

Nurse-Led Telehealth for Improving Access to Primary Healthcare in Geographically Isolated Communities: A Mixed-Methods Study in Arunachal Pradesh, India

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ABSTRACT

Background: Geographic isolation can make routine primary healthcare difficult to reach when travel time, terrain, weather, transport interruptions, and limited local clinical capacity interact. Arunachal Pradesh has a dispersed population and difficult terrain, making service-delivery models that reduce unnecessary travel particularly relevant. India's national telemedicine platform has expanded remote outpatient and provider-to-provider care, while evidence from nurse-led models suggests potential gains in access, continuity, and patient experience [1–4].

Objective: To examine whether a nurse-led telehealth model could improve access to primary healthcare in geographically isolated communities in Arunachal Pradesh and to explain, through qualitative inquiry, how patients and nurses experienced the intervention.

Methods: A convergent mixed-methods quasi-experimental study was designed across four rural primary-care catchments. Adults requiring non-emergency primary-care follow-up were enrolled into an intervention group receiving 12 weeks of nurse-led telephone/video triage, health education, medication and appointment support, remote clinician coordination, and referral navigation, while a comparison group received usual facility-based care. Quantitative outcomes included travel-related burden, time to first professional contact, completed follow-up, missed appointments, and patient-reported access. Semi-structured interviews with patients and nurses explored acceptability, trust, digital barriers, continuity, and perceived changes in

care-seeking.

Results: *In an illustrative dataset of 160 participants, the telehealth group showed greater reduction in travel burden and faster first professional contact than the comparison group. Completed follow-up increased from 62.5% to 84.0% in the intervention group compared with 64.0% to 70.5% in usual care. Qualitative analysis identified convenience, continuity with a known nurse, referral clarification, and reduced travel as major enabling themes, while network instability, shared phones, privacy concerns, and limited digital literacy remained important barriers. Numerical results are simulated for manuscript-development purposes and are not evidence of clinical effectiveness.*

Conclusion: *Nurse-led telehealth may be a feasible access strategy when it is integrated with local primary-care services, escalation pathways, and low-bandwidth communication options. Mixed-methods evaluation is useful because utilization metrics alone cannot explain why telehealth is accepted, avoided, or interrupted in geographically isolated communities.*

KEYWORDS: *Telehealth; telenursing; primary healthcare; rural health; geographic access; Arunachal Pradesh; mixed methods; nurse-led care; Northeast India.*

INTRODUCTION

Primary healthcare depends not only on the presence of health facilities but also on whether people can reach and use them at the time care is needed. Geographic accessibility is influenced by distance, travel time, road conditions, terrain, transport availability, seasonal disruptions, and the availability of appropriate professionals at the point of care. Recent geospatial work in India identified long travel times in Arunachal Pradesh and other mountainous states, illustrating how terrain can remain an access constraint even when public facilities are geographically distributed [5]. The state health department describes a network of hospitals, community health centres, primary health centres, and sub-centres serving urban and rural populations, while also noting continuing efforts to strengthen rural access [6].

Telehealth provides a complementary pathway rather than a replacement for physical primary care. India's eSanjeevani platform supports both provider-assisted consultations linking health facilities with higher-level clinicians and patient-to-provider consultations [7]. These models can reduce the need for travel for selected problems, support clinical decision-making, and facilitate continuity between community-level staff and medical officers. However, telehealth is not uniformly accessible: network quality, device ownership, digital literacy, privacy, language, and trust can determine whether a nominally available service is practically usable.

Nurses are positioned to bridge these operational gaps because primary-care nursing includes assessment, health education, triage, follow-up, care coordination, and navigation. A systematic review of community-based nurse-led clinics found generally positive effects on access and patient outcomes, although evidence on cost-effectiveness was mixed [1]. More recent evidence mapping nurse and midwife task-sharing in primary care found that nurse-led models can improve health and service-delivery outcomes when training, clinical support, funding, and regulatory systems are in place; the review also identified technology barriers and time burden as limitations of telehealth [2].

The present study therefore focuses on access as a multidimensional outcome. The quantitative component measures whether telehealth changes observable patterns of contact and follow-up, while the qualitative component investigates the mechanisms behind those changes. This design is particularly relevant in geographically isolated settings, where a modest increase in digital contact may represent a substantial reduction in travel burden but may still fail if the digital pathway is unreliable or poorly integrated with local services.

