Stakeholder-driven multi-stage adaptive real-world theme-oriented (SMART) telehealth evaluation framework: a scoping review

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Summary

Telehealth has revolutionized healthcare delivery by integrating cutting-edge technologies, yet evaluations of its services and programs often lack comprehensive frameworks, resulting in unclear standards for quality assurance. To address this gap, we conducted a scoping review of telehealth evaluation frameworks applicable to the United States healthcare system, following the Joanna Briggs Institute methodology and a published protocol. Twelve telehealth evaluation frameworks published between 2019 and 2023 were identified, focusing on four key themes: program implementation, clinical impact, economic impact, and equity. Guided through two auxiliary frameworks, we further developed a stakeholder-driven multi-stage adaptive real-world theme-oriented (SMART) conceptual framework for telehealth evaluation. We illustrated this framework through a use case on a remote patient monitoring program. This comprehensive telehealth evaluation framework not only facilitates stakeholders in developing tailored evaluation plans but also contributes to the standardization and enhancement of telehealth services, ultimately improving health outcomes and promoting greater equity across society.

Keywords: Telehealth; Evaluation; Framework; Scoping review; Stakeholder

Introduction

Telehealth leverages cutting-edge technologies—including video conferencing, remote patient monitoring (RPM), wearable technology, implantable devices, mobile applications (apps), virtual reality, and artificial intelligence—to transform healthcare delivery.[1–6] These innovations allow healthcare providers to reach isolated populations, enhance service accessibility, and reduce operational burdens, ultimately improving the cost-effectiveness of healthcare services for society. For example, RPM technologies enable providers to monitor patient health status synchronously and asynchronously, enhancing patient care.[5,7–10] Virtual reality allows mental health providers to create immersive environments for treating patients,[3] and the growing utilization of artificial intelligence in clinical assessment has shown promising results in personalized prediction and telehealth computing.[6,11]

The diversity and rapid evolution of integrating various advanced technologies into healthcare services create challenges in standardizing telehealth services, such as a fragmented regulatory landscape and varying standards of quality and data privacy.[12] This lack of standardization raises concerns about service quality, prompting regulatory bodies, professional groups, and other telehealth stakeholders to develop operational guidelines and evaluation frameworks. The World Health Organization (WHO) has published multiple guidelines supporting global digital health strategies,[13–16] while in the United States (U.S.), organizations such as the American Telemedicine Association (ATA) and other stakeholders have formulated

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disease-specific guidelines for telehealth applications, like tele-mental health services and telehealth-diabetic retinopathy.[17,18]

While these guidelines are helpful for condition-specific applications, the existing frameworks for evaluating telehealth services and programs, often referred to as telehealth evaluation frameworks, lack broader application and are limited in scope. For example, the American Heart Association (AHA) guideline for RPM focuses on improving cardiovascular disease outcomes,[19] whereas the Agency for Healthcare Research and Quality (AHRQ) concentrates on mental health mobile apps.[20] The innovative integration of cutting-edge technologies and the rapid expansion of telehealth services and programs necessitate a comprehensive understanding of telehealth evaluation to further develop standards for these programs.

Individual researchers have devised frameworks to guide telehealth program evaluations. For example, Zhang et al. designed a framework centered on program sustainability, structuring its evaluation into three domains: program implementation, clinical effectiveness, and economic sustainability, with additional consideration of equity.[21] Additionally, Harvey et al. developed a framework that delineates telehealth maturity into four stages: service feasibility, pilot exploration, established program, and optimization.[22–24] While these frameworks provide foundational structures, they primarily address operational and outcome measures without fully integrating the perspectives of various stakeholders involved in telehealth programs.

In light of the rapid evolution and the heterogeneity of telehealth services and programs, a scoping review is necessary, particularly suited for areas where research is emerging or has not been comprehensively reviewed. This review aims to systematically explore the landscape of telehealth evaluation, identifying what should be considered in these evaluations and how they should be conducted. Following the published protocol, this scoping review aims to (1) map the current landscape of telehealth evaluation, (2) identify key concepts for evaluation, (3) synthesize existing frameworks, and (4) identify key measurement concepts considered in telehealth evaluations across the U.S.[25] From this review, we propose a stakeholder-driven multi-stage adaptive real-world theme-oriented (SMART) telehealth evaluation framework that comprehensively integrates outcomes with perspectives from multiple telehealth stakeholders within the complex U.S. healthcare system. This framework is designed to guide stakeholders in crafting comprehensive evaluation plans that include various developmental stages of telehealth programs in non-experimental, real-world settings, thereby fostering broader standardization and enhancing the cost-effectiveness of telehealth services.

Methods

The scoping review was conducted following the Joanna Briggs Institute methodology for scoping reviews and in accordance with a published protocol,[26] associated registration with the Open Science Framework (AYTUS, available here: https://doi.org/10.17605/OSF.IO/AYTUS),[25] and written following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR).[27–29]

Search strategy and selection criteria

Search strategy

Given that many evaluation frameworks are likely to be published in peer-reviewed journals and on stakeholders' websites, we sourced data from peer-reviewed journals and grey literature, including reports, white papers, policy documents, and guidelines.

