Advancing Regional and Remote Healthcare with Virtual Hospital Implementation: A Rapid Review

Artika Archana Kumari, Urooj Raza Khan, Tafheem Wani, Michael Liam, James Boyd

Submitted to: Journal of Medical Internet Research
on: July 20, 2024

Table of Contents

Advancing Regional and Remote Healthcare with Virtual Hospital Implementation: A Rapid Review

Artika Archana Kumari[1*] BSc, MSc, MDH; Urooj Raza Khan[1*] PhD; Tafheem Wani[1*] PhD, MIT; Michael Liam[1*] PhD; James Boyd[1*] PhD

[1]La Trobe University Bundoora AU
[*]these authors contributed equally

Corresponding Author:
Urooj Raza Khan PhD
La Trobe University
Plenty Road
Bundoora
AU

Abstract

Background: Health equity between metropolitan and rural areas is a global concern, especially in vast countries like Australia, Canada, and the USA. Virtual care models in healthcare settings show promise in reducing disparities, with virtual hospitals potentially bridging the gap for isolated or underserved regions. However, evidence-based strategies and the complexities of virtual hospital implementation necessitate further research.

Objective: This research examined the role of virtual hospitals in enhancing regional and remote healthcare by focusing on accessibility, patient and provider experiences, and implementation barriers and facilitators. It provides tailored recommendations for large-scale implementation in communities with access issues, contributing to the discussion on equitable healthcare.

Methods: A rapid review following WHO guidelines was conducted, covering 23 peer-reviewed articles and 12 sources of grey literature on virtual hospitals and virtual care-from-home services in regional and remote communities. Thematic analysis identified key themes.

Results: The findings were categorised into four main themes: 1) Clinical and Health System Outcomes: Virtual hospitals reduced admissions, mortality, and length of stay while improving compliance, healthcare processes, and access to care. 2) Patient and Provider Perspectives: Enhanced satisfaction due to convenience, time and cost savings, and improved service delivery. 3) Barriers and Facilitators: Barriers included poor digital and language literacy, lack of coordination and communication, technical infrastructure, and financing. Facilitators addressed these issues. 4) Recommendations: Successful implementation requires stakeholder collaboration, patient-centred approaches, digital equity, sustainable funding, smart technology, and improved digital literacy.

Conclusions: Virtual hospitals have the potential to revolutionise regional and remote healthcare by overcoming barriers, utilising facilitators, and following recommended practices, leading to better clinical outcomes and increased satisfaction for patients and providers.

(JMIR Preprints 20/07/2024:64582)
DOI: https://doi.org/10.2196/preprints.64582

Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

✓ **Please make my preprint PDF available to anyone at any time (recommended).**
Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.
Only make the preprint title and abstract visible.
No, I do not wish to publish my submitted manuscript as a preprint.

2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✓ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**
Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain v
Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in <a href="http

Original Manuscript

Authors

Name	Designation	Affiliation
A Kumari	MSc, MDH	La Trobe University
U Khan	PhD	La Trobe University
M Liem	PhD	La Trobe University
T A Wani	PhD	La Trobe University
J H Boyd	PhD	La Trobe University

A Kumari, MSc, MDH; U Khan, PhD; T A Wani, PhD; M Liem, PhD; J H Boyd PhD

Advancing Regional and Remote Healthcare with Virtual Hospital Implementation: A Rapid Review

Abstract

Background: Health equity between metropolitan and rural areas is a global concern, especially in vast countries like Australia, Canada, and the USA. Virtual care models in healthcare settings show promise in reducing disparities, with virtual hospitals potentially bridging the gap for isolated or underserved regions. However, evidence-based strategies and the complexities of virtual hospital implementation necessitate further research.

Objective: This research examined the role of virtual hospitals in enhancing regional and remote healthcare by focusing on accessibility, patient and provider experiences, and implementation barriers and facilitators. It provides tailored recommendations for large-scale implementation in communities with access issues, contributing to the discussion on equitable healthcare.

Methods: A rapid review following WHO guidelines was conducted, covering 23 peer-reviewed articles and 12 sources of grey literature on virtual hospitals and virtual care-from-home services in regional and remote communities. Thematic analysis identified key themes.

Results: The findings were categorised into four main themes: 1) Clinical and Health System Outcomes: Virtual hospitals reduced admissions, mortality, and length of stay while improving compliance, healthcare processes, and access to care. 2) Patient and Provider Perspectives: Enhanced satisfaction due to convenience, time and cost savings, and improved service delivery. 3) Barriers and Facilitators: Barriers included poor digital and language literacy, lack of coordination and communication, technical infrastructure, and financing. Facilitators addressed these issues. 4) Recommendations: Successful implementation requires stakeholder collaboration, patient-centred approaches, digital equity, sustainable funding, smart technology, and improved digital literacy.

Conclusions: Virtual hospitals have the potential to revolutionise regional and remote healthcare by overcoming barriers, utilising facilitators, and following recommended practices, leading to better clinical outcomes and increased satisfaction for patients and providers.

Keywords: virtual hospitals; regional and remote healthcare; healthcare accessibility; patient experiences; provider perspectives; rural healthcare; telehealth; virtual care from home; telemedicine; health system outcomes; clinical outcomes; barriers and facilitators; recommendations.

Introduction

Healthcare disparities between rural and remote regions and urban centers are a global challenge. Countries like Australia, Canada and the USA have documented significant disparities in access and outcomes (1-3). Data from the Australian Institute of Health and Welfare reveals a 1.4-fold increased incidence of disease in remote and very remote regions compared to urban cities (4). Furthermore, in very remote regions, the risk of premature mortality is elevated by 1.3 times for men and 1.5 times for women compared to metropolitan areas. This disparity aligns with findings from the Centers for Disease Control and Prevention (CDC), which highlights the challenges faced by rural Americans due to limited access to specialised and emergency healthcare, ultimately contributing to a higher prevalence of preventable deaths in these communities (5).

Traditional healthcare models often struggle to provide equitable services in geographically isolated regions due to shortages of medical facilities, specialised professionals, and advanced diagnostic equipment. Consequently, rural and remote populations experience higher rates of preventable diseases, avoidable hospitalisations, and mortality compared to urban counterparts (2, 5, 6).

The emergence of virtual health offers a promising solution to bridge the healthcare gap in regional and remote locations. Virtual health, driven by digital technologies, has made considerable strides, transforming primary, secondary, and tertiary care services. Healthcare institutions have embraced virtual health solutions such as virtual hospitals (VH) to provide advanced treatments, surgical consultations, multidisciplinary team discussions, and hospital-at-home care, enhancing patient access to complex medical interventions. VH leverage digital initiatives such as telehealth and telemedicine technologies to deliver a comprehensive range of remote healthcare services, including consultations, diagnostics, treatment plans, and hospital-level care at home (7). These services are typically delivered through videoconferencing, web platforms, mobile apps, and other digital channels. Figure 1 further illustrates the concept of VH.

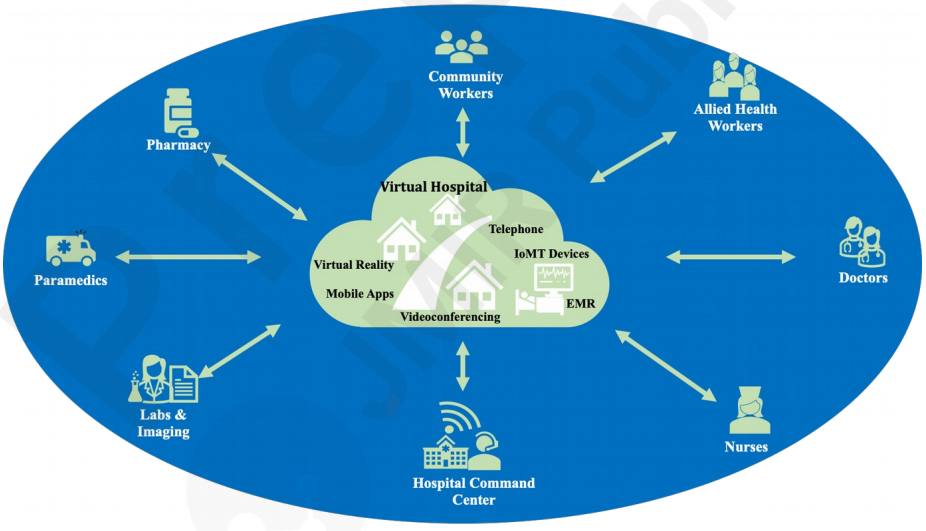

Figure 1: Concept of Virtual Hospital

Unlike traditional hospitals with physical infrastructure, VH operates primarily in the digital realm. Their significance lies in their ability to transcend geographical barriers, enhancing access to healthcare for patients in remote or underserved areas (8). It is important to note that while the terms VH, virtual care, hospital at home (virtual wards), and telehealth are sometimes used interchangeably, there are key distinctions between them. Virtual care is the broadest term, encompassing any form of healthcare delivered remotely, often involving consultations with doctors or specialists via video or phone calls. While telehealth is a subset of virtual care that focuses on telecommunications technology for remote consultations and patient monitoring. VH, on the other hand, represents a more comprehensive approach to remote healthcare, offering a wide range

of services beyond consultations, including remote diagnostics, treatment plan development, and virtual wards. Hospital-at-home programs, a subset of VH or standalone initiatives, provide hospital-level care in the patient's home, incorporating remote monitoring and regular consultations.