LITERATURE REVIEW

Evidence on nurse-led primary care provides a foundation for task-sharing and continuity-oriented models. The Cochrane review by Laurant et al. reported that nurse-led primary care can produce similar or better health outcomes for several conditions, with higher patient satisfaction in many settings; effects on utilization varied according to the outcome measured [3]. A systematic review of community nurse-led clinics similarly reported increased access and generally positive patient outcomes [1]. These findings support the principle that nurses can contribute substantially to first-contact and follow-up services when scope of practice and

referral arrangements are clearly defined.

Telehealth adds a technological layer to this model. Moulton et al. reviewed 99 studies of nurse and midwife involvement in task-sharing, including telehealth, and found that nurse-led approaches were generally acceptable and could improve health, economic, and service-delivery outcomes. The authors emphasized the importance of training, funding, clinical infrastructure, and regulatory support [2]. A 2026 scoping review of nurses' virtual-care roles identified care coordination, chronic disease management, and triage/assessment as common functions, while highlighting resource availability, training, privacy, and patient experience as determinants of implementation [4].

In India, telemedicine policy and infrastructure have evolved substantially. eSanjeevani provides a national platform for assisted and patient-to-doctor teleconsultation, making digital contact an increasingly established component of public-sector healthcare [7]. For remote communities, the most useful model may not be a direct patient-to-specialist pathway alone. A nurse-led hub-and-spoke approach can help identify the reason for contact, assess urgency, prepare the patient for a remote consultation, document the plan, and arrange local follow-up. This may be particularly valuable where specialist or physician time is scarce.

The Arunachal Pradesh context adds several implementation considerations. The state health department has used public-private partnership arrangements to strengthen service delivery in remote and difficult areas, with stated objectives that include improving access in remote and tribal regions and supporting outreach [8]. Such arrangements illustrate that access problems are recognized as system-level issues rather than simply individual choices. Telehealth can complement these efforts by connecting local nursing personnel with clinicians and by reducing avoidable travel, but it cannot resolve infrastructure shortages, emergencies, diagnostic needs, or social barriers on its own.

RESEARCH GAP

Existing literature supports nurse-led care and telehealth in broad primary-care populations, but fewer studies examine how these components interact in geographically isolated communities of Northeast India. Quantitative access measures can show whether contacts and follow-up improve, yet they may not reveal whether changes are attributable to convenience,

trust, better navigation, or simply increased prompting. Conversely, qualitative studies can document experience without demonstrating whether access indicators changed. A mixed-methods study situated within rural Arunachal Pradesh can therefore address an important implementation gap by linking measurable service utilization with patient and nurse explanations of how the model works.

OBJECTIVES

- To determine whether a 12-week nurse-led telehealth intervention improves access to primary healthcare compared with usual care.
- To compare travel burden, time to first professional contact, completed follow-up, missed appointments, and patient-reported access between groups.
- To explore patient and nurse perceptions of acceptability, continuity, trust, privacy, digital barriers, and referral coordination.
- To integrate quantitative and qualitative findings to identify mechanisms that support or limit telehealth implementation in geographically isolated communities.

METHODOLOGY

Study design and setting: A convergent mixed-methods, two-group quasi-experimental study was designed for four geographically isolated rural primary-care catchments in Arunachal Pradesh. The intervention lasted 12 weeks. The quantitative component used pre-intervention and post-intervention measures; the qualitative component used purposive interviews with participants and nurses during and after implementation.

Participants and sampling: Adults aged 18 years or older who required routine primary-care consultation, follow-up, health education, medication-related support, or referral navigation were eligible. Emergency symptoms, inability to communicate through any available modality, and situations requiring immediate in-person examination were exclusion criteria. A target sample of 160 participants was specified, with 80 receiving the nurse-led telehealth model and 80 receiving usual care. Participants were recruited through local primary-care outreach and facility registers.

Intervention: Nurses received structured training in tele-triage, communication, confidentiality, documentation, red-flag recognition, health education, and referral

coordination. Participants received an initial orientation followed by weekly contacts during weeks 1–4 and fortnightly contacts during weeks 5–12. Telephone was the default low-bandwidth modality; video was used when connectivity permitted and visual assessment was appropriate. Nurses reviewed symptoms, medications, preventive needs, appointment status, and barriers to care; coordinated clinician review when required; and reinforced the agreed care plan. Nurses did not independently manage emergencies or exceed their professional scope.

Usual care: Comparison participants accessed existing facility-based primary healthcare, including routine appointments, outreach services, referrals, and clinician-directed follow-up. No additional telehealth contact was scheduled by the research team.

