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Telemedicine Readiness in East African Regional Centres of Excellence: An Assessment of Digital Infrastructure, Services, and Human Resources

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ABSTRACT

Background: The East African Community (EAC) faces inequalities in access to specialised healthcare, shortages of skilled health professionals, and limited digital infrastructure. Telemedicine can extend specialised services and clinical expertise across geographic boundaries, but implementation requires adequate digital infrastructure, skilled human resources, interoperable systems, and supportive governance. The EAC Regional Centres of Excellence (RCoEs) are strategically important as regional hubs for specialised healthcare delivery, advanced training, research, and innovation. However, recent evidence on their digital readiness for telemedicine and the alignment of their digital assets and institutional capacities with telemedicine requirements is limited. This study assessed digital assets and capacity for telemedicine in EAC RCoEs to identify readiness gaps and inform regional policy, investment, and capacity-building priorities.

Methods: A descriptive qualitative study was conducted across six EAC RCoEs in Burundi, Kenya, Rwanda, Tanzania, and Uganda from April to May 2025. Data were collected through document reviews, structured assessments using a Telemedicine Assessment Framework, observation, and semi-structured interviews with executive leaders, Information and Communication Technology (ICT) personnel, healthcare professionals, and supporting staff. Thematic analysis was undertaken using ATLAS.ti version 23.2.1(ATLAS.ti Scientific Software Development GmbH, Berlin, Germany) to identify patterns and barriers affecting readiness.

Results: The RCoEs demonstrated foundational digital infrastructure, but readiness for advanced telemedicine was constrained by infrastructural, governance, workforce, interoperability, financing, and regulatory gaps. Key challenges included unreliable internet connectivity, limited specialised telemedicine platforms, inadequate formal training in virtual care, weak data governance, limited adoption of Health Level Seven (HL7) and Fast Healthcare Interoperability Resources (FHIR) standards, insufficient dedicated Digital Health (DH) financing, and inadequate telemedicine policies. Existing digital systems predominantly supported academic and administrative functions rather than clinical telemedicine, indicating a mismatch between available digital assets and clinical requirements.

Conclusion: The EAC RCoEs have foundations for telemedicine but require coordinated action. Priorities include strengthening digital infrastructure and connectivity, workforce competencies, interoperability, data governance, financing, and regulatory frameworks. A coordinated EAC regional telemedicine policy and standards-aligned interoperability framework could strengthen RCoEs as regional DH hubs, improve equitable access to specialised healthcare, and contribute to Universal Health Coverage (UHC).

BACKGROUND

The East African region continues to face substantial challenges in achieving equitable access to healthcare. These include shortages of skilled health workers, rising healthcare costs, limited health insurance coverage, weak health-system governance, and disparities in health infrastructure.[1–3] These challenges are compounded by a dual burden of communicable and non-communicable diseases, persistent maternal and child health inequities, and recurrent infectious disease outbreaks.[4–7] Together, these pressures place considerable demands on health systems and highlight the need for approaches that can extend access to healthcare across the East African Community (EAC).

Telemedicine, which is broadly defined as *"the delivery of healthcare services and information via digital technologies"*,[8] has emerged as a promising strategy to bridge critical gaps in healthcare access and delivery. Telemedicine can support remote consultation, diagnosis, monitoring, and collaboration among health professionals. It is particularly relevant where specialist services are concentrated in a limited number of facilities.[8–11] Recent implementation guidance also

emphasises that telemedicine requires appropriate planning, infrastructure, workforce capacity, governance, and ongoing support.[12,13]

Telemedicine should be distinguished from the broader concept of Digital Health (DH). DH encompasses the use of digital technologies to improve health and health system performance, including health information systems, interoperability, data exchange, remote monitoring, and telemedicine.[14] Telehealth is a broader service concept that includes telemedicine and other technology enabled health activities.[15] In this study, telemedicine readiness refers to the extent to which an institution has the services, digital infrastructure and assets, human resource competencies, and institutional conditions required to implement and sustain telemedicine. Capacity refers to the resources and organisational capabilities available to support these functions. These distinctions are important because the presence of digital technologies does not necessarily mean that an institution is ready to deliver safe, reliable, interoperable, and sustainable telemedicine services.

The East African Health Research Commission (EAHRC) launched the Digital Reach Initiative (DRI) to advance digital health equity in the region. The initiative seeks to strengthen connectivity, interoperable health information systems, and workforce capacity.[16] The Regional Centres of Excellence (RCoEs) are important within this agenda. They are specialised institutions that support healthcare delivery, advanced training, research, regional cooperation, and capacity development.[16] Their specialised functions and regional mandate provide an opportunity to extend healthcare services beyond their immediate geographical locations.

However, the ability of the RCoEs to support telemedicine may be affected by gaps in digital infrastructure and internet connectivity. Other challenges include limited specialised workforce competencies, weak data governance, and inadequate cybersecurity arrangements.[17–21] These challenges can be particularly pronounced for rural and underserved populations. Limited connectivity and inadequate last-mile infrastructure can constrain access to telemedicine services.[18,19] Telemedicine also involves the collection, transmission, storage, and exchange of sensitive health information. Therefore, appropriate data-governance arrangements, including privacy and confidentiality safeguards, cybersecurity controls, secure information exchange, and interoperability standards, are essential for protecting patients and supporting safe, integrated care.[22,23]

The COVID-19 pandemic further highlighted the potential value of remote healthcare delivery.[19,24] However, it also exposed weaknesses in the digital infrastructure and systems required to implement such services effectively and at scale.[9,20,24] Evidence from sub-Saharan Africa indicates that telemedicine implementation continues to face infrastructural, workforce, policy, regulatory, and organisational barriers.[17,25] These challenges suggest that successful telemedicine implementation requires more than the availability of individual technologies. It requires an enabling institutional and health system environment.

Despite growing policy attention to DH and telemedicine in the EAC, there is limited recent comparative evidence on telemedicine readiness at the level of the RCoEs. Existing literature has examined telemedicine development and barriers in sub-Saharan Africa, as well as specific national or service level experiences.[10,17,21,26] However, less attention has been given to the readiness of specialised regional institutions that are expected to support cross border specialised healthcare. In particular, there was a need to assess capacity and capability of RCoEs for telemedicine.

