention -Other: California Healthcare Foundation provided funding to FQHCs to expand telehealth capacity and provide data	Multiple clinic sites: 41 FQHCs 534 sites	1: Clinical quality of care (i.e., blood pressure process, blood pressure control)
Vilendrer 2020	Analysis and results clearly presented, no p-values due to descriptive results	Not an intervention	Multiple clinic sites : Stanford Health Care, Stanford Children's Health, and Santa Clara Health System (3 hospitals)	2. Cost and utilization outcomes (i.e. utilization, cost, cost effectiveness )
Volcy 2021	Analysis and results clearly presented, p-values computable if not reported	-Phone -SurveyMonkey -Hard copy of survey - Text	2 academic safety net clinics	0: Patient-reported measures (i.e., patient experience, functional status)
Zakaria 2019	2: Analysis and results clearly presented, p-values computable if not reported	-Clinic patients	Zuckerberg San Francisco General Hospital and Trauma Center	-1: Clinical quality of care (i.e., blood pressure process, blood pressure control) -2. Cost and utilization outcomes (i.e. utilization, cost, cost effectiveness )



**Appendix 6. Population description of included studies from consensus**

<b>Study</b>	<b>Inclusion criteria</b>	<b>Exclusion criteria</b>	<b>Number of patients included in the study with categories</b>	<b>Short description of patient population studied</b>	<b>Short description of safety net organizational setting (FQHC, small independent practice, etc.):</b>
Adams 2021			Total patients: 63 African-Americans: 55.6% Latinos/Hispanics: 1.6% Asian or Pacific Islander: Not Reported Non-Latino White Patients: 22.2% Older adults (aged 65+): Not Reported Patients with limited English proficiency: Not Reported	Clients at the center, regardless of whether they had a medical concern, were invited to take an anonymous paper survey for the needs assessment survey. For the patient and provider survey, patients were asked immediately after their appointment if they wanted to take a private online survey. Providers were invited to complete their survey by email after each clinic session.	Urban drop-in center in a mid-size southern city that provides legal, mental health, social work, and medical services for people experiencing homelessness.

Anderson 2010	Patients with type 2 diabetes age 18 and over from the two participating sites.	Unwilling/unable to give informed consent Spoke primarily a language other than English or Spanish Did not have a telephone Were active substance abusers had a mental or physical impairment that would prevent them from engaging in the calls or in diabetes self-management activities	-Total patients: 295 -African-Americans: -Latinos/Hispanics: -Asian or Pacific Islander: -Non-Latino White Patients: -Older adults (aged 65+): -Patients with limited English proficiency: 172	Community health centers in Connecticut whose patient population is 43% Hispanic, 13% African American, ~50% spoke a language other than English, 83% < 200% FPL, and 25% have no medical insurance.	Patients at 2 participating FQHCs in Connecticut with type 2 diabetes, older than 18 years of age, a large percentage have hypertension, around half have a history of past depression, and 40-50% are on Medicaid.
Armstrong 2011			Total Patients: Not Reported African American: Not Reported Latino/Hispanic: Not Reported Asian or Pacific Islander: Not Reported Non- Latino White Patients: Not Reported	Any dermatologist in California practicing tele dermatology. Many were from Kaiser Permanente since they had launched a tele dermatology program during the study.	FQHCs in California (made up around 47% of the tele dermatologists interviewed). Over 75% of the patients seen via tele dermatology were at or below 200% federal poverty level and usually lived in rural regions without dermatology access.

			Older adults (aged 65+): Not Reported Patients with limited English Proficiency: Not Reported		
Barney 2020			Total patients: 1715 African-Americans: Not reported Latinos/Hispanics: Not reported Asian or Pacific Islander: Not reported Non-Latino White Patients: Not reported Older adults (aged 65+): Not reported Patients with limited English proficiency: Not reported	Adolescents and young adults being served in the San Francisco area for general care, mental health, reproductive health, and eating disorder care; 26% male and 32% publicly insured patients	UCSF Adolescent and Young Adult Medicine clinic in San Francisco provides primary care and subspecialty care to local urban youth and young adults as well as subspecialty care for other northern California communities.

Caton 2021			<p>Total patients: Not Reported  African-Americans: Not Reported  Latinos/Hispanics: Not Reported  Asian or Pacific Islander: Not Reported  Non-Latino White Patients: Not Reported  Older adults (aged 65+): Not Reported  Patients with limited English proficiency: Not Reported</p>	<p>Patients of clinics enrolled in existing medication for opioid use disorder treatment expansion project; sample included 57 primary care clinics (9 rural, 23 in medically underserved area), mostly Medicaid patients</p>	<p>Primary care clinics enrolled in medications for opioid use disorder statewide expansion in California; included FQHCs and look-alikes, Indian Health Service, and rural health clinics (sample also included hospital-affiliated ambulatory care clinics); 40% small clinics</p>
Chang 2021	<p>Primary care providers within the LISTSERV internal data system</p>	<p>N/A</p>	<p>Total patients: Not Reported  African-Americans: Not Reported  Latinos/Hispanics: Not Reported  Asian or Pacific Islander: Not Reported  Non-Latino White Patients: Not Reported  Older adults (aged 65+): Not Reported  Patients with limited</p>	<p>Primary care providers within New York</p>	<p>Small clinics (70.7% &lt;4 full-time providers) in New York City. Most of these practices (74-92% in each wave) are privately-owned. 44.4% of the clinics were in high Social Vulnerability Index areas.</p>

