The Role of Virtual Hospitals in Limited-Resource Settings: A Scoping Review

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ABSTRACT

The emergence of virtual hospitals, digitally coordinated healthcare systems offering remote consultations, diagnostics, monitoring, and specialist care, has introduced transformative opportunities in global health. These models have proven effective in high-income countries for addressing issues such as hospital congestion and chronic disease management. However, their potential in limited-resource settings, where healthcare systems are often constrained by poor infrastructure, workforce shortages, and geographical barriers, remains underexplored. Virtual hospitals could bridge critical access gaps in such contexts, particularly for underserved rural and peri-urban populations, if appropriately designed and supported.

This scoping review aimed to systematically map the implementation models, digital technologies, governance and financing structures, and reported outcomes of virtual hospital systems operating in limited-resource settings. Additionally, the review sought to analyse the extent to which these models align with national digital health strategies, global policy frameworks, and Sustainable Development Goal 3 on universal health coverage.

A comprehensive literature search was conducted using PubMed, Scopus, Google Scholar, and grey literature sources such as the WHO Digital Health Repository, national health ministry websites, and organizational reports. Studies published in English between January 2015 and May 2025 were included. The inclusion criteria focused on studies that described or evaluated virtual hospital models implemented in low- and middle-income countries, particularly those addressing healthcare access, service delivery, digital infrastructure, or health policy alignment. Data were extracted using a standardized charting tool and thematically analysed.

Thematic synthesis revealed three dominant models of virtual hospital implementation: centralized hub and spoke systems, decentralized community-linked systems, and hybrid public-private partnerships. Technologies employed included mobile health applications, wearable diagnostic tools, AI-driven triage systems, cloud-based electronic health records, and remote teleconsultation platforms. Governance structures ranged from government-led models to those managed by NGOs and private tech companies, with financing derived from national health budgets, donor support, and emerging health fintech solutions. Service delivery outcomes included improved access to care in remote areas, enhanced follow-up and adherence in chronic disease management, reduced patient travel time and costs, and increased efficiency in referral coordination. Most models demonstrated alignment with national health strategies and global digital health priorities, although gaps in infrastructure, policy enforcement, and interoperability were common.

Virtual hospitals hold considerable promise in reconfiguring healthcare delivery in limited-resource settings. Their scalability and impact depend on supportive policies, digital infrastructure investment, integration into national health systems, and community engagement. The Kenya case study illustrates how virtual care can be locally adapted to improve chronic disease management and mental health services through a tiered digital referral network. However, significant challenges persist, including limited digital literacy, unreliable internet

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and power supply, inconsistent policy regulation, and fragmented health information systems. Future research should prioritize the evaluation of long-term health and economic outcomes, patient and provider experiences, and strategies for equitable scale-up across diverse contexts. Tailored implementation frameworks and stronger cross-sector partnerships are essential to fully harness the potential of virtual hospitals in advancing universal health coverage in LMICs.

Keywords: Virtual hospitals, Digital health, Telemedicine, Limited-resource settings, Kenya, Health systems, Public-private partnerships, Scoping review, eHealth, Chronic disease management

INTRODUCTION

Background on the Rise of Virtual Hospitals

The global shift toward digital health has been both inevitable and transformative. Virtual hospitals—digitally coordinated care hubs that operate without a traditional physical footprint, are emerging as a central innovation in this transformation. These models provide a full spectrum of services including triage, specialist consultations, chronic disease management, and post-discharge monitoring, all facilitated through digital platforms (Kruse et al., 2022; Keesara et al., 2020). Virtual hospitals reduce dependence on brick-and-mortar infrastructure and support continuity of care, especially during disruptions like pandemics, political unrest, or natural disasters (Golinelli et al., 2020).

Initially driven by high-income settings, the concept of virtual care has now gained traction globally. Innovations such as Mercy Virtual in the U.S., the NHS Virtual Wards in the UK, and India's eSanjeevani showcase how virtual hospitals can deliver cost-effective and scalable solutions. These platforms often incorporate AI, cloud-based EHRs, and IoT devices to support care continuity and patient self-monitoring (Iyengar et al., 2021; Gudi et al., 2022). Such tools have helped reduce hospital congestion, facilitate early intervention, and improve outcomes for patients with chronic conditions. As healthcare systems face rising costs and population aging, virtual hospitals offer a vision of care that is proactive, connected, and patient-centered.