This evidence gap has practical implications. Investments in connectivity, equipment, digital platforms, and workforce development need to correspond to the actual requirements and readiness of institutions. A structured assessment can identify existing strengths and reveal gaps that may otherwise remain hidden. It can also help distinguish between institutions that have basic digital foundations and those that have the broader capabilities required for sustainable telemedicine implementation.[12,13]

This paper therefore presents an assessment that directly aligns with the DRI's initiative, aiming to systematically evaluate the "*Digital Assets and Capacity to support the establishment of Telemedicine*" within the East African RCoEs. Specifically, this assessment focused on understanding the current state of telemedicine services, human resources, and digital infrastructure. It involved mapping existing digital assets against identified telemedicine demands and critically assessing institutional capacities, including leadership commitment, workforce digital literacy, and the strength of existing partnerships. By grounding its findings in the strategic priorities of the EAHRC, this assessment sought to provide actionable insights for informing targeted policy reforms, strategic infrastructure investments, and comprehensive capacity building programs. Ultimately, this work aimed to enhance the pivotal role of the RCoEs in advancing equitable healthcare access and accelerating progress towards achieving universal health coverage (UHC) throughout the East African Community.

METHODS

Study Design

This study employed a descriptive qualitative design to assess telemedicine readiness across RCoEs in the EAC. A qualitative design was appropriate because the study sought to understand institutional practices, capacities, barriers, and enabling conditions from the perspectives of stakeholders involved in telemedicine and DH activities.[27,28] The descriptive component was used to provide a structured account of the existing telemedicine environment without manipulating study conditions.[29]

The study used multiple qualitative and documentary sources to strengthen the assessment. These included stakeholder interviews, institutional document review, structured observation, and review of available digital system information. Using multiple sources enabled triangulation of findings and reduced reliance on a single source of evidence.[30]

Study Setting and Participants

The study was conducted between April and May 2025 across six RCoEs in five EAC Partner States: the East African Centre of Excellence for Nutrition Sciences (EAC-ENS) in Burundi; the East African Centre of Excellence for

Nephrology and Urology in Kenya; the East African Centre of Excellence for Vaccines, Immunisation, and Health Supply Chain Management (EAC-VIHSCM) in Rwanda; the East African Centre of Excellence in Biomedical Engineering, E-Health, and Health Rehabilitation (CEBE) in Rwanda; the East African Centre of Excellence for Cardiovascular Sciences (EAC-CoECS) in Tanzania; and the East African Centre of Excellence for Oncology in Uganda.

The six RCoEs included in the study were the designated Regional Centres of Excellence participating in the East African Health Research Commission's Digital Reach Initiative (DRI) assessment at the time of the study. Their inclusion was therefore based on their designation as RCoEs and participation in the DRI assessment, rather than investigator selection

The study population comprised stakeholders directly involved in the planning, implementation, management, or use of telemedicine-related activities at the RCoEs. Participants were drawn from three role groups: Executive Directors, ICT Focal Persons, and Telehealth Providers. Executive Directors provided strategic and institutional perspectives; ICT Focal Persons provided information on digital infrastructure, systems, maintenance, and technical support; and Telehealth Providers provided perspectives on the delivery and use of remote healthcare services.

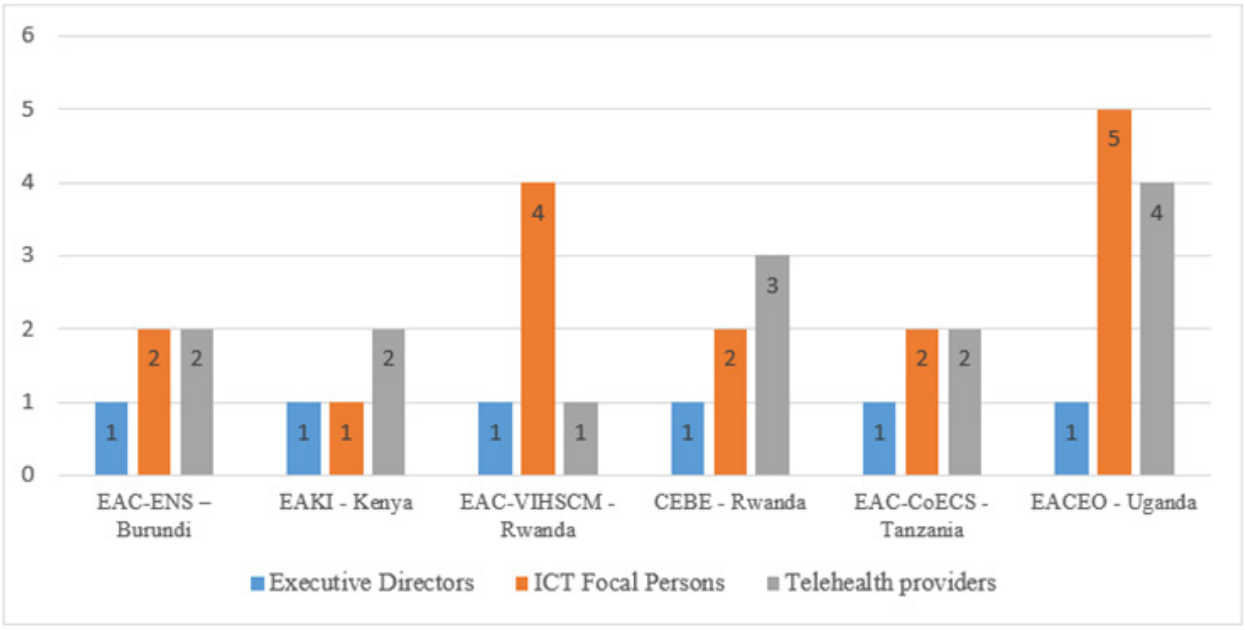
A total of 36 in-depth interviews were conducted across the six RCoEs. Participants were purposively selected based on their roles, involvement in telemedicine-related activities, and availability during the study period. They comprised six Executive Directors, 16 ICT Focal Persons, and 14 Telehealth Providers. The distribution of participants across the RCoEs and participant categories is presented in Figure 1. Because selection was purposive, the number of participants was not expected to be equal across centres or roles.

