

Telecare and Care Infrastructure in Rural Areas: literature review and research agenda

Visar Emerllahu

Law And Real Estate Management
European Faculty of Law, New University
Ljubljana, Slovenia
vemerllahu@hotmail.com

David Bogataj

Alma Mater Europea University
Maribor, Slovenia
david.bogataj@gmail.com

Abstract— *An ageing global population, which is further compounded by enduring discrepancies in access to health care between urban and rural settings, has created a sense of urgency regarding the development of new health care delivery models. Telecare has become the most promising solution to these geographical distances, but its adoption is hindered by several neurovascular challenges. The purpose of this review article is to provide a comprehensive synthesis of the literature related to the adoption of telecare in rural communities. We identify essential infrastructure needs, discuss complex adoption barriers, and outline a research agenda to design future policies and practices that improve healthcare equity. A systematic review of the literature was conducted, searching the Web of Science and other relevant sources for publications focusing on issues, barriers, and best practices in the deployment of telecare in underserved rural areas. The review highlights that telecare has the potential to enhance health outcomes and service efficiency, as well as provide access to specialist support, but only if considerable barriers can be overcome. Key bottlenecks presented included insufficient technology resources, low digital literacy among patients and providers, financial issues, the lack of standard regulatory protocols, and social-cultural resistance. A successful rollout also depends on technical preparedness, seamless integration into healthcare systems, and strong community involvement.*

Keywords: *Telecare, care infrastructure, rural areas, assistive technology, human-machine system*

I. INTRODUCTION

The worldwide demographic transition toward an elderly population, combined with continued inequities in access to health services between urban and rural areas, underscores the need for a thorough investigation of the role of telecare interventions and the infrastructure that supports them in underserved regions [1]. Although the concept of telemedicine has been around for years, little progress has been made in the last decade in developing a comprehensive research strategy and enhancing the quality of research [2]. The success levels of different telecare programmes vary, often depending on factors such as well-developed technology infrastructure, funding, and successful integration as an integral part of existing healthcare systems [3]. Understanding advantages,

challenges, and fundamental conditions is important for the efficient design of telecare in rural areas [4]. Progress in communication technologies and digital health platforms can help reduce healthcare inequalities, promote patient-centred outcomes, and deliver resources efficiently to remote communities [5]. Poor service connections and paucity of expertise remain significant barriers to the equitable implementation of telecare in rural areas [6]. Persistent rural–urban healthcare access disparities have made it urgent to develop innovative solutions, such as telecare, to address the geographical determinants of health [7]. Telemedicine has become an essential intervention to bridge such geographical disparities, facilitating virtual consultations and specialised care that may not be available to those in rural areas [8]. Starting with NASA's initial use with astronauts, telemedicine has expanded to the point that it is almost ubiquitous in North America, surpassing implementation in Europe and Asia [9]. These differences in adoption rates can be attributed to variations in regulatory systems, reimbursement policies, and cultural attitudes toward digital healthcare services across different countries/continents [10]. Although telemedicine has been considered a means to reduce healthcare disparities, notably in rural underserved settings, several factors hinder its full integration, including ethical issues, technological limitations, and patient confidence [11] [8]. In this context, the main aim of telemedicine is to use IT to overcome spatial distance and improve access to health services for people residing in distant and/or rural areas [12]. This is accomplished through various modalities, including live video consultations, store-and-forward technology for the asynchronous sharing of data, and remote monitoring devices, each with distinct benefits in different clinical settings [13]. The increasing utilisation of telemedicine platforms, which support patient-pharmacist teleconsultations, provides personalised medication management and adherence, and streamlines drug development and clinical trials with virtual contact [14]. The COVID-19 pandemic era has increased the adoption and utility of telehealth and telemedicine, particularly among rural and low-income populations, where access to medical facilities is limited [15]. A steep increase in utilisation reflects the indispensable role of telemedicine in addressing health disparities and improving access to healthcare for vulnerable populations [16].

