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Scaling Telehealth Solutions: Insights from Northeast India and Applicability in the Global South

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Continued on back inner cover

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Contents

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Introduction

The North-Eastern Region (NER) of India represents a unique and complex landscape within the country's healthcare system. The region is characterized by its rugged terrain, socio-cultural diversity, and geographic isolation, and faces persistent challenges in ensuring equitable access to quality healthcare services. With its eight constituent states spread across the Himalayan foothills and dense forests, delivering healthcare in NER has been hindered by limited physical infrastructure, inadequate health workforce distribution, and logistical constraints.

In this context, the emergence of digital health technologies, particularly telehealth, has opened up new avenues for addressing structural disparities in service delivery. Over the past two decades, several pilot initiatives and government-supported programs have introduced telemedicine services in the region, aiming to bridge the gap between patients in remote areas and specialized medical expertise located elsewhere. These interventions ranging from remote consultations to teleradiology and tele-education, have produced encouraging results in terms of accessibility, responsiveness, and continuity of care. While the success of these programs has varied across states and sectors, they collectively demonstrate the feasibility and relevance of telehealth in overcoming geographic and infrastructural limitations.

However, the adoption of these technologies has largely remained localized and fragmented, with limited efforts toward system-wide scalability. Despite these limitations, the experiences from NER provide a valuable blueprint for leveraging telehealth in other resource-constrained and hard-to-reach geographies. As such, they hold particular significance

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for countries in the Global South that face similar development challenges, where dispersed populations, weak health infrastructure, and human resource constraints intersect to impede equitable healthcare access.

Rather than positioning NER solely as a beneficiary of telehealth interventions, this paper frames the region as a learning site, an ecosystem from which broader lessons about digital health equity can be drawn. Although questions around long-term sustainability, policy integration, and digital health governance require deeper examination, they are acknowledged as important areas for future inquiry. This paper, therefore, focuses on the operational and contextual dynamics of telehealth implementation in the NER, and how these may inform equitable healthcare strategies in comparable settings across the Global South.

Background

The NER of India has garnered significant attention for the enhancement of its healthcare institutions (HCIs). Geographical obstacles, including rugged mountainous landscapes with unpredictable and heavy rains, as well as extensive forested areas, have resulted in inaccessibility for much of the year. Developmental progress has been hindered by socioeconomic factors such as ethnic tensions and poverty, which have impeded regional growth, with insurgent activities further exacerbating the situation. In its 2014–2015 report, the Ministry of Health & Family Welfare identified persistent challenges, including a scarcity of medical personnel, difficulties in accessing remote areas, and the necessity for improved healthcare governance and quality of service (Prakash & Saxena, 2016).

Efforts to expand healthcare reach are still undermined by the limited presence of professionals in rural belts, making deployment inconsistent and urban-centered. In recent years, the government has implemented initiatives to address these issues, such as the Ayushman Bharat Health and Wellness Centres (AB-HWCs), which aim to provide comprehensive healthcare access in rural areas, and the Pradhan Mantri Jan Arogya Yojana (PM-JAY), which addresses inadequate access to medical care for these populations. Over 7,500 Health and Wellness Centres across

northeastern states offer comprehensive health services, including maternal care, non-communicable disease management, and free essential drugs as of July 2023 (Strengthening healthcare in North East India, 2023). Furthermore, the launch of the Ayushman Bharat Digital Mission (ABDM) seeks to establish an integrated digital health system, facilitating the generation of personal health records for all individuals within the region. In the northeastern states, more than 18 million Ayushman Bharat Health Accounts (ABHA) had been registered as of June 2023, further harmonizing healthcare benefits offered in these regions.

Moreover, the region is experiencing targeted infrastructure investments under the PM-Ayushman Bharat Health Infrastructure Mission and the North East Special Infrastructure Development Scheme (NESIDS), enhancing healthcare delivery systems. These initiatives are designed to reduce disparities between the region and the rest of India. Significant disparities in infrastructure and health service delivery persist, despite recent governmental support to narrow the accessibility gap. These reforms represent a significant advancement toward improving healthcare outcomes in the region.

