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Safeguarding Patient Confidentiality in Telemedicine: A Systematic Review of Privacy and Security Risks, and Best Practices for Data Protection

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ABSTRACT: The COVID-19 pandemic accelerated telemedicine adoption, showcasing its potential in improving healthcare delivery. However, privacy and security risks pose challenges, impeding widespread acceptance. The aim is to investigate the integration of data analytics, data analysis, and data cleaning in telemedicine, focusing on patient data privacy and security, with the goal of proposing strategies to mitigate risks and uphold confidentiality. Utilizing a qualitative approach, privacy and security challenges in telemedicine were investigated. Multiple databases, including PubMed, Embase, and Cochrane Library, were searched from 2018-2023. Inclusion criteria involved English-language, peer-reviewed empirical studies focusing on telemedicine privacy and security. Out of 770 unique records screened, eight studies were included. Full-text review and risk of bias assessment were conducted using CASP tool. Privacy and security, technology hurdles for providers, patient trust, professional training, physical assessment challenges, and disparities among special populations were identified. Environmental, technological, and operational factors contribute to privacy and security risks in telehealth. Technology challenges like restricted access to telehealth tools and poor internet hinder adoption. Data analytics in telemedicine facilitates healthcare transformation, addressing privacy and security while optimizing patient outcomes through advanced analytics techniques and structured data analytics lifecycles. The integration of data analytics in telemedicine shows promise for healthcare transformation by providing insights into patient behavior and policy impacts, while ensuring data privacy and security. Addressing barriers, accelerated by the COVID-19 pandemic, requires infrastructure enhancements and global research efforts for inclusive telehealth ecosystems.

KEYWORDS: Data protection, Data analytics, Healthcare delivery, Privacy, Security, Professional training, Regulatory frameworks, Telemedicine.

INTRODUCTION

Telemedicine, the provision of healthcare services remotely using telecommunications technology, has experienced a profound surge in demand, particularly catalyzed by the extended lockdowns necessitated by the COVID-19 pandemic [1]. While telehealth services had existed prior to the pandemic, their widespread adoption was hindered, largely attributed to reimbursement challenges [2]. Nevertheless, the pandemic served as a catalyst, highlighting telemedicine's potential in improving healthcare delivery, cost-effectiveness, and accessibility, regardless of geographical constraints [3]. Before the pandemic, telehealth services were predominantly utilized in mental and behavioral health sectors; however, with the onset of the public health emergency in March 2020, its necessity permeated across various disciplines, including primary care, mental health, and pediatrics [4].

The American Medical Association's 2022 telehealth survey underscores the positive perceptions of telehealth among physicians, with a significant majority affirming its capability to deliver high-quality care and enhance patient access [5]. Despite these benefits, the rapid adoption of telehealth during the pandemic exposed several challenges, including healthcare disparities and, notably, privacy and security risks [6]. As telehealth services expanded, so did the spectrum of risks, encompassing cyber threats and technology-related data breaches, further exacerbated by patients' apprehension and unfamiliarity with telehealth technologies [7].

In the burgeoning domain of telemedicine, the integration of data analytics assumes paramount significance, serving as a linchpin for unraveling intricate patterns and discerning trends within patient data repositories [8]. With meticulous attention to detail, data cleaning processes precede the narrative of data analytics, ensuring the integrity and reliability of telemedicine datasets. Through the lens of statistical analysis and machine learning algorithms, data analytics emerges as the guiding force, illuminating correlations between patient characteristics, treatment outcomes, and telemedicine usage patterns [9]. Concurrently, business intelligence platforms orchestrate the synthesis of disparate telemedicine data streams, facilitating strategic decision-making and ensuring

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compliance with privacy and security regulations [10]. Moreover, insurance data analytics play a pivotal role in navigating the complexities of claims processing and telemedicine reimbursement, bolstering the financial sustainability of telemedicine initiatives [11].

This study aims to explore the interplay between telemedicine data analytics, data analysis, and data cleaning in relation to patient data privacy and security. By dissecting key challenges and factors, the research seeks to develop optimal strategies for safeguarding patient data within telehealth services. Through a thorough examination of telemedicine data analytics frameworks and regulatory considerations, the investigation aims to provide insights for enhancing data privacy and security measures. The primary goal is to assess the impact of data analytics practices on patient data privacy and security within telemedicine and propose best practices to mitigate risks and uphold patient confidentiality.

METHODS

Research design and research question

This systematic review adopts a qualitative approach to investigate the privacy and security challenges associated with telemedicine [12]. The research questions guiding this study are formulated as follows:

Research Question 1 (RQ1): What are the challenges and barriers faced by both patients and healthcare providers in utilizing telemedicine services?