1 LITERATURE REVIEW

There are 4962 papers published in journals indexed in Web of Science on the topic of Telecare

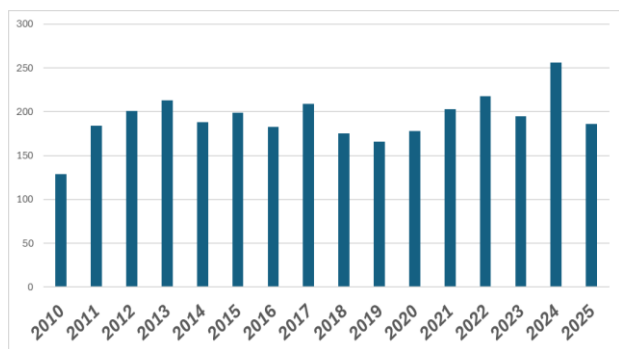


Figure 1: Number of publications published in journals indexed in Web of Science on the topic Telecare in the period from 2010 to 2025

There are 958 papers published on the topic of Care Infrastructure.

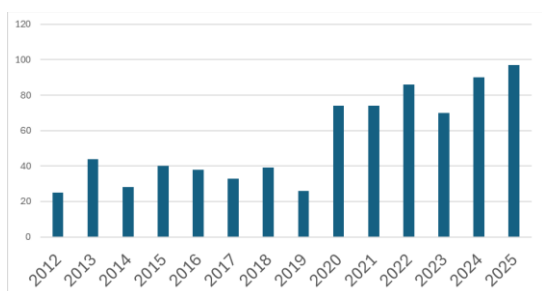


Figure 2: Number of publications in Web of Science on the topic Care Infrastructure in the period from 2010 to 2025

There are only 106 papers on Telecare and Rural Areas published in journals indexed in Web of Science.

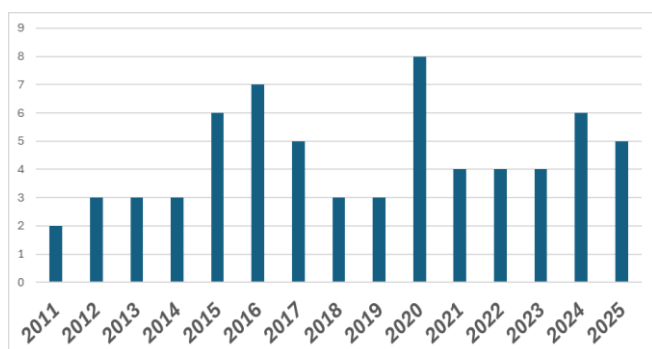


Figure 3: Number of publications published in journals indexed in Web of Science on the topic Telecare and Rural Areas in the period from 2010 to 2025

Research should consider the impact of telehealth interventions on established healthcare systems, accounting for professional, social, economic, infrastructural, and cultural conditions in rural areas [17]. Researchers need to examine the complex challenges, from technological, regulatory, and socio-cultural perspectives, that hinder the optimal adoption and use of these services [18]. The debate also includes whether artificial intelligence and other cutting-edge digital technologies can further transform remote healthcare by improving diagnostic accuracy and patient monitoring in these rural regions, as well as whether large amounts of both human and financial capital are needed to make these new techniques

take hold [19] [20] [21]. Examining the impact of precision medicine and virtual care models on improving outcomes within rural health systems in relation to the quadruple aim [22].