Before data collection, stakeholder mapping was undertaken to identify individuals according to their interest, influence, and expertise in telemedicine. Two resource persons from each RCoE, typically the Executive Director and ICT Focal Person, served as on site facilitators. They coordinated site access and helped schedule interviews but were not automatically treated as the complete study sample. Participant inclusion was based on relevance to the study objectives and the individual's direct knowledge or involvement in telemedicine-related activities.

Participant Selection

Participants were selected purposively because the study required information from individuals with specific institutional, technical, or service-delivery knowledge. The selection process prioritised participants who could provide substantive information on telemedicine services, digital infrastructure and assets, human-resource capacity, governance, and implementation conditions. Recruitment continued until the planned stakeholder categories had been adequately represented across the six RCoEs and additional interviews were no longer generating substantially new information relevant to the assessment.

FIGURE 1: Distribution of Study Participants per RCoE



Data Collection

Data collection used four complementary approaches: documentary review, structured assessment using the Telemedicine Assessment Framework, qualitative in-depth interviews, and direct observation or system-level verification where feasible.

Telemedicine Assessment Framework

A structured Telemedicine Assessment Framework (Figure 2) was developed from established approaches, including the Pan American Health Organisation (PAHO) Telemedicine Framework,[12] The Open Group Architecture Framework (TOGAF),[31] and the World Health Organisation–International Telecommunication Union (WHO–ITU) Digital Health and Telehealth Guidance.[15] The framework guided assessment of telemedicine services, digital infrastructure and assets, human resource capacity, organisational readiness, governance, interoperability, and related enabling conditions. The framework was adapted for this study to provide a common qualitative structure for cross centre assessment. Before field deployment, the assessment domains and interview guide were reviewed and pre-tested for clarity, relevance and completeness. Each domain was assessed against available interview, documentary, observational and system-verification evidence; status labels were applied descriptively and consistently across centres. The framework was used as an assessment structure rather than as a psychometrically validated readiness scale.

The framework was also used to structure the interview guides and to organise documentary and observational evidence. This ensured that evidence collected from different sources addressed comparable domains across the six RCoEs.

FIGURE 2: Telemedicine Assessment Framework



Data Collection Tools and Procedures

Semi-structured interview guides were developed from the Telemedicine Assessment Framework. The guides contained open-ended questions on existing telemedicine services, human-resource competencies, digital infrastructure and assets, governance, barriers, enabling factors, and future requirements. The guides were pre-tested before the main data collection to assess clarity, sequencing, and relevance.

A total of 36 in-depth interviews were conducted between April and May 2025. Semi-structured stakeholder interviews were conducted with Executive Directors, ICT Focal Persons, and Telehealth Providers. All interviews were conducted by the first author and in English, which was used as the common language across the participating RCoEs. Interviews lasted approximately 45-60 minutes and were conducted either face-to-face or virtually, depending on site accessibility and participant availability. With participants' consent, interviews were audio-recorded, transcribed, anonymised, and reviewed against the recordings to ensure accuracy

Documentary review covered institutional records relevant to telemedicine readiness. These included hardware and software inventories, technical reports on existing information systems, and available telemedicine logs. Where authorised, direct access to relevant systems was also used to verify network configuration, system uptime, bandwidth use, and network reliability. These sources provided objective evidence that complemented information obtained through interviews.

During planned site visits, direct observation was used to assess the operational environment, availability and condition of digital assets, connectivity, power-backup arrangements, and other features relevant to telemedicine implementation. Observational findings were recorded and compared with interview and documentary evidence.

Data Saturation and Quality Assurance.

Data collection was reviewed progressively to determine whether interviews were continuing to generate new information relevant to the study domains. Sampling was considered adequate when the major stakeholder categories had been represented across the RCoEs, and successive interviews were producing limited additional information. Triangulation across interviews, documentary evidence, observation, and system-level verification were used to strengthen credibility and identify inconsistencies requiring clarification.

Data Analysis

Data from stakeholder interviews, documentary review, observations, and system verification were analysed using thematic analysis. The analysis, guided by the approaches outlined by Kiger & Varpio[32] and Maguire & Delahunt,[33] began with repeated reading of interview transcripts, observational notes, and document summaries to achieve familiarity with the data. Initial codes were then assigned to meaningful segments of text relating to telemedicine services, human resources, digital infrastructure and assets, governance and regulation, data governance, interoperability, financing, and partnerships. Related codes were grouped into broader categories and candidate themes. The themes were subsequently reviewed and refined to ensure that they were coherent, distinct, and adequately supported by the data. Final themes were defined and named before the findings were synthesised. ATLAS.ti was used to support qualitative coding, data organisation, and retrieval. Coding and theme development were conducted iteratively across the six centres and stakeholder groups, with the framework domains used as an organising structure rather than predetermined findings. The analysis therefore combined deductive organisation around the assessment domains with inductive identification of recurrent barriers, enablers and contextual differences.

The structured assessment findings were interpreted alongside the qualitative evidence rather than treated as a separate quantitative analysis. For each assessment domain, the status was determined using evidence from stakeholder interviews, institutional documents, direct observation, and system verification where authorised. Classifications such as "*Not implemented*", "*In progress*" and "*Active*" described the observed status of the assessed capability at the time of data collection. Terms such as "*Basic*" and "*Limited*" were used to describe partial or constrained capacity. These classifications were applied consistently across the six RCoEs to facilitate cross-centre comparison. They were descriptive rather than numerical scores and were not used to generate an overall ranking of the RCoEs.

The qualitative findings were then used to explain the context underlying each assessment status. This approach enabled the study to integrate structured assessment evidence with stakeholder perspectives and direct observations while retaining the qualitative character of the study. Triangulation across data sources strengthened the credibility of the findings and helped identify areas of convergence or discrepancy between reported and observed capacity. No composite readiness score was calculated, because the evidence did not support assigning validated numerical weights to the domains.