Justification for Focusing on Limited-Resource Settings

While the benefits of virtual hospitals are evident in well-resourced systems, their impact can be even more transformative in limited-resource settings. In many LMICs, health systems are burdened by insufficient medical personnel, poor infrastructure, limited diagnostic capabilities, and logistical challenges that impede access to timely care (Otu et al., 2021; Adebayo et al., 2023). According to the World Bank, sub-Saharan Africa has only 0.2 physicians per 1,000 people, far below the WHO recommended threshold (World Bank, 2022). For patients in rural areas, receiving specialist care often involves long travel distances, financial hardship, and delayed treatment, which can result in preventable complications or death.

Virtual hospitals can help reconfigure care pathways by integrating technology with frontline services. By empowering community health workers with mobile devices and linking them to virtual specialists, even the most remote populations can receive timely consultations and follow-up care (Kichbusch et al., 2020). Additionally, virtual platforms facilitate triaging and referrals, reducing unnecessary hospital visits and optimizing resource allocation (Langarizadeh et al., 2017). Their adaptability also supports targeted interventions for maternal health, non-communicable diseases, mental health, and nutrition areas often underserved in traditional models (Mugo et al., 2022). Despite infrastructural limitations, the widespread use of mobile phones and growing 4G/5G coverage in African and South Asian regions creates a strong foundation for virtual care expansion.

Alignment with Kenya's Digital Health Strategy and Global Health Goals

Kenya's health system is at a digital crossroads. The Kenya Digital Health Strategy 2020–2030 articulates a clear national vision for leveraging digital health to support Universal Health Coverage (UHC), guided by the

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principles of equity, interoperability, and sustainability (Ministry of Health Kenya, 2020). The strategy emphasizes expanding access to health services through telemedicine, digital patient records, and mobile health innovations, particularly in under-resourced counties. Virtual hospital initiatives such as the Digital Virtual Health System (DVHS) at Mama Lucy Kibaki Hospital demonstrate the practical application of this vision, providing community-linked virtual consultations for chronic disease, mental health, and palliative care.

Globally, virtual hospital models align with Sustainable Development Goal 3 (SDG 3)—which aims to ensure healthy lives and promote well-being for all—as well as the WHO Global Strategy on Digital Health 2020–2025**,** which advocates for inclusive and context-sensitive adoption of digital tools (WHO, 2021). Further, regional frameworks such as the Africa CDC Digital Health Action Plan underscore the importance of scaling virtual services to bolster primary care, enhance pandemic response, and strengthen health system resilience (Africa CDC, 2022). By aligning virtual care initiatives with these agendas, countries like Kenya can avoid fragmented investments and instead create interoperable, patient-centered digital health ecosystems. Moreover, virtual hospitals can serve as a blueprint for scalable public-private partnerships (PPPs), supporting sustainable innovation within national health systems.

This review thus seeks to synthesize evidence on the implementation, effectiveness, and sustainability of virtual hospital models in limited-resource settings. It maps the structures, technologies, and policy environments that enable or constrain virtual care, with a focus on contexts like Kenya. By doing so, the review contributes critical insights for researchers, policymakers, and implementers working to scale digital health in equitable, efficient, and transformative ways.

Why a Scoping Review is Needed

Virtual hospitals represent a rapidly growing innovation in healthcare, yet their implementation, effectiveness, and adaptability in limited-resource settings remain underexplored in academic and policy literature. While high-income countries have documented the role of virtual hospitals in reducing hospital admissions, enhancing patient outcomes, and supporting chronic disease management (Kruse et al., 2022; Iyengar et al., 2021), such evidence is sparse or scattered when it comes to low- and middle-income countries (LMICs). The diversity in models, technologies, and governance structures across different geographies makes it difficult to draw generalizable lessons without a comprehensive synthesis.

