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THE DIGITAL TRANSFORMATION OF HEALTH SERVICES AFTER THE COVID-19 PANDEMIC: AN EVALUATION OF TELEMEDICINE POLICIES IN THE UNITED STATES

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The Digital Transformation of Health Services after the COVID-19 pandemic: an Evaluation of Telemedicine Policies in the United States

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Abstract: Before the COVID-19 emergency, telemedicine in the United States was regulated by stringent rules set by the federal and states governments. The pandemic led to significant changes in telemedicine policy, coverage, and implementation. The federal government has loosened restrictions on telemedicine, allowing beneficiaries from any location to access services from their homes. State governments have focused on expanding telemedicine in their Medicaid programs and lowering provider licensing regulations. Despite these advancements, inconsistent state, and federal reimbursement policies, as well as different policies for various telemedicine services, might still hinder telemedicine implementation. The purpose of this research is to evaluate the effect of such policy changes on the diffusion of telemedicine using Household Pulse Survey Data provided by the US Census Bureau.

Keywords: Digital Health Services, Telemedicine, Policy, Social Acceptance, Technology Adoption
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Ethical Standards

-The authors declare the compliance with Ethical standards and the absence of competing interests.

Highlights

-The pandemic has led to significant changes in telemedicine policy

- The purpose of this research is to identify the determinants of telemedicine services use

-We aim at evaluating the impact of various policies favoring the adoption of digital health services

Data Availability Statement

-Data are freely available at the following link: https://www.census.gov/data/experimental-data-products/household-pulse-survey.html. The dataset organized by the authors is available upon reasonable request

1. Introduction

The digital transformation experienced in recent decades has led to several innovations in the healthcare sector (Frishammar et al., 2023; Sestino and D'angelo, 2023; Kuoppakangas et al., 2023; Keegan et al., 2023). Among these, telemedicine - the supply of medical services between patients and physicians remotely by means of information-communication technology (ICT) devices (Sood, 2007) - is certainly one of the most important, especially after the COVID-19 pandemic.

Before the start of the Public Health Emergency (PHE) in March 2020, Telemedicine use in the United States was increasing but its absolute integration in health care standard practices remained low (Shaver, 2022), partially because of technological barriers (Huilgol et al., 2020; Ranganathan and Balaji, 2020). Indeed, its usage varies depending on the specific medical specialty, psychiatry and cardiology are characterized by the highest diffusion of telemedicine practices (Kane and Gillis, 2018), and There is still a lack of empirical research to determine the size of these hurdles, although there are several policy articles on institutional impediments to telemedicine in the US. Therefore, the research tries to fill this gap by providing new insights into the effectiveness of policies aimed at eliminating barriers to telemedicine.

The purpose of this research is to estimate the impact of the driving factors for telemedicine services use by employing the Andersen's Behavioral Model of Health Services Use (BHS) proposed by Andersen and Newman (1973) and further developed by Andersen (1995). The BHS model is based on three clusters of variables: i) *predisposing* factors, as socio-demographic characteristics; ii) *enabling* factors, as barriers and incentives; and iii) *needs* factors related to human well-being and the need of medical treatments.

To the best of our knowledge, this model has been rarely used in the context of telemedicine (Narcisse et al., 2022). For instance, Guzman-Clark et al. (2020) conducted a retrospective cohort study using Department of Veterans Affairs (VA) clinical and facility data of veterans with heart failure enrolled in the VA Home Telehealth (HT).

Choi et al. (2022) used the BHS model to analyze data from the COVID-19 supplemental survey of the National Health and Aging Trend Study. Their results show that insuring that older adults have ICT devices and internet access may reduce health disparities and improve telehealth care delivery.

Narcisse et al. (2022) used data from the 2020 National Health Interview Survey to examine predisposing, enabling, and needs factors associated with past-year telehealth use. A negative association was found for those with no insurance and telehealth use, whereas a positive association was found for military insurance.

All the above cited applications of the Andersen BHS model involve few thousand of observations from specific surveys. We contribute to the existing literature, by analyzing almost one million of observations from the Household Pulse Survey Data provided by the US Census Bureau, focuses on the impact of US federal and state policies aimed at eliminating regulatory barriers during the 2021-2022 pandemic period. This allows us to focus on different insurance policies, licensure policies, and waivers which have not been analyzed at the same time until now.

By estimating the effect of policy changes during the pandemic crisis, an indirect measure of the effect of telemedicine barriers before the pandemic crisis is obtained. In particular, the research focuses on state-level differences in licenses and reimbursement policies.

The paper is structured as follows. Section 2 discussing telemedicine's advantages and barriers before the pandemic crisis, section 3 summarizing the main actions at the federal and state level to eliminate institutional barriers to telemedicine and face pandemic medical needs, data and the empirical analysis being reported in section 4, and policy implications and concluding remarks presented in section 5.

2. Telemedicine in the U.S.

2.1. Before the Pandemic Crisis

Telemedicine can increase the productivity of physicians and benefits for patients, improving the healthcare service accessibility, representing a significant cost saving when compared to traditional physician-staffed outreach clinics per patient visit. For instance, Simko et al. (2022) found that the actual cost of a regional pediatric neurosurgery telemedicine clinic was 32.5% less than the estimated cost of a traditional outreach clinic with physician staff, which was $547 per patient. According to Green et al. (2022), telemedicine results in less time being wasted by doctors and a significant increase in the number of patients they can take care of without endangering patient access to care.

Despite the economic convenience of telemedicine, there are still causes of reluctance to adopt telemedicine, especially in the mental care sector. For instance, many practitioners are afraid that Tele Mental Health (TMH) may hinder their capacity to successfully connect with patients and develop a professional connection (Cliffe et al., 2020; Jameson et al., 2011; Wagnild et al., 2006, Brooks et al., 2013).

Besides these critical voices, the increasing supply of telemedicine solutions had a positive impact on the quality of health care services. Kruse et al. (2017) identified some key factors correlated with patient satisfaction from telemedicine services through a systematic review and narrative analysis on patients' satisfaction from telemedicine services. These factors include:

- Telemedicine improves outcomes of health services.
- Telemedicine improves communication with providers.
- Telemedicine is characterized by low cost.
- Telemedicine can decrease travel and increase communication with providers.
- Telemedicine increases access to care.
- Telemedicine increases self-awareness and empowers patients to manage their chronic conditions.