The COVID-19 pandemic accelerated the adoption of virtual hospitals (VH) as a means to manage healthcare demands while mitigating infection risks. This rapid expansion led to demonstrated improvements in patient outcomes, including Length of Stay (LoS) and improved wait times (9-11). Success stories like the RPA virtual hospital (12), the Mayo Clinic Advanced Care at Home program(13) and the Victorian Virtual Emergency Department (14) further, exemplify the capability of VH to deliver effective healthcare remotely. The experience gained during the pandemic highlights the need for strategic planning and investment in VH to address healthcare disparities in rural and remote areas (15, 16).

The successful implementation of VH is a complex endeavour, requiring careful planning, assessment, and integration of digital technologies (17). Challenges such as inadequate guidance, poor governance, technological literacy, and concerns about safety and privacy can hinder the seamless adoption of VH and related virtual care-from-home solutions (10, 11). To overcome these barriers and successfully implement VH, evidence-based recommendations must be prioritised (18).

Research Focus and Aims

Despite the potential of VH to transform healthcare delivery, there is a notable lack of evidence supporting context-specific and comprehensive implementation strategies of these systems (19). Existing research often focuses on individual virtual care programs rather than the broader array of integrated healthcare technologies used in VH (20). To effectively deliver virtual hospital services, a deeper understanding of how different virtual care technologies contribute to overall patient care is essential. This knowledge is critical for optimising the design, implementation, and scalability of VH services, particularly in rural and remote regions..

Current evidence highlights the potential of VH to revolutionise healthcare delivery by offering improved clinical and health system outcomes, enhanced provider and patient experiences, and increased healthcare accessibility. However, this evidence is largely limited to the broader healthcare landscape, with a noticeable gap in understanding the specific application of VH in regional and rural settings. Existing studies discuss the clinical effectiveness of VH but primarily address the general population (21, 22). Similarly, research on the barriers, facilitators, and recommendations for implementing VH does not align with the unique challenges of regional and remote communities, such as limited access to specialists, longer travel distances, and a higher prevalence of preventable conditions (10, 11). This gap in the literature necessitates research focused on tailored recommendations, barriers, and facilitators specific to virtual hospital implementation in regional and remote areas, enabling healthcare systems to fully harness the potential of this innovative approach.

This rapid review aims to synthesize existing evidence on the role of VH in enhancing healthcare delivery in regional and remote areas. It seeks to analyse clinical and health system outcomes, explore patient and provider perspectives, identify implementation-related barriers and facilitators, and provide recommendations for its successful implementation. The findings will contribute to evidence-based policymaking and decision-making to optimise the use of VH in addressing healthcare disparities in challenging geographic settings.

Methods

A rapid review was conducted to assess the potential of VH in addressing healthcare disparities in regional and remote areas. This approach aligns with the need to understand how VH address healthcare disparities and improves access for remote and underserved populations in a timely manner. By analysing a wide range of literature, a rapid review helped in identifying the most current evidence and trends, providing a comprehensive overview of the benefits, challenges, and best practices associated with developing VH to

support regional and remote healthcare.

Using the WHO rapid review guideline (26) and the 2020 PRISMA statement (27), a systematically defined, transparent, and concise approach was employed to identify relevant peer-reviewed articles and grey literature, extract relevant information, and synthesise the findings of this review.

Protocol Development

The research protocol for this study was developed using the PICO framework (23). The protocol, as presented in Table 1, guided the development of the search strategy.

Table 1: PICO Protocol Development

Parameter	Description	Keywords
Population	- Patients living in regional and remote areas. - Patients having limited access to healthcare due to distance and lack of resources	regional health, rural health, remote health, rural health services remote and regional area health
Intervention	Building virtual hospitals using telemedicine, telehealth, or e-health technologies	virtual hospital, telemedicine telehealth, telemonitoring, remote consultation, virtual care, virtual health, e-health, mhealth, health virtualisation
Comparison	Physical Public & Private Hospitals (Traditional healthcare delivery models) without virtual hospitals or digital health technologies	
Outcome	Improved healthcare access, quality of care, patient satisfaction, healthcare provider satisfaction, reduced healthcare costs, and improved health outcomes	healthcare delivery, healthcare access, health planning, hospital strategy, healthcare accessibility, clinical effectiveness, user experience, implementation, best practices, recommendations, enablers, strategies, benefits, facilitators, challenges, barriers, problems

Search Strategy

We searched for peer-reviewed articles from January 2015 to March 2023 across three key databases: PubMed, Medline, CINAHL, and the La Trobe University Library. Our search strategy was designed to align with the PICO framework, employing two distinct approaches. The first strategy targeted articles discussing enablers and facilitators of virtual hospital implementation, while the second strategy focused on identifying literature addressing barriers, challenges, and limitations. The number of articles retrieved from individual databases or systems for each search strategy is detailed in Appendix.

To identify relevant grey literature, the research topic “Advancing Regional and Remote Healthcare with Virtual Hospital Implementation” was googled, and from the first four pages of the search result, policy documents and web articles that discussed the research questions were marked as relevant and selected for further analysis. Snowballing was also used to screen and select other grey literature cited in relevant web articles (24).

Inclusion and Exclusion Criteria

A set of inclusion and exclusion criteria was developed using the PICO framework (Table 3). Included were: (a) studies addressing regional or remote populations or populations facing healthcare access difficulties; (b)

studies discussing recommendations, strategies, facilitators, barriers, challenges, or limitations to VH or virtual care-from-home solutions, telehealth, telemedicine, eHealth, mHealth, and remote monitoring for hospital-level care at home; (c) studies discussing clinical or health system outcomes, user experience, and patient perspectives of the innovative technologies used in developing VH and (d) studies with country as Australia or countries with similar geographic landmass such as Canada, the USA or India.

Excluded were (a) studies addressing urban or suburban population settings with comprehensive and timely healthcare access and (b) studies solely discussing hybrid models of care. Furthermore, only peer-reviewed studies published in English between January 2015 and March 2023 were included.

Table 2: Inclusion and Exclusion Criteria

Parameter	Inclusion Criteria	Exclusion Criteria
Population	-People of all age groups living in regional or remote regions -People with acute or chronic illness experiencing difficulties in accessing healthcare due to distance and lack of resources	-People living in urban or suburban areas -People having no limitation to healthcare access
Intervention	-Virtual hospital or virtual care-from-home implementation -Telemonitoring/ telehealth/ telemedicine implementation supporting care-from-home -Ehealth/ Mhealth implementation -Remote Monitoring -Country = Australia or countries with similar healthcare systems and geographic challenges. -Discusses recommendations, opportunities and challenges of implementing healthcare virtualisation -Discusses patient or provider experience or successful virtual hospital or virtual care-from-home implementation stories	-Traditional healthcare delivery models with minimum virtualisation -Virtualisation in urban and suburban geographic regions
Comparison	-Optional comparison group: people with no limitations accessing healthcare but prefer virtual consultation included.	
Outcomes	-Clinical outcomes of healthcare virtualisation (Improvements in health for people living in remote or regional areas or having limited access to resources) -Improved delivery of services -Success strategies(stories) of virtual hospital implementation -Program user experience (Access, engagement, usability, experience, satisfaction) -Changes in healthcare resourcing	-Studies discussing only the benefits and challenges of telehealth or telemedicine -Studies discussing user perspectives only
Studies	-Published in peer-reviewed journals, conference proceedings, or healthcare services reports. -Published in the English language -Published between January 2015 to March 2023	-Studies or reports from unverified sources -Has not been peer-reviewed -Published in other languages -Published before January 2015 or after March 2023

Screening & Study Selection

The PRISMA diagram (Figure 2) demonstrates the screening and selection process.

Figure 2: Prisma Diagram

Data Extraction and Knowledge Synthesis

A data extraction template was customised in Microsoft Excel, which was then used to systematically extract and record relevant information from the studies and grey literature included. The template was prepared based on extraction variables retrieved from the research question and objectives. Apart from the core characteristics such as title, abstract and author, the data extraction template included demographic location, healthcare conditions addressed, healthcare services provided virtually, virtual care technology used,

healthcare outcomes, patient satisfaction, provider perspectives, barriers and facilitators, and recommendations and strategies for implementation. This approach helped ensure consistency and accuracy during the data extraction process. Additionally, a concept matrix was constructed to assess the relevance of each study to specific research objectives.

