

Optimising digital solutions to improve access to comprehensive primary health care services in remote Indigenous communities: A participatory action research project protocol

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Abstract

Background: Aboriginal and Torres Strait Islander (Indigenous) peoples living in remote Australia experience a heavy burden of ill health and multiple barriers to accessing health care. Digital health technologies (DHTs) have the potential to help overcome some of these challenges and increase access to comprehensive primary health care (CPHC), thereby improving equity of health outcomes. However, little is known about the community and provider preference of the use of digital technologies for improving health and wellness.

Objective: The aim of this project is to co-design, implement, and evaluate how DHTs can improve access to CPHC in remote Indigenous communities in the Northern Territory.

Methods: This multi-phased project will take a participatory action research approach to co-design and optimise digital health solutions with local community members and health services staff in two communities. Our mixed methods approach will include pre- and post-implementation focus group discussions, interviews, quantitative analysis of CPHC utilisation administrative data and surveys administered by Indigenous community-based researchers to understand the use of digital devices and connectivity, eHealth literacy, preferences for different attributes of DHTs using best-worst scaling, and consumer satisfaction and experiences with DHT interventions. Priority DHTs will be selected for implementation based on consumer and health staff preferences. Focus group discussions and interview data will explore community and health service staff preferences, experiences and satisfaction with implemented DHTs. A realist approach will be taken to identify how DHT interventions work, for whom and in what circumstances, so that understanding of why some interventions work while others do not is expanded. Economic analyses will be conducted to calculate the incremental costs and benefits of implemented DHT interventions. The scalability of digital health solutions will be tested in two additional communities. Project partners include key funding, service and support agencies in the NT and nationally.

Results: As of November 2024, we have selected two implementation sites. Digital health initiatives are underway at the implementation sites, and evaluation activities are progressing. The initial findings from these sites have informed our scalability assessment in additional two sites.

Conclusions: Knowledge translation is integral to the study design which involves partnering with consumers, CPHC service providers, and a range of key stakeholders to inform health service providers and policymakers about what DHTs work for which groups of consumers, and under what circumstances, to improve access to CPHC. This unique study will accommodate consumer and provider preferences regarding the use of DHTs to improve CPHC access and address the lack of knowledge about how to deploy digital solutions to best support CPHC in remote Indigenous Australia. Clinical Trial: Not applicable.

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Original Manuscript

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Abstract

Background: Aboriginal and Torres Strait Islander (Indigenous) peoples living in remote Australia experience a heavy burden of ill health and multiple barriers to accessing health care. Digital health technologies (DHTs) have the potential to help overcome some of these challenges and increase access to comprehensive primary health care (CPHC), thereby improving equity of health outcomes. However, little is known about the community and provider preference of the use of digital technologies for improving health and wellness. The aim of this project is to co-design, implement, and evaluate how DHTs can improve access to CPHC in remote Indigenous communities in the Northern Territory.

Methods: This multi-phased project will take a participatory action research approach to co-design and optimise digital health solutions with local community members and health services staff in two communities. Our mixed methods approach will include pre- and post-implementation focus group discussions, interviews, quantitative analysis of CPHC utilisation administrative data and surveys

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Discussions: Knowledge translation is integral to the study design which involves partnering with consumers, CPHC service providers, and a range of key stakeholders to inform health service providers and policymakers about what DHTs work for which groups of consumers, and under what circumstances, to improve access to CPHC. This unique study will accommodate consumer and provider preferences regarding the use of DHTs to improve CPHC access and address the lack of knowledge about how to deploy digital solutions to best support CPHC in remote Indigenous Australia.

Keywords

Indigenous peoples, primary health care, digital health, telehealth, remote, access, participatory action research, co-design

Main text

Introduction

Comprehensive primary healthcare (CPHC) is the delivery of essential healthcare services from the first point of contact, enabling equitable access to health and well-being for all residents in a community [1]. In the Australian context, CPHC includes health promotion, illness prevention, care of the sick, advocacy, and involvement of the community in planning and managing health services. It is characterised by achievement of more equitable health outcomes in line with the 1978 Alma Ata Declaration on Primary Health Care [2, 3]. CPHC is also the most inclusive and cost-effective approach to delivering health services and involves identifying local health needs and responding to fill health provision gaps [1]. Strong CPHC systems are therefore essential for optimising health outcomes for high needs, dispersed and marginalised communities.