Disease burden in NER

The NER of India faces a complex and multifaceted disease burden that includes communicable diseases, non-communicable diseases (NCDs), and mental health challenges. One of the key concerns is the widespread prevalence of communicable diseases. Vector-borne illnesses such as malaria, Japanese encephalitis, and dengue are common in NER states, where climatic conditions such as heavy rainfall and dense forestation facilitate disease transmission (Swargiary & Lhungdim, 2021).

Table 1: Vector-borne Diseases: Malaria Prevalence

State	Malaria Prevalence (per 1000)	National Average	Notes
Arunachal Pradesh	High (>6/1000)	1.5/1000	One of the highest in India
Assam	Moderate		Outbreak-prone regions

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Manipur	High		Hill districts impacted most
Meghalaya	High		Dense forest cover -vector habitat
Mizoram	High		Consistent seasonal outbreaks
Nagaland	Moderate		Some districts malaria-free
Sikkim	Low		Cold climate less favourable
Tripura	Moderate		Seasonal peaks reported

***Source*:** Mutheneni & Upadhyayula (2014).

Tuberculosis remains a significant public health issue, particularly in rural areas with limited access to healthcare facilities. The porous international borders with Myanmar and Bangladesh also contribute to the spread of diseases like HIV/AIDS, which is notably prevalent in states like Manipur, Mizoram, and Nagaland. The 2017–2018 National Sample Survey (NSS) reported a prevalence rate of 22.9 per 1,000 population for infectious diseases, with Arunachal Pradesh, Manipur and Mizoram showing the highest rates, especially for malaria, diarrhoea, and tuberculosis. (Swargiary & Lhungdim, 2021).

Table 2: Infectious Disease Prevalence

State	TB Prevalence Rank	Notes
Arunachal Pradesh	High	Accessibility delays treatment
Mizoram	High	Associated with HIV prevalence
Manipur	High	Cross-border transmission
Nagaland	Moderate	Lack of early detection
Meghalaya	Moderate	Rural underdiagnosis
Assam	Moderate	Variable urban-rural prevalence
Tripura	Low	Improved screening
Sikkim	Low	Better infrastructure

***Source*:** Swargiary & Lhungdim (2021).

Table 3: HIV/AIDS Prevalence

State	HIV Prevalence Rate (%)	National Avg (%)	Notes
Manipur	1.2	0.22	Highest in India
Mizoram	2.3		Injecting drug use-driven
Nagaland	0.7		Third-highest
Others	<0.2		Relatively low

***Source*:** Ngangbam & Ladusingh (2015).

Parallel to communicable diseases, the burden of non-communicable diseases has risen considerably. Cancer rates are notably higher in the northeastern states compared to the rest of the country. Arunachal Pradesh, particularly the Papumpare district, reports one of the highest age-adjusted cancer incidence rates for females and the second highest for males among all Indian registries (Kumar & Singh, 2022). The widespread use of tobacco and high rates of alcohol consumption are strongly associated with increased cases of oral, lung, and liver cancers.

In addition to cancer, lifestyle-related conditions such as diabetes, hypertension, and cardiovascular diseases are becoming more common. Sikkim and Mizoram have reported particularly high prevalence of these conditions. Sikkim, for instance, reported a prevalence of 39 per 1,000 for diabetes, underscoring the rising threat of lifestyle-induced health issues in the region. (Menon et al., 2022).

Table 4: Cancer Incidence (Age-adjusted Rate per 100,000)

State	Male Cancer Incidence	Female Cancer Incidence	National Average	Notes
Arunachal Pradesh	270 (2nd highest)	229 (highest)	~100	Papumpare district critical
Mizoram	240	210		Tobacco-related cancers
Meghalaya	180	170		Esophageal cancer prevalent
Others	100–150	100–140		Lower rates but rising

***Sources*:** Kumar & Singh (2022); Sharma et al. (2014).

Table 5: Non-Communicable Diseases (NCDs)

State	Diabetes (per 1000)	Hypertension (per 1000)	Stroke/Heart Disease Prevalence	Notes
Sikkim	39	70	Moderate	Highest diabetes in region
Mizoram	36	67	High stroke deaths	NCDs rising fast
Tripura	33	66	Moderate	Lifestyle-driven increase
Others (avg)	25–30	55–60	Variable	

Sources*:* Menon et al. (2022); Dandona et al. (2017).