Scoping reviews are particularly suited for mapping emerging, heterogeneous fields—especially where concepts are still evolving, and the evidence base is broad but fragmented (Arksey & O'Malley, 2005; Peters et al., 2015). This review will collate and categorize evidence on virtual hospital models across limited-resource settings to provide an overview of implementation approaches, key enablers and barriers, and alignment with national and global health strategies. It will also help to identify gaps in knowledge and practice that can inform future research, policy formulation, and implementation planning.

Justification for Focusing on Limited-Resource Settings

Health systems in limited-resource settings are frequently challenged by underfunding, uneven workforce distribution, logistical constraints, and weak referral systems. In Kenya, for instance, only 50% of the population lives within a 5-kilometer radius of a health facility with essential services (Ministry of Health Kenya, 2020). These structural limitations disproportionately affect rural populations, low-income households, and vulnerable groups such as women, children, and the elderly. Virtual hospitals offer an opportunity to reimagine care delivery in these contexts by providing remote access to diagnostics, consultations, and follow-up services using scalable digital platforms.

Focusing on limited-resource environments is also timely, given the increasing global push for equitable digital transformation in health. Organizations like the Africa CDC**,** WHO**,** and the Global Digital Health Partnership have emphasized the need for context-appropriate digital health solutions that can support resilience, continuity of care, and universal health coverage (Africa CDC, 2022; WHO, 2021). This review

aligns with that goal by focusing on how virtual hospitals can support the "last mile" in healthcare access in environments where physical infrastructure remains a persistent barrier.

Study Objectives

This scoping review aims to systematically explore the landscape of virtual hospital implementation in limited-resource settings by addressing the following objectives:

1. To map implementation models of virtual hospitals in limited-resource settings
2. To assess the sustainability, efficiency, and effectiveness of virtual hospitals in improving healthcare access, quality, and continuity
3. To examine governance, management, and financing structures, including the role of public-private partnerships and alignment with legal and regulatory frameworks
4. To identify the technological infrastructure and digital tools enabling virtual hospital services
5. To analyse how virtual hospital models, align with global, regional, and national health priorities

METHODOLOGY

This scoping review was conducted using the Arksey and O'Malley (2005) five-stage framework, with methodological refinements from Levac et al. (2010) and the Joanna Briggs Institute guidelines. The process also adhered to the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) checklist, which offers a structured approach for ensuring rigor, transparency, and reproducibility in scoping reviews.

Identifying the Research Question

The central research question guiding this review was: *What are the implementation models, enabling technologies, governance frameworks, and health outcomes associated with virtual hospitals in limited-resource settings?* This question was developed to be broad enough to capture the diverse configurations and innovations in virtual care across low-resource health systems, yet focused enough to support thematic categorization. Sub-questions further explored service delivery strategies, health conditions addressed, digital tools deployed, and how these models aligned with national and global policy frameworks. The question was framed to reflect the multi-dimensional nature of virtual hospitals and to guide the identification and mapping of relevant literature.

Identifying Relevant Studies

A systematic literature search was conducted to capture both peer-reviewed and grey literature relevant to virtual hospital models in low-resource contexts. Electronic databases searched included PubMed, Scopus and Google Scholar. To broaden the scope, additional sources were searched manually, such as the WHO Digital Health Repository, national digital health policy portals, and government websites of countries implementing digital health systems (e.g., Kenya, Rwanda, India). The search strategy combined terms like "virtual hospital," "digital hospital," "telemedicine," "remote care," "low-resource settings," "LMICs," "governance," and "outcomes," using Boolean operators to refine results. Only English-language sources published between January 2015 and May 2025 were included, ensuring a contemporary focus that captures the digital acceleration prompted by the COVID-19 pandemic.