Remote Aboriginal and Torres Strait Islander (Indigenous) Australians experience the heaviest burden of ill health, and highest rates of preventable hospital admissions and potentially avoidable deaths of all Australians [4]. Overall, Indigenous Australians have a 2.3 times higher burden of disease compared to the non-Indigenous population [4]. Responding adequately to this burden of disease and associated need for CPHC in remote Indigenous communities of Northern Territory (NT) is challenging [5]. The NT spans a large geographical area (1 347 791 km²) all of which is classified as rural or remote, and population density is sparse [6]. In Australia, geographical remoteness has been associated with long-standing health workforce issues, including poor supply, low retention, and high turnover, with associated adverse impacts on access to CPHC, especially continuity of care [7-10]. Additionally, high proportions of nurses are employed on casual or short-term agency contracts [11]. On average, only (20%) of Remote Area Nurses (RANs) and Aboriginal Health Practitioners (AHPs) remain working in the same clinic 12 months after commencing their

employment [7, 11, 12]. While the use of temporary staff provides a short-term solution to address dire need, there are trade-offs regarding the skills and suitability of these staff, with consumers preferring to have their complex chronic conditions managed by health professionals they know [7, 8, 11]. High mobility of remote populations is also a unique feature of the remote communities and is a further barrier to continuity and access to care.

Digital health technologies (DHTs) such as telehealth, wearable devices, and mobile health (mHealth) apps can help to address barriers to CPHC for people living in remote Indigenous communities as well as support remote area health professionals [5, 13]. Telehealth has been shown to reduce the need to travel and decreased waiting periods to see a clinician, and improve continuity of care [14, 15]. DHTs can also increase flexibility of employment and provide enhanced training opportunities for remote clinicians [16], thereby promoting workforce retention. DHTs may also improve communication between different service providers [16] which can improve coordination of health care, improve decision-making, and strengthen communications between specialists and primary health care providers. DHTs also have the potential to increase cultural security and minimise disparities in the access to the health care [17]. For instance, a recent systematic review reported that in some circumstances Indigenous people may feel more comfortable using telehealth and thereby avoiding embarrassment which might arise from a face-to-face interaction with a health provider who lives in their community [18]. The vision of the NT Virtual Care Strategy [5], therefore, is that DHTs will facilitate improved access and result in more choices being available to consumers, reduce travel time to get to appointments, and increase convenience for consumers.

A number of studies have developed and applied digital tools such as apps and programs to promote health and wellness in rural and remote communities but these are often not developed in collaboration with communities and, when they have been, are rarely evaluated [19, 20]. In the NT, DHTs currently being used include telehealth (audio with video), electronic patient management information systems, and a range of mobile applications. However, despite existing use and the potential for more widespread use of DHTs, it is not well understood what DHTs might work well, how and for whom, to improve access to CHPC for remote Indigenous populations in the NT. While some health services in the NT have used DHTs to deliver CPHC and follow-up of specialist care, DHTs generally remain underutilised, and DHTs have neither been systematically implemented nor evaluated [19, 20]. The use and type of DHTs in the NT has primarily been driven by providers' preferences [13], with limited focus on consumer preferences and experiences. Likewise, there is little evidence of consumer involvement in the design and delivery of healthcare using DHTs in remote Indigenous settings elsewhere in Australia which stand to most benefit from this technology. In light of these important gaps, this research will co-design, implement and evaluate the use of DHTs, in order to strengthen the evidence based about how DHTs can best support access to CPHC for remote Indigenous communities, considering consumer and remote health staff preferences.

Methods

Setting

This project is being conducted in two remote Indigenous communities in the NT where CPHC services are delivered by either NT Government-run or Aboriginal Community Controlled Health Services (ACCHSs). Health services across the NT were invited to express their interest to participate in the project. A project advisory committee, consisting of key decision makers from the NT and Commonwealth Health Departments, ACCHSs and stakeholder partners selected the sites considering community size, remoteness, location (Top End, Central Australia), health service delivery and governance model (government, ACCHS), and estimated readiness to engage with DHTs. This approach sought to maximise opportunity to evaluate and compare the findings from

diverse communities with different governance structures. The clinics in these communities are mostly staffed by RANs, AHPs, and non-clinical administrative staff based in the community, with visiting (and sometimes telehealth) services provided by general practitioners (GPs), Allied Health Professionals (AHPs), and various medical specialists. The NT has unique cultural, social, and language considerations, with 26.3% of the population identifying as Aboriginal or Torres Strait Islander (compared to 3.2% across Australia) [21]. In remote and very remote communities of the NT, more than 90% of the population identify as Aboriginal and for many, English is not their first language [21].