Research Question 2 (RQ2): How can these challenges and barriers be effectively overcome to optimize the use of telemedicine?

Search Strategy

The search strategy employed a comprehensive literature search across multiple databases, including PubMed, Science Direct, ProQuest, Embase, CINAHL, and the Cochrane Library. A combination of Medical Subject Heading (MeSH) terms and advanced search terms such as privacy, security, and telehealth were utilized. The search terms were meticulously chosen to ensure the retrieval of relevant studies focusing on telemedicine privacy and security challenges. Key search terms used in PubMed included telemedicine, telehealth, e-health, security and privacy. The search was conducted using Boolean operators (OR/AND) to ensure comprehensive coverage. The search period spanned from 2018 till 2023, and articles were restricted to English-language, peer-reviewed empirical studies as shown in table 1.

Table 1. Inclusion and Exclusion Criteria for the Study

Inclusion Criteria	Exclusion Criteria
1. Articles published in English language.	1. Non-empirical studies, including systematic reviews, literature reviews, and commentaries.
2. Only empirical studies were included (qualitative, cross-sectional etc.).	2. Studies not addressing privacy and security concerns in telehealth.
3. Studies primary focused on privacy and security as the main outcome.	3. Articles published before 2018 and no full-text articles.

Study Selection and Risk of Bias Assessment

The selection process of abstracts for full review was divided among three reviewers. Each reviewer independently assessed abstracts for inclusion based on the predefined criteria. Discrepancies were resolved through group discussions, and a third reviewer intervened if necessary. Full-text review of selected studies was conducted by four reviewers. The risk of bias assessment was performed using specific assessment tools the Critical Appraisal Skill Program (CASP). The quality of studies was categorized based on predefined scoring criteria to ascertain the reliability of the evidence presented [13].

Data Extraction and Synthesis

Two reviewers independently extracted data from included studies, focusing on study design, telemedicine interventions utilized, and ethical and legal issues reported. The extracted information encompassed telemedicine challenges and barriers identified in the studies. Data synthesis involved grouping studies based on their main outcomes and conducting a narrative synthesis. This synthesis entailed analyzing and interpreting the extracted data to elucidate patterns, relationships, and conclusions. The synthesis process

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facilitated a comprehensive understanding of the privacy and security challenges associated with telemedicine and provided insights into potential strategies for addressing these challenges effectively (Appendix table 4).

RESULTS

Search Results

Initially, 893 records were retrieved from various databases: 145 from MEDLINE, 108 from EMBASE, 81 from Scopus, 145 from CINAHL, 267 from ProQuest, and 147 from PUBMED. Additionally, 22 records were sourced from other channels. After removing duplicates, 770 unique records remained for screening. Of these, 457 articles were excluded based on title and abstract assessment due to lack of relevance. Subsequently, 313 articles underwent full-text evaluation, leading to the exclusion of 305 articles for reasons including being case reports or reviews (180), not aligning with the research question (54), inappropriate study designs (25), unclear methodologies (8), and high risk of bias (38). Ultimately, eight articles were deemed relevant and included in the review (figure 1).

Characteristics of the included studies

The review comprised eight studies primarily conducted in the USA (6 out of 8), with one study from Nigeria and one from the Netherlands. Various study designs were utilized, including cross-sectional surveys (4), qualitative studies (3), and a combination of qualitative and quantitative approaches (1). Telemedicine interventions explored ranged from virtual primary care visits to telemedicine consultations for surgical assessments (6), telehealth integrated ambulance-based settings for stroke care (1), and telehealth with remote blood pressure monitoring (1). Ethical, social, and legal issues surrounding telemedicine were prominently discussed, including concerns related to patient data privacy (4), informed consent (3), regulatory challenges (3), and the impact on patient-surgeon relationships (5). Identified challenges included data quality, reimbursement concerns, patient satisfaction, regulatory hurdles, and impact on healthcare workflow and communication. CASP assessment of the studies showed six with moderate quality scores (CASP scores: 7-8), and two with high score (CASP: 10) (table 2 and 3).

Privacy and Security Challenges in Telehealth

Privacy and security present significant hurdles in telehealth, highlighted by four studies. Environmental factors, such as inadequate private spaces and difficulties in sharing sensitive health data remotely, were noted in two studies [14] [15]. Technology-related risks, including issues with health/digital literacy and technical glitches, were underscored in one study [15]. Operational challenges, like reimbursement issues and limited technology access, were mentioned in two studies. Additionally, concerns about patient and provider privacy were addressed, with age-related privacy issues also recognized. The patient's surroundings were identified as a privacy risk in two studies [16] [17] (figure 2, 3 and 4).