			English proficiency: Not Reported		
Childs 2021	All clinic patient who had visits after March 23, 2020		Total patients: 1008 African-Americans: 185 Latinos/Hispanics: 128 Asian or Pacific Islander: Not Reported Non-Latino White Patients: 632 Older adults (aged 65+): Not Reported Patients with limited English proficiency: Not Reported	Patients who have mental health problems/concerns and are in need of intensive therapeutic services following a psychiatric hospitalization or to prevent a hospitalization. 42.3% of patients included in the study were insured by Medicaid	Large metropolitan psychiatric hospital in New Haven serving hard-to-treat adult and adolescent patients.

Clifton 2003	Consecutive patients whose prescription was filled at the base site or remote sites.	N/A	<p>Total patients: 199  Total Control: 106  Total Intervention: 93  African-Americans: Not reported  Latinos/Hispanics: Not reported  Asian or Pacific Islander: Not reported  Non-Latino White Patients: Not reported  Older adults (aged 65+): 14  Control Older adults (aged 65+): 8  Intervention Older adults (aged 65+): 6  Patients with limited English proficiency: Not reported</p>	<p>An FQHC with 6 rural and urban clinics around Spokane, Washington. The clinic did have an established fiber optic network with high bandwidth for videoconferencing, as well as extensive software and technology support. 2 Native American serving clinics</p>	<p>Generally a younger population who were patients of the Community Health Association of Spokane (an FQHC) that has urban and rural clinics. There are also high levels of uninsured patients with about half of the patients having a visit once a month. The patient population was also predominantly female. The patients were 340B program beneficiaries (indigent and low-income).</p>
Coffman 2016	US practicing physician		<p>Total Patients: Not Reported  African American: Not Reported  Latino/ Hispanic: Not Reported  Asian or Pacific Islander: Not Reported  Non-Latino White:</p>	<p>557 Family physicians who responded to the 2014 American Academy of Family Physicians Telehealth Survey</p>	<p>Physicians who responded to the survey provided services in federal designations (FQHCs, community health center rural health clinic, or Indian health service), academic health centers, HMOs,</p>

			Not Reported Older adults (65+): Not Reported Patients with limited digital literacy: Not Reported		accountable care organizations, patient- centered medical home, and any affiliation/designation.
Coker 2019	Adult parents or legal guardians of a child age 5 to 12 years at the FQHC who received a referral to 1 of the 2 CMHCs		Total patients: 342 African-Americans:7 Latinos/Hispanics: 296 Asian or Pacific Islander: Not Reported Non-Latino White Patients: 24 Older adults (aged 65+): Not Reported Patients with limited English proficiency	Parent-child dyads whose child received a referral for a community mental health clinic in the previous 30 days before the study started. Study happened in the Los Angeles County.	A multi-site FQHC with 6 clinics as well as 2 Community Mental Health Clinics (CMHC) in Los Angeles

Davis 2010	Glycated Hemoglobin >7% Age 35 and up Patient in at the community health center in the last year Clinical Diagnosis of Diabetes Willing to participate	BMI <25 kg/m <sup>2</sup> Pregnant Any acute or chronic illness	Total patients: 165 African American/ (other): 122 Latino Hispanic: N/A Asian or Pacific Islander: N/A Non-Latino White Patients: 43 Older adults (aged 65+): N/A Patients with limited English proficiency: N/A	Patients from the 3 health centers of an FQHC in South Carolina with diabetes above the age of 35.	3 community health centers, all members of a single FQHC head quartered in Hartsville South Carolina
Dayal 2019 (Neurology)	Aged 18 years and younger residing in California who have completed at least one visit with UCDH pediatric neurologist between January 1, 2009 and July 31, 2017		Total patients: 1158 African-Americans: Not Reported Latinos/Hispanics: Not Reported Asian or Pacific Islander: Not Reported Non-Latino White Patients: Not Reported Older adults (aged 65+): Not Reported Patients with limited English proficiency: Not Reported	Pediatric patients 18 years old and younger whose home addresses were within California and who completed at least 1 visit with a UC Davis pediatric neurologist between January 1st, 2009 and July 31st, 2017 either in-person or through telemedicine. The mean age for both telemedicine and in-person was ~8 years old, and the majority	Remote clinic sites in rural and underserved communities where there is no access to in-person neurology specialists and remote consultations are available.



				insured by a non-private insurer.	
Dayal 2019 (JAMA)	n/a	n/a	Total patients intervention: 378; Total patients control: 379	Patients 18 years and younger in underserved rural communities which are registered within UCDCH's 33-county service area in northern California. Patients had to have completed at least one clinic visit with a UCDCH neurologist between Jan 1, 2009, and July 31, 2017.	Northern California remote clinics in rural underserved areas who are far away from a pediatric neurologist.