A mixed-method thematic analysis was used to extract information from the included studies to identify recurring patterns, emerging trends, and insights into common recommendations for developing VH and their related barriers and facilitators (25). Data was also analysed to identify common themes emerging from clinical and healthcare system outcomes and patient and provider perspectives.

Results

Study Characteristics

Overall, 23 peer-reviewed articles and 12 grey literature sources were included in our review (Figure 2). Detailed characteristics of all included peer-reviewed articles and grey literature are presented in Tables 4 and 5. Among the peer-reviewed articles, 12 focused on telehealth interventions (26-37), 6 discussed virtual hospital or hospital-at-home interventions (38-43), 2 examined telemedicine (44, 45), 2 addressed remote patient monitoring (46, 47), and 1 evaluated a virtual pharmacy (48). In the grey literature, 8 of the 12 pieces discussed virtual care-from-home solutions comprehensively (49-57), while 4 articles specifically addressed the concept of VH (51, 58-60).

In terms of digital technology used for virtual hospital implementation, the majority of the peer-reviewed articles explored the use of videoconferencing (n=20) (26-28, 30-34, 36-42, 44-48), followed by telephone communication (27, 29, 30, 38, 39, 42-44, 47)and wearable sensors (6, 28, 30, 32, 33, 43, 45, 46) 7 studies focused on the use of online EMR systems (28, 29, 38, 42, 43, 46, 48), 5 studies described mobile applications (28, 30, 37, 39, 46), while 4 studies highlighted text messaging for virtual care (30, 35, 39, 46). Other technologies such as store and forward (n=3) (26, 32, 33), email and chatbot (n=1) (46) and robotic ultrasonography (n=1) (33) were also included as supportive virtual hospital technologies. Among the 12 grey literature, only 2 reports explicitly addressed virtual care-from-home technologies. Miranda Shaw and Wilson (60) discussed the use of videoconferencing, IoMT devices, and telephone technology for remote monitoring and directed self-care while Microsoft Australia (59) concentrated on the use of mixed reality and space technology to support virtual hospital implementation. The remaining 10 grey literature sources holistically discussed the implementation and use of digital care technologies.

Study Design

Among the 23 peer-reviewed studies, 6 were case studies(27, 38, 41, 42, 44, 48). One study was a mixed-method study (28). Additionally, there were 8 qualitative studies (29, 31, 32, 34-37, 46), one quantitative study (40), one scoping review (47), two systematic reviews (26, 43), and four low-quality commentaries (30, 33, 39, 45). Among all included articles, only two reported selection bias(40, 42). For grey literature sources, there were two national strategies (50, 52), three state-level strategy documents (54, 55, 57), six web reports (49, 51, 56, 58-60), and one telecommunications survey report (53).

Table 3: Included Peer-Reviewed Articles

Study	Title	Country	Study Design	Population	Healthcare Condition Addressed	Intervention Discussed
AlDossary *et al.* (44)	The Development of a Telemedicine Planning Framework Based on Needs Assessment	USA	Case Study	N/A	Equitable access to specialty healthcare services	Telemedicine
Davis *et al.* (27)	Designing a multifaceted telehealth intervention for a rural population using a model for developing complex interventions in nursing	USA	Case Study	The study involved a team of health policy, management, and leadership (HPML) faculty members, a graduate student, a program manager, two telehealth experts, and state stakeholders. The stakeholders included the TMH Director, BMS medical director, two BMS nurses, the program manager for the state traumatic brain injury waiver, the director of the WV Home and Community-Based Services program, one Medicaid Waiver participant advocate, and the chief operations officer.	Multiple chronic conditions	Telehealth
DeHart *et al.* (28)	Benefits and Challenges of Implementing Telehealth in Rural Settings: A Mixed-Methods Study of Behavioral Medicine Providers	USA	Mixed Methods	17 Healthcare Providers	Mental Health	Telehealth

Giroux *et al.* (39)	It's not one size fits all: a case for how equity-based knowledge translation can support rural and remote communities to optimize virtual health care	Canada	Commentary	N/A	Equitable access to healthcare services	Virtual Hospital - Hospital in the Home
Haque *et al.* (29)	Factors influencing telehealth implementation and use in frontier critical access hospitals: Qualitative study	USA	Qualitative study	36 Stakeholders (8 Critical Access Hospitals)	Frontier Critical Access Care	Telehealth
Head *et al.* (40)	Virtual Visits for Outpatient Burn Care During the COVID-19 Pandemic	USA	Quantitative study	143 Patients	Burn care	Virtual Hospital - Hospital in the Home
Hirko *et al.* (30)	Telehealth in response to the COVID-19 pandemic: Implications for rural health disparities	USA	Commentary	N/A	Ambulatory practices and triage before hospitalisation	Telehealth
Howland *et al.* (31)	Psychiatrist and Psychologist Experiences with Telehealth and Remote Collaborative Care in Primary Care: A Qualitative Study	USA	Qualitative study	Tele psychiatrists - 10 Telepsychologist - 4	Mental Health	Telehealth
Jong *et al.* (33)	Enhancing access to care in northern rural communities via telehealth	Canada	Commentary	N/A	General healthcare	Telehealth

LeBlanc *et al.* (47)	Patient and provider perspectives on Ehealth interventions in Canada and Australia: A scoping review	Australia and Canada	Scoping Review	N/A	General healthcare	Remote Patient Monitoring
Thomas *et al.* (37)	Health workforce perceptions on telehealth augmentation opportunities	Australia	Qualitative study	53 - Healthcare professionals	Primary healthcare	Telehealth
Johnston *et al.* (32)	"From the technology came the idea": safe implementation and operation of a high quality teleradiology model increasing access to timely breast cancer assessment services for women in rural Australia	Australia	Qualitative study	55 Service Providers	Breast Cancer Screening	Telehealth
Correale *et al.* (38)	A Model to Implement Standardized Virtual Care for Low Back Pain Amongst a Large Network of Providers in Urban and Rural Settings	Canada	Case Study	12 Focus Group	MaN/Agement of Lower Back Pain	Virtual Hospital - Hospital in the Home
Kocanda *et al.* (34)	Informing telehealth service delivery for cardiovascular disease management: exploring the perceptions of rural health professionals	Australia	Qualitative	10 Healthcare Professionals	Cardiovascular Disease	Telehealth
McPherson and Nahon (35)	Telehealth and the provision of pelvic health physiotherapy in regional, rural and remote Australia	Australia	Qualitative study	54 Participants	Pelvic Health	Telehealth
Allan *et al.*	"This is streets ahead of what	Australia	Case Study followed by	15 Focus Groups (42 nurses, 8	Use of medication in	Virtual Pharmacy

(48)	we used to do": staff perceptions of virtual clinical pharmacy services in rural and remote Australian hospitals		Qualitative analysis	doctors, 12 managers, 4 allied health, 3 pharmacists)	rural and remote NSW public hospitals	
Nataliansyah *et al.* (36)	Managing innovation: a qualitative study on the implementation of telehealth services in rural emergency departments	USA	Qualitative study	18 Participants	Emergency Department	Telehealth
Kuperman *et al.* (41)	The virtual hospitalist: a single site implementation bringing hospitalist coverage to critical access hospitals	USA	Case Study	N/A	Emergency and Inpatient care at critical access hospitals	Virtual Hospital - Hospital in the Home
Sitammagari *et al.* (42)	Insights from rapid deployment of a virtual hospital as standard care during the COVID-19 pandemic	USA	Case Study	1477 Patients	COVID-19	Virtual Hospital - Hospital in the Home
Vindrola-Padros *et al.* (43)	Remote home monitoring (virtual wards) for confirmed or suspected COVID-19 patients: a rapid systematic review	UK, US, Canada, China, Netherlands, Ireland, Brazil, Australia	Systematic review	N/A	COVID19 positive cases	Virtual Hospital - Hospital in the Home
Haleem *et al.* (45)	Telemedicine for healthcare: Capabilities, features, barriers, and applications	India	Commentary	N/A	General healthcare	Telemedicine
Gray *et al.* (46)	The Rapid Development of Virtual Care Tools in Response to COVID-19: Case Studies in Three Australian Health Services	Australia	Qualitative	13 Participants	COVID-19	Remote Patient Monitoring
Bradford *et al.* (26)	Telehealth services in rural and remote	Australia	Systematic Review	N/A	General healthcare	Telehealth

	Australia: a systematic review of models of care and factors influencing success and sustainability				

Table 4: Included Grey Literature

Literature	Title	Country	Literature Type	Healthcare Condition Addressed	Intervention
Miranda Shaw and Wilson (60)	RPA Virtual Hospital Proof of concept trial Evaluation Report 2020–2021	Australia	Web Report	Overall Hospital Care	Virtual Hospital
Rowan Strain *et al*. (56)	Improving equity of access in rural and regional health through hybrid and connected care	Australia	Web Report	General Health	Virtual Care-From-Home
Microsoft Australia (59)	Remote Australian community harnesses mixed reality and space technologies to deliver better healthcare	Australia	Web Report	General Health	Virtual Hospital
Hospital and Healthcare (58)	The virtual hospital	Australia	Web Report	General Health	Virtual Hospital
Agency for Clinical Innovation (49)	Virtual care in practice	Australia	Web Report	General Health	Virtual Care-From-Home