Technology Challenges for Providers

Three studies emphasized technology hurdles as a major obstacle in telehealth adoption. Common issues included restricted access to telehealth-specific tools, poor internet connectivity, and problems with devices and software updates [18]. Providers faced difficulties in initiating video sessions, managing electronic records, and accessing documentation platforms. Lack of technical proficiency among healthcare staff, highlighted in three studies, emphasized the need for extensive training programs [19] [7].

Patient Trust and Acceptance

Three studies identified patient confidence as a barrier to telehealth adoption [17]. Participants emphasized the importance of providers demonstrating technology use to build trust. Patient acceptance of remote consultations reflected trust, but there was a preference for in-person visits, particularly for surgeries [20]. Concerns were raised about the lack of physical presence and support during telehealth sessions, impacting confidence and satisfaction [14].

Professional Training

Training for healthcare providers and patients was crucial for telehealth adoption. Shortcomings in technical skills and suitability were evident, highlighting the need for training programs focusing on technical competence, virtual examination skills, and communication [21]. Challenges in staff management, electronic record integration, and platform usability were recognized. Providers expressed concerns about potential misdiagnoses due to inadequate knowledge, emphasizing the need for continuous training and support [22].

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Physical Assessment and Diagnosis

Two studies revealed concerns about conducting remote examinations and tests. Certain medical procedures were deemed unfeasible remotely, especially in surgical specialties [19]. Patients preferred face-to-face consultations due to doubts about the accuracy of virtual examinations. Telemedicine was found inadequate for specialties like ophthalmology and dermatology, where physical examination is essential [22].

Special Populations

In two studies, challenges faced by special groups in telemedicine were explored, including age-related barriers, technological hurdles, and demographic disparities. The elderly struggled with digital literacy and preferred traditional consultations, while marginalized communities faced difficulties accessing specialized care [23]. Rural residents and people with disabilities encountered obstacles in accessing telemedicine, worsening healthcare disparities [18].

Training for Providers and Patients

The studies highlighted the lack of training for healthcare professionals and patients in using telemedicine. Both groups lacked technical skills and struggled with virtual communication. Training programs were seen as vital for improving technical proficiency, virtual examination skills, and interpersonal communication [19].

Doctor-Patient Relationship

The included studies discussed challenges in the doctor-patient relationship due to virtual visits, which hindered rapport and trust-building. Patients missed personal connections and emotional support, preferring face-to-face interactions. Non-verbal cues were hard to convey, complicating patient-provider interactions [22].

Acceptance and Satisfaction

The studies examined acceptance and satisfaction issues, with hesitancy and uncertainty among providers and patients regarding telemedicine. Concerns about technology and preference for in-person visits were common. Acceptance varied by specialty, with some patients embracing telemedicine for specific procedures [23].

The significance of data analytics in transforming healthcare delivery and importance of addressing privacy and security concerns in telemedicine data analysis include:

Big Data Analytics in Telemedicine

The adoption of electronic health records (EHRs) mandated by the US Department of Health and Human Services (HHS) has revolutionized healthcare analytics by providing access to extensive data [24]. Beyond EHRs, data from wireless health monitoring devices and behavioral social media sources offer additional insights. Various software vendors, such as IBM and SAS, have developed tools tailored to healthcare, facilitating data management, analysis, and visualization [25]. These tools empower healthcare organizations to manage and analyze vast datasets, including those generated by telemedicine platforms.

The Telemedicine Data Analytics Lifecycle

The adoption of data analytics in telemedicine has accelerated with the emergence of specialized tools and methodologies. Vendors have refined a lifecycle for data analytics, comprising stages such as problem formulation, data preparation (including data cleaning), exploration, transformation, modeling, and evaluation [26]. This structured approach provides a framework for analyzing telemedicine data and involves key roles such as data managers, system managers, analysts, and data miners [27].

Expert Systems and Telemedicine Data Modeling

Telemedicine analytics tools incorporate elements of expert systems, leveraging data mining methods and statistical models to transform data into actionable knowledge. Common approaches to modeling telemedicine data include rule-based, case-based, logic-based, frame-based, and object-based systems [28]. These models enable efficient decision-making and knowledge dissemination within healthcare organizations, contributing to improved patient outcomes and resource allocation.