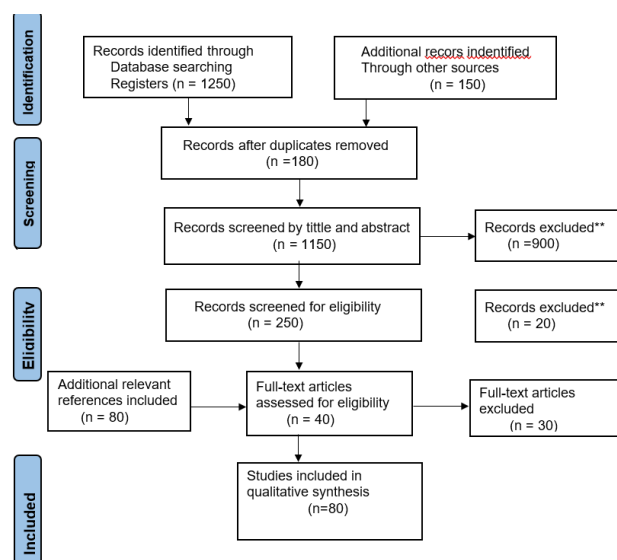


Fig 1. PRISMA DIAGRAM

Furthermore, the modular nature of telecare programs means they can be tailored to local requirements, enabling a "bottom-up" approach in which community input and support for local health workers are crucial to ensuring program sustainability [23]. Notably, the development of telemedicine is closely linked to advancements in mobile communication, sensors, and nanotechnology, which are poised to alter the patterns of future medical delivery [24]. Additionally, healthcare information technology helps improve the quality of care, delivery processes, and patient safety by minimizing human errors and improving organizational activities [25]. It also helps stakeholders and healthcare providers save money, decision-makers and organizations cut costs, and manage the diminishing number of trained clinicians in rural areas [26]. This new reality emphasizes the need for proactive policymaking and projects to meet the growing demand for remote healthcare while translating technological innovation needs into improvements in patient care and accessibility. Telemedicine is the use of information and communication technologies for the exchange of valid information for diagnosis, treatment, and prevention of disease and injuries, and for research and evaluation, and for the continuing education of healthcare providers, all in the interests of advancing the health of individuals and their communities[12]. This description focuses on telemedicine's core function: overcoming geographical limitations in healthcare, an essential service in rural areas with insufficient access to specialty care [27] [28]. The term telemedicine is also described by the Federation of State Medical Boards as the practice of medicine using various electronic methods, in which the physician and patient are not in the same location, and which requires remote consultations [29]. The historical narrative of telemedicine, spanning from its roots in long-distance semaphore and telegraph communication to its current advanced digital capabilities, highlights the evolution from basic tools for connectivity to complex tools for decision support and patient activation[30]. The success of such synchronous consultations depends on the availability and quality of appropriate technology as well as more structured

processes for assessing patients and making shared decisions [31]. Such flexibility also means that patients in underserved rural locations can obtain advanced medical advice without the logistical and financial costs of travel [32]. Furthermore, research on the socioeconomic causes of adoption and the effectiveness of hybrid-care models that incorporate both virtual and in-person services is critical to the optimal delivery of rural healthcare [33] [5]

3. RESEARCH AGENDA

Technological, economic, and policy factors hinder or enable the lay use of telecare services in rural areas [34] [12]. These areas should thus be a focus of future research to enhance and expand our understanding of the effects and limitations of telecare [35][24]. Researchers should examine the effectiveness and barriers to telecare implementation in rural areas, which should inform further work and policy-making [36][37] [38]. There are multifaceted barriers, including technological, regulatory, and socio-cultural dimensions that hinder the efficient provision and use of telecare services [39]. These include cybersecurity of sensitive patient data [40]. Research shows significant disparities in digital literacy and access, as well as a need for collaborative work and information sharing for integrated care [41]. Research has identified operational difficulties associated with telemonitoring and teleconsultation, including staff training and remuneration issues, as well as an unfair reward structure for additional work demands, which render these services unsustainable for integration into routine clinical care [42]. Furthermore, the literature reports a lack of uniform guidelines and policies governing telecare practices that address patient safety, data privacy, and access to care across diverse rural populations [43] [44]. Synthesising these results provides a foundation for discussing critical policy implications and areas for future research to improve the implementation of telecare in rural, underserved settings. This review aims to close these evidence gaps by consolidating the evidence base on telecare applications, identifying key success factors, and highlighting areas warranting further investigation to support rural healthcare equity. We critically examine whether and how telecare addresses the system challenges of access to care in these settings, including distance and provider shortages, with a special focus on the sustainability and scalability of these interventions [45]. Furthermore, telecare has significant potential to augment healthcare delivery in rural areas; however, inefficient technology infrastructure and low digital literacy among patients and healthcare providers hinder its success [46] [47]. Additionally, challenges to adopting telemedicine in rural regions include widespread distrust of digital technologies, a lack of patient self-efficacy in interacting with telecare technologies, and low social acceptance of participation in distance medical care services [48]. In addition, strong opposition from healthcare professionals and end users, combined with financial constraints and poor system quality, are key barriers to the widespread adoption of telemedicine in these areas [49]. Although telemedicine offers a potential approach to expanding healthcare access in underprivileged rural communities, it faces constraints in conducting comprehensive physical examinations and in providing specialised medical services at a distance [8].