Ethical Considerations

Ethical clearance was obtained from the East African Health Research Commission. Permission to access the study sites was sought from the Ministries of Health of the participating EAC Partner States through their respective Ministries responsible for East African Community Affairs (Ref: INS/6/1/25/3). Written or documented informed consent was obtained from participants before interviews were conducted. Participants were informed about the purpose of the study, the voluntary nature of participation, and the intended use of the information provided. Confidentiality and anonymity were assured.

RESULTS

The Results are organised according to the seven components of the Telemedicine Assessment Framework: financial sustainability; governance and organisational capacity; legal and regulatory framework; workforce capacity; technology platforms and infrastructure; interoperability and data sharing; and clinical service readiness and quality considerations. The framework-based classifications are qualitative descriptions of the status observed or reported during the assessment; they are not numerical scores and do not constitute a validated overall readiness index. The clinical service

readiness and quality domain assessed the presence of clinical telemedicine workflows, service arrangements and quality-related safeguards; it did not measure patient outcomes or clinical effectiveness.

East African Centre of Excellence for Nutrition Sciences (EAC-ENS)-Burundi

EAC-ENS had foundational digital resources but had not established an operational telemedicine service. Its strongest assets were basic connectivity, general ICT literacy and a relevant nutrition and public health workforce. However, the centre lacked specialised telemedicine tools, formal digital health governance, interoperable data systems and dedicated financing Table 1.

East African Centre of Excellence for Nephrology and Urology (EAC-NEU/EAKI)- Kenya

EAKI had institutional interest in telemedicine and a relevant specialist workforce, but implementation remained pre-operational. The centre had basic digital infrastructure and general ICT support, while formal telemedicine systems, specialised training, interoperability, patient-facing services and dedicated financing were not yet established Table 2.

East African Centre of Excellence for Vaccines, Immunisation, and Health Supply Chain Management (EAC-VIHSCM)-Rwanda

EAC-VIHSCM demonstrated the strongest combination of digital infrastructure, interoperability, ICT capability and digital investment among the assessed centres. However, its digital ecosystem primarily supported education, administration, technical assistance and regional collaboration rather than clinical telemedicine Table 3.

East African Centre of Excellence in Biomedical Engineering, E-Health, and Health Rehabilitation (CEBE)-Rwanda

CEBE demonstrated an operational community-based digital rehabilitation model. The centre had a clearly articulated strategic vision, an active technology ecosystem and a trained community workforce. However, national integration, specialist capacity, data integration, formal governance and sustainable financing remained incomplete Table 4.

East African Centre of Excellence for Cardiovascular Sciences (EAC-CoECS)- Tanzania

EAC-CoECS had an established ICT unit, a substantial academic workforce and a national eHealth policy environment. Nevertheless, the centre lacked several components needed for integrated cardiovascular telemedicine, including specialised platforms, interoperability, telemedicine-specific workforce development, formal licensing and consent mechanisms, and dedicated financing Table 5.

East African Centre of Excellence for Oncology (EACEO)-Uganda

EACEO demonstrated active but limited clinical telemedicine capacity. It had a functioning digital clinical environment, a defined group of staff using telemedicine tools, operational telepathology and hybrid server/cloud infrastructure. However, specialised tele-oncology workflows, regulatory arrangements, institutional consent procedures and dedicated financing remained incomplete Table 6.

Cross-RCoE Comparative Synthesis

The framework-based comparison shows that telemedicine capacity varied substantially across the seven assessment components. The findings do not support a single numerical readiness ranking because the centres demonstrated different combinations of strengths and gaps. The comparison below therefore summarises the observed status of each framework component across the six RCoEs Table 7.

The comparison reveals a clear divergence between foundational digital capacity and clinical telemedicine capability. EAC-VIHSCM demonstrated strong technology, interoperability, workforce and digital-financing foundations, but its reported services were primarily educational, administrative and technical rather than clinical. CEBE, in contrast, had an operational community digital-rehabilitation model supported by trained CHWs and active technology platforms, although its institutional integration and long-term financing remained incomplete. EACEO had active patient teleconsultations and operational telepathology, but the service was limited and lacked oncology-specific workflows.

Governance and legal-regulatory capacity were uneven across the centres. EAC-VIHSCM had relatively developed ICT governance arrangements, whereas EAC-ENS, EAKI, CEBE, EAC-CoECS and EACEO had important gaps in institution-specific telemedicine strategies, consent arrangements, ethical guidance, licensing or formal operational policies. These findings indicate that the presence of a national digital-health policy does not necessarily mean that the institutional requirements for telemedicine are fully established.

Interoperability was another major differentiating component. EAC-VIHSCM reported use of HL7, FHIR and regional data-sharing frameworks. By contrast, EAC-ENS, EAKI and EAC-CoECS had not implemented the specified interoperability standards. CEBE had not yet integrated digital rehabilitation data with the national HMIS, while EACEO's core clinical systems were only partially integrated.

Workforce capacity also varied in form rather than simply in size. EAC-VIHSCM had a highly qualified ICT team, CEBE had trained 70 CHWs supporting digital rehabilitation, and EACEO had an identified group of health and IT staff actively using telemedicine tools. Other centres had relevant clinical or academic workforces but lacked specialised telemedicine training. Thus, workforce availability did not automatically translate into telemedicine-specific capacity.

Across the framework as a whole, the principal pattern was that technology and infrastructure were generally more developed than the organisational, regulatory, interoperability and financing arrangements required for sustained clinical telemedicine. The findings therefore point to a multidimensional and centre-specific readiness profile rather than a uniform level of preparedness across the six RCoEs.