Telemedicine offers several advantages and benefits to both patients and doctors. Here are some of the advantages worth considering:

- Telemedicine decreases the strain on the healthcare system.
- Telemedicine increases access to physicians and specialists, ensuring that patients receive the right care, at the right place, at the right time.
- Telemedicine reduces patient care costs by avoiding unnecessary admissions, transfers, and readmissions.
- Telemedicine reduces inefficiencies in overall care by providing timelier access to doctors.
- Telemedicine improves patient outcomes, communication with providers, and access to care while also reducing costs (Kruse et al., 2017).
- Telemedicine can decrease missed appointments, is a good modality for education, decreases wait times, decreases readmissions, and improves medication adherence (Kruse et al., 2017).

Despite the aforementioned advantages of telemedicine, before the COVID-19 pandemic there were several legal and regulatory barriers to telemedicine in the US, including wide variance in laws, standards, and best practices. Although the use and acceptance of telemedicine were already expanding before the pandemic crisis, many barriers prevented it from realizing its full potential (Svorny, 2017). Before engaging in telemedicine, US practitioners should be knowledgeable of the most recent regulations, guidelines, and insurance coverage for malpractice. The uncertainty experienced by telemedicine providers is a result of this diversity. Healthcare professionals should be aware of potential telemedicine legal risk as well as risk management techniques. State-specific telemedicine laws, policies, and licensing practices differed significantly from one another and are constantly developing. This led to a lack of clarity across healthcare organizations and groups

regarding standards and procedures. The rapid growth of telemedicine, particularly during the COVID-19 epidemic, along with varying legislation and policies raises the possibility of legal problems (Cason and Brannon, 2011; Balestra, 2018; Gajarawala and Pelkowski, 2021).

Besides the legal environment, there were (and still are) several recognized obstacles to telemedicine, including financial needs for broadband and other necessary equipment, sociocultural background, digital literacy, education, community acceptance (Jang-Jaccard et al., 2014; Holtz, 2021; Triana et al., 2020; Savage et al., 2021; Seron et al., 2021). These barriers can prevent patients from accessing care and providers from delivering it. However, telemedicine has been shown to reduce healthcare disparities, particularly for patients in rural and underserved areas, by improving access to healthcare and allowing specialists to serve more patients without extensive travel (Alghatani, 2016; Azalea Health, 2022).

According to a survey conducted by the American College of Physicians (ACP),[1] the biggest perceived barrier to telemedicine adoption is fitting telemedicine into the daily workflow of a medical practice. Members struggle with how to integrate telemedicine into their practice workflows and must figure out how to change their procedures and incorporate new types of visits into these practice workflows. The rate of adoption and usage varied widely depending on the type of technology involved, although 51% of respondents said they used at least one of the five categories of telemedicine technologies. E-consult technology, in which physicians use either real-time or "store-and-forward" virtual communication tools to consult about a patient, was the most widely used technology, at 33% of respondents. Perceived barriers to adoption of telemedicine included difficulties integrating it into the practice workflow, no patient access to the technology, concern about potential medical errors, and security and privacy of patient information.

Before the pandemic, licensing policies and medical reimbursement rules were among the most important barriers to telemedicine. Practitioners were required to seek a license from the state of origin, i.e. the state where the client was resident. Although not all states have specific laws about telemedicine, a state regulatory board receiving a complaint about telemedicine services without license in the state where the client is located would rely on the "operating without a license" penalty provision that is present in every state (Cason and Brannon, 2011). This creates a challenge for practitioners and patients seeking to access telemedicine services across state lines.

To address this challenge, the Interstate Medical Licensure Compact (IMLC) was founded in 2017 to provide qualified physicians who wish to practice in other states and partially solve these problems. There are also similar compacts for other medical professions, such as the Nurses Licensure Compact (NLC) and the Compact Physiotherapy (PTC). However, these compacts simplify but do not eliminate states' licensing obstacles. Physician candidates must pay an initial charge in addition to the costs and renewal fees of licenses in Compact states where they wish to practice, and costs related to Compact licenses/renewals constitute another barrier to multistate licensure via the IMLC or similar compacts. In 2021, licensing costs varied by state, costing $75 in Alabama, Wisconsin, and Maryland, $790 in Maryland, and several hundred dollars in most states (CMS, 2021). These costs may be a significant barrier for many medical offices, especially small practices, that are still trying to recover from COVID-19-related income losses.

To ensure maximum access to healthcare while assuring quality, it is essential to update laws and policies that haven't yet reflected new technological realities, especially in the context of telemedicine. Consumers who have experienced telemedicine services and investors seeking to join the hot business opportunity will ultimately drive the solution by "voting with their wallets," aided by giant, consumer-focused retailers like Amazon and Walmart, both of which in recent months made forays into telemedicine. However, the whole challenge is to ensure maximum access to health while assuring quality, and laws and policies must be updated to reflect new technological realities.

Before the pandemic, telemedicine faced many government-imposed restrictions that prevented it from improving and lowering the cost of medical care. Some states placed so many restrictions on

[1] ACP Telehealth Survey Results 2020 March (acponline.org)

doctor-patient interactions that they made telemedicine more challenging than face-to-face consultations (Svorny, 2017). These constraints artificially maintained high medical pricing and imposed significant time and financial expenses by restricting access and competition in the market for physician services. State regulations, such as extra exams or coursework, made the procedure even more complicated. Other barriers to telemedicine adoption include (Chan et al., 2020; Dixit et al., 2022):

- Different levels of private insurance coverage for telemedicine services.
- Compensation schemes that usually give preference to in-person appointments,
- Penalties for institutions that offer treatment for medically underprivileged patients,
- Discouragement of telemedicine utilization by lower compensation for audio-only versus video consultations.

All these restrictions deter telemedicine service providers from offering audio-only meetings to patients in rural areas and those with little financial resources.

Legal trust is another key barrier to the adoption of telemedicine systems. The privacy and confidentiality of patient data are important issues that compete with more conventional ways of providing medical care. Additionally, the regulation of the "virtual health services" sector may be unclear, which raises more questions about data security. However, regulatory requirements have also an impact on how health services are organized. Medical personnel and the medical entity itself face significant obstacles due to unclear legal regulations surrounding liability when implementing telemedicine procedures (Klazinga et al., 2011; Lmathami et al., 2020). The implementation of telemedicine services is significantly impacted by awareness-related barriers as well. For the adoption of telemedicine services to be successful, telemedicine systems must gain the confidence and acceptance of the users participating in the innovation processes in healthcare systems and medicine generally (Marchell et al., 2017). For instance, there is still resistance to adopting the" unconventional" telemedicine model in the elderly and between individuals with little technological advancement and access to ICT devices (Alghatani, 2016; Lmathami et al., 2020; Berryhill et al. 2019; Cowan et al. 2019).