Disabilities and injuries also account for a significant portion of the disease burden, affecting 10.2 per 1,000 people, with Mizoram and Sikkim reporting the highest incidences (Swargiary & Lhungdim, 2021).. These conditions necessitate both acute and long-term care, placing additional demands on already strained public health systems.

Mental health disorders and substance abuse contribute further to the health crisis in the northeastern region. Manipur and Nagaland are particularly affected by high rates of drug addiction, which in turn has intensified the spread of HIV/AIDS (Ngangbam & Ladusingh, 2015). Cultural stigma around mental health and the scarcity of mental health professionals result in many psychological conditions going undiagnosed and untreated. Additionally, fever-related illnesses, respiratory infections, and diarrhoeal diseases remain among the most common causes of morbidity, together accounting for more than half of all reported cases (Swargiary & Lhungdim, 2021). This broad spectrum of diseases, both communicable and non-communicable, continues to challenge the healthcare infrastructure and necessitates targeted interventions to reduce health disparities in the region.

Challenges in access to healthcare in NER

Connectivity gaps, particularly in Arunachal Pradesh, significantly hinder the scalability of telehealth platforms. These infrastructural limitations are compounded by a severe shortage of trained healthcare professionals. The region faces a persistent lack of qualified doctors, nurses, and allied health workers, especially in rural and tribal communities. Many medical personnel are reluctant to work in these remote locations due to inadequate facilities, challenging living conditions, and limited career advancement opportunities. This results in high patient-to-provider ratios, overburdening the healthcare system and diminishing the quality of care. Additionally, many primary healthcare centres lack essential medical equipment and supplies, further compromising the capacity to deliver quality healthcare services.

Table 6: Healthcare Workforce per 10,000 Population in NER vs India

State	Total Health Workers per 10,000
Arunachal Pradesh	12.2
Assam	14.8
Manipur	18.2
Meghalaya	15.9
Mizoram	19.4
Nagaland	16.3
Tripura	20.5
Sikkim	22.0
India (Avg.)	20.8

***Source*:** WHO, 2022.

Healthcare utilization also reflects stark disparities. Despite the high disease burden in the region, a substantial proportion of the population opts for private healthcare services over public facilities. Around 54% of the population seeks care from private providers, primarily due to dissatisfaction with public services, extended wait times, and long distances to healthcare centres (Swargiary & Lhungdim, 2021).

Table 7: Public vs Private Healthcare Utilization in NER

State	% Using Public Facilities	% Using Private Facilities
Arunachal Pradesh	47%	53%
Assam	52%	48%
Manipur	45%	55%
Meghalaya	49%	51%
Mizoram	55%	45%
Nagaland	46%	54%
Tripura	50%	50%
Sikkim	58%	42%

***Source*:** Swargiary & Lhungdim, 2021.

Ethnic and socio-political factors add complexity to healthcare access. The Northeast is home to numerous ethnic groups, each with distinct languages and cultural practices, which can create communication challenges between patients and providers. Furthermore, insurgency and political instability have disrupted healthcare delivery in several northeastern states. Conflicts have damaged infrastructure and restricted the movement of healthcare workers, while safety concerns deter professionals from serving in affected areas.

Governance has also been a barrier. Policies addressing the specific healthcare needs of the region have often been inadequate. The rural-urban healthcare divide remains pronounced, with healthcare facilities concentrated in urban centres. Poor coordination between central and state governments, alongside inefficient utilization of resources, continues to hamper healthcare development (Prakash & Saxena, 2016). Initiatives such as the National Rural Health Mission (NRHM) and Ayushman Bharat have made some progress, but gaps remain.