Theoretical frameworks

A participatory action research (PAR) methodology actively involves key stakeholders, including patients (consumers), healthcare providers, caregivers, and community members in the research process. This methodology emphasises collaboration, shared decision-making, and engagement of those directly affected by the research [22, 23]. The intention is that a network of participants who are actively engaged in the project can help bridge the gap between research and practice to create sustained system change.

We will apply three theoretical frameworks in the design, implementation, and evaluation of DHT solutions in the two communities. First, an overarching logic model (Figure 1) for CPHC will be employed to provide a systematic approach for data collection across the different components of a CPHC system (context, inputs, enablers, outputs, and immediate, intermediate and final outcomes), and the contribution of each component will be monitored against relevant outcome measures [24].

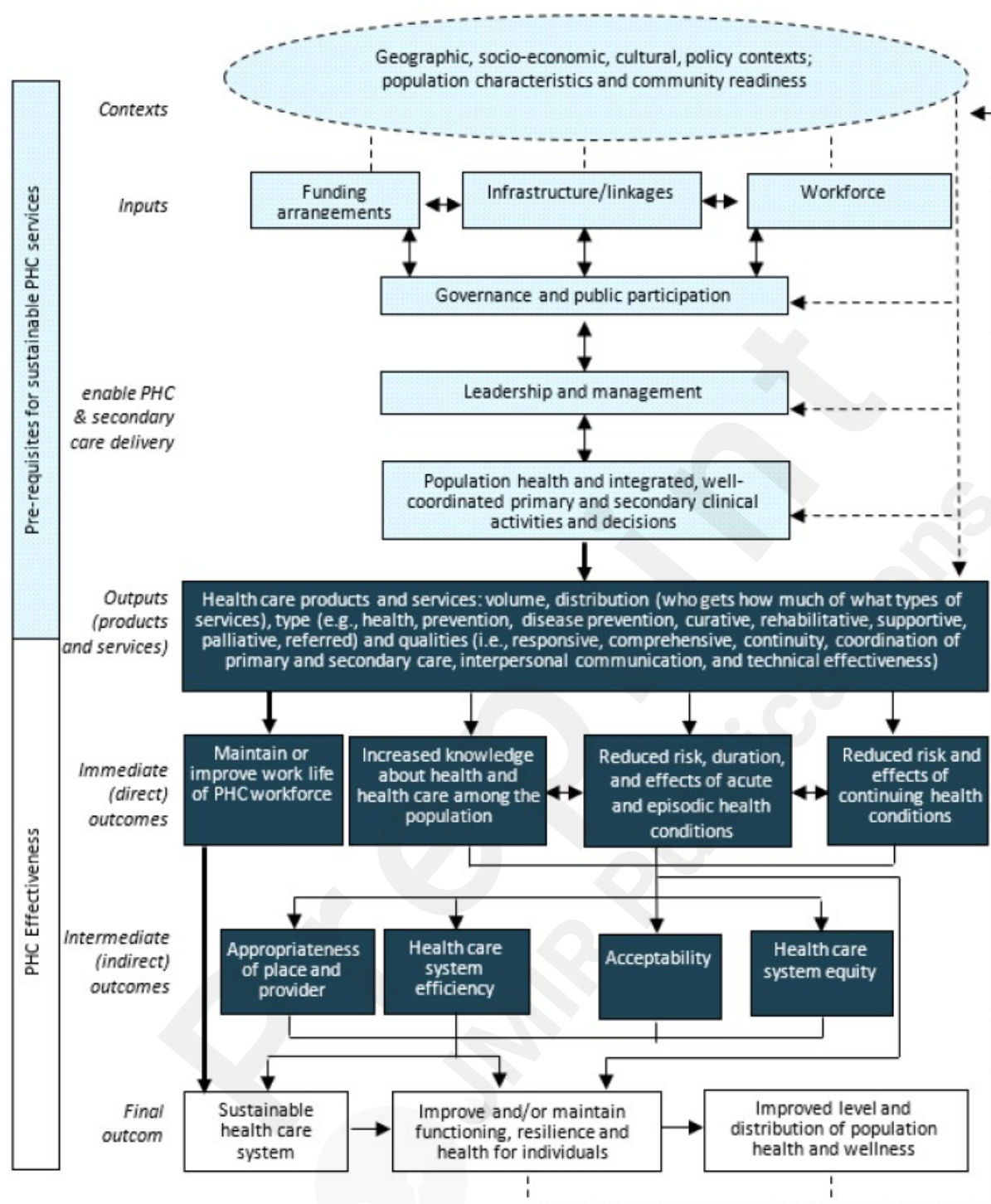


Figure 1: An evidence-based logic model for sustainable comprehensive primary health care for small rural and remote communities (after Watson et al, 2009).

Second, the six dimensions of the modified theory of access: acceptability, accommodation, affordability, accessibility, availability, and awareness (including digital health literacy) will be used to evaluate the impact of DHTs in providing enhanced access to CPHC [25, 26].

Third, a realist approach will be used to explore which DHTs work, for whom, and under what circumstances [27, 28]. Realist evaluations go beyond simply determining whether an intervention is effective or not; they provide insight into underlying mechanisms and the context of causal relationships between interventions and outcomes.

This tri-part approach is likely to be especially useful to unpack the complex interplay of factors operating within remote and Indigenous healthcare environments [27, 29].

Specific research questions include:

1. What technologies are available to support CPHC, including prevention and health promotion programs, in remote communities?
2. How can existing technologies be modified or enhanced to support CPHC and what new technologies are needed?
3. What are consumer and provider preferences for the use of digital technologies to support CPHC in remote communities?
4. How can technologies be used to promote access to care support a holistic approach to social and emotional wellbeing in remote communities?
5. How can digital technologies support coordination of, and access to CPHC in a highly mobile population, as well as collaboration between providers?