TABLE 1: Current State of Digital Ecosystem at the EAC-ENS

Telemedicine Assessment Framework component	Key findings	Status
Financial Sustainability	Digital investment was minimal and focused mainly on connectivity. No dedicated budget was available for telehealth platforms, tools or capacity building. External partnerships were limited to academic exchange.	Limited
Governance/Organizational	No institution-specific digital-health strategy was reported. Existing arrangements did not provide a formal roadmap for telemedicine implementation or alignment with EAC digital-health priorities.	Not established
Legal & Regulatory Framework	General academic consent forms were used, but specific policies for health-data protection, patient consent and community engagement were not established. Formal telemedicine governance arrangements were absent.	Incomplete
Workforce Capacity	Faculty and administrative staff had general computer literacy. Dietitians, nutritionists and public-health professionals provided a potential clinical base, but staff had no prior training in tele-nutrition platforms, digital counselling or M&E for virtual care.	Basic; specialised capacity absent
Technology Platforms and Infrastructure	Basic government broadband and desktops/few laptops were available. A generator supported core services, but UPS and solar backup were absent. Remote-consultation tools were unavailable, and the local server infrastructure was outdated for telemedicine.	Basic; not telemedicine-ready
Interoperability & Data Sharing	HL7, FHIR and structured data-exchange formats were not implemented. Nutrition surveillance relied on manually aggregated field reports. Data were stored in spreadsheets and printed reports, with no structured database, encryption or access-control system.	Not implemented
Clinical Effectiveness & Quality of Care	Community nutrition assessments and education were conducted mainly in person, with radio messaging. No tele-nutrition or remote clinical consultation service was in use; mobile/SMS follow-up was absent.	Not operational

TABLE 2: Current State of Digital Ecosystem at EAC-NEU/EAKI

Telemedicine Assessment Framework component	Key findings	Status
Financial Sustainability	No dedicated digital-health budget was reported. Financial constraints delayed procurement and deployment of infrastructure that could support telemedicine. Leadership was exploring an innovation hub and external partnerships.	Limited
Governance/Organizational	An institutional telemedicine strategy had not yet been developed. Leadership showed strong interest and advocated for a shared EAC telemedicine strategy.	In progress at leadership level; formal strategy absent
Legal & Regulatory Framework	The assessment reported no national telemedicine policy in Kenya at the time of study. Licensing and liability arrangements were not established, and telemedicine-specific data-protection and ethical practices had not been formally adopted.	Incomplete
Workforce Capacity	The centre had 18 healthcare professionals. Staff were willing to adopt telemedicine but required formal training. General IT support was available, but there was no dedicated digital-health focal point or specialised telemedicine technical support.	Basic; specialised capacity limited
Technology Platforms and Infrastructure	University internet supported academic activities but was inadequate for high-bandwidth teleconsultation. Basic laptops and desktops were	Basic; integration

Continue

TABLE 2: Continued

Telemedicine Assessment Framework component	Key findings	Status
	available, but no hardware standards had been defined. Imaging systems were not integrated with remote diagnostics.	limited
Interoperability & Data Sharing	HL7, FHIR and other recognised health-data exchange standards were not implemented. A live nephrology/urology patient registry was not yet available; the registry was under development.	Not implemented/ in progress
Clinical Effectiveness and Quality of Care	No teleconsultation platform was in use. WhatsApp and Zoom were identified as informal future options. No digital patient-provider channel, public sensitisation programme or operational telemedicine service was reported.	Not operational

TABLE 3: Current State of Digital Ecosystem at EAC-VIHSCM

Telemedicine Assessment Framework component	Key findings	Status
Financial Sustainability	Core funding included KfW German Development Bank support, tuition and sustainability funds. Approximately 20–25% of the budget was directed to digitalisation. Partnerships with vaccine manufacturers, NGOs and academic institutions were established.	Relatively strong
Governance/Organizational	Digital operations were supported by institutional ICT arrangements and regional collaboration. ICT policies were aligned with national and EAC digital-security requirements, including access control and secure data sharing.	Established
Legal & Regulatory Framework	ICT policies were aligned with national and EAC digital-security requirements. Data were hosted locally in Rwanda in accordance with national and EAC data policies.	Relatively developed
Workforce Capacity	A highly qualified ICT team supported infrastructure and cybersecurity. In-house staff supported online content development and delivery.	Strong ICT capacity
Technology Platforms and Infrastructure	4G and fibre-optic connectivity were reported with high satisfaction. High-performance computing resources were available. E-tendering and digital repository platforms were in development; minimum hardware standards had not been specified.	Strong; some elements in development
Interoperability & Data Sharing	HL7, FHIR and regional data-sharing frameworks were reported as being in use. Medical-vocabulary harmonisation was in progress.	Implemented; harmonisation in progress.
Clinical Effectiveness and Quality of Care	Digital services included blended postgraduate/professional education and technical support for procurement, logistics and communication. No clinical consultations were conducted.	Clinical telemedicine not operational

TABLE 4: Current State of Digital Ecosystem at CEBE

Telemedicine Assessment Framework component	Key findings	Status
Financial Sustainability	Funding was largely project-based, supported by JAMK and private technology partners. No institutional budget line for long-term operations was reported, and a clear fundraising strategy had not been developed.	Project based

Continue

TABLE 4: Continue

Telemedicine Assessment Framework component	Key findings	Status
Governance/Organizational	The hub's mission and objectives provided a clear strategic vision. Pilot-level planning was in place, and two policy documents were underway, but integration into the national eHealth strategy and the strategic roadmap were not finalised. Government engagement had begun.	In progress
Legal & Regulatory Framework	No formal national or institutional guidelines specific to digital rehabilitation were reported. Privacy procedures were basic and guided by research consent. Full operational ethical and governance guidelines were required for scale-up.	Incomplete
Workforce Capacity	Seventy CHWs had been trained and were actively supporting community-based digital rehabilitation. The core team had limited specialist IT capacity. Training was mainly in-house, without formal accreditation, and a formal CHW supervision hierarchy was still needed.	Active; scale-up capacity needed
Technology Platforms and Infrastructure	Connectivity was stable at the hub but weak in rural outreach areas. Smartphones, smart screens, cameras and tablets supported pilot activities. The Inclusion App and Goodlife Technology were active, while AIRe was being tested. Facility and national referral-system integration had not been achieved.	Active; scale-up constrained
Interoperability & Data Sharing	Digital rehabilitation data were not yet integrated into Rwanda's HMIS. Patient information was tracked manually or through basic spreadsheets, with limited analytics and semi-digital outcome tracking.	In progress
Clinical Effectiveness and Quality of Care	Goodlife Technology supported video-guided rehabilitation, clinician oversight and real-time progress dashboards. More than 10,000 people had been reached across three districts, and 96% of patients reported improved mobility and quality of life. Community feedback was very positive.	Operational community digital care

TABLE 5: Current State of Digital Infrastructure and Human Resources at EAC-CoECS

