Unveiling the Adoption and Barriers of Telemedicine in US Hospitals: A Comprehensive Analysis (2017–2022)

John Xuefeng Jiang, PhD[1], Joseph S. Ross, MD, MHS[2,3], and Ge Bai, PhD, CPA[4,5]

[1]Accounting & Information Systems, Eli Broad College of Business, Michigan State University, East Lansing, USA; [2]Yale School of Medicine, Yale University, New Haven, USA; [3]Yale School of Public Health, Yale University, New Haven, USA; [4]Johns Hopkins Carey Business School, Baltimore, USA; [5]Johns Hopkins Bloomberg School of Public Health, 100 International Drive, Baltimore, MD 21202, USA

ABSTRACT

BACKGROUND: Telemedicine has emerged as a vital healthcare delivery model, especially pronounced during the COVID-19 pandemic. Our study uniquely focuses on an institutional lens, examining US hospitals to offer targeted policy implications.

OBJECTIVE: To investigate the trend in telemedicine adoption across US hospitals from 2017 to 2022 and analyze the institutional challenges they encounter, particularly in the realm of electronic health information exchange.

DESIGN: Cross-sectional study leveraging data from the American Hospital Association's (AHA) annual surveys for the years 2017 to 2021 and the 2022 AHA IT Supplement Survey.

SETTING: The study includes a national sample of US hospitals, covering a diverse range of hospital types including large, nonprofit, teaching, and system-affiliated institutions.

PARTICIPANTS: US hospitals form the study's participants, with a substantial response rate to the surveys.

MAIN MEASURES: Key metrics include the number of telemedicine patient encounters, percentage of hospitals offering telemedicine services, and institutional challenges to electronic health information exchange.

KEY RESULTS: Telemedicine encounters saw a 75% increase, growing from approximately 111.4 million in 2020 to nearly 194.4 million in 2021. The percentage of hospitals offering at least one form of telemedicine service went from 46% in 2017 to 72% in 2021. Larger, nonprofit, and teaching hospitals were more prone to telehealth adoption, without notable urban-rural disparities. While over 90% of hospitals allow patients to view and download medical records, only 41% permit online data submission. Importantly, 25% of hospitals identified Certified Health IT Developers such as EHR vendor as frequent culprits in information blocking, with cost being the primary obstacle.

CONCLUSIONS: The findings underscore the rapid yet uneven adoption of telemedicine services in U.S. hospitals. The results point to the need for comprehensive policy interventions to address the challenges identified and realize telemedicine's full potential in healthcare delivery and resilience.

Received November 21, 2023
Accepted June 3, 2024
Published online July 10, 2024

J Gen Intern Med 39(13):2438–45
DOI: 10.1007/s11606-024-08853-0

INTRODUCTION

Telemedicine, the remote provision of healthcare through electronic information and telecommunications technologies, has undergone a profound transformation in recent years.[1] It has emerged as a pivotal model of care delivery, significantly enhancing patient outcomes, convenience, and accessibility, while reducing costs.[2–5] The COVID-19 pandemic has further underscored its critical role, especially during community lockdowns and public health emergencies.[6]

Numerous studies have focused on the consumer perspective of telemedicine, primarily using household surveys for their research. In contrast, our study adopts an institutional approach, specifically focusing on hospitals.[7–9] As the backbone of the healthcare system, hospitals serve as key barometers for telehealth adoption and technological innovation. This shift in perspective from the consumer to the institution offers several benefits. It allows for an in-depth examination of the healthcare system's readiness to scale telehealth services, illuminates the technical and logistical challenges in data exchange crucial for coordinated care, and provides policymakers with targeted, actionable insights that extend beyond the consumer-focused landscape.

The aim of this study is to explore the evolution of telemedicine adoption in US hospitals from 2017 to 2022, with a particular focus on the institutional challenges encountered in the area of electronic health information exchange. Despite policy initiatives such as the 21st Century Cures Act and the ONC Health IT Certification Program Final Rule, which were designed to eliminate information blocking and enhance data interoperability, hospitals may still encounter hurdles in the seamless exchange of electronic health records with other healthcare providers. Our study investigates these complex aspects of telemedicine adoption within the hospital environment, highlighting key areas that may require policy intervention to enable effective patient data sharing. Overcoming these challenges is vital to fully realize telemedicine's potential as a transformative model of healthcare delivery, facilitating coordinated care and enhancing patient outcomes across the healthcare system.

METHODS

This study was not submitted for institutional review board approval because it used nonidentifiable public data and did not constitute human participant research (45 CFR §46.102).

Data Source and Analysis Sample

The AHA has long conducted an Annual Survey of Hospitals, a resource widely consulted by policymakers, scholars, journalists, and healthcare consumers.[10,11] In 2017, the survey introduced questions specifically targeting the provision of five key telemedicine services, including electronic ICU service, psychiatric and addiction treatment, remote patient monitoring, stroke care, and consultations and visits. In 2020, the survey expanded to ask about the number of patients or visits within four distinct telemedicine categories: remote monitoring, audit visits, video visits, and other virtual services.

Our analysis uses data from the AHA Annual Surveys from 2017 to 2021, with a sample size ranging from 4077 to 4400 respondents. This provides the most recent insights into the types of telemedicine services offered by US hospitals. We first examine the trend in the availability of these services over a 5-year period, categorizing them into the five key areas mentioned above.