Australian Government - Department of Health (52)	Future focused primary health care: Australia's Primary Health Care 10 Year Plan 2022-2032	Australia	National Strategy	General Health	Virtual Care-From-Home
Queensland Government (55)	Digital Strategy for Rural and Remote Healthcare - 10 Year Plan	Australia	State Strategy	General Health	Virtual Care-From-Home
Northern Territory Government (54)	NT Health Virtual Care Strategy	Australia	State Strategy	General Health	Virtual Care-From-Home
Victoria Department of Health (57)	Virtual Care standard and guide	Australia	State Strategy	General Health	Virtual Care-From-Home
Australian Government - Department of Health (50)	National Strategic Framework for Rural and Remote Health	Australia	National Strategy	General Health	Virtual Care-From-Home
Australian Government - Department of Infrastructure (51)	Better Connectivity Plan for Regional and Rural Australia	Australia	Web Report	General Health	Virtual Hospital
National Rural Health Alliance (53)	Regional Telecommunications Review 2021	Australia	Telecommunications Survey Report	General Health	Virtual Care-From-Home

Clinical Outcomes

Only 7 academic studies and 2 grey literature sources assessed the clinical outcomes of the VH or virtual care-from-home models.

Findings from existing literature demonstrate that VH have contributed towards positive clinical outcomes, including specialist medication advice, better medication knowledge, reduced medication errors (48), reduced disease transmission (42, 45), minimised disease exposure to staff (42), improved patient safety (46, 48), reduced admission and readmission (41, 60), lower mortality, shorter length of stay, and maximised adherence to clinical best practices (41, 43, 58).

According to Allan *et al.* (48), VH facilitate enhanced medication management by enabling specialists to provide tailored advice based on individual patient needs. This personalised approach improves patient understanding and medication adherence. Furthermore, by facilitating direct communication between healthcare providers and specialists, VH can help reduce medication errors since specialists can review prescriptions remotely, identify potential errors, and provide immediate feedback or corrections.

VH also enable remote consultations, diagnosis, and monitoring, reducing the need for physical interaction between patients and healthcare staff (42, 45). This reduces the risk of disease transmission, particularly in cases of infectious diseases. Moreover, by minimising in-person visits, healthcare staff are exposed to fewer patients, reducing their risk of contracting contagious diseases.

Gray *et al.* (46), Allan *et al.* (48) emphasised the role of continuous monitoring and timely interventions in enhancing patient safety. Remote monitoring devices and telemedicine consultations enable early detection of complications, facilitating prompt medical interventions and reducing the risk of adverse events. Through remote monitoring and timely interventions, VH can also manage chronic conditions more effectively, thereby reducing the frequency of hospital admissions and readmissions (41, 60). Additionally, by providing patients with better access to healthcare resources and support, VH can prevent exacerbations of chronic conditions, further reducing hospitalisations.

VH have demonstrated potential in improving patient outcomes and reducing healthcare costs. By enabling continuous monitoring and timely interventions, VH contribute to reduced mortality rates, shorter hospital stays, and lower readmission rates. Vindrola-Padros *et al.* (43) reported that virtual wards for COVID-19 patients had lower mortality rates, only 29% admission to the ED and less than 36% readmission rate. Likewise, Kuperman *et al.* (41) reported that the pilot virtual hospital pilot recorded a 6% decrease in patient transfers, a 17% decrease in admissions, and a 3.7% decrease in LoS. (40), also discussed that virtual care-from-home for burn-injured patients has similar clinical outcomes when compared to in-person care. None of the studies reported negative clinical outcomes for VH.

Despite diverse healthcare conditions, studies revealed similar clinical outcomes. For instance, (40), concentrated on burn care, Kuperman *et al.* (41) discussed emergency and inpatient care, and Miranda Shaw and Wilson (60) addressed overall hospital care, however, all reported that VH reduced admission, readmission, and transfer in their respective studies. Likewise, Gray *et al.* (46), addressing virtual pharmacy, and Allan *et al.* (48), discussing COVID-19, both discovered that virtual care-from-home solutions improve patient safety.

Health System Outcomes

A total of 12 academic studies and 3 grey literatures sources discussed 9 positive health system outcomes.

The reported outcomes include improved access to care and efficient use of resources (28, 41, 43, 60), reduced patient and healthcare costs (26, 28, 37, 40, 42, 45, 47), enhanced patient experience and safety (45-47, 58), enhanced healthcare delivery and provider support through trusted workflow and virtual relocation (42, 43, 47, 48), improved process outcomes and enhanced compliance (26, 41, 43, 47, 60), enhanced

geographic coverage, and better integration of healthcare services (56, 60).

VH utilise telemedicine technologies to provide remote healthcare services, enabling patients to access healthcare professionals without physical travel, and enhancing access to care in underserved areas (28, 41, 43, 60). Similarly, VH enhance healthcare efficiency by streamlining delivery processes, reallocating resources towards virtual care platforms, reducing physical infrastructure requirements, and resulting in cost savings and improved service delivery.

VH also lower patient and healthcare costs by minimising the need for in-person visits, hospitalisations, and associated travel expenses. Telemedicine consultations and remote monitoring enable timely interventions, preventing costly complications and reducing the overall healthcare expenditure for patients and healthcare providers. According to Head *et al.* (40), virtual visits resulted in significant savings, including an average reduction of 130 miles in travel distance, 164 minutes of travel time, US$104 in travel costs, and US$81 in forgone wages due to the time saved from not having to travel. None of the articles highlighted negative healthcare system outcomes.

Again, VH can offer convenient and personalised healthcare experiences tailored to patients' needs since remote consultations and digital health tools empower patients to actively participate in their care, leading to greater satisfaction and engagement (45-47, 58). Additionally, virtual care models prioritise patient safety by minimising exposure to healthcare-associated infections and promoting adherence to evidence-based practices. Similarly, by leveraging technology to optimise healthcare delivery processes and support healthcare providers in delivering high-quality care, virtual hospital facilitators have managed to enable seamless coordination among multidisciplinary teams, improving communication, collaboration, and patient outcomes (42, 43, 47, 48). The virtual support systems also enhance provider efficiency and job satisfaction, ultimately enhancing the overall quality of care delivery.

Findings from the literature also reveal that VH improve healthcare by standardising workflows, promoting clinical adherence, and facilitating efficient data management (26, 41, 43, 47, 60). The use of digital health solutions helps improve care coordination and patient outcomes while ensuring regulatory compliance and quality standards in healthcare delivery.

The findings are consistent across different healthcare conditions. While Head *et al.* (40), DeHart *et al.* (28), Kuperman *et al.* (41), Miranda Shaw and Wilson (60), Vindrola-Padros *et al.* (43) each focus on burn care, mental health, emergency and inpatient, general hospital care, and COVID-19, respectively, their studies collectively highlight that healthcare virtualisation significantly improves access to care. The Australian-based RPA virtual hospital has also received positive feedback from patients for the convenience and stress-reducing benefits of receiving care from home (60).

Rowan Strain *et al.* (56), Miranda Shaw and Wilson (60) also reported that VH offer healthcare services beyond traditional boundaries, improving accessibility and enabling broader geographic coverage. Telemedicine and remote monitoring enable patients to have specialised care, reducing disparities in access. This care model also facilitates better integration of healthcare services by fostering collaboration among providers, improving care transitions, and promoting continuity of care across different settings.

Patient Perspectives

8 peer-reviewed articles and 1 web report examined patient perspectives regarding the implementation of VH and virtual care-from-home solutions.

Allan *et al.* (48) and Correale *et al.* (38) highlighted high patient acceptance and satisfaction with virtual care-from-home services. Similarly, DeHart *et al.* (28) noted increased satisfaction due to time, cost, and travel savings from telehealth services for rural patients. Likewise, Giroux *et al.* (39) disclosed that quality virtual care-from-home enhances empowerment, self-management, and expanded access to culturally appropriate care locally.

Patient involvement in remote care is associated with improved outcomes and satisfaction Vindrola-Padros *et al.* (43) VH provide patients with the convenience of receiving treatment locally rather than having to relocate to a secondary care hospital thus leading to an increased level of satisfaction Gray *et al.* (46) and Kuperman *et al.* (41) While none of the studies discussed the negative patient perspective, LeBlanc *et al.* (47) stated that patient satisfaction is highly dependent on technological proficiency, healthcare provider readiness, and the quality of care provided virtually.

Healthcare Provider Perspectives

Eight peer-reviewed articles and one grey literature discussed the provider perspectives on the implementation of VH and virtual care-from-home solutions.