Reimbursement policies are another obstacle to telemedicine (Bailey et al., 2021). In the United States, before the pandemic, telemedicine was subject to a complex regulatory framework that varied by state and payer. Regulations determined who could provide which telemedicine services to whom, where, and how they were reimbursed. The federal government regulated telemedicine for Medicare and self-insured plans, while states largely regulated telemedicine for Medicaid and fully insured private plans. This complexity created challenges for patients to understand what services were covered and for providers to know which regulations to follow (Weigel et al., 2020).

During the pandemic, states took action to enhance private insurance coverage of telemedicine. Twenty-two states changed laws or policies to require more robust insurance coverage of telemedicine, including requiring coverage of audio-only visits, waiving, or reducing cost sharing, and requiring reimbursement parity between telemedicine and in-person services. States used executive orders, bulletins, notices, and other agency actions to quickly implement these changes. Insurers were generally cooperative with these changes, but longer-term adoption of reimbursement parity may be contentious. Policymakers will need to collect data to guide future policy decisions on whether and how to adopt these changes on a permanent basis (Volk et al, 2021).

2.2. The COVID-19 emergency policy changes

Given the increasing relevance of telemedicine during the COVID-19 epidemic (AMA, 2022), policymakers involved in the process made some progress in facilitating the use of such a system (Weigel et al., 2020).

Despite ongoing challenges, telemedicine has been an invaluable tool for those patients who were reluctant to seek in-person care, had difficulty accessing in-person care, or had chronic conditions that place them at high risk for severe COVID-19.

States, health systems and insurance companies have also moved with unprecedented speed to move many previously face-to-face visits to a telemedicine platform. To help providers better serve patients who shelter-in-place during the COVID-19 pandemic, many states (as well as federal Medicare) have taken steps to temporarily eliminate policies limiting the use of telemedicine (CCHP, 2023).

Several issues need to be considered to encourage the spread of telemedicine practices, such as regulations, infrastructure, and quality of services.

While it is not yet clear how these items will be addressed after COVID-19, we can expect that some of the temporary policies implemented during the pandemic will become permanent even after the pandemic has been resolved (CCHP, 2023).

2.2.1. Federal Changes

The federal government has implemented several policies related to telemedicine, regulating the use of different telemedicine platforms and introducing different reimbursement and telemedicine policies.

Telemedicine platforms are generally required to comply with patient privacy laws (HIPAA), which protect patient privacy and health information. However, some flexibilities were introduced during COVID-19 to allow patients access to instant visits and quick access to controlled substance prescriptions.

Additionally, in response to COVID-19, an extension of Medicare coverage has been introduced, which covers more types of remote visits not covered prior to the outbreak.

Extended assistance plans have therefore been created, such as Medicare Advantage, which has provided and covered additional teleassistance services.

2.2.2 State Changes

Telemedicine policies are identified primarily at the state level, creating great heterogeneity in the level of service management at the federal level. Indeed, each state can potentially introduce its own criteria for licensing and coverage of the services involved. Basically, during a removal visit, the originating site at which the visit is requested (i.e., the location of the patient) is the "place of service," and the distant site (i.e., the site provider) must comply with the rules of the place of service. In addition to this standard approach, there is high heterogeneity among countries in the administration of the telemedicine law. This variability can be seen as a limitation in the practice of out-of-state services, as physicians need to be aware of the different laws in place in the specific state. To address this problem, some states introduce waivers allowing the provision of cross-border health care in limited circumstances, while others prohibit it completely. In some states, to increase cross-border compatibility of physician-specific licenses, licensing compacts have been introduced, which allow practitioners from participating states an expedited process to practice in other states in the compact. During COVID-19, this practice was temporarily adopted in several states, as will be discussed in the data section. As a result, a new normal in health care emerged due to the COVID-19 pandemic, characterized by telemedicine and temporary out-of-state medical licenses for physicians caring for geographically dispersed patients.

According to the Health Resources and Services Administration (HRSA), in response to COVID-19, nearly all U.S. states changed licensing requirements and renewal policies for health care providers.

Given the large amount of time required to approve a permanent policy change, different temporary waivers have been introduced to tackle immediately the COVID-19 public health emergency. For instance, CMS, by means of Medicaid Section 1115, extended HCBS flexibilities to beneficiaries receiving long-term services and supports under SPA and to allow for applicant self-attestation of resources for the purpose of determining eligibility for certain groups. States must complete a final monitoring and evaluation report one year after the demonstration ends.

At the end of 2023, several waivers allowing cross-border healthcare are actually expired. Following the last report of the Federation of State Medical Boards (FSMB) [2] and recent studies (Bressman et al., 2023), only two States are still renewing waivers. This is an issue worthy of analysis, since the elimination of waiver without an immediate substitution with a permanent and more flexible policy can temporarily reduce service accessibility might discourage patients' treatments (Bressman et al., 2023).

2.2.3. Telemedicine reimbursement policies

The U.S. health care system is a combination of public and third-party commercial insurance. The cost of health care is shared by the government, citizens and employers. Employers and individuals pay premiums to private insurance companies to cover the cost of health care. The government aids certain groups of people at the federal and state levels, such as the elderly, disabled, low-income and veterans. Private insurers can also provide coverage to citizens who receive government insurance.
The two most widely used public insurance plans are Medicare and Medicaid, with the former aiding anyone over 65 or with disabilities, while the latter is an insurance system for those unable to pay their own health care costs.

Much debated was the regulation of reimbursement for telemedicine, as there was a call to assimilate the type of reimbursement to the types of services that were already covered for the in-person visit, so-called "service parity." In response to COVID-19, more and more states have enacted parity of service and payment requirements for fully insured private plans.

The federal government regulates telemedicine reimbursement and coverage for Medicare and self-insured plans, while Medicaid and fully insured private plans are largely regulated at the state level. In response to the COVID-19 emergency, the federal government has taken steps to make telemedicine more widely available.

Medicaid telemedicine policies differ across U.S. territories. We can group these policies into three categories, such as (i) live video reimbursement (LVR), (ii) audio-only reimbursement (AOR), and (iii) other types of reimbursement, such as Store and Forward and remote patient monitoring reimbursements.

With the outbreak of the global Covid-19 pandemic, many states have asked these insurers to expand the services that can be provided through telemedicine, obtaining temporary allowances that in most cases expire at the end of the public health emergency.