Inclusion/Exclusion Criteria and Screening Process

After retrieving citations, references were imported into Mendeley reference manager and duplicates were removed. The screening process was conducted in two phases. In the first phase, two independent reviewers screened titles and abstracts to assess relevance. In the second phase, full-text articles were obtained and reviewed for eligibility based on predefined inclusion and exclusion criteria. Studies were included if they described or evaluated virtual hospital models implemented in limited-resource settings, particularly those focused on health service delivery, digital tools, financing models, or health outcomes. Excluded were studies set exclusively in high-income countries, those describing only standalone telemedicine tools not integrated

into broader systems, and those without sufficient methodological detail. Any disagreements in the screening process were resolved through consensus or adjudication by a third reviewer.

Data Extraction Process

The process of charting the data involved the development and application of a standardized data extraction form designed to capture key variables relevant to the implementation and functioning of virtual hospitals in limited-resource settings. This form was initially piloted on a subset of studies to ensure its comprehensiveness and applicability across both peer-reviewed and grey literature. The finalized charting tool captured a wide range of information including study identification details such as authorship, publication year, and geographic location; the type and structure of the virtual hospital model; the health conditions targeted—such as chronic illness, maternal and mental health, or palliative care; the technologies utilized, including teleconsultation platforms, mobile applications, wearables, or AI-driven tools; and the level of care integration from community health services to tertiary referral facilities. In addition, the form recorded governance structures, such as whether the model was led by a Ministry of Health, an NGO, or a public-private partnership, as well as the financing approaches used, including donor support, government funding, or insurance-based models. Reported outcomes were also documented, ranging from improvements in healthcare access, patient satisfaction, and continuity of care to cost-effectiveness and disease management indicators. Furthermore, the form captured contextual insights into implementation barriers and enablers, such as infrastructure limitations, policy alignment, digital literacy, and user acceptance. Data extraction was performed manually by a primary reviewer and verified for accuracy by a second reviewer for a random sample of the studies. Both quantitative indicators and qualitative narratives were extracted, allowing for a rich understanding of how virtual hospitals are structured, deployed, and received within their respective contexts. The extracted data were entered into Microsoft Excel to enable sorting, filtering, and thematic analysis in preparation for synthesis.

Consideration of Study Quality

Although scoping reviews typically do not require formal appraisal of study quality, acknowledging the methodological robustness of included studies can inform the interpretation of findings. Many of the studies included in this review were descriptive or exploratory in nature, with few employing experimental or quasi-experimental designs. The lack of rigorous outcome measurement tools in several evaluations limits the generalizability of reported impacts on health system performance or patient outcomes. Future scoping or systematic reviews in this area might incorporate a basic appraisal of methodological rigor—such as risk of bias assessments or quality rating tools—to guide readers in evaluating the strength and applicability of the evidence (Peters et al., 2015; Levac et al., 2010).

Collating, Summarizing, and Reporting the Results

Extracted data were analysed and synthesized thematically, guided by the review's objectives. First, studies were grouped according to core themes, such as implementation models, service outcomes, technological innovations, governance structures, and policy alignment. Narrative synthesis was used to explore patterns, similarities, and differences across settings. Where relevant, illustrative examples were highlighted to emphasize context-specific lessons. Additionally, attention was given to identifying cross-cutting barriers (such as digital literacy, funding limitations, or regulatory gaps) and enablers (such as strong political will or mobile connectivity) that influenced success. The results were organized in alignment with the review objectives, providing a cohesive narrative that integrates conceptual, empirical, and practical insights.

RESULTS

Implementation Models of Virtual Hospitals

The implementation of virtual hospital models in limited-resource settings demonstrates considerable heterogeneity, reflecting variations in healthcare infrastructure, policy environments, and digital maturity. Three primary configurations emerged: centralized "hub-and-spoke" models, decentralized community-linked platforms, and hybrid public-private partnerships (PPPs). Hub-and-spoke systems typically feature a

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centralized digital care hub that coordinates virtual consultations with satellite health facilities. India's *eSanjeevani* exemplifies this model, delivering government-supported, two-tiered telemedicine—provider-to-provider and provider-to-patient—across both rural and urban settings (Gudi et al., 2022). Similarly, Rwanda has leveraged its health extension worker system in combination with mobile tools to provide community-based consultations and referrals, thus enhancing last-mile service delivery in maternal and child health (Kichbusch et al., 2020).