Positive healthcare provider perspectives included increased provider satisfaction (32, 48), enhanced service delivery (32, 48), better collaboration and teamwork (28, 38, 39, 49), and increased efficiency and accessibility (41, 45, 47, 49). Providers reported that VH and hospital-in-the-home solutions offer them more flexibility in delivering care and managing their workload. They can engage in telemedicine consultations, remote monitoring, and virtual care delivery, which leads to reduced burnout and increased job satisfaction. The convenience and efficiency of virtual care platforms contribute to a more satisfying work environment for healthcare professionals. Both articles also highlighted that providers reported that VH improve healthcare delivery by enabling telemedicine consultations and remote monitoring, thus allowing them to reach a wider patient population, deliver timely interventions, and offer continuous support. The providers also stated that the integration of digital health tools allows for enhanced service quality, accessibility, and patient outcomes.

Healthcare providers also expressed that virtual care platforms allow them to facilitate collaboration and communication among healthcare team members, regardless of their physical location (41, 45, 47, 49). Rural providers can easily consult with specialists, share patient information, and coordinate care plans in real-time, promoting interdisciplinary collaboration and teamwork. This seamless exchange of information enhances care coordination and improves patient outcomes.

Studies by Allan *et al.* (48) and Johnston *et al.* (32) indicated that enhanced service timeliness, greater accessibility, and reduced provider travel time increased provider satisfaction. They also stated that improved workflows and clinic processes and better medication management further contributed to enhanced service delivery.

No patients or healthcare providers reported negative views of the results.

Barriers in Virtual Hospital Implementation

Barriers to virtual hospital implementation were reported in 21 peer-reviewed articles and 6 web reports.

Poor digital literacy and language barriers among rural patients emerged as significant obstacles, hindering successful virtual hospital adoption. Language barriers and a lack of digital skills presented challenges in connecting remote patients with virtual care solutions, contributing to a digital gap (37, 39, 42, 47, 60). The lack of digital skills also presents a substantial obstacle in connecting remote patients with virtual care-from-home solutions (28, 46, 60). These issues often deter patients for engaging in virtual care services (46) and a lack of patient commitment to continue using virtual care-from-home services (28). Healthcare providers' low adoption and lack of provider knowledge/skills were also reported, resulting in resistance to change and workforce constraints, indicating a need for targeted strategies to address these issues (26-29, 33, 37, 42, 57, 60).

Technological barriers such as poor technical infrastructure and connectivity (30, 34, 37-40, 42, 45, 47, 53, 56, 57), limited technical support (28, 35, 39, 46, 47, 49, 57, 60), restricted access to digital equipment (27, 32, 35, 38, 42, 46, 49), and legacy and outdated technologies (36, 57, 60) were also identified as significant barriers to virtual hospital implementation for regional and remote communities.

In remote and rural areas, inadequate technical infrastructure and connectivity hinder the effective deployment of virtual hospital services (30, 34, 37-40, 42, 45, 47, 53, 56, 57). Without reliable internet access and robust communication networks, healthcare providers and patients face challenges in accessing telemedicine consultations, remote monitoring, and digital health platforms.

Similarly, the absence of adequate technical support exacerbates challenges associated with virtual hospital implementation (28, 35, 39, 46, 47, 49, 57, 60). Healthcare providers and patients encountered difficulties in troubleshooting technical issues, configuring digital devices, or navigating telemedicine platforms.

Another major technological barrier faced by individuals in remote and underserved communities is a lack of access to digital devices such as tablets, webcams, or computers, which are essential for participating in virtual care consultations (27, 32, 35, 38, 42, 46, 49). The digital divide exacerbates disparities in healthcare access and highlights the need for initiatives aimed at providing digital equipment to marginalised populations.

Also, the presence of legacy and outdated technologies impedes the adoption and effectiveness of virtual hospital solutions technologies (36, 57, 60). Incompatible systems, outdated software, and obsolete hardware hinder interoperability, data exchange, and user experience.

Several studies reported barriers related to processes of coordination and communication among stakeholders (27, 47), cultural neglect for rural communities (55, 57) , absence of robust governance and effective leadership (31, 32, 48, 57, 60), data privacy and security concerns (27, 37, 38, 45, 47, 58), organisational challenges in relation to resource planning (43, 48), operational processes (27, 31, 49), and limited policies supporting rural community inclusion (34, 37, 43, 46).

According to Davis *et al.* (27), LeBlanc *et al.* (47), effective coordination and communication among stakeholders are essential for the successful implementation of VH. Barriers within these processes, such as fragmented communication channels or lack of standardised protocols, impede the seamless delivery of care and collaboration among healthcare providers, patients, and support staff.

Also, the cultural neglect of rural communities highlights disparities in healthcare access and delivery. Policies and initiatives that fail to consider the unique cultural, social, and geographic factors of rural populations exacerbate healthcare inequities (55, 57). Recognising and addressing cultural diversity and rural-specific healthcare needs is essential for ensuring inclusive and patient-centred virtual hospital services.

Again, inadequate governance frameworks and leadership support lead to ambiguity, resistance to change, and lack of accountability, hindering progress and sustainability (31, 32, 48, 57, 60). Strong leadership and governance mechanisms are essential for guiding strategic planning, resource allocation, and decision-making processes in virtual hospital initiatives and these are fundamental for driving organisational change and ensuring the successful implementation of VH.

Another critical consideration for virtual hospital implementation is data privacy and security concerns, particularly regarding the storage, transmission, and sharing of sensitive patient information (27, 37, 38, 45, 47, 58). Failure to address these concerns can impact patient trust, compromise confidentiality, and expose healthcare organisations to legal and regulatory risks. Robust data privacy policies, secure information systems, and adherence to industry standards are essential for safeguarding patient data and maintaining confidentiality.

Organisational challenges, such as inadequate resource planning and inefficient operational processes, also impede the scalability and sustainability of VH (43, 48). Limited resources, workforce shortages, and inefficient workflows hinder the delivery of timely and quality care, affecting patient outcomes and satisfaction. Strategic resource allocation, process optimisation, and continuous quality improvement are necessary for overcoming organisational barriers and enhancing operational efficiency in VH.

Likewise, limited policies supporting rural community inclusion also affect the implementation of equitable

virtual hospital services (34, 37, 43, 46). The absence of supportive policies may limit funding opportunities, regulatory incentives, and infrastructure development for VH in rural areas. Advocacy for policies that prioritise rural community inclusion, address healthcare disparities, and incentivise virtual hospital adoption is essential for promoting equitable access to healthcare services.

A few studies also identified financial sustainability challenges (36, 46, 49, 58) and the unfair distribution of funds among different healthcare settings (31, 36, 46).

Facilitators of Virtual hospital initiatives

Facilitators for the successful implementation of VH were identified in 19 peer-reviewed articles and 7 web reports.

The literature strongly suggested that key facilitators include clinical leadership and advocacy (26, 37, 60) together with staff and patient enrichment and training (29, 31, 32, 35, 36, 41, 43, 48, 60), emphasising the importance of enhancing patient and provider capabilities for successful virtual hospital implementation. The Australian federal and state governments are investing in digital literacy upskilling programs to empower patients to self-manage symptoms and navigate VH confidently (56, 57).

Few other facilitators were recognised as a way to mitigate barriers like collaboration and partnerships (32, 37, 46, 48, 60), effective communication (37, 38, 41, 54), purposeful planning and development (26, 49, 54, 60), a comprehensive governance structure (49, 54, 60), optimised organisational structure (27, 32, 38, 42), iterative system implementation (48, 54, 60), and supportive government policies (26, 40, 56, 58).

Collaboration and partnerships among stakeholders, including healthcare providers, government agencies, technology vendors, and community organisations, are instrumental in overcoming barriers and driving the adoption of VH (32, 37, 46, 48, 60). By fostering collaboration, organisations can leverage collective expertise, resources, and networks to address challenges, share best practices, and promote innovation in virtual care delivery. Likewise, Effective communication strategies are essential for ensuring clear understanding, alignment, and engagement among stakeholders involved in virtual hospital implementation. Open and transparent communication channels facilitate knowledge sharing, stakeholder engagement, and problem-solving, enabling organisations to address concerns, manage expectations, and drive consensus towards common goals (37, 38, 41, 54).

Purposeful planning and development also incorporate strategic initiatives aimed at designing, implementing, and optimising VH (26, 49, 54, 60). By adopting a systematic approach to planning, organisations can anticipate challenges, identify opportunities, and develop robust strategies for addressing barriers and achieving desired outcomes in virtual care delivery. Similarly, a comprehensive governance structure provides the framework for guiding decision-making, accountability, and oversight in virtual hospital initiatives (49, 54, 60). Clear governance mechanisms, policies, and procedures ensure alignment with organisational goals, regulatory requirements, and industry standards, while also promoting transparency, efficiency, and stakeholder engagement.