Telemedicine Analytics and Healthcare Improvement

Telemedicine analytics hold immense potential for enhancing healthcare quality and reducing costs. By analyzing telemedicine data at both state and national levels, insights can inform policy decisions, improve patient outcomes, and optimize resource allocation

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[29]. Initiatives like the Comprehensive Healthcare Electronic Software System (CHESS) enable researchers to harness telemedicine data for advanced analytics, driving improvements in patient care and healthcare delivery [30].

DISCUSSION

This systematic review analyzed eight studies from 770 unique records across databases, primarily from the USA, with one study each from Nigeria and the Netherlands. Key findings underscored challenges in telemedicine adoption, including privacy concerns, technological hurdles, patient trust issues, and the importance of professional training. Privacy risks stemmed from environmental, technological, and operational factors, while technology challenges underscored the need for comprehensive training programs for healthcare providers [31]. Patient trust emerged as a barrier, with concerns about the lack of physical presence and support during telehealth sessions affecting confidence and satisfaction [12]. The review underscores the importance of addressing these barriers to optimize telemedicine effectiveness and accessibility while ensuring the privacy and security of patient data. The integration of data analytics in telemedicine, spurred by mandated EHR adoption, enables healthcare organizations to leverage vast datasets for enhanced analysis and decision-making. Specialized tools and methodologies, structured within the telemedicine data analytics lifecycle, facilitate efficient data processing and modeling, empowering improved resource allocation and patient outcomes [32]. Leveraging expert systems and advanced analytics, telemedicine data analysis holds potential for driving policy decisions, optimizing resource allocation, and ultimately enhancing healthcare quality and delivery [33].

The surge in telehealth utilization amid the COVID-19 crisis has underscored both its potential and limitations. This comprehensive systematic review aimed to dissect the challenges obstructing successful telemedicine integration and offer remedies to enhance its utilization during and beyond the pandemic. Our findings validate existing literature, unveiling akin obstacles to telemedicine adoption, albeit with nuanced variations. While technical hurdles emerged as the primary impediment in our analysis, others have pointed to technology acceptance as the predominant challenge [34]. These disparities underscore the multifaceted nature of telemedicine adoption and highlight the necessity for tailored interventions. Notably, our review identified environmental, technological, and operational obstacles impacting privacy and security in telehealth realms, aligning with broader apprehensions in the literature [35].

In addressing technical challenges, our study underscored the pivotal role of internet speed and infrastructure, particularly in underdeveloped regions and rural locales [36]. These echoes prior research emphasizing the imperative of governmental backing to bolster internet accessibility and network technologies. Operational complexities, encompassing reimbursement issues and regulatory frameworks, were equally evident [37]. Legal ambiguities, particularly surrounding patient privacy, pose formidable hurdles necessitating comprehensive legislative guidance for telemedicine practices. Comparative studies further substantiate the urgency of standardized regulations to safeguard all stakeholders involved [38] [39].

Securing patient data privacy and security is paramount in telemedicine data analysis. Effective data analysis strategies include implementing encryption techniques, access controls, and anonymization methods to safeguard patient information [40]. Additionally, robust data governance frameworks and compliance with regulatory requirements, such as HIPAA, are essential to ensure the ethical and lawful handling of patient data [41]. Continuous monitoring and auditing of data access and usage can help detect and mitigate security breaches, thereby bolstering patient trust and confidence in telemedicine services [42].

Moreover, our review highlighted the pivotal role of professional training for both healthcare practitioners and patients. Bridging the digital divide and augmenting digital literacy emerge as crucial steps in enhancing telemedicine adoption [43]. Training initiatives, integrated into academic curricula and spearheaded by experienced practitioners, can bolster technical proficiency and confidence in telehealth interactions. Comparative studies have underscored the efficacy of such training initiatives in facilitating telemedicine adoption [44] [45].

This study presents several limitations that merit acknowledgment. Primarily, the search and review were confined to studies conducted in English-speaking countries, predominantly within the United States, potentially limiting comparisons with research conducted in non-English languages and other regions such as Europe and Africa. Moreover, the focus on peer-reviewed empirical studies might have overlooked valuable insights from non-peer-reviewed sources such as reports and case studies. Additionally, the study period spanned from 2018 to 2022, potentially excluding relevant literature published before 2018 or after 2022. Future research avenues include exploring telehealth policy development to offer better practice guidance, given the ongoing global demand [46]. Additionally, investigating privacy and security concerns across diverse regions, including Europe and Africa, is crucial.

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Prioritizing efforts to address digital health literacy disparities among vulnerable populations is essential. Lastly, delving into challenges like provider telehealth burnout offers opportunities for deeper investigation and intervention.