Emergence of telehealth as a solution

In response to these systemic challenges, telehealth has emerged as a crucial enabler of healthcare delivery in the Northeast. The Indian Space Research Organisation (ISRO), in collaboration with state governments

and healthcare institutions, launched satellite-based telemedicine services that connect rural hospitals with specialized care centres in urban areas. This initiative has facilitated remote consultations, diagnostics, and treatment in states like Assam, Manipur, and Arunachal Pradesh (Barman, Council for Social and Digital Development (CSDD), Digital Empowerment Foundation (DEF), 2023). According to the Centre for Innovations in Public Systems, by 2014, over 60 hospitals in the Northeast were linked through satellite telemedicine nodes, enabling access to specialty consultations in cardiology, radiology, and oncology (CIPS, 2014).

One of the most impactful applications has been in the management of non-communicable diseases such as cancer. Arunachal Pradesh, which reports one of the highest age-adjusted cancer incidence rates in India, previously relied on a single tertiary care centre. Through platforms like e-Sanjeevani and integration with the National Cancer Grid, patients now receive virtual consultations, treatment planning, and follow-up care remotely. Public perception surveys from Arunachal Pradesh indicate over 50% of respondents have a favourable view of telemedicine, particularly for cancer care (Kumar & Singh, 2022).

Tripura has also seen early adoption of telemedicine. A state-wide project launched in 2005 through a partnership between the Government of Tripura, Ministry of Health & Family Welfare, IIT Kharagpur, and Webel Electronic Communication Systems connected Sub-Divisional Hospitals and Primary Health Centres to tertiary hospitals in Agartala. Between 2005 and 2013, over 30,000 patients were treated, mainly in specialties like general medicine, radiology, and orthopaedics. Subsequent expansion phases and the introduction of the iMediK system enhanced the network's security and functionality (Centre for Innovations in Public Systems (CIPS), 2014). Teleradiology further increased access to diagnostic services (Kalyanpur, Meka, Joshi, Nair, & Mathur, 2022).

Limitations in Implementation

Despite progress, telehealth implementation in the region has faced persistent challenges. The long-term sustainability of ISRO's satellite-based telemedicine project was limited by poor connectivity and

insufficient local expertise in managing telemedicine equipment (Bhaskaranarayana, Satyamurthy, Remilla, Sethuraman, & Rayappa; Movva & Naga Pradeep, 2013).

Tripura's program encountered scalability issues due to infrastructure deficits in remote villages (Kalyanpur et al., 2022). Mobile telemedicine units in Nagaland and Mizoram brought healthcare services to isolated villages, but were frequently disrupted by power outages and network downtimes in hilly regions (Kaeley, Choudhary, Mahala, & Nagasubramanyam, 2021). Internet and mobile connectivity remain insufficient across large parts of Arunachal Pradesh (Desk, N. L. D., 2024).

Funding and resource limitations have also impeded the effectiveness of partnerships, such as those involving the Apollo Telemedicine Networking Foundation. Inadequate financial provisions for infrastructure upgrades limited their impact (Rani, Uma, Devendran, & J. Sridevi, 2015). Moreover, linguistic diversity, particularly in Meghalaya where Khasi, Garo, and Pnar are commonly spoken, presents communication barriers, as telehealth services are predominantly delivered in English or Hindi. These constraints highlight the need for region-specific adaptations in technology, governance, and community engagement to ensure telehealth's long-term viability in the Northeast.

Telehealth framework in Global South Countries

Building on the experience of Northeast India, where innovations like tele-oncology services in Arunachal Pradesh and drone-based medical supply delivery in Manipur and Nagaland have addressed geographic and infrastructural barriers, several low- and middle-income countries (LMICs) across the Global South are exploring scalable telehealth frameworks. While telehealth offers transformative potential in resource-constrained settings, its implementation requires context-specific strategies in policy, technology, financing, and community engagement.