The AHA survey defines "remote monitoring" as the exchange of physiological data between healthcare providers and patients at different locations, either in real time or delayed. This process includes collecting, transmitting, evaluating, and discussing health data. "Video visits" are real-time, interactive audio and video communications between patients and healthcare providers in separate locations. "Audio visits" involve real-time, two-way audio communication only. "Other virtual services" include additional remote interactions between healthcare providers and patients, or among providers, either synchronous (real-time) or asynchronous (delayed), and encompass messaging, eConsults, and virtual check-ins. "Electronic ICU (eICU)" is a telemedicine innovation that uses advanced technology to enhance critical care, extending clinical expertise and providing round-the-clock ICU care. "Stroke telemedicine" is a specialized approach that uses telemedicine for consultative support in managing acute stroke patients, ensuring they receive expert care promptly.

We then quantify and compare patient utilization of the four distinct telemedicine services offered by hospitals in 2020 and 2021. We also examine the distribution of telehealth services in 2021, considering factors such as hospital size, ownership, teaching status, location, and system affiliation.

Further enriching our dataset, we also utilize the 2022 AHA IT Supplement Survey. This survey, a joint effort between the Office of the National Coordinator for Health Information Technology (ONC) and the AHA, includes 3127 hospitals as respondents. It focuses on the adoption and utilization of healthcare information technology and evaluates the specific electronic functions available to patients at both inpatient and outpatient settings. This survey also examines the challenges hospitals face in the electronic exchange of patient information and identifies issues like information blocking by healthcare providers and EHR vendors. The Department of Health and Human Services defines information blocking as practices that are likely to impede the access, exchange, or use of electronic health information.[12]

We explore the digital features that facilitate patient-hospital interactions, including the ability for online clinical note access, personal health data downloads, and requesting amendments to medical records. We also identify the challenges hospitals face in electronic data exchange, including issues of information blocking encountered when dealing with other healthcare providers, certified IT developers like EHR vendors, and health information exchanges.

This combination of data from the AHA and ONC surveys allows us to construct a comprehensive and detailed portrait of the current status of telemedicine in US hospitals.

Statistical Analysis

We employ SAS 9.4 proc surveyreg to assess the differences in telehealth provision among various groups, each characterized by distinct hospital attributes. A hospital is deemed a telemedicine provider if it offers at least one of the five categories of services. To account for potential non-response bias, we utilize logistic regression to estimate the probability of receiving a survey response, considering factors such as hospital size, ownership, teaching status, urban status, and system membership. The inverse of these predicted probabilities is then used as weights in our statistical analyses. We calculate the least squares means for each group and perform pairwise comparisons using *t*-tests. To account for multiple comparisons, we apply the Bonferroni correction, considering a Bonferroni-adjusted *p*-value of less than 0.05 as statistically significant.

Furthermore, we use a multivariate logistic regression model with SAS 9.4 proc surveylogistic to assess the independent impact of each hospital characteristic on the likelihood of telehealth provision, while controlling for other characteristics. We use independent, small, urban, and nonprofit hospitals as the reference groups. For each level of each characteristic, we report the odds ratios and their corresponding 95% confidence intervals (CIs).

This study is exempt from ethics review as it utilizes publicly available data without any protected health information. All analyses are conducted using SAS 9.4 (SAS Institute Inc., Cary, NC), and the outcomes are reported as the proportion of hospitals providing telemedicine services.

RESULTS

Telemedicine Availability by Hospitals from 2017 to 2021

An increasing proportion of hospitals provides at least one type of telemedicine service, from 47% in 2017 to 72% in 2021 (Table 1). Across the 5-year period, the provision of consultation and visit services experienced the fastest growth—it was available among 26% of hospitals in 2017 and 55% in 2021. The availability increased from 28 to 39% for stroke care, from 15 to 27% for psychiatric and addiction management, and from 14 to 29% for remote patient monitoring. Electronic ICU had the slowest growth (from 12 to 13% availability) and was less commonly provided than the other four telemedicine services in 2021.

Volume of Telemedicine Rendered by Hospitals 2020 vs. 2021

The COVID-19 pandemic has acted as a significant catalyst for the adoption of telemedicine. This is evidenced by the robust and rapid growth in patient utilization from 2020 to 2021, as illustrated in Fig. 1. The total number of patient encounters for all telemedicine services surged from approximately 111.4 million in 2020 to nearly 194.4 million in 2021, an increase of almost 75%. Among the various categories, Other Virtual Services emerged as the most commonly used telemedicine service, increasing from about 38.2 million encounters (34% of total visits) in 2020 to nearly 84.8 million (44% of total visits) in 2021—representing an increase of over 122%. Video visits, the second most utilized service, saw the most substantial increase, nearly doubling from around 41.2 million (37% of total visits) in 2020 to about 71.2 million (37% of total visits) in 2021, while maintaining its relative share of total telemedicine visits. Audio-only visits also experienced significant growth in absolute terms, rising from approximately 29.6 million in 2020 to about 35.7 million in 2021—an increase of nearly 21%. However, the relative share of audio-only visits declined from 27% of total visits in 2020 to 18% in 2021, marking the largest relative decrease among all categories. Remote monitoring, while growing more modestly, saw its user base increase from roughly 2.5 million (2% of total visits) in 2020 to around 2.7 million (1% of total visits) in 2021, marking a growth rate of approximately 7% but a slight decrease in its relative share of total telemedicine visits.