Teleconsultations and remote monitoring are utilised to enhance access to care and improve health outcomes for rural populations, and we must consider both the benefits and drawbacks of telemedicine use [50] [8]. Locally adapted models are required based on specific social, economic, and technological contexts [51]. Furthermore, the implementation of these digital health tools can ease a burden on the local health systems by cutting long waiting times at outpatient departments and allowing remote access to specialist medical support – a factor which can improve both efficiency and reach in the delivery of care to people in the more rural areas [52]. Such are the challenges that underscore the need for a nuanced understanding of rural infrastructure and socio-cultural factors if telecare solutions are to be not only genuinely effective but, more importantly, sustainable [53]. These complex barriers and concerns require remediation through investment in digital infrastructure improvements, targeted, context-specific technological solutions, and education efforts to enhance digital health literacy among rural individuals [9]. A good understanding of these regulatory landscapes is therefore essential for creating robust, trustworthy telecare systems that can extend healthcare services to remote populations. It systematically reviews literature to elucidate themes, challenges, and practices related to the implementation of telecare in rural locales. It elucidates the technology and the social and policy issues that affect the effectiveness and sustainability of such interventions, providing a starting point for further research and policy-making. This discrepancy highlights the need for targeted research to bridge the gap between technological potential and actual utility in strengthening rural healthcare ecosystems [54].

4 DISCUSSION

This paper set out to clarify what is known—and what remains under-specified—about telecare as part of care infrastructure in rural areas, against the backdrop of population ageing, persistent rural–urban inequalities in access to care, and renewed momentum for remote service delivery models. Three discussion points stand out: (i) the scale mismatch between the broader telecare literature and the comparatively small evidence base explicitly addressing rural contexts; (ii) the need to treat telecare as a care-infrastructure intervention (not merely a digital tool); and (iii) the predominance of implementation barriers that are socio-technical, organizational, and regulatory rather than purely technological.

The literature mapping suggests a substantial body of work on telecare and a smaller but still meaningful body on care infrastructure, while the overlap explicitly targeting rural areas remains limited. This imbalance is not just a publication-count curiosity; it shapes what decision-makers can reliably generalize. Evidence generated in urban or well-resourced settings often presumes baseline conditions (broadband connectivity, device availability, dense provider networks, specialized support services, mature referral pathways, and stable reimbursement) that may not hold in rural environments. As a result, “telecare effectiveness” claims can become context-dependent: outcomes that look strong in well-supported systems may degrade when the enabling infrastructure is absent, fragmented, or unreliable.

A further interpretation is that “telecare in rural areas” is frequently studied under adjacent labels (telehealth, digital health, remote monitoring, virtual care, hospital-at-home), which can disperse the evidence across different indexing terms. This creates a classification problem: rural telecare may be undercounted when authors avoid the term “telecare,” while practice may move faster than the formal literature. Either way, the implication for research synthesis is clear: future reviews should use broader, harmonized vocabularies and explicitly define “rurality” (geographic remoteness, service density, travel time, socio-economic profile), because rural settings are not a single homogeneous category.

A core contribution of the review is the framing of telecare as a human–technology–organization system embedded in care infrastructure. This matters because the success conditions are not limited to whether video consultations or remote monitoring “work,” but whether the service system can safely and continuously deliver care at distance. In practice, telecare requires at least four coupled infrastructure layers:

Technical layer: connectivity, devices/sensors, data transmission reliability, cybersecurity controls, and technical support.

Clinical layer: protocols for triage, escalation, documentation, continuity, and management of clinical uncertainty when physical examination is limited.

Organizational layer: workflows, staffing models, task redistribution, training, interoperability with records, and integration with primary care, home care, rehabilitation, pharmacy, and social services.

Governance and financing layer: reimbursement rules, licensure/scope-of-practice alignment, data protection compliance, procurement standards, and accountability for adverse events.

The discussion here is that most “telecare adoption” problems emerge at the interfaces between layers (e.g., good devices but poor workflow integration; motivated clinicians but no reimbursement; adequate connectivity but weak cybersecurity and unclear liability; enthusiastic pilots that fail when scaled). This explains why the paper’s identified bottlenecks—digital literacy gaps, resource constraints, non-uniform regulatory protocols, and socio-cultural resistance—are so persistent: they are not bugs in the technology, but misalignments in infrastructure.

Equity and access: telecare can reduce distance, but may widen digital exclusion

Telecare is often positioned as an equalizer for geographically driven inequities, particularly where travel time, transport availability, and provider shortages constrain access. The review supports this potential: remote consultations, store-and-forward modalities, and remote monitoring can improve continuity, reduce avoidable travel, and extend specialist input to underserved populations.