6. What skills are required for remote providers to use digital technologies to support CPHC in remote communities?
7. What is the impact of deploying different digital technologies to support CPHC on consumer and staff experiences in remote communities?
8. What are the potential cost consequences of deploying different digital technologies to support CPHC in remote communities?
9. How can the deployment of digital technologies improve efficiency of CPHC in remote communities?

Project co-design, implementation, and evaluation

The project will be conducted in multiple phases, including investigation and co-design of DHTs with consumers and health service staff, iterative implementation of different DHTs in two community sites and evaluation of these DHTs on consumer and staff experiences and access to CPHC (*Figure 1*).

Pre-implementation activities and co-design of digital health interventions

A desktop review will identify existing DHTs currently being applied in the NT and elsewhere that can be applied to support CPHC in remote Indigenous communities. A concurrent realist review will develop initial program theories about how and for whom DHTs affect access to CPHC in remote Indigenous communities [27, 30]. Initial program theories developed from the existing literature will be refined using data collected from thought leader interviews. Some of these theories may subsequently be tested during the evaluation phase (depending on preferences for DHTs to be implemented).

A technology-enabled patient journey map will be prepared and refined iteratively for use during interviews and community interactions. It will be a tool to assist with identifying the facilitators and barriers for remote residents accessing CPHC during different stages of their healthcare journey.

Initial community-engagement activities will be undertaken in the two selected sites at the initial stage led by a male and a female local community-based Indigenous researcher employed at each site. These researchers will be key to ensuring locally responsive and culturally appropriate data collection and for developing and maintaining relationships between the research team and local stakeholders [31]. They will actively participate in all stages of the project: data collection, analysis, co-design, analysis of results and publication preparation.

Baseline data will be collected on general communities views on the use of technology of health and wellness, digital health coverage [32], eHealth literacy [33], and consumer satisfaction with current use of telehealth to access health services and group health promotion sessions [34-36].