The databases searched include PubMed (U.S. National Library of Medicine), Health Technology Assessments (International Network of Agencies for Health Technology Assessment), and Web of Science Core Collection (Clarivate Analytics). The search strategies for all searched databases are listed in Supplementary Tables S4–S6 within the Supplementary Material, "4. Supplementary Methods." A hand search was followed for telehealth evaluation frameworks published on websites of telehealth stakeholders, professional organizations, and authoritative sources. These sources were identified from the title and abstract screening. The hand search was independently performed by YZ and YL. Any disagreements during any selection process were resolved through discussion between YZ and YL.

Eligibility criteria

A Population, Concept, and Context (PCC) framework was adopted for document selection. Specifically, we included reviews, reports, and white papers related to telehealth evaluation frameworks and associated measurements, focusing on telehealth services and programs that are utilized for the provision of telehealth services through a variety of modalities, such as store-and-forward telemedicine, RPM, real-time counseling, audio and video conferencing, and videotelephony, as well as emerging innovations, such as virtual realities and artificial intelligence, integrated with telehealth platforms. We sought documents published in English across various healthcare settings, including primary care, specialty care, and rural healthcare for both adult and pediatric patients.[30]

Given the unique and complex nature of the U.S. healthcare system, we required that the documents be relevant to U.S. telehealth programs and services. As such, we excluded evaluation frameworks developed exclusively for regions outside the U.S. to maintain a focus on the applicability to the U.S. healthcare system, while aiming for comprehensive consideration. For

instance, documents published by worldwide health organizations were included due to their relevance and influence on U.S. healthcare. Additionally, we excluded frameworks published in non-English languages. Frameworks developed by individual researchers were excluded to focus on those reflecting the collective expertise and consensus of experts within the respective professional group.

We considered documents published in English from January 1, 2019, to December 1, 2023. While recognizing earlier publications, the COVID-19 pandemic significantly catalyzed the expansion and diversification of telehealth services and modalities. Focusing on recent work allows us to capture the most relevant evaluation of telehealth services and programs.

Document selection and data extraction

Following a pilot test of the inclusion and exclusion criteria, all records identified from databases were collated and uploaded into EndNote V21 (Clarivate Analytics, PA, USA), with duplicates removed. Two independent reviewers (YZ and YL) screened titles and abstracts against the inclusion criteria. Records identified from databases were screened through Rayyan,[31] a web-based tool for evidence synthesis projects, while records from professional websites were organized in Microsoft Excel. Two independent reviewers (YZ and YL) assessed the full text of selected documents. All disagreements between the reviewers were reviewed by a third reviewer (JCR) and resolved through group discussion.

The data extraction process was conducted by two independent reviewers (YZ and YL) using an extraction instrument developed based on the Joanna Briggs Institute data extraction template for scoping review,[28] as published in the research protocol,[26] with modifications to better capture details relevant to our review aims. Any disagreements were resolved through discussion. The charted data items included: document metadata (title, author, organization, year, and type of evidence source), framework contextual information (aim/purpose, target population, healthcare setting, and telehealth modality), and framework characteristics (framework summary, domain, subdomain, and measurement).

Data synthesis

Data across selected frameworks were synthesized into tables. Frequency counts of framework characteristics, as well as domains and subdomains considered in these frameworks, were tabulated to highlight key patterns. A narrative summary was crafted to describe the extracted data.

Additionally, we employed two auxiliary frameworks to facilitate data synthesis, the sustainable telehealth development framework by Zhang et al. and the telehealth maturity framework by Harvey et al.,[21–24] which facilitated the development of the SMART telehealth evaluation framework. Visualization techniques, including a Venn diagram, a heatmap, and three-dimensional modeling, were employed to depict the framework. Furthermore, a use case of RPM was developed to illustrate the practical application of the SMART telehealth evaluation framework for the comprehensive evaluation of telehealth programs.

Role of the funding source

The funding agency did not participate in the design, conduct, analysis, or interpretation of the data. The development of the SMART telehealth evaluation framework, the conclusions drawn, and the opinions expressed in this review are solely those of the authors and not influenced by the funding agency.

Results

Document selection and characteristics

A total of 5782 records were identified from PubMed (n = 2338), Health Technology Assessment (n = 45), Web of Science Core Collection (n = 3345), and organization websites (n = 54). After deduplication, 4361 records remained for title and abstract screening, and 4343 were excluded for evidence of not meeting the study inclusion criteria. Following a full-text review of the remaining 18 records, 6 documents were excluded for the following reasons: (i) not applicable to the U.S. context (n = 1), (ii) not for telehealth (n = 3), or (iii) not evaluation framework (n = 5). This resulted in the inclusion of 12 frameworks. Fig. 1 presents the PRISMA flowchart for the scoping review.[32] Supplementary Tables S1 and S2, in Supplementary Material "1. Selected frameworks," provide detailed characteristics and overviews of included frameworks.