However, the equity argument is conditional. Rural populations frequently include older adults and people with

multimorbidity—groups more likely to experience limited digital literacy, sensory impairments, cognitive decline, low confidence with technology, and constrained household resources. If telecare implementation assumes patient-side capacity that is not actually present, the burden of system functioning shifts from providers to patients and informal caregivers. This can invert the equity goal, producing a two-tier system: digitally fluent users gain access while others face additional friction.

The practical implication is that telecare programs should be assessed not only on utilization and clinical outcomes, but also on distributional effects: Who benefits? Who drops out? Who requires support? Equity-sensitive metrics (completion rates by age, education, income, disability; broadband and device availability; caregiver burden) should become routine in evaluation designs.

A recurring concern in rural telecare is the constraint on physical examination and the management of diagnostic uncertainty. This does not imply that telecare is inherently unsafe; rather, safety depends on clear clinical pathways: when a case is appropriate for telecare, when it is not, how escalation occurs, and how monitoring thresholds trigger timely intervention. Rural settings can complicate escalation (long distances to emergency services, limited local diagnostics), underscoring the importance of conservative triage protocols and robust handoffs.

Safety is also influenced by data integrity and continuity: missing data, device failures, poor connectivity, and unrecognized deterioration can pose risks. The review’s emphasis on preparedness and integration is therefore well-placed: telecare should be implemented as a clinical service with explicit safety engineering, not as an add-on communication channel.

The review highlights socio-cultural resistance and professional skepticism as non-trivial barriers. This aligns with what is commonly observed in digital health implementations: clinicians may resist when telecare increases workload, adds documentation steps, reduces perceived clinical control, or shifts responsibility without adequate compensation or training. Rural systems are particularly sensitive because staffing is often thin and role coverage is fragile; additional “digital work” can crowd out essential face-to-face services.

A key discussion point is the need to recognize and design for hidden labor: onboarding patients, troubleshooting devices, coordinating remote follow-up, monitoring dashboards, responding to alerts, and liaising with caregivers. If these tasks are not explicitly staffed and reimbursed, telecare becomes dependent on unpaid or under-recognized work—making scale-up unlikely. Workforce models should specify who does what (and when), including community-based roles (e.g., digital navigators, community health workers, home-care aides trained to support device use) that can be especially valuable in rural contexts.

Data protection, cybersecurity, and trust as enabling infrastructure

Concerns about privacy, data security, and trust are not peripheral—they are enabling conditions. Rural residents

may be especially sensitive to confidentiality in small communities, and breaches can damage trust quickly. The review's identification of cybersecurity and non-uniform regulatory protocols points to a broader governance need: consistent standards for authentication, access control, encryption, audit trails, vendor accountability, and incident response.

Trust also includes clinical trust (confidence in remote decisions) and system trust (belief that telecare is legitimate care, not "second-best"). Building that trust requires not only technical safeguards but transparent communication, consent practices that patients understand, and clear accountability when something goes wrong.

. 4 CONCLUSION

It is anticipated that the use of these technologies will reduce residents' functional decline and delay their relocation to a nursing home, thereby significantly reducing public spending on health care and long-term care for older people. This review carefully combines and summarizes available research and provides insight into how telecare can be used to overcome the spatial challenges of rural-based health care, especially those posed by the fact that rural-based health care tends to be deficient and often lacks dedicated infrastructure. The paper presents how telecare is currently being implemented in rural areas, reviews key infrastructural conditions for its successful roll-out, and highlights obstacles to its broader implementation. This review has highlighted the versatile advantages of telemedicine with its revolutionary capacity to alleviate healthcare disparities in rural settings through improved accessibility, efficiency, and outcomes. However, the effective and equitable use of telecare infrastructure in rural settings depends on overcoming perennial challenges, such as the digital divide, regulatory issues, and integration with the health care system. To address these gaps, a multifaceted plan is required that targets not only technology implementation but also policy creation, community involvement, and workforce education, to ensure that telecare solutions are appropriately applied and fit for purpose. Thus, studies should consider empirical evidence on long-term health equity and economically sustainable telecare models, as well as patients' satisfaction across different rural populations [8]. Additionally, studies are needed to assess the ethical and privacy implications of the broader use of telecare platforms for collecting and transmitting patient data in rural areas.

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