CONCLUSION

In conclusion, integrating data analytics in telemedicine offers promise for healthcare transformation. Advanced analytical techniques provide crucial insights into patient behavior, trends, and policy impacts, aiding decision-making. Ensuring patient data privacy and security through robust cleaning processes and compliance measures is essential. This systematic review underscores telemedicine's potential and barriers, accelerated by the COVID-19 pandemic. Addressing challenges requires infrastructure enhancement, regulatory frameworks, and professional training. Despite advancements, language and geographical biases persist, urging global research efforts for inclusive telehealth ecosystems. Strategic navigation of challenges can propel telemedicine towards enhanced accessibility, efficiency, and security in healthcare delivery.

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APPENDIX

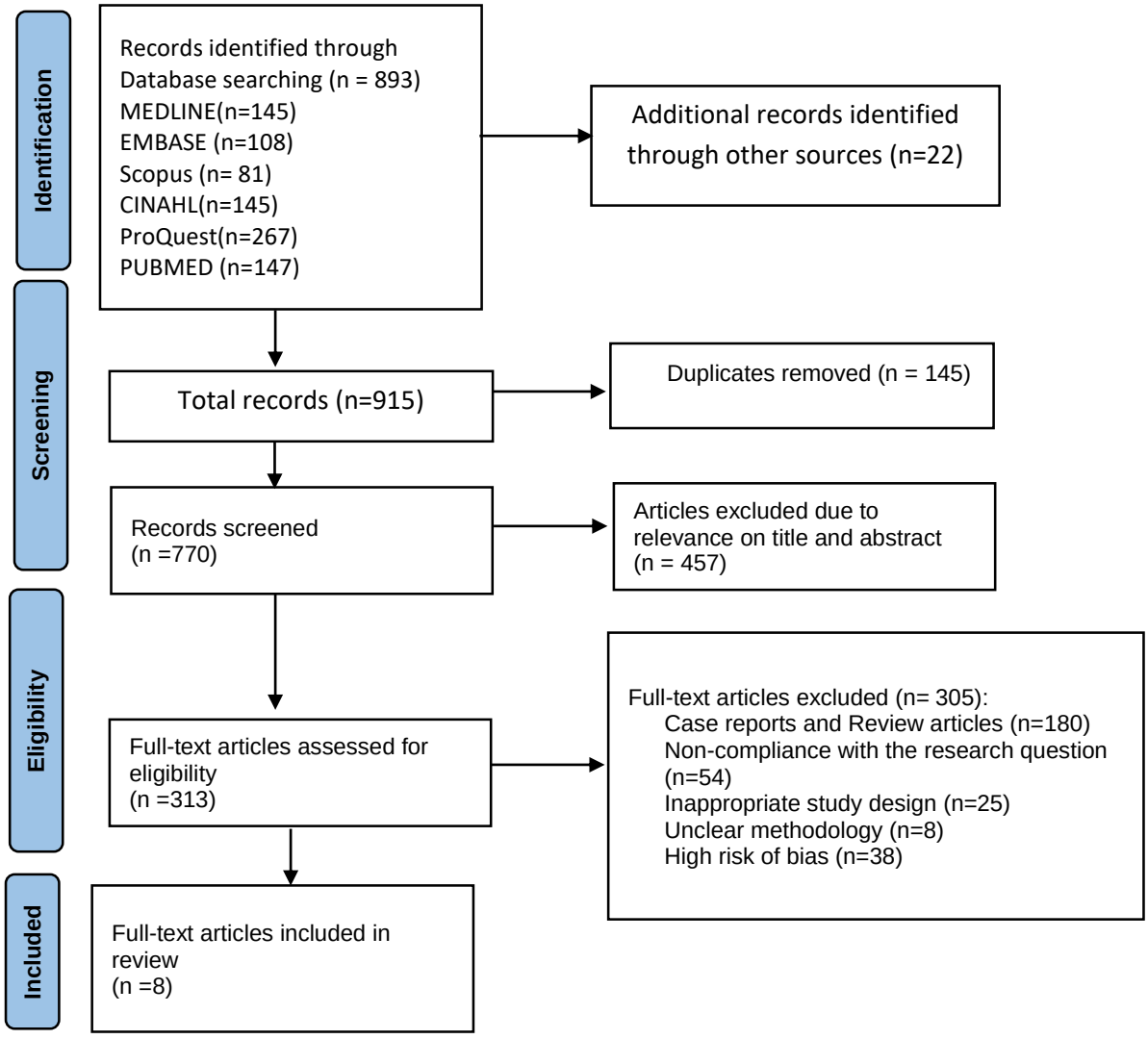

Figure 1: Prisma Flow Diagram

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Table 2. CASP Risk of Bias Assessment Tool of The Qualitative Studies