As for private entities, private telemedicine payer laws have been one of the most important telemedicine policy areas since 2012. Forty-three states, the District of Columbia and the Virgin Islands have private payer laws that cover telemedicine reimbursement. In addition, twenty-four of these states have an explicit requirement for payment parity within the law-private payer parity legislation-that requires insurers to reimburse telemedicine services at the same rate as in-person care (full private telemedicine reimbursement).

2.3. Telemedicine policies after the COVID-19 pandemic

Most of the temporary policies due to the COVID-19 pandemic have ended, prompting states to adopt permanent agreements. As anticipated previously, many states have not renewed the waivers; however, the main directive is to permanently favor service accessibility. As reported by the Center for Connected Health Policy[3], although the waivers have expired, approximately 40 States are now part of the Interstate Licensure Compact, thus making registration practices for physicians in other States more consistent, easy, and accessible. Regarding the economic accessibility of the service, several States have made progress in this direction. In fact, the requirements for access to private parity law reimbursement have been reviewed and simplified, and there has been an increase in the number of states that have included complete reimbursement for audio services. The most significant

[2] states-waiving-licensure-requirements-for-telehealth-in-response-to-covid-19.pdf (fsmb.org)
[3] State Telehealth Laws and Reimbursement Policies Report, Fall 2023 - CCHP (cchpca.org).

progress regarding reimbursement policies has been made regarding the inclusion of the patient's home as the originating site of care. Now, in 46 states, Medicaid programs specify that telehealth services provided at the patient's residence are eligible for reimbursement, indicating an increase in home telemedicine services.

3. Methods

As anticipated in the introduction, the analysis is based on the application of the Andersen's model. This theoretical framework allows us to systematically analyze the factors that encourage or hinder the use of the service. In particular, in our study, we tackle the theme of telemedicine for the first time using large-scale data (more than one million observations) rather than focusing on specific case studies. The database used - the Household Pulse Survey - allow us to identify the different factors proposed by Andersen, namely *predisposing*, *enabling*, and *needs* factors. We hypothesized a significant association between these factors and telemedicine use. By using this framework, we can also assess the impact of the policies used, classifying them as enabling factors that either facilitate or impede access to these digital resources. In the following subsections, we will first introduce the available data and then demonstrate the empirical strategy used.

3.1. Data

The Household Pulse Survey[4] is the primary source of data for our research. Data on the social and economic impacts of the coronavirus on American families were produced through a survey that the US Census Bureau, in association with many federal agencies. The survey is structured into many data collection periods, namely Phases 1 to 3, where the last includes 10 subphases, from 3.1 to 3.10. Data covers weeks starting from 23rd of April 2020 on. However, only subphases 3.1 to 3.4 include questions about telemedicine use. The related waves are described in table 1. This restricts our sample to the period starting from April 2021 to May 2022, that corresponds to the early pandemic recovery phase.

Table 1 - Household Pulse Survey data used in our analysis: list of waves of questionnaires.

Phase	Start	End	Weeks
3.4	March 2, 2022	May 9, 2022	43-45
3.3	December 1, 2021	February 7, 2022	40-42
3.2	July 21, 2021	October 11, 2021	34-39
3.1	April 14, 2021	July 5, 2021	28-33

The Household Pulse Survey data waves listed in table 1 constitutes a good laboratory for our analysis since
the period 2021-2022 have been characterized by many State provisions in response to pandemic, after the first wave of provisions provided at federal level during the early phase of the pandemic emergency.

The Federation of State Medical Boards (FSMB) is our second source of information on medical insurance reimbursement coverage and state-level license regulations in the US. Data includes information about public health insurance (PuHI) and public health insurance (PrHI). Data are constantly updated,[5] we use the version updated to November 2022,[6] which covers the period of our analysis. All state medical boards, according to FSMB statistics, demanded that telemedicine

[4] https://www.census.gov/programs-surveys/household-pulse-survey/data.html
[5] https://www.fsmb.org/siteassets/advocacy/key-issues/telemedicine_policies_by_state.pdf
[6] https://shorturl.at/bsCG0

practitioners hold valid licenses in the state where the patient resides or is registered if they maintained a registry for interstate practice. Among them, 22 state medical boards permitted some types of interstate telemedicine practices. FSMB provided reports for each US state**.**

Regarding private insurance plans, there were several private payer telemedicine reimbursement policies in 43 states and the District of Columbia. Only 24 of them had private payer parity legislation, which obliged insurers to reimburse telemedicine services at the same rate as in-person care (full private telemedicine reimbursement). The FSMB also provided information regarding Medicaid reimbursement procedures. Except for Virginia, all states and the District of Columbia provide LVR under the Medicaid fee-for-service program. In addition, 34 states provided AOR, 25 states paid for store-and-forward, and 34 state paid for remote patient monitoring. The remaining two clinical practice reimbursement categories frequently come with limitations. For instance, as part of Communications Technology Based Services (CTBS), which restricts reimbursement codes and amounts, the state may pay for store-and-forward or remote patient monitoring. Due to this, we combined the remaining two reimbursements into the ORs category.

Data on the Interstate Medical Licensure Compact comes from imlcc.org. Data on waivers and US States and Territories Modifying Requirements for Telemedicine in Response to COVID-19 (Out-of-state physicians; pre-existing provider-patient relationships; audio-only requirements; etc.) are taken from the Federation of State Medical Boards[7] and matched to the Household Pulse Survey data in the weeks/waves in which they have been adopted. Due to the high variability of waivers' provisions, we aggregate all measures under the "State Emergency Waivers" umbrella. Figures 1 and 2 shows the adoption and validity of IMLC compact and State waivers for each survey wave in the period considered.