Qualitative semi-structured interviews and focus group discussions (FGDs) with consumers and providers will be undertaken to explore preferences for DHTs and to inform the attributes of DHT interventions [37, 38]. Community-based researchers will actively identify and recruit participants for FGDs and interviews. The information obtained from the FGDs, and interviews will be used to identify the key attributes of DHT interventions, which will inform the pre-implementation quantitative survey. The survey will quantify best and worst attributes of DHTs using Best-Worst Scaling (BWS), digital technology coverage, eHealth literacy and satisfaction of consumers who have used DHTs. The BWS will quantify consumer and local PHC staff members' priorities for key attributes of DHTs, and any differences in preferences amongst different groups of respondents. These findings will be used to further refine and target DHT development and implementation [38].

Implementation

Information regarding the candidate DHTs identified during the co-design phase will be presented to the consumers, local health staff and the leaders in government and community sectors. An integrated set of candidate DHTs will be implemented based on their feasibility and anticipated impact on access to CPHC. Interventions will be tailored to the local context using the PAR design approach led by community-based researchers who will support intervention implementation and lead the collection of feedback.

Evaluation

Post-intervention data will be collected as the interventions are implemented and iteratively refined. We will use quantitative administrative data and qualitative data from interviews and FGDs with consumers and stakeholders about their experiences with DHTs in order to identify what works for whom, in what context and by which mechanism [27].

An economic analysis will investigate the incremental costs of implementing DHTs and the associated benefits. The incremental resource use will be calculated based on different patterns of digital solution uptake in terms of additional resources required, and staff costs are based on assumptions around how many extra staff hours would be required per patient per unit of time. Whether a cost-effectiveness or cost-benefit analysis will be conducted will be decided determined on consultations with key stakeholders.

Scalability analysis

Scalability analyses will be conducted in two additional communities, using a previously published framework [39]. The objectives of such analysis will be to (i) identify core and adaptable features of implemented DHTs and (ii) explore the feasibility of scaling DHTs to additional community sites, including cost implications. The scalability analysis will enable the evaluation team and participating organisations and their respective health boards to assess the suitability of the developed DHTs for scale and further implementation. This component will have strong translational implications.

Participants

Community partnership is an important aspect of this project. It is crucial to understand how remote communities experience access to CPHC and how DHTs may improve or deter their access to and experiences of health services. Six different stakeholder groups were identified as crucial partners in this project (see Table 1 for details). Briefly, Group 1 includes community leaders; Group 2 includes consumers; and Group 3 includes health service staff, health board members, clinical and non-clinical staff at the participating sites. Likewise, Group 4 includes project partner organisation staff; Group 5 includes technology provider organisation staff; and Group 6 includes other stakeholders and thought leaders. Participants will be eligible if they are 18 years or older and are able to give informed consent.

This a multi-institutional collaboration that includes government and industry partners [40]. The key partners include Digital Health Cooperative Research Centre (DHCRC), The Commonwealth Department of Health & Aged Care (DHAC), Northern Territory Government, Northern Territory Primary Health Network (NTPHN), Aboriginal Medical Services Alliances Northern Territory (AMSANT), Health Direct (HD), the Australian Digital Health Agency (ADHA), Menzies School of Health Research, and The University of Sydney. The representatives from each partner provide substantial research and industry inputs at all stages of the project.

Data collection

Table 1 provides a summary of data sources used in each stage as the project progresses.

Primary data

Initial workshops and key informant interviews with thought leaders will be used to develop primary healthcare journey maps that depict how different DHTs are being used. The barriers and enablers of access to CPHC and the role of DHTs in improving will be discussed to identify initial outcomes and mechanisms.

Interviews with stakeholders will be used to explore their perspectives on various barriers and enablers of access to CPHC and the role of DHTs in improving various aspects of access. Focus group discussions with consumers in the communities will explore key challenges and identify their preferences. A baseline survey, including the BWS survey, will collect data on DHT coverage, consumer experiences with DHT use [34, 35], e-Health literacy [33], and consumers and health staff preferences for DHT implementation [37, 38].

Once preferences of consumers and health care providers regarding DHTs are identified and feasible DHTs are implemented and optimised, focus group discussions, interviews and surveys will be used to collect data about consumer use and satisfaction data. This will be an iterative process and will inform scalability to other remote Indigenous communities.