In sub-Saharan Africa, countries such as Kenya, Nigeria, and Rwanda have adopted public-private models and decentralized telehealth platforms to enhance healthcare accessibility. Nigeria's rapid telehealth

expansion during the COVID-19 pandemic showcased both increased public receptivity and systemic policy gaps (Adeyemo et al., 2021). Rwanda has demonstrated success with a national health information exchange infrastructure, enabling real-time data interoperability across public and private providers (Crichton et al., 2013). Like Manipur's drone logistics initiative, Rwanda's integrated approach illustrates how hybrid digital-physical systems can overcome last-mile challenges and improve continuity of care.

Latin American countries, notably Brazil, have also adopted integrated digital health strategies. However, they continue to face challenges such as inconsistent regulations around clinical protocols and patient privacy (Paquel & Norbert, 2017). Telehealth adoption across these regions is frequently hindered by outdated legal frameworks, particularly concerning provider licensing, cross-border consultations, and data governance.

Scholars increasingly recommend alignment with global standards such as the General Data Protection Regulation (GDPR) to safeguard personal health data (Moyo, 2025). Financial sustainability remains a critical issue. While high initial investment requirements deter many LMICs from expanding telehealth programs, innovative models such as blended financing, combining public sector investment, philanthropic contributions, and donor support are gaining traction in countries like Bangladesh and Ethiopia (Ramnath, 2023).

In addition, the development of low-cost, offline-capable diagnostic devices and solar-powered telemedicine units has enabled consistent service delivery in areas with limited electricity and internet connectivity (Lestari, Miranda, & Fuady, 2024).

Community engagement and workforce training are pivotal to long-term success. In South Asia and East Africa, for example, mobile health workers serve as trusted intermediaries, facilitating teleconsultations and reducing patient apprehension (Agbeyangi & Lukose, 2025). Effective programs often incorporate culturally adapted digital literacy modules, in-person workshops, and ongoing remote mentorship to equip local

health workers with essential telemedicine competencies. The Ghana Health Service's collaboration with Ericsson and the Novartis Foundation exemplifies this approach. Through device provisioning and government-supported Community Health Worker training, the program successfully expanded access to decentralized diagnostics and specialist consultation in remote districts (Novartis Foundation, 2015).

Moreover, public awareness campaigns are crucial for driving adoption. Community-centered education, partnerships with local leaders, and media outreach can help build trust in digital healthcare platforms. Integration with electronic health records (EHRs) and national information systems further enhances interoperability, ensuring seamless care coordination across regions. Ultimately, the lessons emerging from Northeast India, Ghana, Rwanda, and Brazil suggest that successful telehealth frameworks in the Global South must be adaptive, legally grounded, community-driven, and technologically inclusive. These systems must evolve to balance cost-efficiency with quality and to incorporate hybrid care models that blend virtual consultation with physical outreach for equitable healthcare access.

A noteworthy example of an effective telehealth intervention in the Global South is the telemedicine initiative implemented by the Ghana Health Service in collaboration with the Novartis Foundation and Ericsson. This program exemplifies a scalable, public-private partnership model that effectively addresses healthcare access challenges in resource-constrained settings. As part of the initiative, Ericsson supplied essential digital infrastructure—including mobile phones, tablets, and diagnostic devices, while the government assumed responsibility for training Community Health Workers (CHWs) in the use of telehealth technologies. These CHWs became pivotal actors in delivering decentralized care by facilitating teleconsultation, conducting basic diagnostics, and expanding the reach of essential health services to remote and underserved populations.

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The program enhanced healthcare accessibility and responsiveness by reducing the need for patient travel and strengthening service delivery at the community level, in rural Ghana. Furthermore, by embedding telehealth within existing health systems and leveraging local human resources, the initiative fostered community trust and contributed to the long-term viability of digital health interventions. This case highlights the critical role of multisectoral collaboration, locally adapted capacity-building strategies, and technological innovation in operationalizing telehealth frameworks across low- and middle-income countries (LMICs).