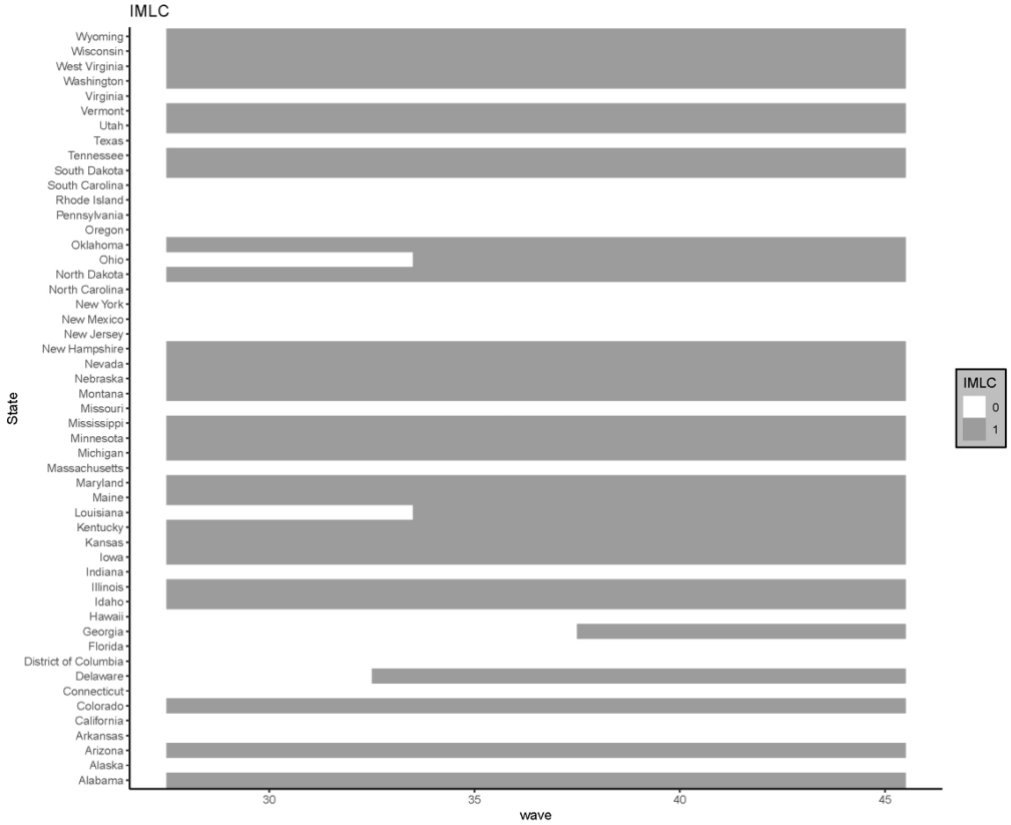

Figure 1 – IMCL duration. Waves 28-45 from 14th April, 2021 to 9th May, 2022.

[7] https://www.fsmb.org/siteassets/advocacy/pdf/states-waiving-licensure-requirements-for-telehealth-in-response-to-covid-19.pdf

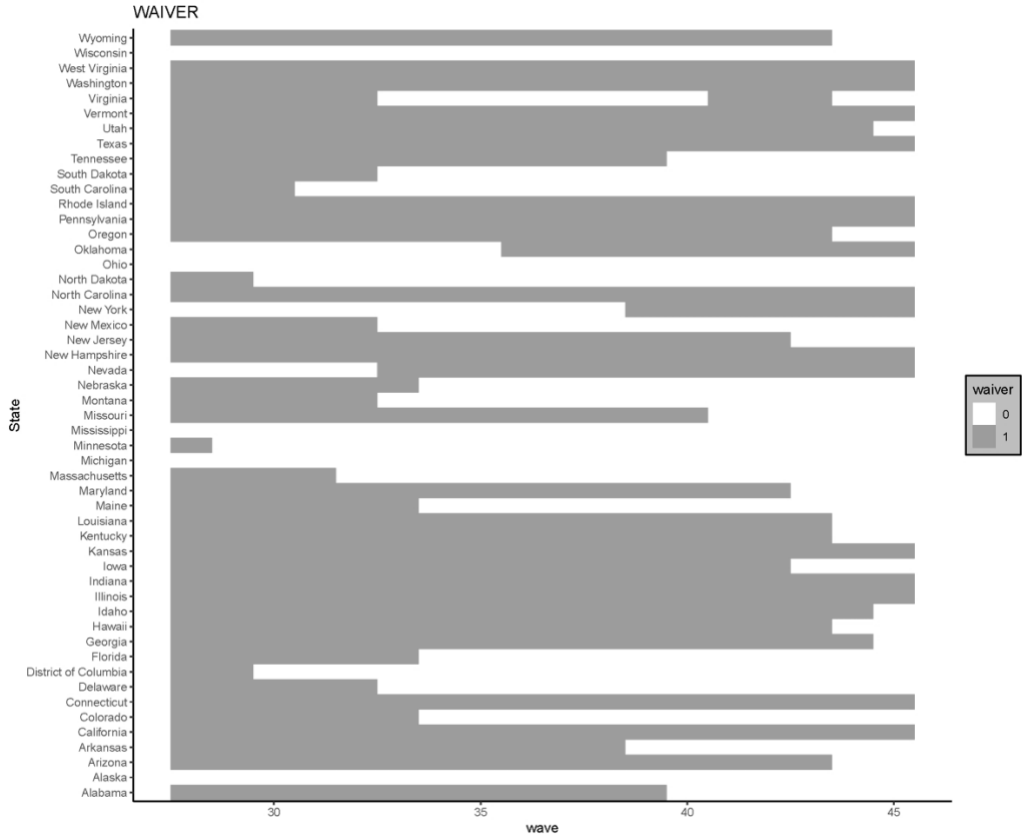

Figure 2 – State Emergency Waivers presence. Waves 28-45 from 14th April, 2021 to 9th May, 2022.

We will describe the variables used, classifying them into the reference groups. Specifically, we distinguish *predisposing*, *enabling*, *needs*, and *control* factors. The list of variables used in our analysis, with their respective descriptive statistics, is shown in Table 2.

The variables in Table 2 were chosen by comparing questions on homogeneous questionnaires that were used in several survey waves. Be aware that surveys are updated in waves over time. The questionnaire does not contain any telemedicine-related questions before week 28 or after week 49.

Unfortunately, until wave 45, this question, which refers to specific people, remains still on the survey. Beginning with wave 46, the question applies to every household member and is not comparable to the wave before it. As a result, our regression sample, which now includes about a million data, is reduced to the weeks 28 to 45. This variable with be used as a time control in the econometric specification.

The *Dependent variable* of interest in this analysis is *Telemedicine*, which assumes a value of 1 if respondents had an appointment with a doctor, nurse, or other health professional by phone or video at any point in the previous four weeks. These appointments only concerned themselves; they did not consider other people in their households. If not, it will be assumed to be 0.