Among the included frameworks, ten (83%) were developed by U.S. agencies and groups to be applicable within the U.S. healthcare system.[20,33–41] The remaining two (17%) frameworks, crafted by the Digital Medicine Society (DiMe) and WHO, have a global scope, making them applicable both within and beyond the U.S.[16,42] Regarding telehealth modalities, three (25%) frameworks specifically addressed mobile applications (apps),[20,33,35] with two focusing on mental health apps.[20,35] Additionally, two (17%) frameworks concentrated on digital health technologies (DHTs),[41,42] including connected sensors such as biometric monitoring technologies (BioMeTs), wearable devices, and Internet of Medical Things (IoMT). Seven frameworks (58%) adopted broader modality definitions, such as synchronous and asynchronous telehealth.[16,34,36–40] Rural community health was the specific focus of two (17%) frameworks.[38,39] Stakeholder perspectives varied, with each framework considering multiple viewpoints; all frameworks included the healthcare provider perspective. Technology developer considerations were included in three (25%) frameworks.[16,41,42] Patient or caregiver

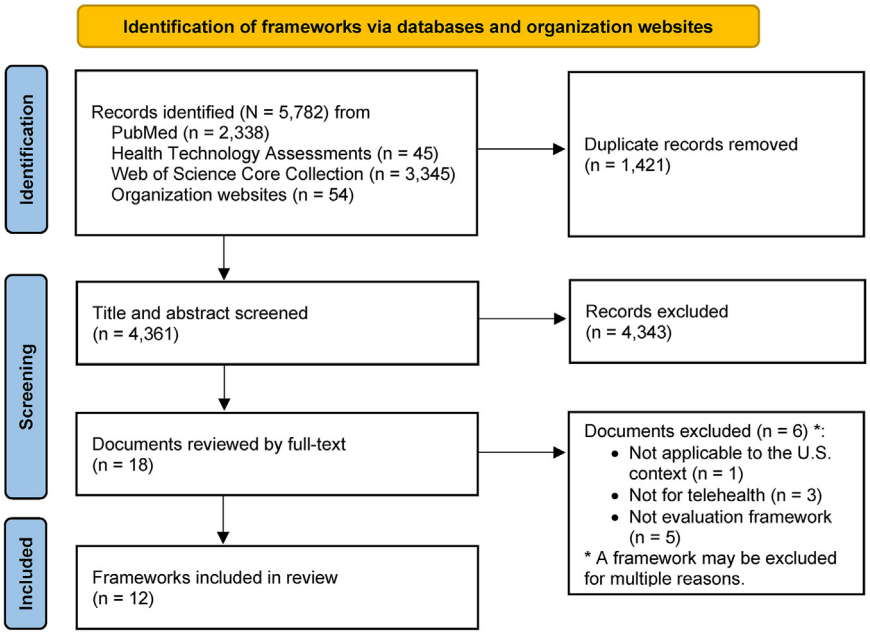

Fig. 1: PRISMA flowchart illustrating the search and selection process results for the scoping review. Of the 4361 unique titles and abstracts initially screened, 12 frameworks were identified for inclusion in the scoping review.

perspectives were featured in half of the frameworks,[20,33–37] while payer perspectives were included in five (42%).[20,34,36,38,39] The healthcare institution perspective, encompassing all stakeholders involved in healthcare delivery, was considered in seven (58%) frameworks.[16,20,34,36,37,39,40] Policymaker perspectives were addressed in five (33%) frameworks.[16,34,38,40,42] Table 1 displays the characteristics summary of included frameworks, and Fig. 2 illustrates the multi-stakeholder interactions in telehealth services and programs.

Evaluation themes

The sustainable telehealth development auxiliary framework provided a foundation that guided the initial categorization and refinement of the domains and subdomains observed across the included frameworks,[21] resulting in four key themes: program implementation, clinical impact, economic impact, and equity. The telehealth maturity auxiliary framework was subsequently used to structure the developmental stages of telehealth services and programs.[22–24]

Table 2 presents the categorization of evaluation themes and their corresponding aspects across the included frameworks.

Program implementation

All frameworks addressed program implementation,[16,20,33–42] with varying coverage of subthemes, including regulatory compliance,[20,33,35,37,41,42] technology stability and safety,[20,33,35,37,41,42] interoperability and integration,[16,20,34,35,37,38,42] usability and accessibility,[16,20,33–40,42] and implementation and program performance.[16,36,37,39] Five frameworks focusing on digital health apps and technologies emphasized adherence to legal requirements like the Health Insurance Portability and Accountability Act (HIPAA) and the Children's Online Privacy Protection Act (COPPA).[20,33,35,41,42] They also highlighted technology stability and safety, data integration to support medical decision-making, and