(Novartis Foundation, 2015)

Cost effectiveness of Telehealth

Telemedicine has demonstrated considerable cost-effectiveness in delivering healthcare, particularly in remote and rural settings. In the United States, hospitals utilizing telemedicine reported annual savings of up to $20,841 per facility, largely attributed to reductions in hospital stays and emergency department visits (Schadelbauer, 2017; Mudiyanselage et al., 2023). Moreover, targeted telehealth interventions for chronic disease management have shown improvements in patient outcomes and decreased hospital admissions, reinforcing the economic viability of such models. In Florida, cost savings per visit during cancer care were estimated to range between $147.4 and $186.1 (Patel et al., 2023).

Experiences from various Asian countries further underscore the economic benefits of telemedicine. In rural Tamil Nadu, India, teleophthalmology screenings for diabetic retinopathy were found to be cost-effective over a 25-year period, primarily due to savings on patient travel and hospital costs. Singapore's Integrated Diabetic Retinopathy Program (SiDRP) reported savings of SGD 63,000 per Quality-Adjusted Life Year (QALY) gained. Thailand's use of video-electroencephalography (VEEG) for managing drug-resistant epilepsy

demonstrated an 84% probability of cost-effectiveness at a threshold of THB 160,000 per QALY. Mobile health interventions have also yielded promising results (Salsabilla et al., 2021).

A program implemented in India's tribal regions targeting infant mortality resulted in cost savings of $74 per life-year (Modi et al., 2020). Similarly, a mobile application developed in Japan for menstrual health management showed a cost reduction of $1,170 per individual in the intervention group (Utami et al., 2024). These examples collectively illustrate that telehealth can play a pivotal role in reducing healthcare expenditures while enhancing health outcomes across diverse and resource-limited settings (Salsabilla et al., 2021).

Way Forward

Measuring the cost-effectiveness and overall impact of telehealth requires a multidimensional approach rooted in comparative, contextual, and longitudinal analysis. While present evidence affirms its value, the heterogeneity of healthcare ecosystems in the Global South necessitates context-sensitive strategies for both implementation and evaluation. Long-term outcome tracking, expanded intervention scopes, and culturally aligned research designs are integral to accurately assessing and scaling telehealth across various geographies.

A forward-looking strategy must adopt a phased implementation model prioritizing high-need areas, with iterative refinement based on real-time data and user feedback. Regional variations in disease prevalence, infrastructure availability, and digital literacy levels must be factored into the telehealth deployment strategy. Further, interoperability standards need to be institutionalized to enable seamless integration with electronic health records and other public health information systems.

Strengthening policy frameworks with clear legal guidance on data privacy, practitioner licensing, and cross-border consultations is also critical. Investment in digital infrastructure and renewable energy solutions such as solar-powered telehealth units, will ensure uninterrupted service in power-deficient zones.

Public-private partnerships should be leveraged for funding hardware, software, and training. Capacity building should target both health professionals and end-users, using multilingual and culturally appropriate content. In addition, establishing peer networks, virtual mentoring, and incentive structures will improve provider retention and patient trust.

Conclusion

The telehealth initiatives piloted across the North-Eastern Region (NER) of India underscore the region's role as a critical learning ground for digital health implementation in challenging, resource-constrained environments. Despite limited scalability across all states, these experiences demonstrate the potential of telehealth to improve access, continuity of care, and efficiency, particularly in geographically dispersed and underserved populations. Importantly, the NER experience reinforces how decentralized digital health can act as an equalizer in healthcare delivery, aligning with the broader aspirations of Universal Health Coverage.

While this paper does not delve into the long-term sustainability models in detail, it acknowledges the need for ongoing attention to systemic readiness, workforce integration, and local ownership to support scale-up. Lessons from these interventions are especially instructive for other regions within the Global South facing similar infrastructural and geographic challenges. As telehealth continues to evolve, these grounded examples provide a valuable starting point for building adaptable and resilient health systems through context-sensitive digital innovation.

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