Hospital Characteristics and Telemedicine Provision

In 2021, telemedicine service provision varied significantly across US hospitals based on hospital characteristics (Fig. 2). Larger hospitals (≥400 beds) were more likely to offer telemedicine (92%) compared to medium-sized (100–400 beds; 77%) and small hospitals (<100 beds; 61%). Nonprofit hospitals had a higher offering rate (82%) than government (71%) and for-profit hospitals (42%). Teaching hospitals were more likely to provide telemedicine services than non-teaching hospitals (78% vs. 62%). These differences were statistically significant at a 1% level using two-tailed *T*-tests with Bonferroni adjustments. However, telemedicine service provision was similar between urban and rural settings (69% vs. 71%) and between system-affiliated and independent hospitals (both 69%).

A multivariate logistic analysis, using independent, small, urban, and non-profit hospitals as the reference group, confirmed that telemedicine offering continued to vary across hospital size and ownership even after controlling for other hospital characteristics (Table 2).

Digital Features that Facilitate Telemedicine

According to the latest AHA IT Supplement Survey from 2022, hospitals are offering an increasingly broad suite of digital services (Fig. 3). The most commonly available features are centered around patient access to health

Table 1 Hospital Telemedicine Provision, by Service Type, 2017–2021

Telemedicine service type	% of hospitals offering telemedicine				
	2017 (*N*=4288)	2018 (*N*=4400)	2019 (*N*=4170)	2020 (*N*=4077)	2021 (*N*=4091)
Electronic ICU*	12%	10%	12%	14%	13%
Psychiatric and addition management†	15%	16%	20%	25%	27%
Remote patient monitoring‡	14%	20%	23%	27%	29%
Stroke care§	28%	30%	34%	37%	39%
Consultation and visit	26%	29%	37%	52%	55%
Any of the above	*47%*	*52%*	*60%*	*70%*	*72%*

*A form of telemedicine that uses state-of-the-art technology to provide an additional layer of critical care. Aims to optimize clinical expertise and offer 24/7 ICU care. All definitions here and below are according to the 2021 AHA annual Survey questionnaire instruction and definitions

†Telepsychiatry encompasses a range of services including psychiatric evaluations, therapy, patient education, and medication management

‡Utilizes digital technologies to collect medical and health data from patients in one location and securely transmit the information to healthcare providers in a different location for assessment and recommendations

§Stroke telemedicine serves as a consultative modality to facilitate the care of acute stroke patients through specialized attention