Secondary data

Secondary administrative data will be retrieved from multiple sources. This will include CPHC data at the two intervention sites, such as utilisation data, as well as hospitalisation, and patient transport data. These analyses will complement scalability, and economic analyses. The expenditure and personnel data (e.g. workforce composition, supply) required for economic analyses will be obtained from the participating organisations. Further secondary data needs will be determined once the DHTs are prioritised (*see Table 1*).

Data analysis

Qualitative data

All interviews, focus group discussions and workshops will be audio-recorded (if acceptable at the time) and transcribed; detailed fieldnotes will also be used to inform analysis and understanding. Transcripts will be thematically analysed using inductive, deductive and realist approaches and NVivo software to identify barriers and facilitators to DHT across the different domains of access and the mechanisms by which interventions impact on access to CPHC for different groups of consumers. Case studies will be used to understand what DHTs work (or don't) for CPHC in remote Indigenous communities, for whom, in what circumstances, and by what mechanism to improve access to healthcare [27]. Two experienced qualitative researchers will be involved with the community researchers in each stage of data collection and analysis. All findings will be interpreted

and reviewed by Indigenous research team members.

Quantitative data

Pre and post intervention data will be compared to investigate the changes in the utilisation of primary health care services. Descriptive statistics using frequency tables and visualisation along with, where possible, univariate and multivariable regression analyses will determine the association between the DHT interventions and revealed access to CPHC.

The economic analysis will present disaggregated incremental costs and consequences of different DHT uptake relative to the status quo. Additionally, changes in patient satisfaction and outcomes, use of primary care, hospitalisations, and patient transport will assess the impact on incremental costs and outcomes of changing values of cost or outcome variables and alternative ways of delivering care.

Ethics

The project was reviewed and approved by the Human Research Ethics Committee of the Northern Territory Department of Health and Menzies School of Health Research (HREC Approval Number: 2022-4275). Administrative approval was also obtained from the Research Governance Office, NT Health (EFILE2023/8720) and the Boards of any participating ACCHS. Research project approval was also sought from the respective land councils, and appropriate travel/work permits were obtained for each site for community-based research activities.

Project governance

This project is situated within the governance of the Strengthening Our Health System Strategy, an established collaboration of AMSANT, NT Health (state health department), and NTPHN. It focuses on crucial aspects of the NT Virtual Care Strategy [5] relating to improving equity, delivering culturally safe services, and providing support, resources, and guidance for staff about how and when virtual care is effectively provided. It is overseen by a Project Control Group and a Project Advisory Group, each having representation across all partner organisations and the Commonwealth Department of Health. Three additional working groups (the research working group, project operational team, and technical working group) hold responsibilities for guiding research activities, ensuring smooth project delivery, and navigating technology issues to the implementation and adaptation of DHTs for CPHC in remote NT.

This implementation project has Indigenous leadership and representation, including as Chief Investigators, and at all stages, including design and implementation. This project also employs one male and one female community-based Indigenous researcher at each study site. The community-based researchers are mentored by experienced research team members and have been provided with training on ethical conduct in research, data collection, and analysis and provide reciprocal cultural mentoring for non-Indigenous research team members.

Knowledge translation

Knowledge translation is an integrated feature of the project and is of particular interest to stakeholders and other partners in the project. The governance structure enables rapid feedback on project developments and outcomes. Sharing findings with stakeholders, health services, funders, and executive groups (e.g. NT Health, Commonwealth Department of Health) will be prioritised to inform the scalability and suitability of DHTs for CPHC in other remote Indigenous communities. Customised reports will be provided to each of the stakeholder groups and participating services. A one-page, plain-language report will also be distributed to the participating communities and all NT remote health services. Dissemination will include peer-reviewed publications and presentations at conferences and professional workshops.

Limitations

Due to the small remote community population sizes, the sample included in the studies will have limited statistical power but will have inclusive consideration for the remote communities. Poor digital connectivity, high staff turnover including changes in the health service administration are also beyond the control of our project team. The use of secondary administrative data which have not been collected for the express purpose of the study is likely to present additional challenges. For example, the ACCHSs and government health services use different patient information management systems, limiting ability to link datasets and comparability of data available at different sites. Despite its strengths, the PAR approach is time-consuming, needs additional efforts to focus on processes, and has the potential of leading to friction among the stakeholders due to competing priorities [22, 23]. While it can be counterproductive if not handled with care and expertise, this has been accounted for in the project design and development strategies which has been founded on the considerable expertise of the research team. The credibility and local ownership offered by the PAR approach outweigh these limitations.