Again, an optimised organisational structure will align roles, responsibilities, and workflows to support the effective delivery of virtual hospital services (27, 32, 38, 42). By streamlining processes, clarifying responsibilities, and fostering collaboration, organisations can enhance efficiency, agility, and responsiveness in virtual care delivery, ultimately improving patient outcomes and satisfaction. Likewise, iterative system implementation will involve continuous assessment, refinement, and optimisation of virtual hospital services and processes. By adopting an iterative approach, organisations can adapt to evolving needs, address emerging challenges, and incorporate feedback from stakeholders, thereby enhancing the effectiveness, usability, and sustainability of virtual care solutions (48, 54, 60).

Moreover, supportive government policies create an enabling environment for virtual hospital implementation by providing regulatory intelligibility, funding support, and incentives for innovation. Policies that promote telemedicine reimbursement, infrastructure development, workforce training, and data

privacy enhance the viability and scalability of virtual care initiatives, while also fostering collaboration and alignment among stakeholders across the healthcare ecosystem (26, 40, 56, 58).

These facilitators highlighted the importance of strategic planning, clear communication, and collaborative efforts involving various stakeholders to overcome process-related challenges and ensure successful virtual hospital deployment.

Investment in **technical infrastructure** (48, 49, 54, 56, 57, 59), quality, user-friendly and affordable technology (42, 48, 49, 56, 57)and technical outreach and support services (32, 47, 57) were noted as enablers for VH.

Robust technical infrastructure forms the foundation for VH, facilitating seamless communication, data exchange, and service delivery (48, 49, 54, 56, 57, 59). Hence, investment in infrastructure such as high-speed internet connectivity, secure data storage, and interoperable systems is essential for ensuring reliable and efficient virtual care delivery. Without adequate infrastructure, VH will face connectivity issues, data security risks, and operational inefficiencies, hindering their effectiveness in reaching and serving rural patients.

Also, access to quality, user-friendly, and affordable technology is critical for enhancing the accessibility and usability of VH (42, 48, 49, 56, 57). User-friendly interfaces, intuitive design, and affordability ensure that healthcare providers and patients can easily navigate and utilise virtual care platforms. Quality technology solutions also contribute to positive user experiences, engagement, and satisfaction, ultimately improving the effectiveness and adoption of VH.

Likewise, technical outreach and support services play a vital role in assisting healthcare providers and patients in navigating and troubleshooting virtual care technology services (32, 47, 57). These services may include training programs, help desks, and technical assistance teams that provide guidance, education, and troubleshooting support. By offering ongoing technical support, organisations can empower users to effectively utilise virtual hospital platforms, address technical issues, and maximise the benefits of remote care delivery.

These facilitators emphasise the importance of a robust technical foundation, user-friendly interfaces, and support services to overcome technological challenges and enhance the acceptance of VH within regional and remote communities.

Sustainable financing also emerged as a crucial facilitator, emphasising the importance of permanent insurance reimbursement solutions and grant funding to support and expand the reach of virtual hospital services (27, 36, 42).

Discussion

This review demonstrated clinical and health system outcomes of VH in remote and rural health settings. It addresses the current evidence gap regarding the impact of VH for regional and rural populations on clinical, health system, patient, and provider outcomes indicating that VH significantly enhance clinical effectiveness, regardless of population demographics.

In terms of clinical effectiveness, the review reported positive outcomes against key indicators commonly used to evaluate healthcare interventions such as mortality rates, readmission rates, length of stay (LoS) and improvement in clinical indicators (60). These findings are consistent with those of Norman *et al.* (10), who reported similar benefits from hospital-at-home care for older individuals, such as shorter LoS and reduced readmission rates. It should be noted though that this review does not examine the impact of VH on chronic condition management, a critical area for evaluating the overall effectiveness of VH. Further research is needed to explore how VH can better support chronic disease management and improve long-term health outcomes.

This study also highlights the health system benefits of VH, noting their potential to reduce patient and healthcare expenditures for various conditions, including general health, mental health, burn care, and

infectious diseases such as COVID-19. The analysis correlates with key metrics like quality care, equitable access, cost management, and population health improvement, affirming that VH significantly enhances health system outcomes in regional and remote communities.

Moreover, the health system outcomes identified in this review align with those observed in urban populations, as reported by Bidoli *et al.* (61) and Snoswell *et al.* (62). Evidence indicates that VH positively impacts health system outcomes by improving efficiency, accessibility, and resource management, thus proving to be a valuable addition to contemporary healthcare delivery.

The findings also reveal that positive patient and provider perspectives are contingent on adequate internet connectivity, user-friendly technology, sufficient training, and enhanced collaboration between urban and rural healthcare providers. A comparison with the studies by Denny and Hill (63), who evaluated patient and healthcare worker perspectives of virtual care delivery for cystic fibrosis (CF) patients in a suburban setting, and Babaei *et al.* (11), who assessed barriers and facilitators of virtual care, revealed similar findings. Both studies support the argument that high patient and provider satisfaction heavily depends on adequate internet, effective technology, and robust technical support systems.

Despite the numerous benefits of VH for rural and remote healthcare, their implementation often faces significant challenges. These challenges can be categorised into four main themes: people, process, technology, and finance (Figure 3). Effectively addressing barriers in these areas requires a multifaceted approach, including digital literacy and enrichment, stakeholder collaboration, a patient-centred approach, sustainable funding structures, and the application of smart technologies. By implementing these strategies, regional and remote communities can gain better access to quality healthcare, potentially improving clinical and health system outcomes and enhancing satisfaction among rural patients and providers.

Addressing these multifaceted challenges is crucial for the successful implementation of VH in regional and remote healthcare settings. The identified facilitators provide a roadmap for strategic interventions and investments to overcome barriers, thereby enhancing the effectiveness of VH in improving healthcare accessibility and delivery in underserved areas.

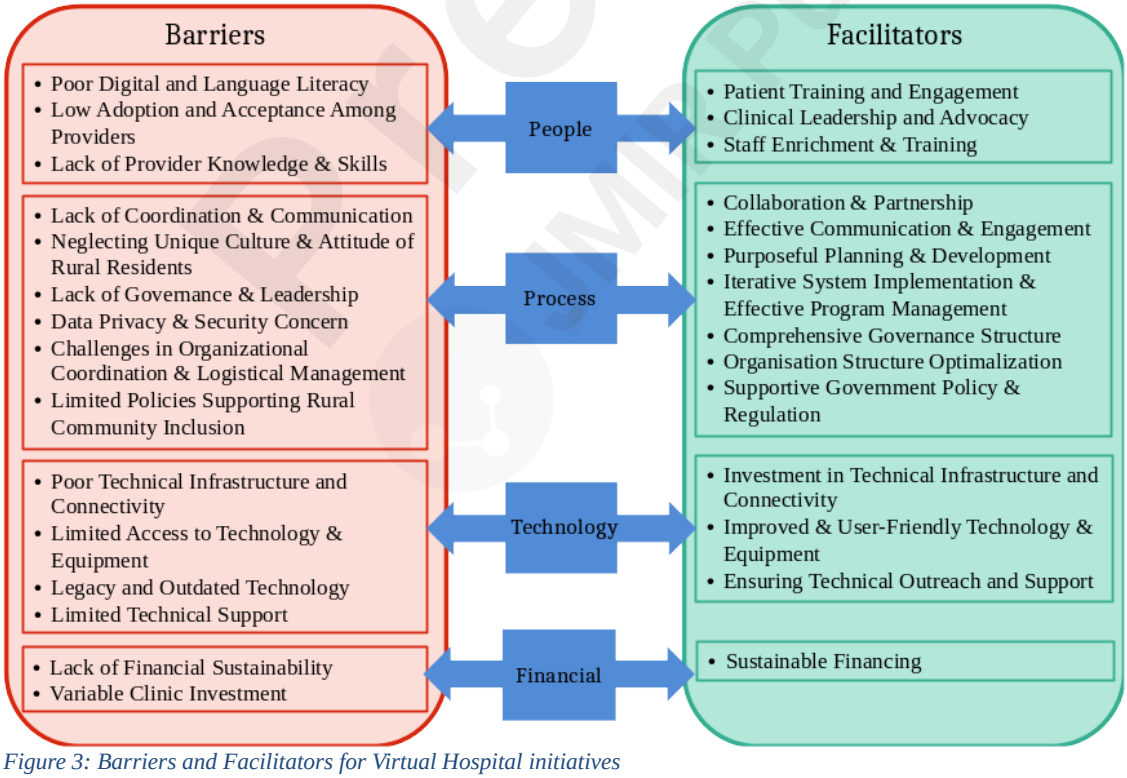

Figure 3: Barriers and Facilitators for Virtual Hospital initiatives

Recommendations for developing Virtual Hospitals

The synthesis of studies on the development of VH in regional and remote areas has led to four key recommendations. Firstly, successful virtual hospital implementation relies heavily on stakeholder collaboration and patient-centred approaches. Engaging a diverse range of stakeholders, including community members and healthcare providers, ensures that VH align with the needs and preferences of all involved. Key elements include collaborative engagement, healthcare professional advocacy, seamless communication policies, patient-centred design, and culturally responsive models. These strategies foster trust, improve coordination, and ensure inclusivity and respect for diverse populations.