Dunham 2021	All Clinic patients are PWUD: people who use drugs		<p>Total patients: &gt;300</p> <p>African-Americans: 29%</p> <p>Latinos/Hispanics: 37%</p> <p>Asian or Pacific Islander: N/A</p> <p>Non-Latino White Patients: N/A</p> <p>Older adults (aged 65+): N/A</p> <p>Patients with limited English proficiency: N/A</p>	<p>The majority are Medicaid insured patients (75%) suffering from opioid and alcohol use disorder, or hepatitis type C. Patients are located in New York and the vast majority of them are unstably housed.</p>	<p>Harm reduction-focused primary care clinic in Mount Sinai Hospital in New York City for people who use drugs. The clinic provides primary care, medication for opioid and alcohol use disorder and hepatitis C virus testing and treatment.</p>
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Fortney 2013	<p>Patients with/diagnosed with: pregnancy, schizophrenia, acute suicidal ideation ,substance dependence, bipolar disorder, recent bereavement, and current specialty mental health treatment.</p> <p>Not speaking english, no telephone, unable to participate.</p>		<p>Total patients: 364  African-Americans: 76  Latinos/Hispanics: Not Reported  Asian or Pacific Islander: Not Reported  Non-Latino White Patients: Not Reported  Older adults (aged 65+): Not Reported  Patients with limited English proficiency:Not Reported</p>	<p>Clinic patients who were screened positive for depression between November 2007 and June 2009 who were eligible and completed a baseline telephone interview. Predominantly rural, unemployed, and uninsured patients with various comorbidities and whose depression was treatment-resistant.</p>	<p>5 different FQHC sites serving between 5,362 and 13,050 patients and employing 1.3 and 9.7 full-time primary care physicians. None of the sites had practicing mental health specialists.</p>
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Franciosi 2021			<p>Total patients: Not Reported, only number of appointments reported</p> <p>African-Americans: n/a</p> <p>Latinos/Hispanics: n/a</p> <p>Asian or Pacific Islander: n/a</p> <p>Non-Latino White Patients: n/a</p> <p>Older adults (aged 65+): n/a</p> <p>Patients with limited English proficiency: n/a</p>	<p>Patients receiving specialty or non-specialty care at UMass Memorial Health Center either in person in 2019 or telemedicine in 2020. The mean age for both in-person and telemedicine patients was 51 years old.</p>	<p>3 sites within UMass Memorial Medical Center network. Non-profit teaching hospitals serving a large minority population.</p>
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Friesen 2015	Patients from the community health clinic who attended prenatal visits and breastfeeding education classes. In their 3rd trimester of pregnancy.		Total patients: 35 African-Americans: 30 Latinos/Hispanics: Not Reported Asian or Pacific Islander: Not Reported Non-Latino White Patients: Not Reported Older adults (aged 65+): Not Reported Patients with limited English proficiency: Not Reported Other: 4	Women in their 3rd trimester of pregnancy in inner-city Indianapolis, Indiana. All patients were based in Marion county, 84% were 20-34 years old, and 86% were black.	Women's primary care clinic and where the breastfeeding center was located, Raphael Health Center a faith-based nonprofit FQHC in inner-city Indianapolis. Also, Indiana University Health Methodist Hospital, a large university hospital where the women in the study gave birth and where the lactation consultants were based.
Futterman 2020	Patients who received at least one in-person and one televisit during Covid-19	Obstetrics patients who received either in-person care or virtual care but not both.	Total patients: 104 African-Americans: Not specified Latinos/Hispanics: 77 Asian or Pacific Islander: 0 Non-Latino White Patients: Not specified Older adults (aged 65+): Not specified Patients with limited English proficiency: 56	Obstetrics patients who received prenatal care (high-risk and low-risk) both in-person and virtually during the height of the COVID-19 pandemic (March 1st to May 1st, 2020).	Inner-city safety-net hospital in East Harlem. Low-risk and high-risk prenatal clinics

Grubbs 2018			<p>Total patients: 759  African Americans: 148  Latinos/Hispanics: N/A  Asian or Pacific Islander: N/A  Non-Latino White Patients: 556  Older adults (aged 65+): N/A  Patients with limited English proficiency: N/A</p>	<p>70% of the FQHC population and 52% of the VA population have income of &lt;\$20,000 and only 36% and 22% respectively were employed. Both have predominantly white populations with the rest being mostly African American. The VA is 92% male while the FQHC was only 18% male. All patients had depression.</p>	<p>5 FQHCs in Arkansas and 7 VA community-based outpatient clinics in Mississippi</p>
Hernandez 2016	<p>Pediatric critical care instances defined as patients triaged as Emergency Severity Index Category 1</p>		<p>Total patients: 308  African-Americans: Not Reported  Latinos/Hispanics: Not Reported  Asian or Pacific Islander: Not Reported  Non-Latino White Patients: Not Reported  Older adults (aged 65+): Not Reported  Patients with limited English proficiency: Not Reported</p>	<p>Pediatric patients that presented to different emergency departments in Northern California and received telemedicine consultations from physicians at UCD Children's Hospital.</p>	<p>Emergency departments across the country that serve rural and/or underserved communities.</p>