Discussion

This project aims to optimise the use of DHTs to improve access to CPHC in remote Indigenous communities. To date, DHTs, including telehealth, have been used ad-hoc or as pilot projects rather than for mainstream ongoing healthcare delivery [41]. While there are promising findings from other studies in the NT [13, 15], to the best of our knowledge, our project will be the first to co-design DHT interventions with consumer and remote health providers, and to systematically evaluate the acceptability and effectiveness in remote Indigenous communities.

The involvement of multiple stakeholders, including consumers, health service providers, technology partners, and policy and funding partners, is critical to improving the knowledge about and skills for using DHTs to provide CPHC in remote communities [22, 42]. The use of one DHT (telehealth) to improve access to CPHC has been examined in remote NT, and it has been reported that the doctors were able to provide more clinical care because less of their time was consumed traveling to each community [13, 15]. This project considers a broader range of DHTs, extending beyond telehealth to include, for example, text messaging of appointment reminders, medication reminders, health promotion messages, community portals, and use of My Health Record. The intention is to improve access to CPHC, promote equity, and improve health outcomes in the two remote communities through improved continuity of care and fewer avoidable hospitalisations and patient transfers. Effective and acceptable CPHC also capitalises and contributes to increased trust and long-term relationships with health service providers, to increased cultural security, greater convenience in receiving health care, a reduction in health care disparities, and stronger community engagement in health management and well-being [13, 43].

The economic analysis is unique as previous studies have not reported such systematic evaluations. The virtual care strategy of NT Health [43] has reported that digital health has the potential to save \$6.3 million on annual travel costs and \$950,000 on the cost of appointment cancellations in the NT. However, these estimates are not based on community-based studies from the NT. Our economic evaluation intends to show the financial benefit at the local level for the clinic and patient, which will inform decision-making about implementing DHTs in CPHC.

Unintended consequences are not uncommon in the digital health space, and one such risk is the additional administrative and clinical workload that the resident staff may bear and the concern for burnout [16, 41]. The co-design and PAR approach is expected to help identify such issues proactively and address these issues in a timely manner. For instance, additional workload needs to

be accounted for when telehealth consultations with outpatient hospital services or health promotion sessions are offered in the community [44].

A second issue is managing the 'digital divide' [45, 46]. Cautious and informed DHT identification and implementation will minimise the impact of broad stroke DHT interventions that widen the gap in access to CPHC experienced by disadvantaged populations who may not have digital devices, connectivity, or digital literacy or skills for such consultations [47, 48]. The realist approach, by identifying how DHTs work, and who needs support, why, and in what circumstance within the available provisions adds further critically important information regarding approaches to DHT implementation in marginalised populations such as those living in remote Indigenous communities [27, 28].

A third issue is managing perceptions that telehealth may be 'a cheaper option' for CPHC in remote communities [9]. In an ideal situation, the same clinical staff would always be available face-to-face for consultations, but in many remote communities, this is not realistic due to high staff turnover, declining GP training enrolments, vast geographical distribution of the smaller communities, and the inequitable distribution of resources [7, 24, 49]. This project will identify opportunities to implement DHTs that do not take away existing face-to-face services but rather complement and enhance CPHC in remote communities. It is possible that the DHT interventions will be catalysts to improve health and well-being in remote Indigenous communities.

Digital innovations have affected every aspect of our lives. It is unlikely that the current health system and health service delivery can remain isolated from such a rapid proliferation of innovative DHTs. This project provides a unique opportunity to optimise and systematically evaluate key digital health interventions. It will also highlight why DHTs work for some but not for others, identifying risk groups to create appropriate supports within the community. Furthermore, the economic analysis will help the local health board and other stakeholders make an informed decision to adopt, refine, or reject DHTs in the future. In conclusion, the project has the potential to substantially improve access to CPHC services for the remote Indigenous communities of the NT. Such improved access will help improve the health outcomes of those living in remote communities.