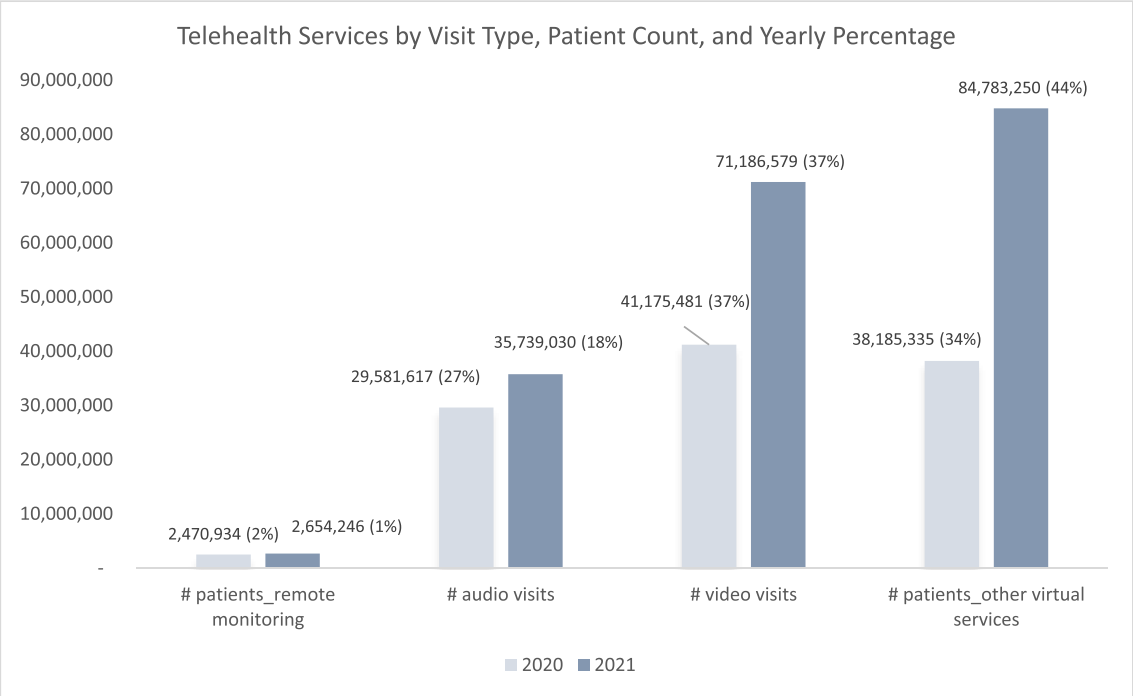


Figure 1 Breakdown of telehealth services by visit type and patient count, with yearly percentage: 2020 vs.2021. The unit of measurement for video and audio services is the number of visits, whereas for remote monitoring and other virtual services, it is the number of patients. Each responding hospital reported the number of patients who received each service. Patients may have received multiple services in one hospital and across different hospitals. According to the AHA survey, remote monitoring refers to either real-time or delayed exchanges of physiological data between healthcare providers and patients who are not at the same location. This process involves collecting, transmitting, assessing, and discussing the gathered information; video visit is the real-time, two-way audio and video interactions between patients and healthcare providers who are not in the same location; audio visits the real-time, two-way audio-only interactions between patients and healthcare providers who are not in the same location; other virtual services refer any additional types of remote interactions that occur between healthcare providers and patients, or between providers themselves. These interactions can take place in real-time or be delayed and include features such as messaging, eConsults, and virtual check-ins.

information, with 92% of inpatient and 78% of outpatient sites enabling patients to view their health/medical information online. Following closely, 90% of inpatient sites and 77% of outpatient sites allow patients to download their health/medical information.

Secure messaging between patients and providers is also commonly available, featured at 77% of inpatient and 75% of outpatient settings. The feature least commonly offered is the ability for patients to submit their own health data through apps, available at 36% of outpatient and 32% of inpatient settings. This landscape reveals a focus on patient accessibility and communication within digital healthcare services, although there are opportunities for growth in other areas, such as patient-generated data submission.

Barriers to Electronic Health Information Exchange

In 2022, the electronic exchange of patient information from outside providers was relatively widespread among hospitals. Specifically, 45% of hospitals reported frequent use of externally received electronic patient data, while 39% utilized such information occasionally. In contrast, only 11% and 6% of hospitals indicated that they rarely or never use externally received electronic patient information, respectively (eFigure 1 in Supplement 1).

However, despite this prevalence, hospitals still face numerous obstacles in the effective electronic exchange of patient information. Figure 4A delves into these challenges based on the most recent 2022 AHA IT Supplement Survey. Starting with the "sending" aspect, 69% of hospitals reported difficulty in locating the Direct address of the intended provider for information transmission. In the "receiving" category, 71% of hospitals stated that some providers are usually unwilling to exchange patient data, and 64% highlighted challenges in matching patients across different systems. In the broader context of "exchanging" information, 85% encountered issues due to interoperability across different vendor platforms, and 55% had to develop customized interfaces. Additionally, 46% cited extra financial burdens for data transmission as a significant barrier.

Information Blocking in 2022

According to the 2022 AHA IT Supplement Survey, various stakeholders engage in such practices to differing degrees. This summary focuses on the cumulative