Telemedicine Assessment Framework component	Key findings	Status
Financial Sustainability	The university had an ICT budget, and World Bank funding and loans, but the allocation was not specific to telemedicine. Technology-firm partnerships were not yet in place.	Available but not dedicated
Governance/Organizational	Tanzania had a national eHealth policy and a plan for digitising cardiovascular services. However, no dedicated cardiovascular telemedicine strategy had been established. An ICT unit existed but required additional capacity to function as a regional telemedicine centre.	Partially established
Legal & Regulatory Framework	Tanzania had a Data Protection Law. However, implementation of compliance was unclear, licensing policies for telehealth were not yet in place, and formal policies for digital consultations and consent mechanisms were absent.	Incomplete
Workforce Capacity	Thirty-eight staff were enrolled, including five PhD holders and other staff with master's degrees. The academic base was strong, but digital skills were basic and specialised telemedicine training was lacking. CPD programmes did not include telemedicine modules.	Strong academic base; specialised capacity limited
Technology Platforms and Infrastructure	Internet bandwidth was 100 Mbps but unreliable. A backup generator was available. No cardiology EMR/EHR module or	Moderate; major gaps

Continue

TABLE 5: Continued

Telemedicine Assessment Framework component	Key findings	Status
	wearable monitoring devices were reported. WhatsApp and video-conferencing tools were available, but no dedicated secure telemedicine platform was in place. Imaging and reports were stored on a local server.	
Interoperability & Data Sharing	HL7, FHIR and LOINC were not in use, limiting integration with external systems. Imaging and reports were not hosted in the cloud.	Not implemented
Clinical Effectiveness and Quality of Care	Media campaigns supported community education on tele-cardiology. However, structured cardiac follow-up protocols and patient-feedback mechanisms were not in place, and a dedicated clinical telemedicine service had not been established.	Limited/not established

TABLE 6: Current State of Digital Ecosystem at EACEO

Telemedicine Assessment Framework component	Key findings	Status
Financial Sustainability	Telemedicine funding existed under the ICT budget but was not separately identified. External support included Fred Hutchinson and RENU, while academic partnerships included Makerere University, Cambridge, UVA and Baylor College.	Available but not dedicated
Governance/ Organizational	Uganda had no separate national telemedicine strategy; telemedicine was embedded in the Uganda Digital Health Strategic Plan. An institutional telemedicine roadmap and governance structure were in progress, while a tele-oncology policy was absent.	In progress
Legal & Regulatory Framework	Uganda's Data Protection Act provided a national legal framework. However, institutional data-use and consent procedures, ethical guidelines for digital health and licensing arrangements for virtual healthcare were absent.	Incomplete
Workforce Capacity	Ten health workers were actively using telemedicine tools, supported by five health workers and five internal IT staff. Regular CME/CPD and VHT/CHW training were reported. Further tele-oncology specialisation was required.	Active; specialist capacity needed
Technology Platforms and Infrastructure	Internet bandwidth was 100 Mbps but unreliable for cross-EAC teleconsultations. Wi-Fi covered all rooms and power backup was satisfactory. Existing telemedicine workstations were not optimised. On-premise and cloud infrastructure were available.	Developed but reliability constrained
Interoperability & Data Sharing	e-AFIA, Clinic Master and the laboratory information system were. functional and partially integrated. No oncology-specific telemedicine platform was available. Mobile diagnostic kits remained in progress.	Partial
Clinical Effectiveness and Quality of Care	Patient teleconsultations were active but limited and relied on general-purpose platforms. Telepathology was operational; other remote diagnostic capabilities were being expanded. Patient-feedback mechanisms were in development, and smartphones had been provided to VHTs for outreach.	Active but limited

TABLE 7: Cross-RCoE Comparative Synthesis

Framework component	EAC-ENS	EAKI	EAC-VIHSCM	CEBE	EAC-CoECS	EACEO
Financial Sustainability	Minimal; no dedicated telemedicine- specific budget	No dedicated telemedicine-specific budget	g20–25% of budget directed to digitalisation; not telemedicine -specific	Project-based; no long-term institutional line	ICT funding available; not telemedicine-specific	Within ICT budget; no dedicated telemedicine allocation
Governance/Organizational	No institution-specific digital-health strategy	Institutional strategy not developed	ICT governance and regional alignment established	Strategic vision strong; national integration in progress	National eHealth policy exists; dedicated cardiac telemedicine strategy absent	Institutional roadmap/ governance in progress
Legal & Regulatory Framework	Consent/privacy arrangements incomplete	Licensing, liability and telemedicine policy gaps	National/EAC ICT security alignment relatively developed	Digital-rehabilitation policy and operational guidelines incomplete	Data protection law exists; licensing/ consent gaps	National data-protection framework exists; institutional governance/ licensing gaps
Workforce Capacity	General ICT literacy; no tele-nutrition training	18 professionals; specialised ICT training needed	Highly qualified ICT team	70 CHWs trained; specialist ICT capacity limited	38 staff; strong academic base; telemedicine training limited	10 active users; 5 health workers + 5 IT staff; tele-oncology specialisation needed
Technology Platforms & Infrastructure	Basic broadband; remote consultation tools absent	Basic infrastructure; imaging not integrated	Strong 4G/ fibre and HPC	Active rehabilitation platforms; rural connectivity constraints	100 Mbps but unreliable; no dedicated secure platform	100 Mbps but unreliable; hybrid infrastructure; specialised platform absent
Interoperability & Data Sharing	HL7/FHIR not implemented; local spreadsheets/reports	HL7/FHIR not implemented; registry under development	HL7/FHIR and regional frameworks in use	HMIS integration not yet achieved	HL7/FHIR/ LOINC not in use	Clinical systems partially integrated
Clinical Effectiveness & Quality of Care	No tele-nutrition/remote clinical service	No operational telemedicine service	No clinical consultations; digital education/ support active	Operational community digital rehabilitation; >10,000 reached	Clinical telemedicine not established	Patient teleconsultations active but limited; telepathology operational

Note. Findings represent the status observed or reported during the April–May 2025 assessment. Descriptors are qualitative and should not be interpreted as numerical scores or as a validated overall ranking.