Characteristics	Number of frameworks	Percentage	Framework references
Context			
U.S.	10	83%	20,33–41
Global	2	17%	16,42
Telehealth modality			
Mobile applications	3	25%	20,33,35
Digital health technologies	2	17%	41,42
General	7	58%	16,34,36–40
Rural health	2	17%	38,39
Target stakeholder			
Technology developer	3	25%	16,41,42
Provider	12	100%	16,20,33–42
Patient/caregiver	6	50%	20,33–37
Payer	5	42%	20,34,36,38,39
Healthcare institution	7	58%	16,20,34,36,37,39,40
Policymakers	5	42%	16,34,38,40,42

Table 1: **Characteristics summary of included frameworks (N = 12).**

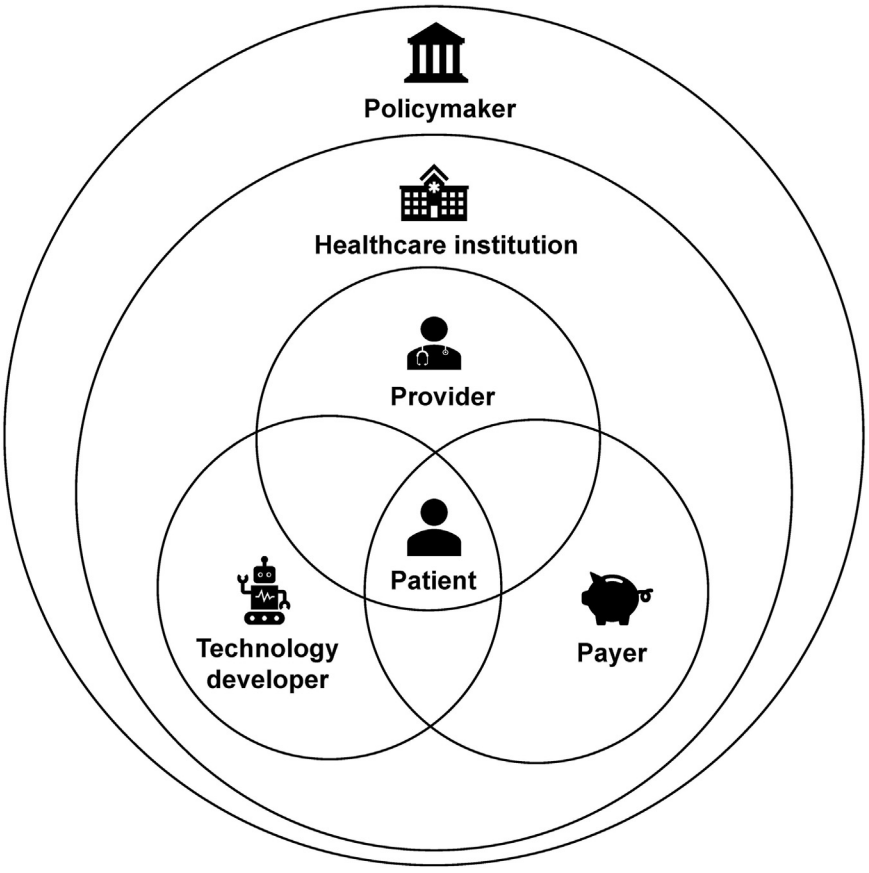

Fig. 2: Multi-stakeholder interactions in telehealth services and programs. This figure depicts key stakeholder interactions centered around patients.

usability enhancement through specific features and components, like user customization.[20,33,35,41,42] On the other hand, frameworks for broader telehealth modalities emphasized telehealth integration and operation with other medical services, including aspects like care coordination, general accessibility of telehealth services, as well as the implementation process and performance.[16,34,36–40]

Clinical impact

Clinical impact, considered in all frameworks, is focused on clinical safety,[16,20,33,35–37,41,42] effectiveness,[16,20,33–42] and individual experience.[16,34,36–42] Recognizing the diverse apps of telehealth services and the importance of a comprehensive approach to describing patient health status, Chuo et al. further suggested subdomains for health outcomes, including physiology, mental health, and quality of life.[36] Reflecting the practical aspects of telehealth delivery, all frameworks advocated for assessing the effectiveness of telehealth services in real-world settings over traditional efficacy evaluation. Additionally, individual experience incorporated provider and patient/caregiver viewpoints, including interactions with telehealth technology and logistics, as well as the provider-patient relationship. For providers, the frameworks emphasized clinical work satisfaction and well-being at work.[36,38–40] For patients and caregivers, emphasis was placed on their experiences with the clinical services received through telehealth and the compliance with their health plans.[36,38–40]

Economic impact

Eleven (92%) frameworks considered the economic impact of telehealth,[16,20,34–42] exploring how these services affect direct and indirect costs across various stakeholders through financial impact (n = 11)[16,20,34–42] and economic sustainability (n = 5).[16,34,38,40,42] The specific considerations varied, reflecting the diverse perspectives of those involved. For patients, evaluation frameworks often focused on immediate financial burdens and benefits, such as savings on travel miles and the costs associated with technology acquisition.[34,36,38,40] For healthcare providers and institutions, the aspects typically extend to program costs and payer reimbursement,