Kenya presents a notable hybrid model through the Digital Virtual Health System (DVHS) implemented at Mama Lucy Kibaki Hospital. This initiative combines public health institutions, community health volunteers (CHVs), and a private technology consultancy to deliver services including chronic disease management, palliative care, and mental health counselling. Patients are triaged at the community level and connected to hospital-based specialists through a secure digital platform (Ministry of Health Kenya, 2020). This integrated, tiered approach demonstrates how virtual hospital models can enhance continuity of care and reduce unnecessary hospital congestion, even within structurally constrained systems.

Technological Infrastructure and Tools

Technological infrastructure enabling virtual hospitals varies significantly across contexts but consistently centers around mobile and cloud-based platforms. In most limited-resource settings, the backbone of virtual hospital technology includes smartphones, mobile apps (e.g., WhatsApp, VSee), cloud-hosted electronic health records (EHRs), and occasionally wearable diagnostic tools such as blood pressure monitors or glucometers. In Kenya, the DVHS utilizes a mobile-friendly, interoperable dashboard for case tracking and remote follow-up, while India's *eSanjeevani* employs a government-hosted teleconsultation platform supporting over 100,000 daily consultations (Iyengar et al., 2021).

However, infrastructure limitations—such as unreliable internet connectivity, intermittent electricity, and low digital literacy—pose persistent barriers. These challenges are partially mitigated by deploying "offline-first" technologies that can sync data when connectivity resumes. AI-driven triage bots and natural language processing tools are beginning to emerge in some pilots, particularly in mental health applications in Bangladesh and Uganda, though their use remains limited by algorithmic bias and regulatory concerns (Langarizadeh et al., 2017). The increasing penetration of mobile networks, particularly 4G coverage in sub-Saharan Africa, offers a promising foundation for broader deployment of such innovations (Otu et al., 2021).

Governance and Financing

Effective governance and sustainable financing are critical determinants of virtual hospital success. Governance models ranged from centralized government-led systems, such as Rwanda's Ministry of Health-led virtual care platforms, to decentralized models coordinated by NGOs or through PPPs. In Kenya, the DVHS is governed through a partnership involving Nairobi County Government, Mama Lucy Kibaki Hospital, and Bob Grogan Consulting Hub, with clear operational protocols for data sharing, referral loops, and accountability (Ministry of Health Kenya, 2020). This kind of partnership has proven instrumental in bridging public service mandates with the flexibility and innovation of private sector actors.

Financing mechanisms were equally diverse. Government funding, often under Universal Health Coverage (UHC) frameworks, provided foundational support in countries like India and Rwanda. In other settings, particularly in sub-Saharan Africa, donor-funded pilots or NGO-led programs dominated. Kenya's DVHS was initially funded through a donor grant with plans to scale via capitation under the National Health Insurance Fund (NHIF). Some models also explored fintech integrations for health micro insurance or mobile-pay consultations, though uptake remains low due to trust and affordability concerns (Adebayo et al., 2023). The findings underscore the need for blended financing models that ensure sustainability beyond initial pilots.

Service Delivery Outcomes

Virtual hospitals have yielded measurable service delivery outcomes, particularly in enhancing access, continuity of care, and cost-efficiency. In India, *eSanjeevani* led to a significant reduction in patient travel time and out-of-pocket expenses, particularly for chronic disease follow-up and routine consultations (Gudi et al.,

2022). Kenya's DVHS improved treatment adherence among hypertensive and diabetic patients by enabling virtual follow-up and reminders coordinated through CHVs. In addition, patients reported higher satisfaction due to reduced wait times and fewer missed appointments (Mugo et al., 2022).

Other documented outcomes include early identification of mental health issues through remote screening, improved maternal health follow-up through mobile midwife services, and enhanced palliative care coordination. While comprehensive cost-effectiveness data remains limited, several programs demonstrated lower per-consultation costs when compared to facility-based services, particularly in rural areas (Kruse et al., 2022). Nevertheless, the success of these interventions often hinged on contextual enablers, including community trust, health worker buy-in, and integration with existing referral systems.