Abbreviations

ACCHSs	Aboriginal Community Controlled Health Services
ADHA	Australian Digital Health Agency
AHP	Aboriginal Health Practitioners
AMSANT	Aboriginal Medical Services Alliances Northern Territory
BWS	Best-worst Scale
CPHC	Comprehensive Primary Health Care
DHTs	Digital Health Technologies
DHCRC	Digital Health Cooperative Research Centre
DHAC	The Commonwealth Department of Health & Aged Care
GPs	General Practitioners
HD	Health Direct
NT	Northern Territory
PAR	Participatory Action Research
RANs	Remote Area Nurses

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Conflict of interests

The authors declare no conflict of interest.

Data availability

Not applicable.

Author contributions

VK wrote the first draft of the manuscript with significant contribution from ES and DR. NN, TS, KC, AP, SN, AH, TC, PB, and JW provided significant input in drafting, revising and finalizing the protocol. TS, JW and DR are leads of this implementation project who conceptualized the initial idea with significant contribution from SN on economic evaluation. All authors have read and approved the final version of the manuscript.

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Table 1. Research participants, recruitment, and data collection methods for each phase of the project evaluating the design and implementation of digital health technologies in two remote Indigenous communities of the Northern Territory, Australia.

Data source	Example participants	Sample	Recruitment method	Data collection method	When
Primary data					
Workshops with remote NT health service providers	GPs, allied health professionals, remote area nurses, health service managers	60	Invitation; convenience sampling	Group discussions	Pre-implementation
Group 1. Community leaders at the two participating sites	Traditional owners, mayor, religious and cultural leaders, local council board members	8	Purposive sampling via local contacts	Individual interviews	Co-design, Implementation and evaluation
Group 2. Consumers at the two participating sites	Consumers (or their carers) who have used local health services	100	Purposive sampling to ensure representativeness	Survey administered in-person (digital technology coverage, Best-Worst Scaling Survey, consumer satisfaction, and eHealth literacy)	Co-design, Implementation and evaluation
Group 2. Consumers at the two participating sites	Consumers (or their carers) who have used local health services	40	Purposive sampling to ensure various perspectives are included	Individual interviews and focus group discussion	Co-design, Implementation and Evaluation
Group 3. Health service staff at the two participating sites	CEOs, managers, Board members (where applicable), clinical (Doctors, remote area nurses, aboriginal health workers) and non-clinical staff (eg. drivers,	25	Purposive sampling from the local sites.	Individual interviews, small group discussion	Co-design, Implementation and Evaluation

	administrative staff)				
Group 4. Partner organization staff	NT Health staff members, other partner organizations such as AMSANT, NT PHN	25	Purposive and snowball sampling	Workshop, small group discussion, individual interviews, System Usability Surveys	Pre-implementation
Group 5. Technology provider organization staff (non-partners)	Current staff of technology provider (s) such as NBNC Co and Telstra	5	Purposive and snowball sampling	Meeting minutes and documents, interviews	Implementation
Group 6. Other stakeholders and thought leaders	Staff at other remote clinics or who have in-depth understanding of remote CPHC context	25	Purposive and snowball sampling	Individual interviews and workshops	Pre-implementation and codesign
Secondary data					
Comprehensive primary health service usage data Clinic records and activity CPHC service utilization data, Hospitalization data, Patient travel data Baseline and endline data (01/01/2022 to 28/02/2025) for all consumers of the participating health services	NT- Health ACCHSs	All consumers	Data request application to respective health services	Activity audit of service utilization data for the catchment community.	Evaluation
Economic data Expenditure and personnel	The incremental resource use (taking a programmatic perspective) associated	All expenditure	Obtain the data from NT-Health	Cost consequence analysis	Evaluation

data from participating institutions. Key data source will be health personnel and technology related costs. Baseline and endline data (01/01/2022 to 28/02/2025)	with different patterns of digital solution uptake, Additional technology resources required Staff costs	relevant to DHTs	for the participating clinic and from the ACCHSs.	Review of establishment and maintenance costs of digital technology for health. [Data need and evaluation method will be determined based on the initial candidates of digital solutions (In-progress).]	
GPs: General Practitioners, CEO: Chief executive officer, NT-Health: Northern Territory Department of Health, AMSANT: Aboriginal Medical Services Alliances Northern Territory, NTPHN: Primary Health Care Network, Northern Territory, CPHC: Comprehensive primary health care, ACCHSs: Aboriginal community-controlled health services, DHTs: Digital health technologies.					

Supplementary Files