Regarding the *Predisposing* factors, following (Narcisse et al., 2022), we consider socio-demographic variables such as gender, education, age, race, and demographic characteristics about the area of residence, such as the population density. *Education* is a categorical variable with a scale of 1 to 7: (1) Less than high school, (2) Some high school, (3) High school graduate or equivalent (for example GED), (4) Some college, but degree not received or is in progress, (5) Associate's degree (for example AA, AS), (6) Bachelor's degree (for example BA, BS, AB), (7) Graduate degree (for example master's, professional, doctorate). *Age* is a continuous variable ranging from 18 to 89; *Race* is accounting for the racial ethnic background, *Marital Status* defines the legal status of relationship of each individual. The *population density* is computed using the Population and Housing Unit Counts data from the 2010 Census of Population and Housing, and the *Total State area in square miles* is from the United States Summary: 2010.

In the set of the *Enabling* factors, we consider the factors and resources that facilitate or hinder access to the service. In this category, economic resources are included, therefore *income*, both individual and at the area level (through real GDP per capita), to have a proxy of the area's wealth where the subjects live. Variable *Income* is also a categorical variable. It measures the total household income (before taxes) in the following income brackets: (1) Less than $25,000, (2) $25,000 - $34,999, (3) $35,000 - $49,999, (4) $50,000 - $74,999, (5) $75,000 - $99,999, (6) $100,000 - $149,999, (7) $150,000 - $199,999, (8) $200,000 and above. The *GDP per capita* is a computed measure based on *Real gross domestic product (GDP)* (Millions of chained 2012 dollars) from the Bureau of Economic Analysis - U.S. Dept. Of Commerce, and the Annual Estimates of the Resident Population for the United States are from the U.S. Census Bureau.

We also include factors concerning the perception of the quality of service. To this end, we introduce variables that measure trust in healthcare services, as an implicit measure of perceived quality. We have included two variables – *no trust in government and medicine* - in our regression sample. With the phrase "Why not be vaccinated," we proxied confidence in both medical and government (COVID-19 vaccine). There are several possibilities available as potential answers to this issue. I don't trust the government, and I don't trust COVID-19 vaccines.

Regarding policies that can facilitate access to the service, as mentioned in the literature review, we introduce variables that identify reimbursement policies of the service used and potential restrictions or about the possibility of offering the service by physicians. The variable *private health insurance reimbursement* is a categorical variable which takes the following values: (0) *no reimbursement for telemedicine services*, (1) *private payer law* (PPL) that allows for some form of partial reimbursement, (2) *private payer parity* (PPP) law that allows for telemedicine services full reimbursement, like any form of traditional health care services. To account for the impact of regulation changes in telemedicine regulations at the state level, we construct the variable *State Emergency Waivers (SEW)*, which has a value of 1 if any waiver has been introduced at the state level, 0 otherwise.

Regarding interstate licensing compacts, we consider the most important compact, that is, the Interstate Medical Licensure Compact (IMLC) that makes medical licensing in the U.S. states simpler if you already hold a license in other states. The IMLC allows a new pathway for licensure without changing a state's existing Medical Practice Act. The IMLC also introduces a uniform standard for licensure, affirming that the practice of telemedicine occurs where the patient is located. Upon licensure via the IMLC, the physician will be under the jurisdiction of the medical board in the state where the patient is located. Since the application process may require days or weeks to be completed, to account for the effect of the compact adoption over time, we construct a variable called IMLC duration which counts the number of waves from the start of the compact agreement. The minimum value is zero if the State does not take part in the compact, the maximum value in our sample is 18 if the questionnaire is produced after 18 waves from the compact adoption.

Data on occupational employment of Healthcare Practitioners and Technical Occupations comes from the US Bureau of Labor Statistics.[8]

Regarding *Needs* factors, we consider the variables that determine the health status both at the individual level and at the geographical area level.

Variables grouped in categories of physical limitations to telemedicine and mental status are categorical variables with the following values: (1) No - no difficulty, (2) Yes - some difficulty, (3) Yes - a lot of difficulties, (4) Cannot do at all.

The Average covid cases per week/wave have been computed starting from USAFACTS daily data.[9]

[8] https://www.bls.gov/oes/current/oes290000.htm

[9] https://usafacts.org/visualizations/coronavirus-covid-19-spread-map/

Table 2 – Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Dependent Variable					
Telemedicine	1036637	0,223	0,416	0	1
Enabling Factors					
Health insurance					
Medicare health insurance	988817	0,314	0,464	0	1
Medicaid health insurance	950219	0,121	0,327	0	1
Medicaid with full LVR	950219	0,119	0,324	0	1
Medicaid with full AOR	950219	0,094	0,292	0	1
Medicaid with full ORs	950219	0,056	0,229	0	1
Private health insurance (PHI)	1229365	1,388	0,694	0	2
PrHI with PPL (1) or PPP (2)	1229365	1,159	0,818	0	2
No Trust in Government	1229365	0,038	0,19	0	1
No Trust in Medicine	1229365	0,046	0,21	0	1
Income	955063	4,616	2,124	1	8
Number of Households	1229365	2,699	1,483	1	10
IMLC duration	1229365	4,569	5,911	0	18
State Emergency Waivers (SEW)	1229365	0,671	0,47	0	1
Health Practitioners over population	1229365	27,538	4,082	22,181	45,141
Real GDP per capita	1229365	59,077,136	18,326,105	35,379,031	192419,8
Predisposing Factors					
Race					
White	1229365	0,819	0,385	0	1
Black	1229365	0,081	0,273	0	1
Asian	1229365	0,054	0,226	0	1
Other	1229365	0,047	0,211	0	1
Gender					
Female	1229365	0,407	0,491	0	1
Male	1229365	0,593	0,491	0	1
Marital Status					
Married	1216205	0,578	0,494	0	1
Widowed	1216205	0,057	0,232	0	1
Separated	1216205	0,155	0,362	0	1
Divorced	1216205	0,018	0,133	0	1
Never Married	1216205	0,192	0,394	0	1
Education	1229365	5,296	1,466	1	7
Age	1229365	54,087	15,845	18	89
Population density (computed)	1229365	316,866	1,110,016	1,102	9,830,305
Needs Factors					
Physical limitations					
Remembering	1025801	1,422	0,589	1	4
Mobility	1026724	1,29	0,568	1	4
Hearing	1024527	1,194	0,461	1	4
Seeing	1026527	1,338	0,541	1	4
Mental status					
Feeling depressed	1062365	1,642	0,908	1	4
Feeling worried	1062120	1,713	0,959	1	4
Feeling anxious	1063761	1,883	1,031	1	4
Average COVID-19 Cases over population	1229365	0,005	0,009	0	0,106
Control factors					
Wave	1229365	36,423	5,262	28	45