S. #	Study Title	CASP Score	Quality
1	Ekong et al., 2020	10	High Quality
2	Rogers et al. 2021	7	Moderate Quality
3	Shachar et al. 2020	7	Moderate Quality
4	Houwelingen et al. 2018	6	Moderate Quality
5	Holtz (2020)	8	Moderate Quality
6	Heather et al., 2020	6	Moderate Quality
7	Sorensen et al., 2020	9	High Quality
8	Thomas et al., 2021	8	Moderate Quality

Table 3. Baseline Characteristics of the Included Studies

Variables	Frequency	Percentage %
Year of publication		
2017-2018	1	12.5
2019-2020	5	62.5
2021-2023	2	25
Region		
United States of America	6	75
Europe (Netherlands, UK etc.)	1	12.5
Africa (Nigeria)	1	12.5
Methodology		
Mix Method Approach	1	12.5
Cross-sectional Survey	4	50
Qualitative Study	3	37.5
Nature of Study		
Primary Care Visits	2	25
Surgical Assessments	3	37.5
Telemedicine Modalities	3	37.5
Barriers in Telemedicine		
Data Quality, Reimbursement, Access	4	50
Privacy Concerns and Regulatory Issues	3	37.5
Ethical Considerations	1	12.5

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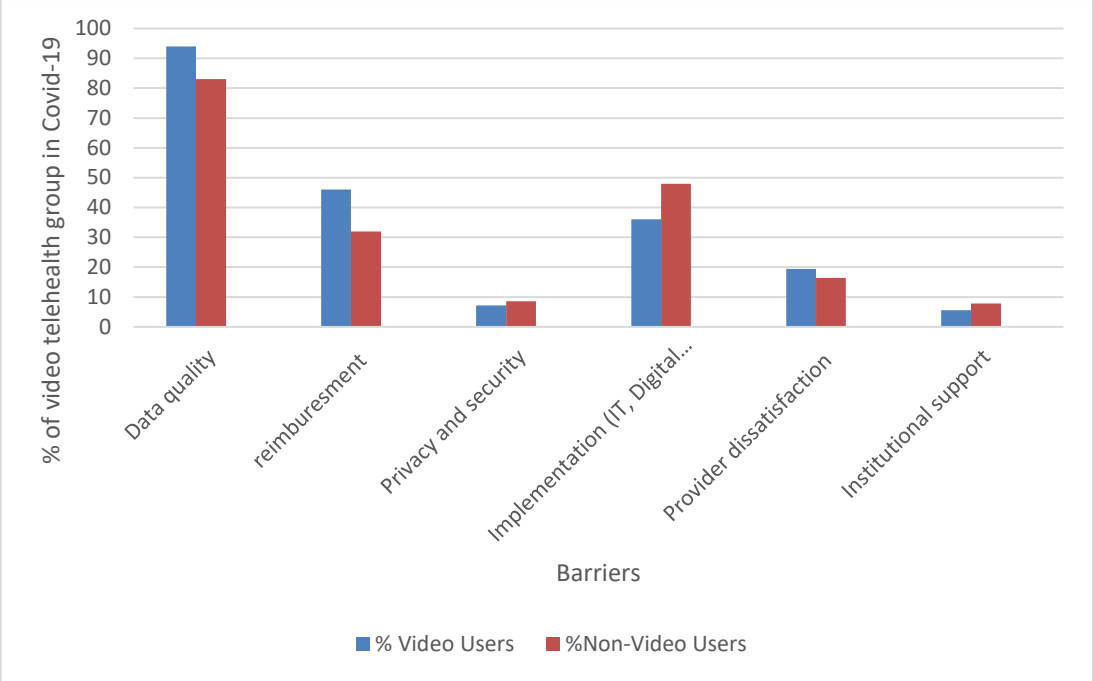

Figure 1. Percentage of Individuals Utilizing Video Telehealth during Covid-19: A Comparative Analysis of Barriers in Telemedicine Adoption
Source: (14)