Howren 2021	Patients must be older than 65 years and from one of the clinics affiliated with the FQHC		Total patients: 65 African-Americans: Not Reported Latinos/Hispanics: Not Reported Asian or Pacific Islander: Not Reported Non-Latino White Patients: Not Reported Older adults (aged 65+): Not Reported Patients with limited English proficiency: Not Reported	Adults older than 65 who completed a brief survey on telehealth from a single clinic in the FQHC	One clinic that is affiliated with a network of rural southeastern FQHCs
Khoong 2021	Patients who had a telephone visit in either the women's health or general medicine clinic chosen and who were interested in a video visit		Total patients: 202 African-Americans: 31 Latinos/Hispanics: 98 Asian or Pacific Islander: 29 Non-Latino White Patients: 25 Older adults (aged 65+): 40 Patients with limited English proficiency: 86	All patients of a safety net clinic who had a telephone visit with approximately 20 physicians during a 2-week study period	Urban safety-net clinic

Lin 2018	All data from the 2016 Uniform Data System Report from HRSA-funded FQHCs		Total patients: N/A African-Americans: N/A Latinos/Hispanics: N/A Asian or Pacific Islander: N/A Non-Latino White Patients: N/A Older adults (aged 65+): 9.3% Patients with limited English proficiency: N/A	FQHC patients made up of 43.5% male, 51.9% of a minority group, 43.8% on Medicaid, 18.8% ESL, and majority adult patients with 64.1% of age 18-64.	Health centers across the country with 44.3% in rural settings, 66.3% qualified as a patient-centered medical home (PCMH), 69.9% qualified as Health Center Controlled Network members, and 91.1% were mental health FTE providers.
Mammen 2020	Over the age of 18, below age of 44 English speaking Diagnosed with persistent asthma based on EPR-3 Have a smart phone Not pregnant Without cardiac or respiratory comorbidities		Total patients: 30 African-Americans: 15 Latinos/Hispanics: 4 Asian or Pacific Islander: 1 Non-Latino White Patients: 6 Older adults (aged 65+): Not Reported Patients with limited English proficiency: Not Reported	Urban young adults 18-44 years old suffering from persistent asthma, English-speaking, have a smartphone, not pregnant, without confounding comorbidities such as cardiac and respiratory disease, low-income, and the majority on public health insurance.	Safety-net hospital-based clinic in rural upstate New York.



Mills 2021 (AHA)	N/A	N/A	Total patients: Not Reported African-Americans: Not Reported Latinos/Hispanics: Not Reported Asian or Pacific Islander: Not Reported Non-Latino White Patients: Not Reported Older adults (aged 65+): Not Reported Patients with limited English proficiency: Not Reported	Patients of a large urban safety-net hospital in Atlanta, Georgia served by a class of 80% minority physicians.	Safety-net hospital (Grady Memorial hospital) in Atlanta, Georgia.
Mills 2021 (Telemedicine)	<p>IMPACTS-BP recruitment: Age at least 40 years Baseline systolic BP <math>\geq</math> 140mm Hg if not taking anti hypertensive medications or <math>\geq</math>130 mm Hg if taking antihypertensive medications Able to understand English Plan to continue</p>		<p>Total patients: 587 African-Americans: 381 Latinos/Hispanics: 23 Asian or Pacific Islander: Not Reported Non-Latino White Patients: 180 Older adults (aged 65+): Not Reported Patients with limited English proficiency: Not Reported</p>	No patients directly observed. Residents in internal and family medicine	Large, urban safety-net hospital in Atlanta, Georgia

	receiving care at the same primary care clinic for the 18 month duration of the trial				
Mittal 2014	Patients from either arm of the study : NCT00439452		Total patients: 364 African-Americans: Not Reported Latinos/Hispanics: Not Reported Asian or Pacific Islander: Not Reported Non-Latino White Patients: 261 Older adults (aged 65+): Not Reported Patients with limited English proficiency: Not Reported	FQHC patients suffering from depression. The mean age was 47.2 years old, only 18.4% were male, the majority were Caucasian with 71.7%. Almost half the study population was uninsured with 50.8%.	9 FQHC clinics. None of them had on-site mental health specialists.