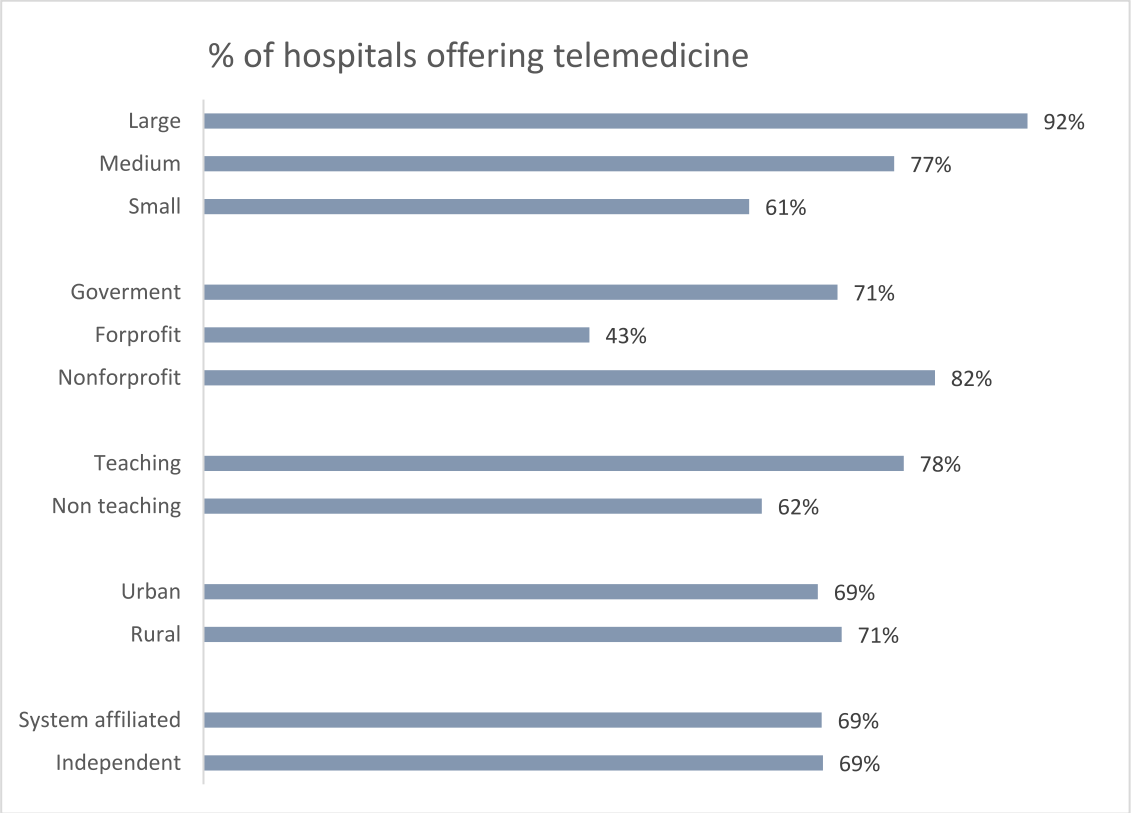


Figure 2 Telemedicine offering and hospital characteristics. This analysis includes 4091 hospitals from the 2021 AHA Annual Survey, classified based on their provision of telemedicine services, which include Consultation and Visits, eICU, Psychiatric and Addiction Management, Remote Patient Monitoring, and Stroke Care. Hospitals are categorized by size (large, ≥ 400 beds; medium, 100–399 beds; small, ≤ 99 beds), ownership, teaching status, urbanicity, and system membership. Significant differences in telemedicine offerings across hospital characteristics are identified using two-tailed *T*-tests with Bonferroni adjustments. Except for comparisons between urban and rural hospitals (p=0.17), and independent versus system-affiliated hospitals (p=0.93), all other p-values are less than 0.001. A logistic regression was employed to predict the likelihood of survey responses, with weights applied inversely to the predicted propensity scores to calculate these statistics.

percentage of hospitals reporting "often/routinely" and "sometimes," excluding those that indicated "rarely" (Fig. 4B).

Starting with the types of stakeholders involved, 25% of hospitals identified Certified Health IT Developers, including Enterprise EHR vendors, as key players in information blocking. Close behind were state, regional, and local health information exchanges, implicated by 22% of respondents, while healthcare providers themselves were identified by 10%.

In terms of specific forms of information blocking by Enterprise EHR vendors, "Price" was the most cited obstacle, flagged by 28% of surveyed hospitals. "Contract language" was next at 22%, followed by "Artificial technical, process, or resource barriers" at 18%. "Refusal" was the least cited, mentioned by 15% of hospitals.

For information blocking by healthcare providers, 28% of hospitals cited "Strategic affiliations" as the most common issue. This was followed by "Artificial technical, process, or resource barriers" at a cumulative 18%, and "Refusal," which was the least frequent at 15%. Lastly, a scant 4% of hospitals reported these incidents of information blocking to the ONC/HHS via the Report Information Blocking Portal.

DISCUSSION

We observed a large increase of telemedicine utilization from 2020 to 2021, steady increase in the proportion of US hospitals providing telemedicine from 2017 through 2021. Extending prior literature,[4,5,13] we also found that telemedicine is most frequently offered for consultation, followed by stroke care and remote patient monitoring. Despite this positive trend, it is worth noting that during the COVID-19 pandemic, only services like electronic ICU were provided by less than 15% of hospitals.

While we find telemedicine is more prevalent in larger, nonprofit, and teaching institutions, this trend highlights an equity gap in service availability. This variance warrants attention, as it could perpetuate healthcare disparities, particularly during public health crisis.[14] We also found the low availability of some online non-clinical services necessary to

Table 2 Odds Ratios for Hospital Characteristics Influencing Telemedicine Provision in 2021

	Odds ratio	95% confidence interval
Medium vs small	1.829	[1.512, 2.212]
Large vs small	5.044	[3.39, 7.503]
Forprofit vs nonforprofit	0.210	[0.175, 0.252]
Goverment vs nonforprofit	0.603	[0.490, 0.742]
Teaching vs non-teaching	1.155	[0.962, 1.387]
Urban vs rural	0.815	[0.656, 1.014]
System affiliated vs independent	0.972	[0.813, 1.161]

This table presents odds ratios (ORs) and 95% confidence intervals (CIs) from a multivariate logistic regression analysis assessing the association between hospital characteristics and the provision of telemedicine services. The analysis is based on responses from 4091 hospitals to the 2021 AHA Annual Survey. Reference groups are independent, small, urban, and non-profit hospitals. To correct for potential non-response bias, weights calculated from the inverse of the predicted probabilities of survey response are used, with the predictive model considering factors such as hospital size, ownership, teaching status, urban status, and system membership. An OR greater than 1 suggests a higher likelihood of telemedicine services provision compared to the reference group, while an OR less than 1 indicates a lower likelihood. For instance, large hospitals are 5.044 times more likely to offer telemedicine services than small hospitals (95% CI, 3.39–7.503), controlling for other factors

support telemedicine, such as submitting patient generated data and importing medical records. Furthermore, we highlight the challenges hospitals face in exchanging electronic health information with outside providers, which warrants attention to ensure seamless patient care and interoperability. Our study also reveals that information blocking serves as a considerable barrier to the effective exchange of electronic health information. The findings suggest that various stakeholders engage in information blocking practices, hindering interoperability and impeding the seamless exchange of patient data. These findings underscore the need for targeted policy interventions to address the barriers to telemedicine adoption and health information exchange.