DISCUSSION

This study assessed telemedicine readiness across six East African Regional Centres of Excellence (RCoEs) using a structured assessment framework and triangulated evidence from interviews, document review, observation, and system verification. The findings show that the centres have important digital foundations, but these have not translated consistently into operational clinical telemedicine. The most important finding is therefore the uneven alignment between digital resources and the organisational, workforce, regulatory, interoperability, financial, and service-delivery conditions required for sustained telemedicine. This finding is consistent with evidence from sub-Saharan Africa and other low- and middle-income countries (LMICs), where telemedicine initiatives have expanded but remain constrained by infrastructure, policy, workforce, and implementation challenges.[11,17]

A particularly important finding is that digital capacity and clinical telemedicine capacity were not synonymous. EAC-VIHSCM had relatively strong connectivity, computing resources, ICT expertise, and use of Health Level Seven (HL7) and Fast Healthcare Interoperability Resources (FHIR) standards, yet its digital services were predominantly educational, administrative, and technical, with no clinical consultations. Conversely, CEBE had an operational community-based digital rehabilitation model, while EACEO had active but limited patient teleconsultations and telepathology. This variation suggests that telemedicine maturity develops through the interaction of multiple system components rather than through infrastructure acquisition alone. Similar observations have been reported in LMICs, where DH initiatives may begin with education, communication, or administrative applications without progressing automatically to integrated clinical services.[11,17] The present study extends this evidence by demonstrating the same distinction within strategically important regional centres with different institutional mandates.

Infrastructure remained a foundational constraint. Although the RCoEs generally had access to computers and internet services, several centres reported connectivity that was adequate for routine administrative or academic activities but insufficient for high-bandwidth or real-time teleconsultations. CEBE also reported a clear difference between stable connectivity at the hub and weaker connectivity in rural outreach settings, while EAC-CoECS reported unreliable internet despite having a relatively substantial bandwidth connection. These findings are consistent with studies from sub-Saharan Africa that identify unreliable connectivity, electricity, equipment, and technical support as persistent barriers to telemedicine implementation.[17,21,25] The findings also indicate why infrastructure should be considered in functional rather than purely nominal terms. A facility may possess internet access without having the reliability, bandwidth, devices, power resilience, or peripheral diagnostic technologies required for clinical telemedicine. The WHO and ITU similarly emphasise accessibility, usability, and appropriate technical conditions in the delivery of telehealth services.[15]

Interoperability was another major weakness and has implications beyond technical compatibility. Most RCoEs had not adopted recognised health information exchange standards, limiting the ability of systems to exchange structured clinical information across institutions. EAC-VIHSCM was the notable exception, with HL7, FHIR, and regional data sharing frameworks already in use. CEBE's digital rehabilitation data were not yet integrated with the national health information system, while other centres had diagnostic or clinical information systems that were not linked to remote consultation workflows. This pattern accords with evidence of fragmented electronic patient information and weak data standardisation practices in African health systems.[34–36] It also supports enterprise-architecture approaches that seek to align digital systems, organisational processes, and health-system requirements.[37,38] For the RCoEs, interoperability is particularly important because their regional mandate implies collaboration across institutions and, potentially, national borders. However, the findings do not imply that telemedicine cannot occur without HL7 or FHIR. Rather, the absence of standards limits scalability, continuity of information, integration with health information systems, and more complex forms of cross-institutional care.

Workforce findings similarly showed a gap between general professional capacity and telemedicine-specific competence. Several centres had qualified clinical staff and ICT personnel, but formal training in virtual care, telemedicine workflows, remote monitoring, digital counselling, and related practices was limited. EAKI, for example, had 18 healthcare professionals and expressed leadership interest in telemedicine, but lacked a structured institutional training programme and dedicated telemedicine technical support. EAC-CoECS had a strong academic workforce but reported limited telemedicine training, while CEBE had trained 70 community health workers (CHWs) who were actively supporting community-based digital rehabilitation. The latter represents an important enabling factor because community-based digital models can extend services beyond specialist facilities. Evidence from Uganda and the wider sub-Saharan African context likewise suggests that CHWs can be supported through telehealth, although training, connectivity, supervision, and digital literacy influence sustainability.[25,39] These findings support the WHO emphasis on developing a digitally capable health workforce as part of broader digital-health system strengthening.[14]

Governance, regulation, and financing emerged as interconnected barriers to institutionalisation. Several centres lacked a dedicated telemedicine strategy, formal procedures for digital consent and patient rights, clear virtual-care licensing arrangements, or specific ethical guidance for remote care. EAKI reported that Kenya lacked a national telemedicine policy, while EAC-CoECS had national data-protection legislation but lacked formal licensing and digital-consultation procedures. EACEO similarly had an established national data-protection framework but gaps in institutional consent, ethical governance, and virtual-care licensing. These findings are consistent with literature showing that regulatory uncertainty, fragmented policy environments, privacy concerns, and weak governance can impede the institutionalisation of digital health in LMICs.[17,40,41] The findings also show that the existence of a national

digital-health or data-protection policy should not be treated as evidence of operational telemedicine readiness. Institutional procedures are needed to translate policy principles into practice.

Financial sustainability further differentiates pilot activity from institutionalised service delivery. Most centres did not have funds specifically earmarked for telemedicine, although telemedicine-related activities could fall within broader ICT expenditure. EAC-VIHSCM was comparatively stronger, directing approximately 20–25% of its budget to digitalisation, while CEBE remained substantially dependent on project-based funding. At EACEO, telemedicine was included within the broader ICT budget but was not separately identified. This pattern suggests that telemedicine is often treated as an extension of ICT rather than as a health-service function with recurrent costs. Such an arrangement may support initial deployment but can make long-term maintenance, training, equipment replacement, cybersecurity, technical support, and service monitoring difficult to sustain. This interpretation is consistent with evidence that viable telehealth programmes require explicit organisational and financing arrangements rather than dependence on short-term project resources.[42]

Taken together, the findings identify both barriers and enablers. The main barriers were unreliable or insufficient connectivity, inadequate integration of digital systems, limited telemedicine-specific workforce training, incomplete governance and regulatory arrangements, and the absence of dedicated or sustainable financing. These constraints were not uniform across the centres. Conversely, important enablers included leadership interest, existing ICT infrastructure, specialised clinical expertise, established academic and institutional partnerships, trained CHWs at CEBE, active telepathology and teleconsultation experience at EACEO, and relatively advanced interoperability and ICT capacity at EAC-VIHSCM. This variation is important because it indicates that the RCoEs should not be viewed as starting from the same baseline. Rather than ranking the centres on a single readiness scale, the findings point to complementary strengths that could be mobilised through regional collaboration. For example, experience in interoperability and digital infrastructure could inform regional standards, community-based digital rehabilitation could provide lessons for decentralised service delivery, and experience with clinical teleconsultation and telepathology could inform service workflows.