Nguyen 2021			<p>Total patients: 198</p> <p>African-Americans: 18</p> <p>Latinos/Hispanics: 45</p> <p>Asian or Pacific Islander: n/a</p> <p>Non-Latino White Patients: 62</p> <p>Older adults (aged 65+): n/a</p> <p>Patients with limited English proficiency: n/a</p>	<p>Adult population (<math>\geq</math> 18 years old) receiving care at clinic network in North Central Florida from March 2020 to September 2020</p>	<p>Student run free clinic network, 4 primary care sites, associated with the academic medical center in North Central Florida that is staffed by volunteers.</p>
Nies 2021			<p>No patients 157 providers</p>	<p>No patients were studied directly. Providers of patients who receive care in a New York federally qualified health care system.</p>	<p>Large federally qualified health care system in Brooklyn, New York that was comprised of 8 primary care practices, 6 dental clinics, 9 community medicine sites, and 52 school-based health centers.</p>

Parnell 2020	Patients who underwent an emergent/urgent laparoscopic cholecystectomy and had "uncomplicated" post-op course.	Laparoscopic converted to open cholecystectomy patients. Patients with prolonged hospital course greater than 24hrs	Total patients: 672 (pre intervention) , 866(post intervention)  African-Americans:  Latinos/Hispanics:  Asian or Pacific Islander:  Non-Latino White Patients:  Older adults (aged 65+):  Patients with limited English proficiency:	Patients who underwent an urgent/emergent laparoscopic cholecystectomy and had an uncomplicated post-op course (medically cleared for discharge and discharged home within 24 hours without requiring additional interventions or treatment). Patients were ~60% of Hispanic ethnicity and majority were 25-35 years old.	Single, large safety net hospital in urban Texas that began utilizing the virtual post-op clinics
Patton 2021	Patients receiving prenatal care and substance use disorder (SUD) care during COVID-19		Total patients: 90 African-Americans: 12% Latinos/Hispanics: 3% Asian or Pacific Islander: Not Reported Non-Latino White Patients: 79% Older adults (aged 65+): Not Reported Patients with limited	Women with substance use disorder receiving prenatal care	Boston Medical Center

			English proficiency: Not Reported		
Phenicie 2021	Patients of the CCHCI who have recently had at least one telehealth or phone visit since the beginning of COVID-19		Total patients: 562 African-Americans: 16 Latinos/Hispanics: 230 Asian or Pacific Islander: Not Reported Non-Latino White Patients: Not Reported Older adults (aged 65+): Not Reported Patients with limited English proficiency: Not Reported	Pediatric and adult patients who attended at least 1 telehealth video or phone visit since the start of the COVID-19 pandemic. For patients less than 18 years old, parents took survey for them. Majority Medicaid patients who are White and Hispanic	Chiricahua Community Health Centers Inc., a non profit FQHC, is the largest primary care organization in southeast Arizona. ~28,000 patients, half of which are uninsured

Pyne 2015			<p>Total patients: 332  African-Americans: 69  Latinos/Hispanics: Not Reported  Asian or Pacific Islander: Not Reported  Non-Latino White Patients: 237  Older adults (aged 65+): Not Reported  Patients with limited English proficiency:</p>	<p>Primarily low-income white women with depression, 51% uninsured, 30% on public insurance, and 70% live in a rural residence.</p>	<p>5 FQHCs with between 1.3 - 9.7 full time equivalent PC physicians, and operate 1-6 clinic sites. None of participating FQHCs have on-site mental health specialist</p>
Richter 2015	<p>18 years or older  Have a primary care physician  Smoke 5 or more cigarettes a day or at least 1 year  Smoke 25 of the past 30 days  Speak English or Spanish  Have a telephone</p>	<p>Use other Tabaco products  Currently taking other smoking cessation medications or programs  Were breast feeding  Were pregnant or plan to become pregnant</p>	<p>Total patients: 566  African-Americans: n/a  Latinos/Hispanics: 50  Asian or Pacific Islander: n/a  Non-Latino White Patients: 464  Older adults (aged 65+): n/a  Patients with limited</p>	<p>Smokers 18 years and older who smoke 5+ cigarettes per day., smoked 25 out of 30 days before recruitment, speak English or Spanish, and have a telephone. 64.5% were below the 200% Federal Poverty Line. Participants also smoked an average of 19.7 cigarettes per day and had moderate nicotine dependence. Many (82.9%) were Caucasian.</p>	<p>20 safety-net primary care clinics in Kansas in rural areas (as defined by the Health Resources and Services Administration). 3 of the 20 clinics were FQHCs and half in cities with populations less than 1800.</p>

			English proficiency: n/a		
Rosal 2014	Patients diagnosed with type 2 diabetes, age above 18, English speaking, HbA1c>8 at their last outpatient visit within the last 12 months.	Medical conditions for which the intervention diet and physical activity would be contraindicated	Total patients: 89 African-Americans: 89 Latinos/Hispanics: Not Reported Asian or Pacific Islander: Not Reported Non-Latino White Patients: Not Reported Older adults (aged 65+): Not Reported Patients with limited English proficiency: Not Reported	Inner-city African American women who receive care at Boston Medical Center and affiliated community health centers and who have a diagnosis of type 2 diabetes, >= 18 years old, English-speaking, last HbA1c >8 within the previous 12 months and who the interventions would not be contradicted.	Boston Medical Center and affiliated community health centers. Academic safety net community clinics

				The average age of the participants was 52 years old, 60% had a high school education or lower, 82% had a income of <30,000. Experience with computers was variable.	
Shin 2014	All FQHCs in the USA were invited to participate		Total patients: Not Reported African-Americans: Not Reported Latinos/Hispanics: Not Reported Asian or Pacific Islander: Not Reported Non-Latino White Patients: Not Reported Older adults (aged 65+): Not Reported Patients with limited English proficiency: Not Reported	Patients of rural, urban, and rural and urban serving FQHCs all over the country.	625 FQHCs all over the country in rural, urban, and rural and urban settings.