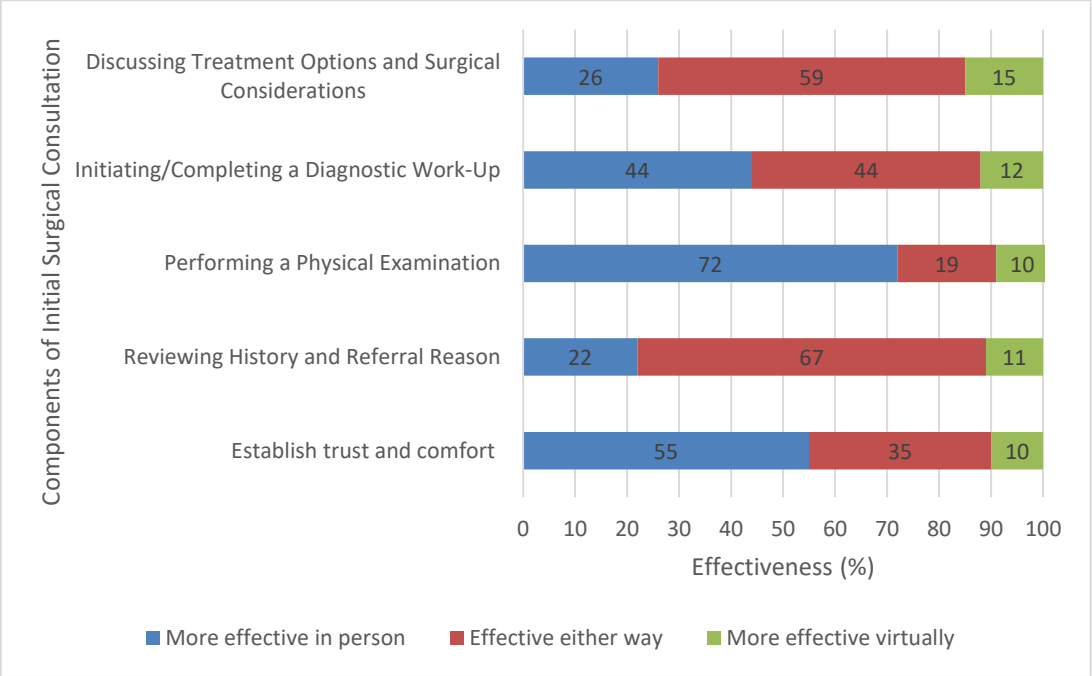

Figure 2. Effectiveness Percentage of Components in Initial Surgical Consultations: A Comparative Analysis
Source: (14)

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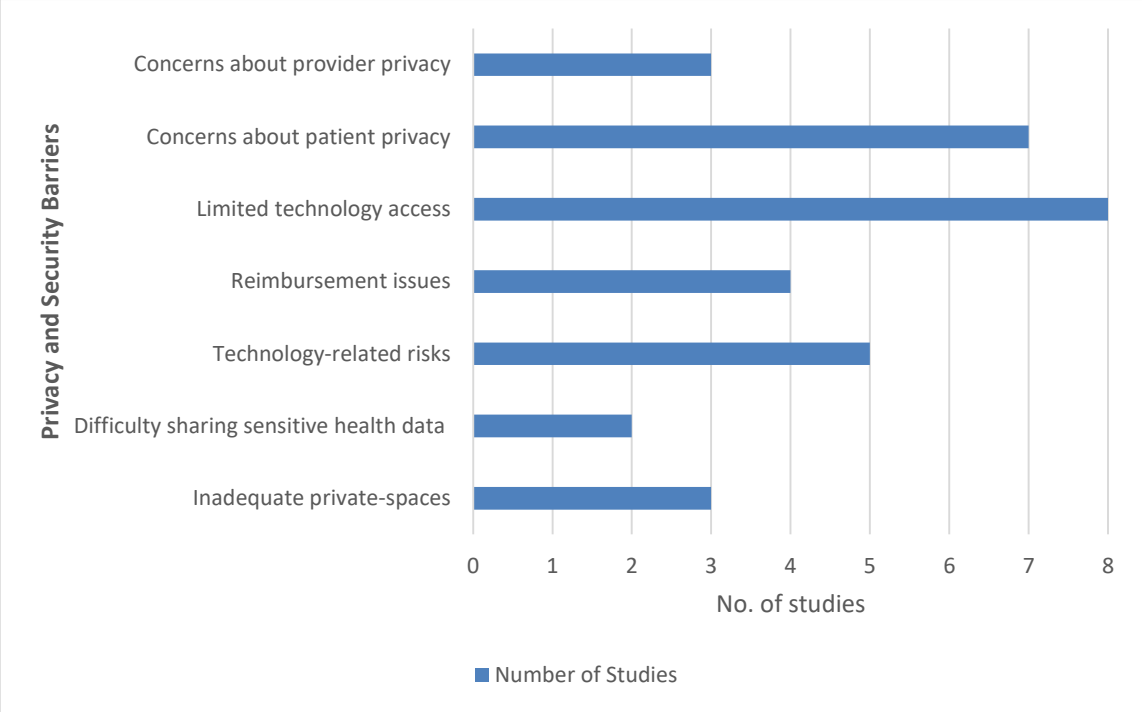