These findings have direct implications for policy and practice within the EAC. First, infrastructure investment should be linked to clearly defined clinical use cases rather than treated as an end in itself. Second, interoperability should be pursued through common regional standards and architecture principles that allow information to move securely between relevant systems. Third, telemedicine competencies should be incorporated into continuing professional development and relevant pre-service training. Fourth, national and institutional governance arrangements should clarify consent, privacy, professional accountability, licensing, quality assurance, and cross-border service delivery. Finally, telemedicine financing should be sufficiently visible within institutional planning to support recurrent operational requirements. These priorities are consistent with the EAC Digital Reach Initiative, the WHO Global Strategy on Digital Health, and the African Union health-information exchange agenda, which emphasise connectivity, workforce capacity, governance, interoperability, and coordinated digital-health development.[14,16,43] The study therefore supports a coordinated regional approach while recognising that implementation must remain responsive to the different mandates and starting capacities of individual RCoEs.

The strength of the evidence lies in the study's use of a common assessment framework across six RCoEs and the triangulation of qualitative interviews with document review, observation, structured assessment, and system verification. This approach reduced reliance on self-report alone and enabled reported practices to be considered alongside observable infrastructure, documented policies, and available systems. The framework also provided a consistent basis for cross-RCoE comparison while retaining the qualitative character of the study. Nevertheless, the findings have limitations. Participants were purposively selected stakeholders and therefore did not represent every staff member or service user. Some evidence was self-reported and may have been affected by reporting or recall bias, although this was mitigated through triangulation. In addition, the cross-sectional design captured telemedicine capacity during April–May 2025 and may not reflect subsequent developments. The classifications of capabilities as 'not implemented', 'in progress', or 'active' should therefore be understood as evidence-based qualitative descriptions rather than numerical readiness scores or validated measures. The study supports comparison of patterns and capabilities across the RCoEs, but not a definitive ranking of their overall readiness.

Overall, the findings indicate that the central challenge for telemedicine development in the EAC RCoEs is not simply the absence of digital technology. It is the incomplete alignment of technology with the organisational, workforce, regulatory, interoperability, financial, and clinical conditions needed for sustained remote care. The contrasting experiences of the RCoEs demonstrate that progress can occur through different pathways, but that isolated digital initiatives are unlikely to achieve regional scale without stronger system integration. The evidence therefore supports a multidimensional approach to telemedicine readiness in which technological investments are accompanied by workforce development, interoperable systems, enabling governance, sustainable financing, and clinically appropriate service models. This provides a more realistic basis for advancing the RCoEs' role within the Digital Reach Initiative and for strengthening regional access to specialised healthcare.

Study Limitations

This study has several limitations. First, 36 participants were purposively selected from the six RCoEs based on their roles, responsibilities, and knowledge of telemedicine-related activities. Although the participants included leadership, ICT, and clinical or telehealth personnel, patients, service users, and some other stakeholder groups were not included. The findings therefore primarily reflect the perspectives of personnel with direct knowledge of institutional telemedicine capacity and may not capture the experiences or views of other stakeholder groups. The

Telemedicine Assessment Framework was adapted from established guidance and pre-tested for this assessment, but it was not presented or used as a formally validated psychometric readiness instrument. Accordingly, the qualitative status classifications should be interpreted as an institutional assessment of readiness conditions rather than as a standardised numerical measure.

Second, some findings were based on self-reported information and institutional documentation. Although triangulation with document review, observation, and system verification was used where feasible, some reporting bias cannot be excluded.

Third, the study was cross-sectional and captured telemedicine capacity during April–May 2025. Subsequent changes in infrastructure, policies, staffing, platforms, or service arrangements may therefore not be reflected in the findings. Finally, the study assessed institutional telemedicine capacity rather than patient outcomes, service utilisation, cost-effectiveness, or clinical effectiveness. The findings should therefore be interpreted as an assessment of institutional telemedicine capacity rather than evidence of its effectiveness or impact on health outcomes.

CONCLUSION

This study found that the six EAC Regional centres of Execellence (RCoEs) have varying levels of digital capacity and infrastructure that are not consistently translated into operational clinical telemedicine. Telemedicine development is constrained not only by technological limitations, but also by gaps in interoperability, workforce capacity, governance and regulation, and sustainable financing. At the same time, the RCoEs have important enabling conditions, including existing ICT infrastructure, leadership commitment, specialised expertise, regional and academic partnerships, community-based digital rehabilitation, and emerging clinical telemedicine experience.

The findings demonstrate that telemedicine readiness is multidimensional and cannot be inferred from the availability of digital equipment or internet connectivity alone. The RCoEs also differ in their areas of strength, which may influence the interpretation of a single regional readiness ranking. Their complementary capabilities instead provide opportunities for regional learning and coordinated capacity development. Strengthening interoperability, workforce competencies, governance, financing, and service integration alongside infrastructure investment would provide a more sustainable pathway for translating existing digital capacity into clinically meaningful telemedicine services.

For the EAC and the Digital Reach Initiative (DRI), the findings support a coordinated regional approach that establishes common standards and governance arrangements while allowing implementation to reflect the specific needs and capacities of individual RCoEs. Such an approach can build on existing institutional strengths while addressing the system-level barriers that currently limit the scale, continuity, and sustainability of telemedicine services.

Future research should build on these findings through longitudinal and patient- and service-level studies to determine whether improvements in institutional telemedicine capacity translate into sustained service utilisation, improved quality of care, and better health outcomes.

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