Alignment with Health Policies and Priorities

Virtual hospital models in the reviewed literature aligned closely with global and national health strategies, particularly those aimed at achieving Universal Health Coverage (UHC) and Sustainable Development Goal 3 (SDG 3). Kenya's Digital Health Strategy 2020–2030 explicitly identifies virtual care as a core component of its UHC agenda, with guiding principles around interoperability, equity, and sustainability (Ministry of Health Kenya, 2020). The DVHS aligns with these priorities by linking community-based care with tertiary-level specialists, thereby decentralizing access without compromising quality.

At the global level, virtual hospitals support WHO's Global Strategy on Digital Health 2020–2025, which advocates for evidence-based, inclusive, and scalable digital solutions (WHO, 2021). Similarly, the Africa CDC's Digital Health Action Plan promotes the use of virtual platforms to bolster primary care and pandemic preparedness. Countries like Rwanda and India have adopted these frameworks in their national policies, facilitating better integration and funding alignment. However, the risk of fragmented implementation persists where digital health investments are not coordinated or regulated effectively, pointing to the need for robust national digital health architectures.

DISCUSSION

Interpretation of Key Findings

This scoping review synthesizes growing evidence on the implementation and outcomes of virtual hospitals in limited-resource settings. The findings suggest that virtual hospitals have the potential to significantly strengthen healthcare systems in contexts where geographical, infrastructural, and human resource limitations hinder service delivery. Virtual hospital models such as hub-and-spoke, decentralized mobile-based systems, and hybrid public-private partnerships (PPPs) emerged as effective structures for delivering care remotely. These models are particularly impactful in addressing chronic conditions, mental health, maternal care, and palliative services—areas typically underserved in conventional facility-based systems (Kruse et al., 2022; Mugo et al., 2022). The evidence also indicates that when supported by appropriate technology, clear governance, and aligned policy frameworks, virtual hospitals can enhance access, continuity, and cost-efficiency of care.

Comparison with Existing Literature

The findings of this review align with and extend existing literature on digital health innovations in low- and middle-income countries (LMICs). Previous studies have noted the benefits of telemedicine in reducing travel burden and increasing care access in rural areas (Langarizadeh et al., 2017; Iyengar et al., 2021). However, this review adds value by highlighting the integrated systems approach of virtual hospitals, which go beyond isolated teleconsultation tools to encompass diagnostics, referral coordination, follow-up, and health data integration. Unlike earlier analyses focused on high-income countries (Kruse et al., 2022), this review emphasizes how virtual hospitals have been adapted to the infrastructural and policy constraints of limited-resource settings. Notably, the use of community health workers linked to virtual platforms, as seen in Rwanda and Kenya, presents a novel approach not widely captured in prior systematic reviews focused on high-tech models in resource-rich settings (Kichbusch et al., 2020).

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Implications for Practice, Policy, and Research

The successful implementation of virtual hospital models carries several implications for healthcare practice and policy. From a **practice** perspective, these models demonstrate how frontline workers—especially CHVs—can be empowered through mobile technology to extend specialist care into underserved communities. This requires robust training, reliable communication platforms, and adequate supervision mechanisms. On a **policy** level, the integration of virtual hospitals into national health strategies is critical for scalability and sustainability. Kenya's Digital Health Strategy (2020–2030), which prioritizes interoperability, sustainability, and equity, provides a strong foundation for virtual care models such as DVHS at Mama Lucy Kibaki Hospital (Ministry of Health Kenya, 2020). However, such strategies must also include regulatory guidance for data protection, digital literacy promotion, and financing models that do not overburden patients.

For **research**, there is a need for more rigorous evaluations of virtual hospital outcomes. Most studies to date are descriptive or observational; randomized trials or controlled implementation studies are scarce. Future research should explore long-term cost-effectiveness, health outcomes disaggregated by population groups (e.g., gender, rural/urban), and the impact of various technologies on health worker workflows and patient satisfaction. In addition, implementation research is needed to assess what works in scaling virtual hospital models within decentralized and often fragmented health systems.