Secondly, achieving digital equity and securing sustainable funding are critical for the success of VH. Implementing robust governance structures and advisory committees to oversee virtual hospital operations ensures coordination, safety, and quality standards. Policy-driven organisational transformation enables VH to adapt to evolving healthcare needs while leveraging government grants to provide essential financial support, addressing infrastructure needs and operational deficits.

Thirdly, investing in sustainable infrastructure and advancing healthcare technology are vital for enhancing virtual hospital services. Recommendations include developing resilient infrastructure to support virtual hospital technology, advancing integrated healthcare systems, empowering remote care staff with the necessary tools and training, building robust digital foundations through iterative development, and implementing stringent privacy and security measures to protect patient data.

Lastly, enhancing digital literacy among healthcare providers and patients is crucial for the seamless implementation of VH. Continuous training and involvement of healthcare providers build trust and competence in using new technologies, while educating patients about virtual care technologies improves acceptance and engagement.

Overall, successful virtual hospital implementation in regional and remote regions requires a holistic approach that considers stakeholder collaboration, a patient-centered approach, digital equity, smart technology application, and digital literacy enhancement. These recommendations provide a comprehensive framework for developing and sustaining VH in regional and remote healthcare settings.

Conclusion

Research into VH is continuously evolving due to developments in regulations, digital advancement, communication tools, and remote monitoring capabilities. By bringing together information across different disciplines, including healthcare, technology, and policies, this evidence-based rapid review aids in effectively strategising virtual hospital deployment so that the benefits can be realised by regional and remote communities.

The review suggests that VH provide a promising solution to bridge healthcare gaps in regional and remote communities by enhancing clinical effectiveness, improving health system outcomes, and increasing patient and provider satisfaction. The review also supports the positive contribution of VH on equitable healthcare access and addresses the existing evidence gap within the context of regional and rural healthcare.

To sum up, this rapid review highlights the barriers, mitigating facilitators, and recommendations that can serve as key strategic pillars to developing VH so that clinical outcomes, health system performance, and satisfaction among patients and healthcare providers are enhanced within the regional and remote communities.

Limitations & Future Research Direction

This review encountered several limitations. Firstly, the absence of studies reporting negative outcomes restricts our understanding of the potential risks and drawbacks associated with the development of VH for remote and regional communities. This lack of balanced reporting may lead to

an overly optimistic view of virtual hospital implementation. Additionally, as a rapid review, this study faced typical limitations such as a constrained timeframe and using English language sources only, which may have led to the exclusion of relevant studies and a less comprehensive literature search. The rapid review methodology, while efficient, offers less depth compared to systematic reviews, potentially limiting the robustness of conclusions..

Future research should focus on evaluating both positive and negative outcomes of VH in comparison to inpatient care, using robust methodologies such as randomised controlled trials or matched cohort studies. Such research would provide a comprehensive evaluation of the clinical and health system outcomes of VH, facilitating direct comparisons to traditional inpatient care. Moreover, there is a pressing need for qualitative research involving interviews with key stakeholders engaged in successful virtual hospital projects. Analysing these interviews would yield valuable insights into the challenges, successes, and lessons learned from specific projects, enabling the development of well-informed recommendations for future VH initiatives.

Acknowledgements
We thank Fiona Sturt and Umer Nisar for their guidance in directing this research. Their valuable time and advice made a huge contribution to this study, and we thank them for this opportunity.

Conflicts of Interest
There is no known conflict of interest to the subject matters discussed in the manuscript here.

Abbreviations

Abbreviation	Expansion
AIHW	Australian Institute of Health and Welfare
CDC	The Centers for Disease Control and Prevention
QCC	Quality Criteria Checklist
ED	Emergency Department
EMR	Electronic Medical Record
HITH	Hospital in the Home
ICT	Information and Communication Technology
IoMT	Internet of Medical Things
IT	Information Technology
LoS	Length of Stay
PICO	Population, Intervention, Comparison, and Outcome
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PROMs	Patient Reported Outcome Measures
USA	United States of America
VVED	Victorian Virtual Emergency Department
WHO	World Health Organization
VH	Virtual Hospitals

References

1. Dixit SK, Sambasivan M. A review of the Australian healthcare system: A policy perspective. SAGE Open Med. 2018;6:2050312118769211.
2. AIHW. Rural and remote health Australian Institute of Health and Welfare Australian Government; 2022 [Available from: https://www.aihw.gov.au/reports/rural-remote-australians/rural-and-remote-health.
3. Rechel B, Džakula A, Duran A, Fattore G, Edwards N, Grignon M, et al. Hospitals in rural or remote areas: An exploratory review of policies in 8 high-income countries. Health Policy. 2016;120(7):758-69.
4. AIHW. Rural and remote health Australian Government: Australian Institute of Health and Welfare; 2022 [Available from: https://www.aihw.gov.au/reports/rural-remote-australians/rural-and-remote-health.
5. Centers for Disease Control and Prevention (CDC). About Rural Health 2023 [Available from: https://www.cdc.gov/ruralhealth/about.html#:~:text=Rural%20Americans%20are%20more%20likely,stroke%20than%20their%20urban%20counterparts.
6. Thomas SL, Wakerman J, Humphreys JS. Ensuring equity of access to primary health care in rural and remote Australia - what core services should be locally available? Int J Equity Health. 2015;14:111.
7. Ghafouri Fard M, Hasankhani Hadi H. Virtual Hospital: a new approach in education and treatment. Journal of medical education development. 2015;8(17):47-57.
8. Hesse BW, Ahern D, Ellison M, Aronoff-Spencer E, Vanderpool RC, Onyeije K, et al. Barn-Raising on the Digital Frontier: The L.A.U.N.C.H. Collaborative. Journal of Appalachian health. 2020;2(1):6-20.
9. Catallo C, Chung-Lee L. How Has COVID-19 Changed the Way We Do Virtual Care? A Scoping Review Protocol. Healthcare (Basel). 2022;10(10).
10. Norman G, Bennett P, Vardy ER. Virtual wards: a rapid evidence synthesis and implications for the care of older people. Age and Ageing. 2023;52(1):afac319.
11. Babaei N, Zamanzadeh V, Valizadeh L, Lotfi M, Samad-Soltani T, Kousha A, et al. A scoping review of virtual care in the health system: infrastructures, barriers, and facilitators. Home Health Care Services Quarterly. 2023;42(2):69-97.
12. Sydney Local Health District. rpavirtual - A New Way of Caring NSW Government: NSW Health; 2020 [Available from: https://www.health.nsw.gov.au/innovation/2020awards/Pages/rpavirtual.aspx.
13. Duska Anastasijevic. Mayo Clinic launches advanced care at home model of care MAYO CLINIC2020 [Available from: https://newsnetwork.mayoclinic.org/discussion/mayo-clinic-launches-advanced-care-at-home-model-of-care/.
14. Premier of Victoria. Virtual Service Expanding To Relieve Hospital Pressures 2022 [Available from: https://www.premier.vic.gov.au/virtual-service-expanding-relieve-hospital-pressures.

15. O'Kane G. Telehealth—Improving access for rural, regional and remote communities. Australian Journal of Rural Health. 2020;28(4):419-20.
16. Australian Digital Health Agency. Australia's National Digital Health Strategy: Australian Digital Health Agency; 2018 [Available from: https://www.digitalhealth.gov.au/sites/default/files/2020-11/Australia%27s%20National%20Digital%20Health%20Strategy%20-%20Safe%2C%20seamless%20and%20secure.pdf.
17. Dhala A, Sasangohar F, Kash B, Ahmadi N, Masud F. Rapid implementation and innovative applications of a virtual intensive care unit during the COVID-19 pandemic: case study. Journal of Medical Internet Research. 2020;22(9):e20143.
18. Gajarawala SN, Pelkowski JN. Telehealth Benefits and Barriers. J Nurse Pract. 2021;17(2):218-21.
19. Alison Brown. Rapid Review of Virtual Care. Consumers Health Forum of Australia; 2021.
20. Armstrong CM, Wilck NR, Murphy J, Herout J, Cone WJ, Johnson AK, et al. Results and Lessons Learned when Implementing Virtual Health Resource Centers to Increase Virtual Care Adoption During the COVID-19 Pandemic. J Technol Behav Sci. 2022;7(1):81-99.
21. Richards D, Caldwell P. Improving health outcomes sooner rather than later via an interactive website and virtual specialist. IEEE journal of biomedical and health informatics. 2017;22(5):1699-706.
22. Summerfelt WT, Sulo S, Robinson A, Chess D, Catanzano K. Scalable hospital at home with virtual physician visits: pilot study. Am J Manag Care. 2015;21(10):675-84.
23. Huang X, Lin J, Demner-Fushman D. Evaluation of PICO as a knowledge representation for clinical questions. AMIA Annu Symp Proc. 2006;2006:359-63.
24. Badampudi D, Wohlin C, Petersen K, editors. Experiences from using snowballing and database searches in systematic literature studies. Proceedings of the 19th international conference on evaluation and assessment in software engineering; 2015.
25. Skillman M, Cross-Barnet C, Friedman Singer R, Rotondo C, Ruiz S, Moiduddin A. A framework for rigorous qualitative research as a component of mixed method rapid-cycle evaluation. Qualitative Health Research. 2019;29(2):279-89.
26. Bradford NK, Caffery LJ, Smith AC. Telehealth services in rural and remote Australia: a systematic review of models of care and factors influencing success and sustainability. Rural and remote health. 2016;16(4):1-23.
27. Davis SM, Jones A, Jaynes ME, Woodrum KN, Canaday M, Allen L, et al. Designing a multifaceted telehealth intervention for a rural population using a model for developing complex interventions in nursing. BMC Nurs. 2020;19(1):9-.
28. DeHart D, King LB, Iachini AL, Browne T, Reitmeier M. Benefits and Challenges of Implementing Telehealth in Rural Settings: A Mixed-Methods Study of Behavioral Medicine Providers. Health Soc Work. 2022;47(1):7-18.
29. Haque SN, DeStefano S, Banger A, Rutledge R, Romaire M. Factors influencing telehealth implementation and use in frontier critical access hospitals: Qualitative study. JMIR Form Res. 2021;5(5):e24118-e.
30. Hirko KA, Kerver JM, Ford S, Szafranski C, Beckett J, Kitchen C, et al. Telehealth