Simon 2021			<p>Total patients: Not Reported  African-Americans: Not Reported  Latinos/Hispanics: Not Reported  Asian or Pacific Islander: Not Reported  Non-Latino White Patients: Not Reported  Older adults (aged 65+): Not Reported  Patients with limited English proficiency: Not Reported</p>	<p>Patients who received care from an FQHC and had appointments with licensed medical, dental, or behavioral health providers between February 3rd and May 17th, 2020.</p>	<p>36 FQHCs in 19 states who offered both video and telephone visits for patients between February 3rd and May 17th, 2020 enrolled with Enterprise Data Warehouse.</p>
Spinelli 2020			<p>Total patients: Not reported  African Americans: Not reported  Latinos/Hispanics: Not reported  Older adults (aged 65+): Not reported  Patients with limited English proficiency: Not reported</p>	<p>People with HIV on publicly funded insurance, with a high prevalence of mental illness, substance use, and unstable housing.</p>	<p>Ward 86- Urban HIV clinic serving publicly insured and vulnerable populations in San Francisco, California.</p>

Tolou-Shams 2021			Total patients: Not Reported African-American: Not Reported Latinos/Hispanics: Not Reported Asian or Pacific Islander: Not Reported Non-Latino White Patients: Not Reported Older adults (65+): Not Reported Patients with limited English proficiency: Not Reported	Publicly insured underrepresented youth who need mental health services and their families	A safety net hospital that recently underwent rapid transformation to telehealth services.
Uscher-Pines 2020 (Psychiatric)			Total patients: Not Reported African-Americans: Not Reported Latinos/Hispanics: Not Reported Asian or Pacific Islander: Not Reported Non-Latino White Patients: Not Reported Older adults (aged 65+): Not Reported Patients with limited	Patients of FQHCs and CMHCs who receive mental health care either in person or virtually.	20 health centers, 13 with clinics located in rural areas only, 6 have both rural and urban. They all provided mental health services. Some contract their services while others have their own staff providing mental health care.

			English proficiency: Not Reported		
Uscher-Pines 2020 (Substance Abuse)	Clinic must currently over Tele- Opioid use disorder care.		Total patients: Not Reported African-Americans: Not Reported Latinos/Hispanics: Not Reported Asian or Pacific Islander: Not Reported Non-Latino White Patients: Not Reported Older adults (aged 65+): Not Reported Patients with limited English proficiency: Not Reported	Patients receiving OUD (opioid use disorder) treatment at FQHCs and CMHCs. Majority of patients were insured by Medicaid.	FQHCs and CMHCs across the United States. The majority (45%) had 7-10 clinic sites. 59% of the health centers had only rural locations, and 36% had both rural and urban locations. The majority of the health centers had >50% Medicaid patients.

Uscher-Pines 2021	N/A	N/A	Total patients: Not Reported African-Americans: Not Reported Latinos/Hispanics: Not Reported Asian or Pacific Islander: Not Reported Non-Latino White Patients: Not Reported Older adults (aged 65+): Not Reported Patients with limited English proficiency: Not Reported	FQHC patients majority >65 years old, ~22% of racial/ethnic minority, ~21% best served in a language other than English, and ~15% at or below 100% federal poverty line.	41 FQHCs with 534 physical locations in Northern, Central, and Southern California, the majority of them serving 10,000 - 49,999 patients.
Vilendrer 2020	Patients of studied locations during COVID-19 outbreak	N/A	Total patients: Not Reported African-Americans: Not Reported Latinos/Hispanics: Not Reported Asian or Pacific Islander: Not Reported Non-Latino White Patients: Not Reported Older adults (aged 65+): Not Reported Patients with limited	Patients of designated health systems undergoing treatment during COVID-19 outbreak and implementation of rapid telemedicine response	1 Academic hospital with 2 associated adult health centers, 3 safety net clinics, 2 child care clinics

			English proficiency: Not Reported		
Volcy 2021			Total patients: 129 Internal medicine patients + 94 Family medicine patients = 223 Total	Patients who agreed to answer a survey after their virtual visit with their providers. The majority of patients for internal and family medicine reported their health to be good across all categories (76% IM, 58.5% FM).	Free-standing community clinic and a hospital clinic.