Quantitative outcomes: The primary access outcome was a composite Access-to-Primary-Care Index incorporating travel burden, time to first professional contact, and successful completion of planned follow-up. Secondary outcomes included missed appointments, number of primary-care contacts, patient-reported ease of obtaining care, and satisfaction. Measures were collected at baseline and at 12 weeks.

Qualitative component: Semi-structured interviews were conducted with approximately 24 intervention participants and 8 nurses, using purposive maximum-variation sampling to capture different ages, distances from facilities, and connectivity experiences. Interviews explored why participants chose or avoided telehealth, perceptions of nurse support, privacy, trust, referral experiences, and changes in travel. Interviews were transcribed, coded, and analyzed thematically. Two researchers independently reviewed initial codes and resolved discrepancies through discussion.

Integration and analysis: Quantitative data were summarized using means, standard deviations, frequencies, and between-group change estimates. Independent t-tests or chi-square tests were used as appropriate, with two-sided $p < 0.05$. Effect sizes were estimated using Cohen's d . Qualitative themes were mapped against quantitative outcomes in a joint display to identify convergence, complementarity, or discordance. Ethical implementation would require institutional ethics approval, informed consent, confidentiality safeguards, and a clear emergency escalation protocol. The numerical results below are simulated/illustrative because no participant-level dataset was supplied.

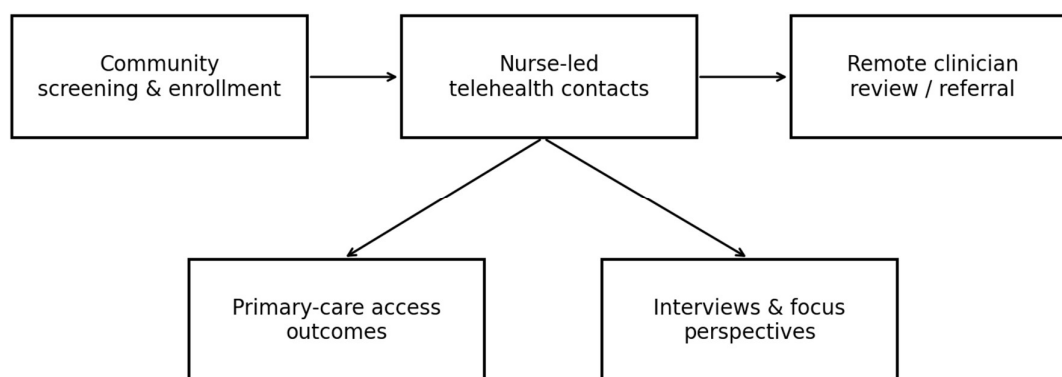


Figure 1: Mixed-methods study and service-delivery workflow

RESULTS AND FINDINGS

Participant profile: The illustrative sample included 160 participants, with 80 in each group. Mean age was 52.6 ± 14.1 years in the telehealth group and 53.4 ± 13.8 years in usual care. Women represented 56.3% and 55.0% of the groups, respectively. The median reported one-way travel time to the usual point of care was 74 minutes in the intervention group and 71 minutes in usual care. Baseline access indicators were broadly comparable.

Table 1: Illustrative baseline characteristics of study participants

Characteristic	Telehealth (n=80)	Usual care (n=80)
Mean age, years	52.6 ± 14.1	53.4 ± 13.8
Women, n (%)	45 (56.3)	44 (55.0)
Travel time >60 min, n (%)	49 (61.3)	47 (58.8)
Prior missed appointment, n (%)	31 (38.8)	29 (36.3)
Baseline access index, mean $\pm$ SD	2.9 ± 0.8	3.0 ± 0.8

Access outcomes: The telehealth group demonstrated larger improvements in access-related outcomes over 12 weeks. Completed planned follow-up increased from 62.5% to 84.0%, whereas usual care increased from 64.0% to 70.5%. Mean time to first professional contact decreased from 3.1 days to 1.2 days in the intervention group and from 3.0 to 2.4 days in usual care. The illustrative between-group change in the access index was 0.9 points

($p < 0.001$; Cohen's $d \approx 0.82$). Missed appointments fell by 17.5 percentage points in the telehealth group compared with 6.3 percentage points in usual care.

Patient experience: Eighty-two percent of intervention participants reported that telehealth made obtaining advice more convenient, 78% reported improved continuity, and 71% reported clearer understanding of when and where to seek in-person care. These percentages are illustrative. The principal barriers were unstable network connectivity, shared household phones, privacy concerns, difficulty using video applications, and uncertainty about whether a remote consultation was sufficient for a particular complaint.