in response to the COVID-19 pandemic: Implications for rural health disparities. J Am Med Inform Assoc. 2020;27(11):1816-8.
31. Howland M, Tennant M, Bowen DJ, Bauer AM, Fortney JC, Pyne JM, et al. Psychiatrist and Psychologist Experiences with Telehealth and Remote Collaborative Care in Primary Care: A Qualitative Study. The Journal of rural health. 2021;37(4):780-7.
32. Johnston K, Smith D, Preston R, Evans R, Carlisle K, Lengren J, et al. "From the technology came the idea": safe implementation and operation of a high quality teleradiology model increasing access to timely breast cancer assessment services for women in rural Australia. BMC Health Services Research. 2020;20(1):1-12.
33. Jong M, Mendez I, Jong R. Enhancing access to care in northern rural communities via telehealth. Int J Circumpolar Health. 2019;78(2):1554174-.
34. Kocanda L, Fisher K, Brown LJ, May J, Rollo ME, Collins CE, et al. Informing telehealth service delivery for cardiovascular disease management: exploring the perceptions of rural health professionals. Australian Health Review. 2021;45(2):241-6.
35. McPherson K, Nahon I. Telehealth and the provision of pelvic health physiotherapy in regional, rural and remote Australia. Australian & New Zealand Continence Journal. 2021;27(3):66-70.
36. Nataliansyah MM, Merchant KAS, Croker JA, Zhu X, Mohr NM, Marcin JP, et al. Managing innovation: a qualitative study on the implementation of telehealth services in rural emergency departments. BMC Health Serv Res. 2022;22(1):852.
37. Thomas LT, Lee CMY, McClelland K, Nunis G, Robinson S, Norman R. Health workforce perceptions on telehealth augmentation opportunities. BMC Health Serv Res. 2023;23(1):182.
38. Correale MR, Soever LJ, Rampersaud YR. A Model to Implement Standardized Virtual Care for Low Back Pain Amongst a Large Network of Providers in Urban and Rural Settings. Journal of Primary Care & Community Health. 2022;13:1-7.
39. Giroux EE, Hagerty M, Shwed A, Pal N, Huynh N, Andersen T, et al. It's not one size fits all: a case for how equity-based knowledge translation can support rural and remote communities to optimize virtual health care. Rural Remote Health. 2022;22(2):7252-.
40. Head WT, Garcia D, Mukherjee R, Kahn S, Lesher A. Virtual Visits for Outpatient Burn Care During the COVID-19 Pandemic. Journal of Burn Care & Research. 2022;43(2):300-5.
41. Kuperman EF, Linson EL, Klefstad K, Perry E, Glenn K. The virtual hospitalist: a single-site implementation bringing hospitalist coverage to critical access hospitals. Journal of Hospital Medicine. 2018;13(11):759-63.
42. Sitammagari K, Murphy S, Kowalkowski M, Chou S-H, Sullivan M, Taylor S, et al. Insights from rapid deployment of a "virtual hospital" as standard care during the covid-19 pandemic. Annals of internal medicine. 2021;174(2):192-9.
43. Vindrola-Padros C, Singh KE, Sidhu MS, Georghiou T, Sherlaw-Johnson C, Tomini SM, et al. Remote home monitoring (virtual wards) for confirmed or suspected COVID-19 patients: a rapid systematic review. EClinicalMedicine. 2021;37:100965.
44. AlDossary S, Martin-Khan MG, Bradford NK, Armfield NR, Smith AC. The

Development of a Telemedicine Planning Framework Based on Needs Assessment. Journal of medical systems. 2017;41(5):74.
45. Haleem A, Javaid M, Singh RP, Suman R. Telemedicine for healthcare: Capabilities, features, barriers, and applications. Sens Int. 2021;2:100117.
46. Gray K, Chapman W, Khan UR, Borda A, Budge M, Dutch M, et al. The Rapid Development of Virtual Care Tools in Response to COVID-19: Case Studies in Three Australian Health Services. JMIR Form Res. 2022;6(4):e32619.
47. LeBlanc M, Petrie S, Paskaran S, Carson DB, Peters PA. Patient and provider perspectives on ehealth interventions in Canada and Australia: A scoping review. Rural and remote health. 2020;20(3):5754-.
48. Allan J, Webster E, Chambers B, Nott S. "This is streets ahead of what we used to do": staff perceptions of virtual clinical pharmacy services in rural and remote Australian hospitals. BMC Health Serv Res. 2021;21(1):1306.
49. Agency for Clinical Innovation. Virtual care in practice: NSW Government; 2021 [Available from: https://aci.health.nsw.gov.au/__data/assets/pdf_file/0004/651208/virtual-care-in-practice.pdf.
50. Australian Government - Department of Health. National Strategic Framework for Rural and Remote Health. 2016.
51. Australian Government - Department of Infrastructure T, Regional Development, Communications and the Arts,. Better Connectivity Plan for Regional and Rural Australia. In: Department of Infrastructure T, Regional Development, Communications and the Arts,, editor. 2022.
52. Australian Government - Department of Health. Future focused primary health care:
Australia's Primary Health Care 10 Year Plan 2022-2032. In: Health Do, editor. 2022.
53. National Rural Health Alliance. Regional Telecommunications Review 2021. 2021.
54. Northern Territory Government. NT Health Virtual Care Strategy. n.d.
55. Queensland Government. Digital Strategy for Rural and Remote Healthcare - 10 year plan. 2021.
56. Rowan Strain, India Hardy, Vanya Rufus, Aarthmi Jeyachandran, Jacqueline Curran. Improving equity of access in rural and regional health through hybrid and connected care n.d. [Available from: https://www.pwc.com.au/health/improving-equity-of-access-through-hybrid-and-connected-care-in-rural-and-regional-health.html.
57. Victoria Department of Health. Virtual Care standard and guide 2022 [Available from: https://www.health.vic.gov.au/virtual-care-standard-and-guide#.
58. Hospital and Healthcare. The virtual hospital Hospital and Healthcare2021 [Available from: https://www.hospitalhealth.com.au/content/technology/article/the-virtual-hospital-234400308.
59. Microsoft Australia. Remote Australian community harnesses mixed reality and space technologies to deliver better healthcare 2022 [Available from: https://news.microsoft.com/en-au/features/remote-australian-community-harnesses-mixed-reality-and-space-technologies-to-deliver-better-healthcare/.

60. Miranda Shaw, Wilson A. RPA Virtual Hospital
Proof of concept trial Evaluation Report 2020–2021. 2022.
61. Bidoli C, Pegoraro V, Dal Mas F, Bagnoli C, Bert F, Bonin M, et al. Virtual hospitals: The future of the healthcare system? An expert consensus. Journal of Telemedicine and Telecare. 2023:1357633X231173006.
62. Snoswell CL, Taylor ML, Comans TA, Smith AC, Gray LC, Caffery LJ. Determining if Telehealth Can Reduce Health System Costs: Scoping Review. J Med Internet Res. 2020;22(10):e17298.
63. Denny C, Hill U. P200 A virtual age? Evaluating the patient and healthcare worker perspective on virtual clinic delivery for patients with Cystic Fibrosis (CF) and non CF bronchiectasis (nCFB) at a specialist cardio-thoracic hospital. BMJ Publishing Group Ltd; 2022.