4.2. Econometric Model

Our main interest is in the determinants of variable telemedicine (t). The classification of variables is included in the column *category* in table 2. The full specification of the model used in our empirical estimates - in the semi-matrix notation - is:

$$1) \quad t_i = \beta_0 + \beta_1 P_i + \beta_2 E_i + \beta_3 N_i + \beta_4 C_i + \beta_5 d_i + \varepsilon_i$$

In equation 1, *i* indicates individuals, β_0 the coefficient associated with constant term, and ε is the idiosyncratic error component. Vector *t* is the dependent variable *Telemedicine;* matrix *C* represents the set of control variables listed in table 2; matrix *P* includes variables related to the *predisposing* factors, while that may affect supply of telemedicine services listed in table 2, matrix *E* includes

enabling variables determining the demand of telemedicine services listed in table 2, while N indicates the Need factors. d is the set of State dummy variables. Note that control variables include the wave of the questionary to account also for possible time effects as pandemic containment measures become less restrictive over time in the period considered. For our binary dependent variable, we fitted a probit model under the assumption that the likelihood of a positive result is dictated by the common normal cumulative distribution function.

Results

Due to the large sample size, statistical significance might be misleadingly high (Lin et al., 2013; Gómez-de-Mariscal, 2021; Chén et al., 2023) because of the tendency of p-values to approach zero with very large sample sizes. Therefore, it is crucial to evaluate not only the statistical significance but also the magnitude and economic significance of our findings. As a result, we address this issue by estimating the average marginal effects of each regressor and its confidence interval to observe the magnitude of the contribution (as shown in Table 3). In this regard, existing studies do not report a standard procedure to resolve the problem. Some studies propose different solutions (Lin et al., 2013), including repeating regressions using sub-samples to study the stability of effects with smaller samples, or considering confidence intervals for higher thresholds. Among the various proposed solutions, in this work, we have decided to study the magnitude of the effect due to the introduction of policies. In other words, after observing the marginal effects of each variable on the probability of recurring to telemedicine services (Table 3), we will study the changes in the predicted probabilities based on different policy scenarios (Table 4). The magnitude of the probability variations will provide a measure of the economic impact of the variable, overcoming inferential obstacles.

Coefficient point estimates are shown in the first column of Table 3, followed by standard errors and confidence intervals. Following the discussion made above, we have also introduced the margins with the confidence intervals to provide a measure of the magnitude of the effect. The statistical significance of margins is related to the corresponding coefficient in the first column.

Considering the sign and the statistical significance of the effect, Public or private health insurance policy shows positive and statistically significant coefficient point estimates. Medicaid insurance characterized by full Live Video Reimbursement (LVR) and full Audio Only Reimbursement (AOR) are associated with positive and statistically significant coefficient point estimates. Also, private health insurances with Private Parity Payments (PPP) or Private Parity Law (PPL) shows positive and statistically significant estimated coefficients. IMLC duration and Waivers (SEW) shows positive and statistically significant estimated coefficients. The magnitude of SEW coefficient is much higher, suggesting that waivers had a larger impact on telemedicine market compared to interstate licenses that need more time to determine the entrance of physicians from other States in the local telemedicine market.

Education and income are positively, and statistically significant estimated coefficients associated with high probabilities of recurrence of telemedicine practices, as are mental conditions that alter patients' perceptions, which tend to recur to telemedicine more frequently probably due to the sense of urgency associated with these conditions. Physical limitations that can make difficult to physically visit a doctor have the same impact. The same is true for divorced or separated, and for the number of households, probably linked to the parents' greater lack of free time during the day. GDP per capita is associated with higher frequencies in telemedicine practices, while population density shows negative and statistically significant estimated coefficient, confirming that telemedicine is more frequently in dispersed areas. Average weekly COVID-19 cases in the State are reasonably associated with high and statistically estimated coefficients, while the presence of many health practitioners in the State is associated with negative and statistically significant coefficient. The two aspects of lack of trust, as expected, have a detrimental effect on telemedicine procedures. In conclusion, it should be noted that the wave variable's coefficient is negative and statistically significant. Our data cover

the period from April 2021 to March 2022, therefore this might be a result of less stringent pandemic restrictions during the last time frame considered.
By analyzing the coefficients and their significance alongside the margins, we can prove the intuition, as different statistically significant coefficients have minimal impact in terms of magnitude.
Among the most relevant factors, it is evident how needs factors play a crucial role in determining the probability of telemedicine use. For instance, mobility issues have an average effect of 5%. Considering the maximum value (4), we can conclude that there is a maximum additional probability of 5%*4=20% of utilizing this service. Among predisposing factors, the impact of education is notable, with an average effect of 1%. Similarly, considering the highest level of education (7), there can be an increase of up to 7% in usage for high levels of education. From a policy perspective, this highlights the importance of having the appropriate level of knowledge and skills to utilize the service. Considering enabling factors, service trust explains variations of approximately 2%. The role of reimbursement policies and service accessibility also appears significant, to which we dedicate a more in-depth analysis in Table 4.

Table 3 – Regression results. Dependent variable (dummy): telemedicine. Probit estimator