Themes	Number of frameworks	Percentage	Framework references
Program implementation	12	100%	16,20,33–42
Regulatory compliance	6	50%	20,33,35,37,41,42
Technology stability and safety	6	50%	20,33,35,37,41,42
Interoperability and integration	7	58%	16,20,34,35,37,38,42
Usability and accessibility	11	92%	16,20,33–40,42
Implementation and program performance	4	33%	16,36,37,39
Clinical impact	12	100%	16,20,33–42
Clinical safety	8	67%	16,20,33,35–37,41,42
Clinical effectiveness	12	100%	16,20,33–42
Individual experience	8	67%	16,34,36–42
Economic impact	11	92%	16,20,34–42
Financial impact	11	92%	16,20,34–42
Economic sustainability	5	42%	16,34,38,40,42
Equity	7	58%	16,36–41

Table 2: **Summary of key themes of included frameworks (N = 12).**

including the investment in telehealth infrastructure and the operational costs associated with delivering these services.[37,38,41,42] Furthermore, several frameworks considered the broader economic effects on societies, such as reduced absenteeism.[16,34,38]

Equity

Equity was addressed in seven (58%) frameworks, each providing a distinct description.[16,36–41] Chuo et al. focused on equity in health delivery quality, particularly emphasizing digital access equity.[36] Demaerschalk et al. explored equity in clinical outcomes, access, and affordability.[37] The National Quality Forum (NQF) incorporated equity by considering the social determinants of health (SDoH).[38] Pearson et al., the Rural Health Information Hub (RHIhub), and the Substance Abuse and Mental Health Services Administration (SAMHSA) all focused on general health equity.[39–41] Meanwhile, the WHO framed equity within the context of gender and human rights concerns.[16]

Stakeholder involvement by evaluation themes

For each theme outlined above, the included frameworks depict varied roles of stakeholders' involvement. We have further synthesized this information in Table 3.

Technology developer

Technology developers play a pivotal role in the development and implementation of telehealth programs, particularly focusing on technical feasibility, safety, and integration with medical services.[33,41,42] Their expertise further contributes to operational efficiency and clinical safety through technology support.[33,41,42] Additionally, the financial implications of technology development and deployment of telehealth programs are considered by technology developers.[41]

Provider

As central figures in healthcare delivery, providers are deeply involved in all aspects of clinical impact.[16,20,33–42] Their involvement in clinical safety extends beyond the technology used in telehealth to include considerations such as antibiotic prescribing practices and triaging emergency department (ED) visits.[34] In addition to clinical effectiveness, provider experiences with telehealth services, such as their satisfaction and burnout reduction, are crucial for ensuring the adoption of these services. Providers may further consider health equity, striving to ensure equitable care across the population.[34]

Patient/caregiver

Although patients and their caregivers are not directly involved in program implementation, their experiences and feedback are vital in informing the decisions of program implementers. Their involvement is critical in all dimensions of clinical impact, ensuring the safety, effectiveness, and satisfaction with the services received. Moreover, patients and caregivers are acutely aware of the financial impact, considering out-of-pocket costs for travel, healthcare service co-pays, medications, and the time dedicated to receiving services.[33,34,36,38–40]

Payer

While payers are not directly involved in the hands-on aspects of program implementation, their influence on the financial dynamics of telehealth is profound. They determine which devices and services are reimbursable and which providers, interventions, medications, and treatments are covered, significantly shaping telehealth program development and integration with existing medical services.[20,34,36,38,39] Furthermore, payers critically assess the clinical safety and effectiveness of telehealth services, influencing their decisions based on the cost-effectiveness and subsequent healthcare resource utilization.[34,36,38] Their role extends beyond immediate financial impacts to include consideration of long-term economic sustainability, which affects their coverage decisions.[16,34,38] Public payers, such as Medicare and Medicaid, collaborate closely with policymakers and play a critical role in promoting equity by shaping healthcare policies that influence both public and private payers, and by providing financial support for healthcare initiatives.[16,34,38]

Healthcare institution

Healthcare institutions are essential in ensuring the interoperability and integration of telehealth programs with medical services, focusing on usability and accessibility, as well as the implementation process and program performance.[34,37–40,43] Healthcare institutions

often lead the development of necessary technological and organizational infrastructure for telehealth programs, and support the integration of these services into clinical workflows and care transitions, while ensuring compliance with regulations.[34,38] They are integral in maintaining all aspects of clinical impact, and promoting best practices across services. Additionally, healthcare institutions play a crucial role in resource allocation for telehealth initiatives, considering the available budget and employee resources, and negotiating with payers to establish reimbursement policies that are critical for the sustainability of these programs.[34,38] Furthermore, healthcare institutions also ensure that telehealth services are accessible and acceptable to the populations they serve, thereby promoting health equity.[16,20,34,38,39]