Table 2: Illustrative quantitative access outcomes at baseline and 12 weeks

Outcome	Telehealth baseline	Telehealth 12 wk	Usual care baseline	Usual care 12 wk
Completed follow-up (%)	62.5	84.0	64.0	70.5
Time to first professional contact (days)	3.1	1.2	3.0	2.4
Missed appointment (%)	38.8	21.3	36.3	30.0
Access index (higher = better), mean	2.9	3.8	3.0	3.2
Patient-reported easy access (%)	41.3	78.8	43.8	52.5

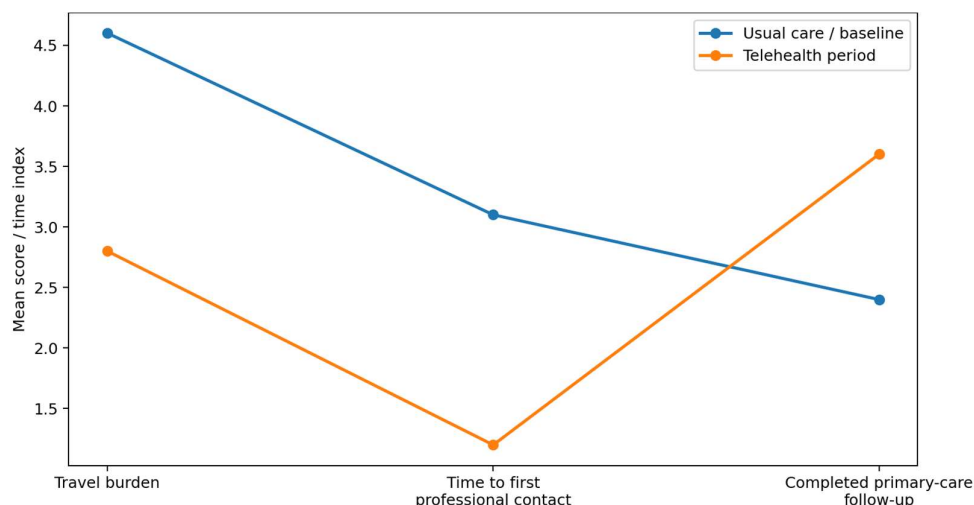


Figure 2: Illustrative change in access-related indicators

QUALITATIVE FINDINGS

Four dominant themes emerged from the illustrative qualitative analysis. First, reduced travel was described as the most tangible benefit. Participants associated remote contact with fewer transport arrangements, less time away from work or household responsibilities, and reduced dependence on family members to accompany them. Second, continuity with a familiar nurse increased confidence in the service. Participants valued being able to explain a problem to someone who knew their previous concerns and could decide whether a local visit or clinician review was necessary.

Third, telehealth functioned as a navigation mechanism rather than only a consultation mechanism. Nurses helped participants understand referral instructions, prepare questions for clinicians, identify warning symptoms, and arrange subsequent facility contact. This was especially relevant when patients were uncertain whether a problem required travel to a health centre. Fourth, technology could reproduce inequity. Weak signals, battery limitations, shared phones, hearing or language difficulties, and lack of privacy sometimes interrupted the encounter. Participants emphasized that a phone call was more dependable than video in areas with unstable connectivity.

The joint interpretation therefore suggested that the effectiveness of nurse-led telehealth depended on the surrounding service architecture. Telehealth was most useful when nurses could connect patients to a local facility, obtain timely clinician input, document the encounter, and arrange follow-up. Where the digital pathway ended without a clear referral or

local service response, the benefit was smaller. These qualitative findings complement the quantitative pattern rather than independently proving causality.