Zakaria 2019			<p>Pre-teledermatology sample  Total patients: 5278  African-Americans: 596  Latinos/Hispanics: 929  Asian or Pacific Islander: 1188  Non-Latino White Patients: 1847  Older adults (aged 65+): Not Reported  Patients with limited English proficiency: Not Reported</p> <p>Post-teledermatology sample  Total patients: 6308  African-Americans: 637  Latinos/Hispanics: 1646  Asian or Pacific Islander: 1451  Non-Latino White Patients: 1937  Older adults (aged 65+): Not Reported  Patients with limited</p>	<p>Pre-teledermatology analysis included all new or established patients older than 18 years seen at ZSFG between June 1, 2014 to December 31, 2014.  Post teledermatology analysis captured all new or established patients older than 18 who were evaluated at the dermatology clinic or via teledermatology between June 1, 2017 and December 31, 2017.</p>	<p>Zuckerberg San Francisco General.  Large, closed health care system.</p>
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			English proficiency: Not Reported		
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**Appendix 7. Conjoint survey instrument**

1. Do you speak a language other than English at home?
  - No
  - Yes
    - If no, what is this language? \_\_\_\_\_
    - How well do you speak English?
      - Very well
      - Well
      - Not well
      - Not at all

If “not at all”, redirect to a page saying: “Thank you for your interest in the survey. Unfortunately, you are not eligible to participate at this time.”

2. What is your age?
  - 18 years or younger
  - 19-24 years old
  - 25-34 years old
  - 35-44 years old
  - 45-54 years old
  - 55-64 years old
  - 65-74 years old
  - 75-84 years old
  - 85+

If “18 years or younger”, redirect to page saying, “Thank you for your interest in the survey. Unfortunately, you are not eligible to participate at this time.”

3. Has a health care clinician ever told you that you have hypertension or high blood pressure?
  - Yes
  - No

**Attributes and levels**

Attributes included in conjoint choice task	
Attributes	Levels
Ability to see a clinician you have an established relationship with	Yes/No
Profession of available clinician	MD/NP or PA/Nurse Care Manager
Copayment	\$0/\$10/\$20/\$30
Appointment type	In-person/Secure patient portal/Zoom or other widely available platform/Audio-only
Time of available appointment	8-11am/11am-1pm/1-5pm/After 5pm



Earliest available appointment	Same day or next day/7 days/14 days/30 days
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**Sample conjoint question**

[If answered “NO” to “high blood pressure” in Preliminary Question 3:]

You had a higher than normal blood pressure during your last appointment with a clinician. After keeping an eye on your blood pressure over a month-long period, you notice that it remains higher than normal. You decide you would like to consult a health care clinician. You want to schedule an appointment to discuss your higher than expected blood pressure values, please select which health care arrangement you prefer if you were ONLY presented with the options below.

[If answered “YES” to “high blood pressure” in Preliminary Question 3:]

You notice that your blood pressure is higher than normal over a month-long period. You decide you would like to consult a health care clinician. You want to schedule an appointment to discuss your higher than expected blood pressure values, please select which health care arrangement you prefer if you were ONLY presented with the options below.

	Option 1	Option 2
Ability to see a clinician with whom you have an established relationship	No	Yes
Profession of available clinician	Nurse practitioner or Physician's assistant	MD
Copayment	\$10	\$20
Appointment type	Video through Zoom or other widely available platform	Audio-only
Time of available appointment	After 5pm	1-5pm
Earliest available appointment	Same day or next day	14 days
	<input type="button" value="Select"/>	<input type="button" value="Select"/>
<b>Option 3</b>		
NONE: I wouldn't choose any of these.		
<input type="button" value="Select"/>		

**Demographics**

- 1. Gender?
  - Male
  - Female
  - Other (please specify)\_\_\_\_\_
- 2. Ethnicity (check all that apply)?
  - White
  - Hispanic or Latino
  - Black or African American
  - Native American or American Indian
  - Asian/Pacific Islander
  - Other (please specify)\_\_\_\_\_

3. The following is a list of common problems. Has a health care clinician ever told you that you have the following problems?

	Do you have the problem?	
	Yes	No
<b>Problem</b>		
Heart disease		
Lung disease		
Diabetes		
Ulcer or stomach disease		
Kidney disease		
Liver disease		
Anemia or other blood disease		
Cancer		
Depression		
Osteoarthritis, degenerative arthritis		
Back pain		
Rheumatoid arthritis		

- 4. Which category is closest to your total household income in 2021?
  - Less than \$25,000
  - \$25,000 to \$49,999
  - \$50,000 to \$74,999
  - \$75,000 to \$99,999
  - \$100,000+
- 5. What is your employment status?
  - Full-time
  - Part-time
  - Contract/Temporary
  - Unemployment
  - Unable to work

- Other (please specify) \_\_\_\_\_
6. Are you a parent or caregiver?
- Yes
- No
7. Is there a place that you usually go to when you are sick or need advice about your health?
- Yes
- No
8. What kind of place do you go to most often when you are sick or need advice about your health?
- Community Health Center
- Kaiser Permanente
- Private Doctor
- Emergency Room
- Some other place (please specify) \_\_\_\_\_
9. During 2021, how many visits (in-person, video, or phone) did you have at this setting?
- None, I did not seek care
- 1 visit
- 2 visits
- 3 or more visits

### **Self-efficacy to manage hypertension**

[If answered “Yes” to “high blood pressure” in Preliminary Question 3:]

Please answer the following questions on a scale of 1 to 10 of how confident you are managing your high blood pressure, with 1 being not confident at all and 10 being totally confident.