Policymaker

Policymakers have a fundamental role in shaping telehealth services and programs by influencing regulations across all aspects of healthcare service delivery.[16,34,38,40,42] Their involvement extends from initiating legislation to set standards for technology and clinical impact, overseeing licensing and credentialing, as well as defining reimbursement policies and sustainable funding models. By actively engaging with these foundational elements of telehealth services and programs, policymakers work to ensure that healthcare institutions serve society effectively and equitably.[16]

Themes	Technology developer	Provider	Patient/ caregiver	Payer	Healthcare institution	Policymaker
Program implementation						
Regulatory compliance	✓				✓	✓
Technology stability and safety	✓				✓	
Interoperability and integration	✓				✓	
Usability and accessibility	✓				✓	
Implementation and program performance	✓				✓	
Clinical impact						
Clinical safety	✓	✓	✓	✓	✓	✓
Clinical effectiveness		✓	✓	✓	✓	✓
Individual experience		✓	✓		✓	
Economic impact						
Financial impact	✓		✓	✓	✓	
Economic sustainability				✓	✓	✓
Equity		✓		✓	✓	✓

Table 3: **Stakeholder involvement by evaluation themes (N = 12).**

Themes emphasis across developmental stages

Given the varied scopes of the included frameworks, which span from early-stage program feasibility to late-stage integration with community and population health to serve society, we employed a secondary auxiliary framework, the telehealth maturity framework,[22–24] to further structure the key themes across telehealth developmental stages. We have depicted the theme emphasis at each telehealth developmental stage based on a qualitative synthesis of evaluation frameworks of telehealth services and programs, combined with authors' experience in telehealth evaluation (see Fig. 3). The stages include program feasibility, pilot exploration, established program, and optimization. Detailed descriptions of each stage can be found in the Supplementary Materials, "2. Developmental stages of telehealth program evaluation."

Stakeholder-driven multi-stage adaptive real-world theme-oriented (SMART) telehealth evaluation framework

Given the above, we incorporated stakeholder involvement and developmental stages with evaluation themes into the SMART telehealth evaluation framework, as depicted in Fig. 4. When evaluating telehealth services and programs, it is essential to consider the interplay between stakeholder perspectives and program developmental stages across evaluation themes. Here, we apply the SMART framework to an RPM program for

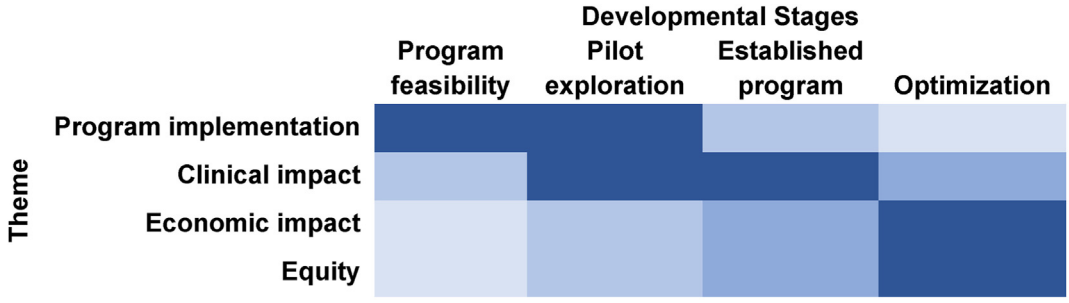

Fig. 3: Heatmap of the theme emphasis at each telehealth developmental stage. The intensity of the color in the heatmap indicates the level of importance, with darker colors representing higher importance and lighter colors indicating lower importance at each developmental stage.