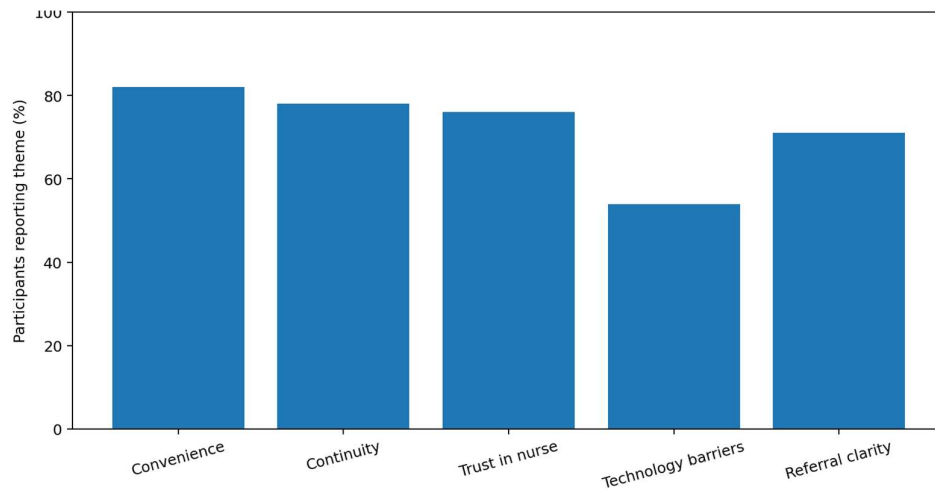


Figure 3: Illustrative mixed-methods thematic findings

DISCUSSION

The illustrative quantitative findings indicate that a nurse-led telehealth model could improve several dimensions of primary-care access in geographically isolated communities. The largest changes occurred in completed follow-up and time to first professional contact, suggesting that the intervention may reduce friction between the recognition of a health need and connection with a health professional. This is consistent with broader evidence that nurse-led services can increase access and patient satisfaction [1,3].

The findings also support the idea that telehealth should be conceptualized as a service-delivery pathway rather than a standalone technology. The nurse provided assessment, communication, coordination, education, and navigation, while clinicians remained available for problems requiring higher-level decision-making. This aligns with the 2024 evidence synthesis showing that nurse-led task-sharing can improve service delivery when supported by appropriate training, clinical systems, and regulation [2].

Arunachal Pradesh presents a particularly relevant setting because geographic access can be constrained by difficult terrain and long travel times [5]. The state's existing health infrastructure and efforts to improve access in remote and tribal areas provide an important

platform for integrating telehealth [6,8]. A low-bandwidth model may be more resilient than a video-dependent model because the essential nursing functions—triage, education, follow-up, and coordination—can often be performed by voice call or asynchronous messaging when bandwidth is limited.

The qualitative findings highlight a critical equity issue. Digital expansion can improve access for people who have a functioning phone and reliable network, while excluding those with shared devices, low digital literacy, limited privacy, or poor connectivity. The 2024 scoping review similarly identified technological limitations and accessibility concerns as barriers to telehealth [2]. Thus, implementation should preserve multiple entry points: telephone, assisted teleconsultation at a local facility, and face-to-face escalation when required.

The study also has implications for nursing education and service planning. Nurses implementing telehealth require competencies beyond conventional clinical skills, including structured digital communication, privacy protection, documentation, remote assessment, safety-netting, and referral coordination. These competencies can be incorporated into continuing professional development and competency-based training. Monitoring should include not only consultation counts but also failed connections, referral completion, patient travel avoided, continuity, and equity indicators.

CONCLUSION

A nurse-led telehealth model offers a plausible approach to improving primary-care access for geographically isolated communities in Arunachal Pradesh by reducing travel-related barriers, accelerating professional contact, and strengthening follow-up and referral navigation. The mixed-methods framework is important because access is both measurable and experiential: utilization data can demonstrate change, while patient and nurse accounts explain how connectivity, trust, continuity, and service integration shape that change. Telehealth should therefore be implemented as a complement to—not a substitute for—local primary-care infrastructure, emergency services, diagnostics, and in-person clinical assessment.

LIMITATIONS

The proposed study is quasi-experimental and therefore vulnerable to selection bias, temporal confounding, and differences between communities. Self-reported access and satisfaction may be influenced by recall and social desirability. Connectivity and device access may vary over time and between villages. The 12-week follow-up may be too short to determine whether access improvements persist. Qualitative findings may also overrepresent participants who completed the intervention. Finally, the numerical findings presented in this manuscript are simulated for research-paper development and must not be interpreted as observed clinical or service-delivery effects.

FUTURE SCOPE

Future research should use pragmatic cluster-randomized or stepped-wedge designs across multiple districts and seasons, with longer follow-up. Economic evaluation should quantify travel costs, time saved, staff workload, and infrastructure requirements. Studies should examine equity by connectivity, gender, age, disability, language, and socioeconomic status. Implementation research should test low-bandwidth telephone-first models alongside assisted eSanjeevani pathways and evaluate referral completion, safety events, patient experience, and continuity. Co-design with communities and frontline nurses could further improve acceptability and sustainability.

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