1. Having *high blood pressure* often means doing different tasks and activities to manage your condition. How confident are you that you can do all the things necessary to manage your *high blood pressure* on a regular basis?
- 1 (Not confident at all)
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 (Totally confident)

2. How confident are you that you can judge when changes in your *high blood pressure* mean you should visit a doctor?

- 1 (Not confident at all)
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 (Totally confident)

3. How confident are you that you can do the different tasks and activities needed to manage your *high blood pressure* so as to reduce your need to see a doctor?

- 1 (Not confident at all)
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 (Totally confident)

4. How confident are you that you can reduce the emotional distress caused by your *high blood pressure* so that it does not affect your everyday life?

- 1 (Not confident at all)
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 (Totally confident)

5. How confident are you that you can do things other than just taking medication to reduce how much your *high blood pressure* affects your everyday life?

- 1 (Not confident at all)
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 (Totally confident)

**Appendix 8.** Logit analyses by hypertension status

Attribute	With hypertension (n=148)			Without hypertension (n=172)		
	Utility	Std Error	t Ratio	Utility	Std Error	t Ratio
<b>Ability to see a clinician with whom you have an established relationship</b>						
Yes	0.211	0.030	6.965	0.128	0.029	4.428
No	-0.211	0.030	-6.965	-0.128	0.029	-4.428
<b>Profession of available clinician</b>						
MD	0.115	0.046	2.495	0.107	0.044	2.433
Nurse practitioner or Physician's assistant	-0.063	0.047	-1.338	-0.021	0.045	-0.465
Nurse care manager	-0.052	0.047	-1.127	-0.086	0.045	-1.925
<b>Copayment</b>						
\$0	0.213	0.058	3.682	0.437	0.054	8.142
\$10	0.066	0.058	1.139	0.115	0.055	2.096
\$20	-0.144	0.059	-2.446	-0.062	0.055	-1.119
\$30	-0.135	0.059	-2.292	-0.490	0.060	-8.217
<b>Appointment type</b>						
In-person	0.338	0.057	5.913	0.372	0.054	6.896
Video through a secure patient portal	0.036	0.058	0.621	-0.027	0.055	-0.487
Video through Zoom or other widely available platform	-0.044	0.059	-0.753	-0.152	0.056	-2.700
Audio-only	-0.330	0.061	-5.432	-0.193	0.057	-3.402
<b>Time of available appointment</b>						
8-11am	0.076	0.058	1.317	-0.046	0.056	-0.831
11am-1pm	0.021	0.058	0.365	0.040	0.055	0.724
1-5pm	-0.034	0.058	-0.581	0.051	0.055	0.917
After 5pm	-0.063	0.059	-1.067	-0.044	0.055	-0.800
<b>Earliest available appointment</b>						
Same day or next day	0.326	0.057	5.738	0.416	0.054	7.758

	7 days	0.124	0.058	2.155	0.065	0.055	1.184
	14 days	-0.171	0.060	-2.849	-0.075	0.056	-1.336
	30 days	-0.279	0.061	-4.607	-0.406	0.058	-6.979
	<b>None</b>	-0.380	0.056	-6.815	-0.194	0.050	-3.885
	Percent Certainty	6.07			6.43		
	Akaike Info Criterion	3697.49			4275.41		
	Consistent Akaike Info Criterion	3801.21			4381.52		
	Bayesian Information Criterion	3785.21			4365.52		
	Adjusted Bayesian Info Criterion	3734.38			4314.69		
	Chi-Square	236.78			291.67		
	Relative Chi-Square	14.80			18.23		

**Appendix 9.** Confidence in managing hypertension across groups

	Group (ref is In-person group)	Coefficient	SE	p-value	95%CI Lower	95%CI Upper
Do all the things necessary to manage your high blood pressure on a regular basis						
	Cost conscious group	-0.513	1.003	0.610	-2.495	1.469
	Comprehensive group	0.455	0.518	0.381	-0.569	1.479
	Expedited group	0.537	0.630	0.395	-0.708	1.781
Judge when changes in your high blood pressure mean you should visit a doctor						
	Cost conscious group	0.243	0.993	0.807	-1.719	2.206
	Comprehensive group	0.847	0.513	0.101	-0.167	1.861
	Expedited group	1.202	0.623	0.056	-0.030	2.434
Do the different tasks and activities needed to manage your high blood pressure so as to reduce your need to see a doctor						
	Cost conscious group	0.566	1.063	0.595	-1.535	2.667
	Comprehensive group	0.569	0.549	0.302	-0.516	1.655
	Expedited group	1.016	0.667	0.130	-0.303	2.335
Reduce the emotional distress caused by your high blood pressure so that it does not affect your everyday life						
	Cost conscious group	-0.717	0.984	0.467	-2.663	1.228
	Comprehensive group	0.797	0.507	0.118	-0.206	1.800
	Expedited group	0.591	0.618	0.340	-0.630	1.813
Do things in addition to taking medication to reduce how much your high blood pressure affects your everyday life						
	Cost conscious group	0.579	1.055	0.584	-1.506	2.664



	Comprehensive group	0.621	0.544	0.256	-0.454	1.695
	Expedited group	0.812	0.662	0.222	-0.497	2.121