The advent of the COVID-19 pandemic has been a catalyst for telehealth adoption nationwide. However, our study highlights that leveraging the full potential of telemedicine involves more than just technological solutions. Addressing systemic barriers like information blocking is equally crucial to ensure that telemedicine serves as an effective, equitable, and resilient healthcare delivery model.

To fully realize the potential of telemedicine, a focused policy agenda is essential. First, investment in technological infrastructure is needed, targeting issues like the prevalent difficulty in locating Direct addresses, a concern for 69% of hospitals. Second, legislation to curb information blocking should be fast-tracked, as 25% of hospitals cite Certified Health IT Developers as frequent culprits. Third, to tackle the interoperability issues faced by 85% of hospitals, standardized data formats and transmission protocols should be urgently developed and implemented. Finally, the financial burdens of data transmission, a barrier for 46% of hospitals, should be alleviated, potentially through subsidies or incentives. These focused policy interventions aim to create a resilient, adaptable healthcare system capable of leveraging telemedicine to meet current and future challenges.

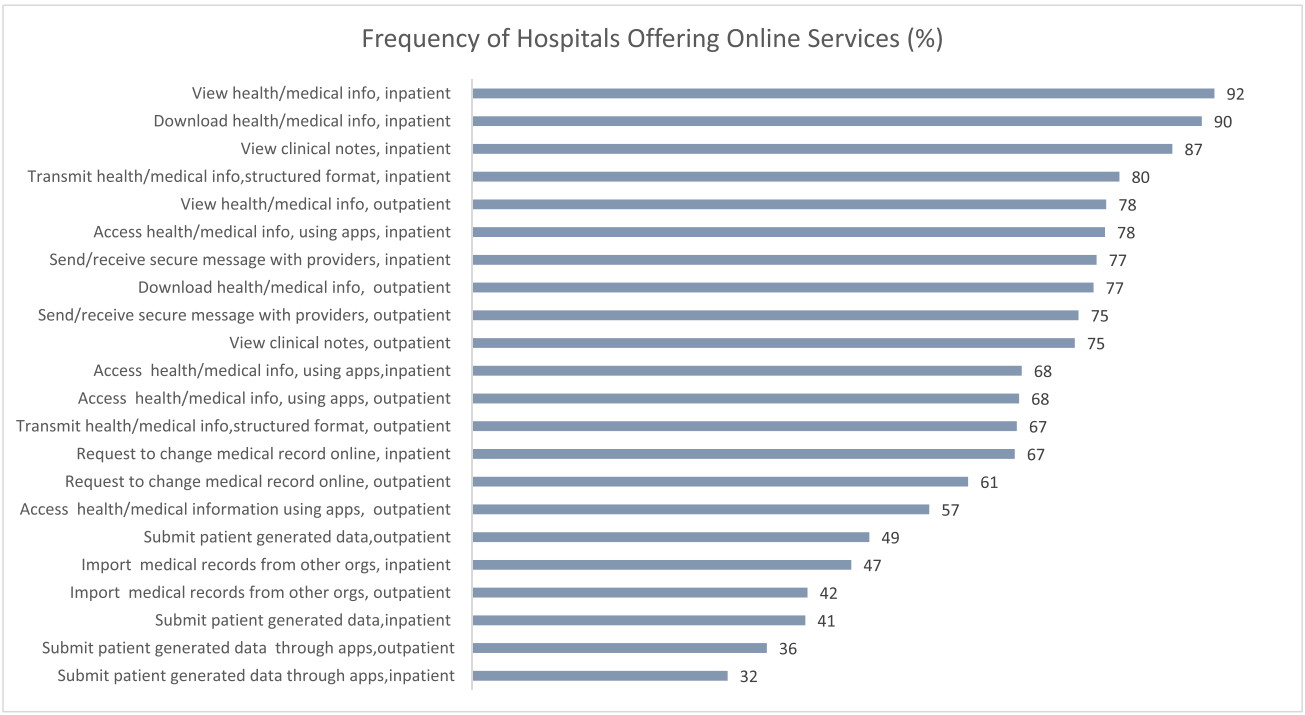
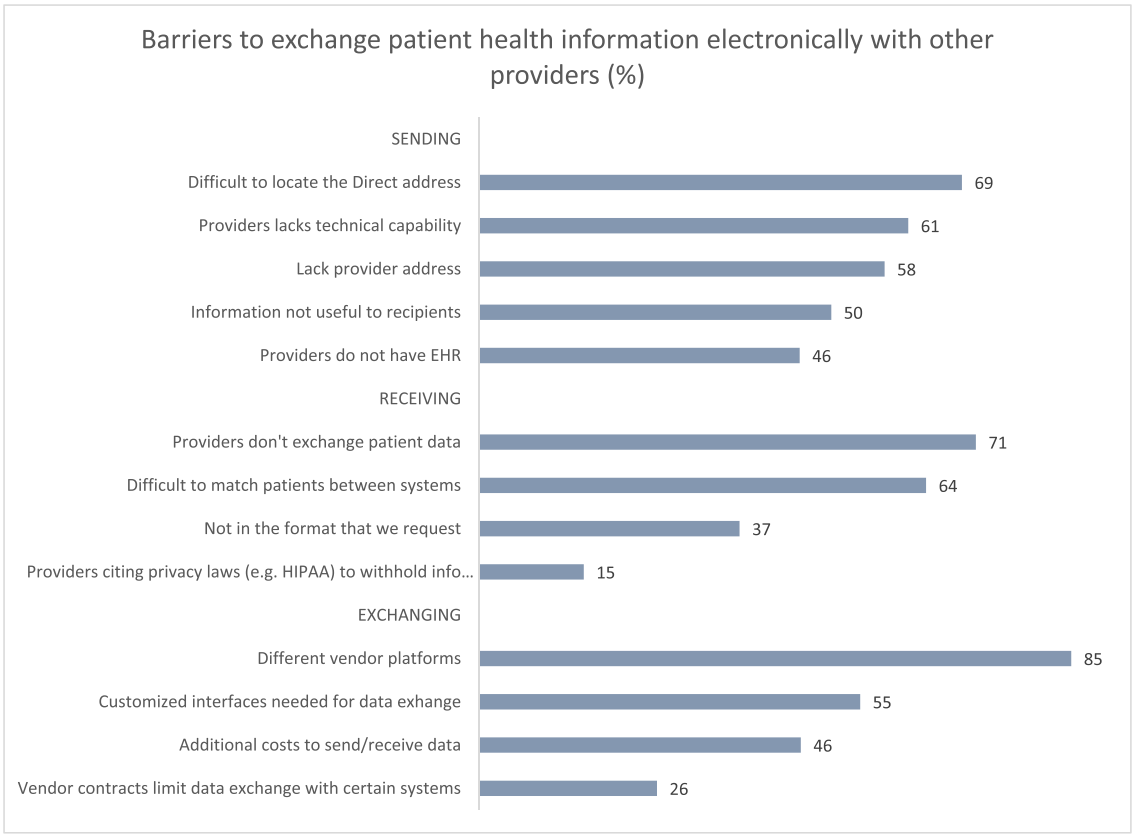
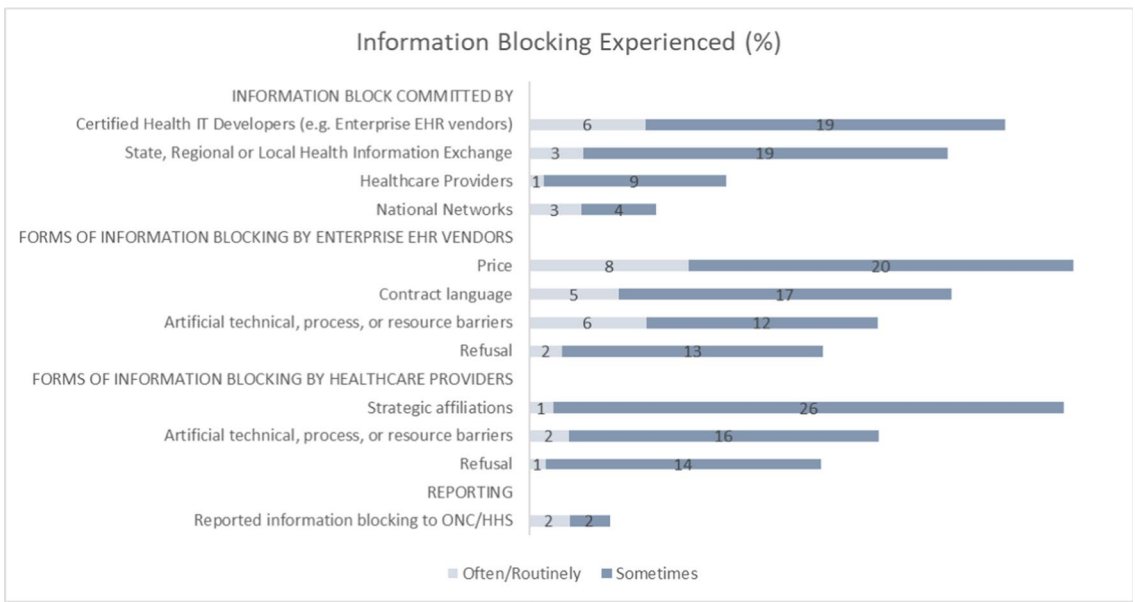