Relevance to the Kenyan Health System

Kenya's experience with the Digital Virtual Health System (DVHS) at Mama Lucy Kibaki Hospital serves as a practical case study of how virtual hospitals can be integrated into public health delivery in limited-resource urban settings. The DVHS bridges the gap between tertiary care and community-level health services by digitally linking CHVs to hospital-based specialists. This has led to improvements in patient follow-up, especially for non-communicable diseases like hypertension and diabetes, and has reduced patient wait times by filtering minor cases at the community level. Additionally, the DVHS model reflects Kenya's policy commitment to leveraging digital innovations for achieving Universal Health Coverage (UHC), as outlined in its national health strategy (Ministry of Health Kenya, 2020).

The program also illustrates how PPPs can be used to introduce innovation into public systems. In this case, technical support from a private consultancy firm enabled rapid platform development and CHV training. However, the model's long-term sustainability depends on integration into county health budgets, alignment with NHIF reimbursement structures, and the capacity for data governance. Moreover, challenges such as limited device maintenance support and inconsistent internet access in informal settlements highlight the infrastructural constraints that must be addressed for full scalability.

Comparative Perspectives Beyond Kenya

While Kenya provides a compelling case study of virtual hospital integration, broader regional comparisons can offer a more balanced and generalizable understanding of implementation strategies in limited-resource settings. For example, Rwanda has pursued a centralized, government-led approach to digital health, integrating virtual care within its national health strategy and leveraging community health workers under direct ministerial coordination (Kichbusch et al., 2020). In contrast, India's eSanjeevani platform operates as a federated, two-tiered telemedicine system with both provider-to-provider and provider-to-patient services, illustrating how large-scale virtual hospitals can be implemented through public sector leadership across diverse states and districts (Gudi et al., 2022). These contrasting governance and implementation frameworks highlight the importance of tailoring virtual hospital models to existing political, infrastructural, and regulatory contexts. Drawing lessons across countries can enhance understanding of what facilitates scale, ensures sustainability, and maintains equity in digital health service delivery.

Opportunities and Challenges

The expansion of virtual hospitals presents significant **opportunities** for transforming healthcare in LMICs. Widespread mobile phone penetration and growing 4G/5G coverage provide a digital backbone that can be harnessed to scale services even in remote regions (Otu et al., 2021). The ability to leverage task-shifting

strategies—where CHVs serve as frontline connectors to virtual specialists—can mitigate healthcare worker shortages. In addition, virtual hospital models align well with donor and government priorities focused on primary care, NCD management, maternal health, and pandemic preparedness, thereby attracting sustained funding.

However, multiple **challenges** persist. These include infrastructural limitations (e.g., unreliable electricity and internet), low digital literacy among both health workers and patients, and fragmented regulatory frameworks. In some settings, trust in virtual care remains low, particularly among older populations or those unfamiliar with technology. Financing mechanisms are also underdeveloped; donor dependence makes many pilots unsustainable, and public health insurance schemes often lack reimbursement codes for virtual services. Data security and patient confidentiality present another critical barrier, particularly where national laws on digital health data remain unclear or unenforced (WHO, 2021).

The role of governance cannot be overstated: countries with clear national strategies and regulatory bodies—such as India and Rwanda—demonstrated smoother integration and broader uptake of virtual hospital models. Conversely, in environments where digital health is fragmented across multiple actors, duplication, inefficiency, and ethical risks are more likely. Therefore, building coherent, interoperable, and inclusive national digital health ecosystems is essential to overcome these barriers and fully realize the promise of virtual hospitals in limited-resource settings.

CONCLUSION

Summary of Key Findings

This scoping review highlights the emerging potential of virtual hospitals as transformative tools in addressing healthcare delivery challenges in limited-resource settings. The findings indicate that virtual hospitals—when appropriately designed and implemented—can significantly enhance access to care, reduce dependency on physical infrastructure, and improve continuity and efficiency of healthcare services. Models such as centralized hub-and-spoke systems, decentralized mobile-linked platforms, and hybrid public-private partnerships have proven effective in extending healthcare access to underserved populations (Kruse et al., 2022; Kichbusch et al., 2020). These models integrate digital technologies such as teleconsultation platforms, cloud-based electronic health records (EHRs), and wearable devices, often mediated through community health workers, to deliver care remotely across varying levels of health systems (Iyengar et al., 2021; Gudi et al., 2022).