TELEHLTH	Coefficient	Robust std. Err.	95% confidence interval		margins	95% confidence interval	
Wave	-.017***	.0004974	-.018501	-.0165511	-.004	-.0051753	-.0046308
Income	.004***	.0009951	.0021219	.0060227	.001	.0005936	.0016849
Black	.145***	.0060915	.1338755	.1577537	.0425	.0389456	.0462008
Asian	-.037***	.0074764	-.0526203	-.0233134	-.010	-.0143358	-.0064255
Other race	.094***	.0073892	.0796429	.108608	.027	.0227262	.0312793
Female	.059***	.0033026	.0534405	.0663865	.016	.0149039	.0184989
Widowed	-.013*	.0073452	-.0278235	.0009693	-.003	-.0077892	.0002559
Separated	.0228***	.0047701	.0134825	.0321811	.006	.0038201	.0091574
Divorced	.040***	.0117629	.0169824	.063092	.011	.0047702	.0181251
Never married	-.072***	.0049394	-.0821222	-.0627602	-.02	-.0225019	-.017262
Education	.001**	29.46	.0388483	.0364247	.010	.0095129	.0108672
Number of Households	.003**	.0012311	.0005565	.0053822	.0008	.0001557	.0015057
Ln Age	.009	.0074115	-.0051995	.023853	.002	-.0014546	.0066731
Medicare	.151***	.0045606	.1426801	.1605573	.042	.0399195	.0449129
Medicaid with full LVR	.280***	.0107558	.2594755	.3016375	.078	.0725952	.0843794
Medicaid with full AOR	.0248**	.0119751	.0013783	.0483199	.007	.0003857	.0135177
Medicaid with full ORs	-.003	.0096676	-.0225455	.015351	-.001	-.0063072	.0042945
No Trust in Government	-.100***	.0115509	-.1226764	-.0773978	-.028	-.0343188	-.0216531
No Trust in Medicine	-.085***	.0103487	-.1061534	-.0655871	-.024	-.0296965	-.0183489
Remembering	.145***	.003045	.1394201	.1513561	.040	.039009	.0423373
Mobility	.194***	.0030175	.1883175	.2001461	.054	.0526933	.0559816
Hearing	.009**	.0036469	.0019299	.0162254	.002	.0005399	.0045392
Seeing	.0125***	.0031739	.0062968	.0187383	.003	.0017616	.0052421
Feeling depressed	.0304***	.0026154	.0253076	.0355598	.008	.0070802	.0099478
Feeling worried	.0443***	.0030519	.0383269	.0502901	.0123	.0107227	.0140684
Feeling anxious	.0875***	.0028183	.0820592	.0931068	.0245	.0229583	.0260454
Average COVID-19 Cases over population	.0033***	.0004852	.0024286	.0043307	.0009	.0006794	.0012115
Population density	-.003***	.0009408	-.0053167	-.0016288	-.0009	-.0014874	-.0004557
Health Practitioners over population	-.054**	.0218667	-.0970664	-.0113506	-.015	-.0271547	-.0031755
Real GDP per capita	0.287***	.264	0.295	3390945	.0803	.6589285	.9486115
PrHI with PPL (1) or PPP (2)	.0936***	.0027568	.0882	.099	.0262	.0247026	.0277213
IMLC duration	.001	.0006	.00063	.0030533	.0005	.0001768	.0008542

SEW	.023087	.0056243	.0120636	.0341104	.0064	.003375	.0095425
Constant	-2.736***	0.06	-3.801	-2.59			
Country effects	yes						
Observations	851014						
Count R2	0.78						

Robust standard errors are in parentheses

**** p<0.01 - ** p<0.05 - * p<0.1*

Based on this, we further analyze the phenomenon by studying the change in the magnitude of the predicted probability based on the policy variables of interest. In Table 4 we conduct this exercise, overcoming the limitations of an inferential analysis based on p-value and statistical significance and relying on economic significance, that is, the magnitude of the effect of the introduced policy. We provide the predicted probabilities of recurring to telemedicine services in different policy scenarios. We can observe that in the early post pandemic period considered, in the worst-case scenario, without any factor facilitating telemedicine people had the 15.5% probability to recur to telemedicine services. In the best scenario, with all reimbursements allowed, Medicare, PPP, state waivers and long term (18 waves) IMCL compact, the probability rises to 37.6%. The relative gap between these two values $\frac{37.6\%-15.5\%}{37.6\%} = 0.588$ provide an indirect measure of the effect of the pre-pandemic existing barriers to telemedicine.

Table 4 – Predicted probabilities. Full model (c3 in table 3). Dependent variable (dummy): telemedicine.

	case 1	**case 2**	**case 3**	**case 4**	**case 5**	**case 6**	**case 7**	**case 8**	**case 9**	**case 10**
IMLC Duration	0	mean	18	mean	mean	mean	mean	mean	mean	18
ELW	0	mean	mean	1	mean	mean	mean	mean	mean	1
Medicare	0	mean	mean	mean	1	mean	mean	mean	mean	1
Medicaid with full LVR	0	mean	mean	mean	mean	1	mean	mean	mean	1
Medicaid with full AOR	0	mean	mean	mean	mean	mean	1	mean	mean	1
Medicaid with full ORs	0	mean	mean	mean	mean	mean	mean	1	mean	1
PrHI with PPP (2)	0	mean	mean	mean	mean	mean	mean	mean	2	2
Predicted Probability	**0.155**	**0.209**	**0.216**	**0.211**	**0.242**	**0.287**	**0.216**	**0.208**	**0.234**	**0.376**

NOTE: All other predictors are set at their mean value

6. Lessons Learned

Before the COVID-19 pandemic, telemedicine services were not widely used, and licensing rules and health insurance reimbursement policies posed barriers to their implementation in the US (Alghatani, 2016; CMS, 2021). However, during the pandemic, the Centers for Medicare and Medicaid Services (CMS) issued several waivers, including those that expanded Medicare coverage for telemedicine services and authorized the use of audio-only technology, to promote access to virtual care. Improved access to care and more cost-effective care management are two potential advantages of telemedicine (Alghatani, 2016).

The analysis found that the absence of health insurances covering telemedicine services, together with a lack of licensing compact and State waivers, led to a cut of about 20 percent points in the probability of recurring to telemedicine services.

Several waivers eliminated several limitations on Medicare coverage of telemedicine services during the pandemic, broadening the number of practitioners that could bill for telemedicine services. Waivers also authorized the use of audio-only for telemedicine services. While CMS has ensured that certain temporary telemedicine services will remain in place after the emergency, there is still uncertainty on which telemedicine practices will be covered by Medicare in the future.

Furthermore, many states have enacted laws extending payment parity and coverage for telemedicine services. Healthcare providers and investors must pay attention to the changes in the regulatory framework as they consider investing in new technologies in healthcare., focusing on further extensions of payment policies and streamlined licensing procedures at the federal level (Alghatani, 2016; CMS, 2021; Weigel et al., 2020).

In conclusion, telemedicine services have become increasingly important in providing necessary care to patients while minimizing the transmission risk of SARS-CoV-2 during the COVID-19 pandemic. While CMS has issued several waivers to expand Medicare coverage for telemedicine services, the expiration of these waivers is a key issue that will impact telemedicine providers in 2023. State medical practice laws and telemedicine standards are also evolving to support the growth of virtual care. Healthcare providers and institutional investors must pay close attention to the changes in the regulatory landscape as they consider investing in new technologies and adapting to the growing digital transformation of healthcare.

Currently, policymakers seem to consider the increase in telemedicine usage due to the relaxation of policy restrictions. Indeed, following the expiration of the waivers, they made room for policies that can consistently ensure openness and greater utilization of the service, incentivizing the use of interstate agreements and the extension of insurance coverage.

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