Figure 3 Availability of online services. Source: the 2022 AHA IT Supplement Survey.



A



B

Figure 4 Challenges in electronic exchange of patient health information: barriers and information blocking (%). A Barriers to exchange patient health information electronically with other providers (%). B Information blocking experienced (%). Source: the 2022 AHA IT Supplement Survey.

This study has several important limitations. First, the AHA survey respondents may not be representative of all US hospitals. Moreover, survey results relied on self-reported responses, which may introduce bias in the findings. Furthermore, the survey lacked details on specific challenges faced by hospitals, and many telemedicine-related questions were not included in earlier periods, limiting the scope of this study. Additionally, due to the lack of data, the efficacy of and patient reaction to telemedicine provided are beyond the scope of this study and remain promising areas for future research. Finally, while we used the most recently available data from the AHA, data on telemedicine services are currently only available through 2021, thus limiting our understanding for how telemedicine efforts were expanded beyond the COVID-19 pandemic.

CONCLUSIONS

In conclusion, our research highlights the rapidly growing role of telemedicine in US hospitals, underscoring its potential to transform healthcare delivery and improve patient outcomes. However, significant barriers persist, particularly in the realm of electronic health information exchange, which hinder the full realization of telemedicine's benefits. Our findings emphasize the urgent need for a focused policy agenda that addresses these challenges head-on. This agenda should prioritize investments in technological infrastructure, the development and enforcement of regulations to curb information blocking practices, the promotion of interoperability through standardized data formats and transmission protocols, and the alleviation of financial burdens associated with data transmission. By tackling these barriers, policymakers can create an enabling environment for telemedicine to flourish, ensuring that it becomes an integral part of a resilient, adaptable, and equitable healthcare system. The insights provided by our study serve as a foundation for future research and policy initiatives aimed at harnessing the power of telemedicine to meet the evolving needs of patients and providers in an increasingly digital healthcare landscape.

Supplementary Information *The online version contains supplementary material available at https://doi.org/10.1007/s11606-024-08853-0.*

Corresponding Author: *Ge Bai, PhD, CPA; , Johns Hopkins Carey Business School, Baltimore, USA (e-mail: gbai@jhu.edu).*

Declarations:

Conflict of Interest: *All authors declare no potential conflicts of interest with respect to the research, authorship, or publication of this article. This study was not supported by any external grants or funds. Dr. Ross currently receives research support through Yale University from Johnson and Johnson to develop methods of clinical trial data sharing; from the Medical Device Innovation Consortium as part of the National Evaluation System for Health Technology (NEST); from the Food and Drug Administration for the Yale-Mayo Clinic Center for Excellence in Regulatory Science and Innovation (CERSI) program (U01FD005938); from the Agency for Healthcare Research and Quality (R01HS022882); from the National Heart, Lung and Blood Institute of the National Institutes of Health (NIH) (R01HS025164, R01HL144644); and from Arnold Ventures; in addition, Dr. Ross was an expert witness at the request of Relator's attorneys, the Greene Law Firm, in a qui tam suit alleging violations of the False Claims Act and Anti-Kickback Statute against Biogen Inc. that was settled September 2022.*

REFERENCES

1. Department of Health and Human Services. What is telehealth? March 27, 2020. Accessed September 1, 2023. https://www.hhs.gov/hipaa/for-professionals/faq/3015/what-is-telehealth/index.html. In this study, we employ the terms telehealth and telemedicine interchangeably.
2. **Dorsey ER, Topol EJ.** State of telehealth. N Engl J Med. 2016;375(2):154-61.
3. **Tuckson RV, Edmunds M, Hodgkins ML.** Telehealth. N Engl J Med. 2017;377(16):1585-92.
4. **Young LB, Chan PS, Lu X, Nallamothu BK, Sasson C, Cram PM.** Impact of telemedicine intensive care unit coverage on patient outcomes: a systematic review and meta-analysis. Arch Intern Med. 2011;171(6):498-506.
5. **Jain S, Khera R, Lin Z, Ross, JS, Krumholz HM.** Availability of telemedicine services across hospitals in the United States in 2018: a cross-sectional study. Ann Intern Med. 2020; M20-1201
6. **Hollander JE, Carr BG.** Virtually perfect? Telemedicine for COVID-19. N Engl J Med. 2020;382(18):1679-81.
7. **Jnr BA.** Use of telemedicine and virtual care for remote treatment in response to COVID-19 pandemic. J Med Syst. 2020;44(7):132.
8. **Koonin LM, Hoots B, Tsang CA, Leroy Z, Farris K, Jolly B, Antall P, McCabe B, Zelis CB, Tong I, Harris AM.** Trends in the use of telehealth during the emergence of the COVID-19 pandemic—United States, January–March 2020. Morb Mortal Wkly Rep. 2020;69(43):1595.
9. **Lee EC, Grigorescu V, Enogieru I, Smith SR, Samson LW, Conmy A, De Lew N.** Updated National Survey Trends in Telehealth Utilization and Modality: 2021-2022 (Issue Brief No. HP-2023-09). Office of the Assistant Secretary for Planning and Evaluation, U. S. Department of Health and Human Services. April 19, 2023.Accessed September 1, 2023. https://aspe.hhs.gov/sites/default/files/documents/7d6b4989431f4c70144f209622975116/household-pulse-survey-telehealth-covid-ib.pdf
10. American Hospital Association. AHA annual survey database. 2023. Accessed September 1, 2023. https://www.ahadata.com/aha-annual-survey-database
11. **Jiang J, Qi K, Bai G, Schulman K.** Pre-Pandemic Assessment: A Decade of Progress in Electronic Health Record Adoption among US Hospitals. Health Affairs Scholar. 2023 Oct 21:qxad056.
12. Office of the National Coordinator for Health Information Technology. Information Blocking. 2023. Accessed September 1, 2023. https://www.healthit.gov/topic/information-blocking
13. Agency for Healthcare Research and Quality. Telehealth: mapping the evidence for patient outcomes from systematic reviews. June 2016. Accessed September 1, 2023. https://effectivehealthcare.ahrq.gov/sites/default/files/pdf/telehealth_technical-brief.pdf
14. **Whaley CM, Pera MF, Cantor J, Chang J, Velasco J, Hagg HK, Sood N, Bravata DM.** Changes in health services use among commercially insured US populations during the COVID-19 pandemic. *JAMA Netw Open*. 2020;3(11):e2024984.