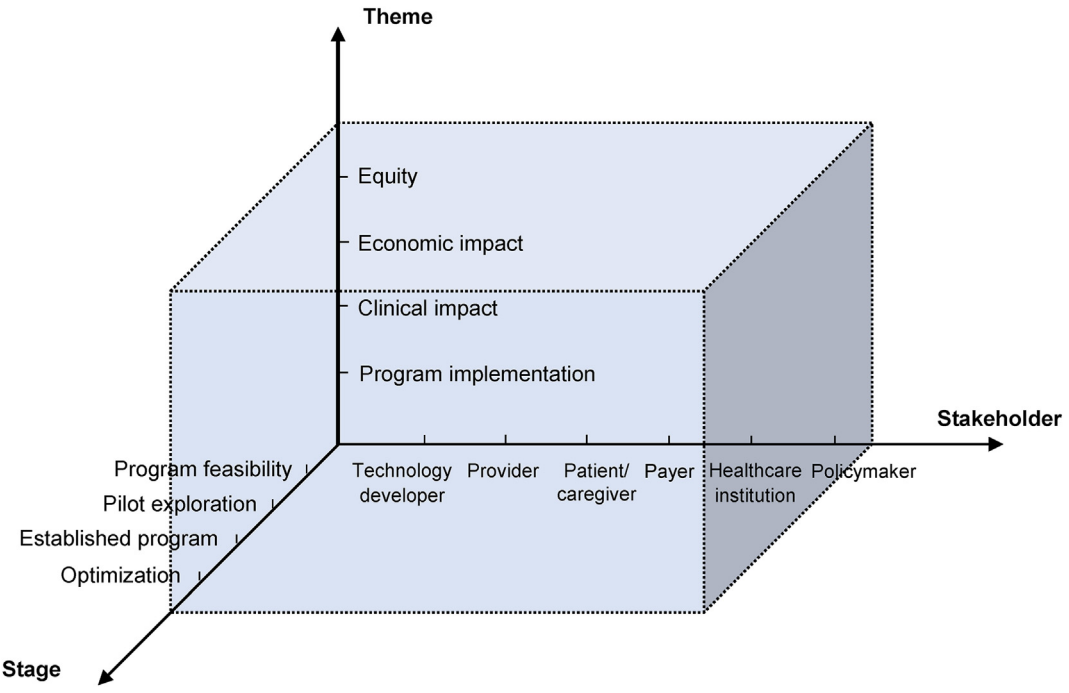

Fig. 4: SMART telehealth evaluation framework. Axes represent the developmental stages, the stakeholders involved, and the key themes.

blood pressure management as a use case, based on measures identified in the included frameworks.

Use case: measurement examples of RPM program for blood pressure management using the SMART telehealth evaluation framework

An RPM program allows providers to closely monitor patients' health status through health information collected outside of conventional clinical settings, such as at home or in remote areas.[20] Patients enrolled in an RPM program of blood pressure management typically receive a telemonitoring kit, which includes a tablet with a pre-installed telemonitoring app and a Bluetooth-enabled blood pressure cuff, allowing for direct transmission of blood pressure measurements and other health information.[7–9]

In the initial program feasibility stage, the focus is on ensuring regulatory compliance and assessing the technology stability, which is crucial for program implementation and clinical safety. Prior to implementation, technology developers and healthcare institutions must evaluate real-world challenges, including the security and stability of Protected Health Information (PHI) data transactions and the accessibility of data for both providers and patients. Key measurements might include the device reliability and the frequency of software updates. Additionally, the functionality of the telemonitoring apps requires comprehensive testing, particularly how devices handle and alert both patients and providers about elevated out-of-range blood pressure readings, ensuring timely awareness and appropriate clinical responses, as conducted in a feasibility study of RPM for pregnant women.[44]

As the program progresses to the pilot exploration stage, the focus shifts towards evaluating interoperability and integration, broader usability, and program performance, alongside a preliminary examination of clinical effectiveness and individual experiences. The financial feasibility should also be assessed to lay a robust groundwork for subsequent phases. It is crucial to consider the program context within this exploration to ensure its integration into the existing healthcare services. For example, technology developers need to test the program integration with the existing electronic health records (EHRs), enabling healthcare institutions to incorporate the program with other services, such as medication management and patient education. Evaluating clinical workflows can provide a further understanding of the program's readiness for broader implementation. Key measurements may also include referral rates, user acceptance testing (UAT), and the types of patients served to facilitate patient-centered program design. Additionally, the financial assessment should cover the costs associated with technology, equipment and supplies, personnel, training of patients and providers, marketing, and overhead, evaluated by technology developers and healthcare institutions against the available budget to support the further development of the program. In a feasibility study of RPM, Kohn et al. enrolled 20 heart failure patients to

examine the process safety and efficiency as well as patient compliance and satisfaction with a program using multiple Food and Drug Administration (FDA) approved devices.[45] In another pilot study of RPM for home automated peritoneal dialysis conducted in Italy, RPM was compared with traditional technology by assessing its organizational and economic impact, including measurements such as the number of unscheduled visits and cost savings to the health system.[46]

Consideration of equity, including digital equity, from the outset is essential to ensure that the communities to be served are similarly able to access services through telehealth. This provides a strong foundation for the program and will contribute to the prevention of future disparities. Although evaluating equity can be challenging due to the small sample size, proactive approaches, such as community outreach and forums, would provide opportunities to examine and address factors negatively impacting access, thereby enhancing the potential for long-term success and inclusivity, particularly for marginalized populations.

When entering the established program stage, technology developers and healthcare institutions continue their role in program implementation by ensuring the smooth operation of the established program and ongoing care coordination, including integration with additional services. Moreover, the evaluation of the established program centers on clinical impact, economic impact, and equity. Key measurements for evaluation include changes in average blood pressure readings over time, reductions in hypertension-related complications, provider and patient/caregiver satisfaction, usage frequency of tele-monitoring kit, and improvements in patient quality of life. Economic considerations have become increasingly important, and providers, payers, and healthcare institutions may compare the cost of the RPM program against alternative blood pressure management programs. Return-on-investment (ROI) is a common financial metric, while economic evaluation methods such as cost-effectiveness, cost-utility, and cost-benefit analyses, allow the evaluation of costs along with various outcome measures, helping to ensure a comprehensive view of financial and clinical benefits. For payers and healthcare institutions, long-term metrics such as 5-year mortality rates and healthcare resource utilization (i.e., inpatient, outpatient, and emergency department utilization) may be of interest for the economic sustainability evaluation. Policymakers may further consider the broader societal impact of the RPM program, such as environmental benefits from reduced carbon emissions caused by transportation and improved labor productivity through decreased productivity losses due to illness. Additionally, healthcare institutions, payers, and policymakers may evaluate healthcare access and health outcome equity across different subpopulations. A systematic review of RPM for cardiovascular diseases identified studies, including randomized clinical trials, that examined clinical effectiveness and economic benefits from various perspectives, including providers, payers, and healthcare systems.[2] Additionally, a recent randomized clinical trial on digital cancer symptom monitoring evaluated patient perspectives and health equity in the provided care.[47]