Notably, the implementation of the Digital Virtual Health System (DVHS) at Mama Lucy Kibaki Hospital in Kenya provides a practical example of how virtual hospitals can be adapted to urban low-resource environments. The model, which connects community health volunteers (CHVs) with hospital-based specialists via mobile tools, has demonstrated measurable improvements in chronic disease management and patient follow-up (Ministry of Health Kenya, 2020; Mugo et al., 2022). These findings affirm that, beyond high-income countries, virtual hospital models can also thrive in low- and middle-income countries (LMICs), particularly when supported by policy alignment, technological readiness, and collaborative governance structures.

POLICY RECOMMENDATIONS

To maximize the impact and sustainability of virtual hospitals in limited-resource settings, several policy actions are necessary. First, national and subnational governments should formally integrate virtual hospital models into their health sector strategic plans and budgeting frameworks. This includes recognizing virtual services—such as remote diagnosis, consultation, and follow-up—as essential healthcare services eligible for insurance reimbursement, particularly under schemes like Kenya's National Health Insurance Fund (NHIF) (Ministry of Health Kenya, 2020).

Second, governments should strengthen legal and regulatory environments to protect patient data, establish clinical standards for virtual care, and define accountability structures. The WHO and Africa CDC both

emphasize the importance of digital health governance, especially in LMICs where data privacy laws are often outdated or poorly enforced (WHO, 2021; Africa CDC, 2022).

Third, countries should promote and institutionalize public-private partnerships (PPPs). These partnerships can accelerate innovation, expand funding sources, and support the training and deployment of digital tools while ensuring equity and accountability. Kenya's DVHS offers a strong model for how PPPs can be structured for digital health innovation (Ministry of Health Kenya, 2020).

Fourth, there is a critical need to invest in digital infrastructure, including expanding broadband coverage, ensuring reliable power supply, and equipping healthcare providers with secure and interoperable systems. Capacity-building efforts should focus on upskilling frontline workers and ensuring communities are digitally literate and able to engage meaningfully with virtual platforms (Otu et al., 2021).

Finally, policymakers should adopt standardized monitoring and evaluation frameworks tailored to digital care delivery. These should include key performance indicators for quality, accessibility, cost-effectiveness, and user experience, enabling evidence-based decision-making and cross-country learning (WHO, 2021).

RESEARCH GAPS AND SUGGESTED FUTURE WORK

Despite the promising evidence presented, several research gaps remain. Most existing studies on virtual hospitals in LMICs are descriptive, with limited use of rigorous methodologies to assess outcomes. There is an urgent need for longitudinal and controlled studies that evaluate the clinical effectiveness, cost-efficiency, and health equity implications of virtual hospital interventions over time (Kruse et al., 2022; Iyengar et al., 2021).

Another critical gap lies in understanding the contextual factors that influence the success or failure of virtual hospital models. Future research should adopt implementation science frameworks to explore how infrastructure, cultural norms, digital literacy, and governance systems affect uptake and sustainability. This is especially relevant in fragmented or decentralized health systems where digital innovation often outpaces regulatory frameworks (Langarizadeh et al., 2017).

Patient experiences with virtual hospitals are also underexplored. Research should examine how different population groups—particularly women, older adults, rural residents, and individuals with low literacy—perceive and interact with virtual care platforms. Understanding these perspectives is essential for ensuring inclusive and equitable digital health services (Mugo et al., 2022).

Finally, there is a pressing need to develop evaluation frameworks tailored to limited-resource settings. These tools should capture a broad range of outcomes—including access, quality, continuity, safety, cost, and satisfaction—and be adaptable across diverse healthcare systems. Collaborative efforts between ministries of health, academia, and international organizations can help build a global evidence base that supports the responsible scale-up of virtual hospitals in LMICs (WHO, 2021; Africa CDC, 2022).

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