Figure 3 Privacy and Security Barriers in Telemedicine: Insights from Eight Studies

Table 4. Data Extraction Sheet of the Eight Included Studies

Author and year of publication	Country	Study design	Telemedicine intervention	Ethical/social/legal issues	Main findings
Holtz (2020) (15)	USA	Cross-sectional survey	Online telemedicine survey conducted from March 31 to April 20, 2020	Ethical considerations regarding patient consent and data usage. Social implications of limited choice of provider and patient due to pandemic circumstances. Legal implications of telemedicine practice regulations and guidelines.	- Patients overall satisfied with telemedicine experiences. - New users more likely to have a primary care physician. - Differences in perceptions between pre-pandemic and pandemic users regarding reasons for use, quality of in-person care, continuity of care, and technical issues.
Heather Moss et al., 2020 (14)	USA	Cross-sectional Survey	Video visits; Remote interpretation of tests; Online second opinions; E-consults	Data quality, reimbursement, access to care, continuity of care, efficiency of care, privacy concerns related to patient data.	- Telehealth modalities, including video visits, increased during the COVID-19 pandemic. - Majority perceived benefits of telehealth, such as improved

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					access, continuity, and efficiency of care. - Main barriers included data quality and reimbursement concerns. - Telehealth was found to be helpful for conditions relying on history, external examination, and previously collected ancillary testing but not for conditions requiring funduscopic examination.
Sorensen et al., 2020 (16)	USA	Cross-sectional Survey	Telemedicine consultations for surgical assessments	Impact on patient-surgeon relationship; Cost of telemedicine visits; Patient satisfaction with telemedicine encounters and privacy concerns.	- Majority (86%) of respondents satisfied with telemedicine encounters. - Preference for in-person consultations decreased from 72% to 33% post-COVID-19 social distancing measures. - Majority believe establishing trust and comfort is best accomplished in person. - Preference for telemedicine decreases with increasing complexity of surgical intervention.
Ekong et al., 2020 (17)	Nigeria	Qualitative study: Mix method approach	Use of mobile positioning data for COVID-19 contact tracing	Patient data privacy regulations, Use of digital tools to adhere to regulations	- Digital contact tracing may conflict with patient data privacy regulations. - Nigeria's response to COVID-19 complies with the National Data Protection Regulation (NDPR). - Leveraging call detail records (CDRs) is suggested to complement existing strategies within the NDPR.
Rogers et al. 2021 (19)	USA	Qualitative study	Telemedicine integrated ambulance-based setting for stroke care	Ethical considerations: Institutional Review Board approval, consent from participants for privacy and security of data Social considerations: Impact on workflow,	- Caregivers experienced moderate workload. - Team effectiveness and usability rated high. - Barriers: Frustration with equipment, lack of personal connection with patients, physical constraints in ambulance.

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				teamwork, communication, data privacy and security.	- Facilitators: Live visual communication increased teamwork, ease of access to neurologist, flexibility, high overall satisfaction. - Future research should focus on eliminating barriers and supporting distributed cognition of caregivers.
Shachar et al. 2020 (7)	USA	Qualitative study	Virtual primary care visits Routine medical consultations Healthcare services delivered remotely via telehealth platforms	Regulatory and Privacy Issues and data collection and processing	The COVID-19 pandemic accelerated telehealth expansion, prompting regulatory changes and challenges. Payment parity between telehealth and in-clinic care improved, but challenges in reimbursement remain. Regulatory changes are necessary to sustain telehealth momentum post-pandemic.
Thomas et al., 2021 (22)	USA	Cross-sectional	Telehealth with remote blood pressure monitoring	Privacy concerns, data security, informed consent	- Postpartum women perceived telehealth as safe and easy to use. - Majority found technology fit into lifestyle easily. - 95% preferred remote care for postpartum follow-up. - Most women were satisfied with devices.
Houwelingen et al. 2018 (23)	Netherlands	Qualitative Study	Videoconferencing	Informed Consent Privacy and Confidentiality Vulnerability of Participants Beneficence and Non-Maleficence Equity and Access	Older people's intention to use videoconferencing was significantly predicted by performance expectancy, effort expectancy, and perceived privacy and security. Self-efficacy appeared to play a role in both intentions to use and actual use of technology.