In the final optimization stage, quality improvement may be enhanced for program implementation and clinical impact, while the evaluation emphasis is on cost-effectiveness and broadening equity, with measurements evaluated across different demographics and long-term sustainability metrics. At this stage, the equity may go beyond health equity to the general gender, equity and human rights, following a core value of WHO.[15] For instance, a qualitative study in Toronto, Canada, focused on a user-centered adaptation of an existing heart failure telemonitoring program, analogous to an RPM program, to ensure sustainability and scalability.[48] Additionally, a multi-country randomized clinical trial conducted in Europe examined noninvasive home telemonitoring for patients with heart failure, finding lower one-year mortality in the home telemonitoring cohort compared to the usual care cohort, and suggesting future refinement of the application of home telemonitoring care.[49] A recent economic evaluation of this study demonstrated the cost-effectiveness of home telemonitoring across a lifetime horizon of patients from both healthcare system and societal perspectives.[50]

Evaluation measurement concepts are summarized in Supplementary Table S3 in the Supplementary Material, "3. SMART telehealth evaluation framework use case."

Discussion

As the first scoping review to synthesize existing evidence of telehealth service and program evaluation in the U.S., our work illuminates the heterogeneity and complexity inherent within telehealth evaluation across the U.S. healthcare system. By analyzing data from a variety of sources, we have developed the SMART telehealth evaluation framework. This SMART framework comprehensively addresses program implementation, clinical impact, economic impact, and equity considerations across multiple telehealth stakeholders and implementation stages.

The rapidly evolving landscape of telehealth, characterized by the integration of cutting-edge technologies across healthcare services, presents significant evaluation challenges. Many existing frameworks tend to focus narrowly, such as on mobile health apps or rural health, leading to a segmented understanding of telehealth programs. Our review further underscores the challenges of developing a universal standard in telehealth evaluation, which is often of interest to regulatory

agencies, but reveals the possibility of a flexible approach that considers diverse stakeholders, developmental stages, and specific environmental contexts of telehealth programs.

To address these complexities, we utilized two auxiliary frameworks, the sustainable telehealth development framework and the telehealth maturity framework to structure our synthesis of the extracted data.[21–24] The resulting SMART telehealth evaluation framework offers an inclusive and adaptive approach to evaluate telehealth services and programs, designed to meet the varied needs of a broad spectrum of telehealth stakeholders. Through the SMART telehealth evaluation framework, stakeholders could craft their tailored evaluation plans to align with specific developmental stages and thematic interests of their program. Moreover, to facilitate this adaptive approach, telehealth toolkits co-designed with specific health professions may be employed.[51]

While this scoping review guides the development of the SMART telehealth evaluation framework, several inherent limitations should be considered. First, our focus on the frameworks applicable within the U.S. might limit the finding generalizability to other healthcare systems, which may differ significantly in structure and operation. Nonetheless, the concepts considered in the SMART telehealth evaluation framework could potentially be adapted for use in other countries, given the similar needs of theme and development considerations of telehealth programs universally. Furthermore, by excluding studies conducted solely by individual researchers, we aimed to present a comprehensive overview that prioritizes expert consensus and broadly recognized evaluation frameworks. As such, when evaluating local telehealth programs, specific environmental and context considerations should be added to the evaluation plan.

In conclusion, our scoping review and the subsequent development of the SMART telehealth evaluation framework present a holistic understanding of telehealth evaluation. By addressing the complexities of program implementation, clinical impact, economic impact, and equity, the framework facilitates a thorough evaluation of telehealth services and programs, ultimately enhancing the quality of healthcare services, improving health outcomes, and promoting greater equity across the society.

Contributors

YZ: conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, validation, visualization, writing—original draft preparation, and writing—reviewing and editing. YL: conceptualization, data curation, investigation, methodology, validation, and writing—reviewing and editing. LSL: conceptualization, investigation, methodology, validation, and writing—reviewing and editing. JCR: conceptualization, investigation, methodology, validation, and writing—reviewing and editing. EGH: conceptualization, data curation, methodology, validation, and writing—reviewing and editing. SC: funding acquisition, investigation, project administration, resources, supervision, validation, and writing—reviewing and editing. JMS: conceptualization, investigation, methodology, supervision, validation, and writing—reviewing and editing.

Declaration of interests

All authors declare no competing interests.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.lana.2025.101041.

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