

Delivering Culturally-Appropriate, Technology-Enabled Health Care in Indigenous Communities

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Keywords: Healthcare Interventions, Shared Decision-Making, Motivation-Opportunity-Ability (MOA) Framework, Indigenous Communities

Abstract: Indigenous health is becoming a top priority globally. The aim is to ensure equal health opportunities, with a focus on Indigenous populations who have faced historical disparities. Effective health interventions in Indigenous communities must incorporate Indigenous knowledge, beliefs, and worldviews to be culturally appropriate.

Introduction

Indigenous health has been recognized as a top priority in various countries, including New Zealand, Australia, and Canada. The emphasis in Indigenous health is to ensure equal health opportunities for all social groups, with a special focus on Indigenous people who have had fewer opportunities in the past.¹ Previous research efforts on Indigenous communities have aimed to address these disparities, with varying levels of success. The key to the effectiveness of these interventions lies in researchers incorporating Indigenous knowledge, beliefs and worldviews to create culturally-appropriate health interventions.²

To assess the effectiveness of health care interventions in Indigenous communities we draw on six studies that focused on improving Indigenous health in New Zealand³ and Canada.⁴ This paper presents these studies by first outlining the importance of Indigenous concepts in the design of culturally-appropriate health interventions, specifically in relation to Māori culture. Next, we employ the motivation-opportunity-ability (MOA) framework to identify the key success factors that drive behavior change, including the individual's willingness to act (motivation), perception of the environment (opportunity), and skills or knowledge related to the action (ability). Under the notion of opportunity, we focus solely on the role of technol-

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ogy, which presents both tremendous opportunities and significant challenges in healthcare interventions for Indigenous communities. As this paper forms part of a special issue on international collaborations about the future of healthcare, our proposed framework aims to guide research teams in successfully developing and implementing culturally-appropriate healthcare interventions for Indigenous communities, developing international standards and best practices for implementing culturally-appropriate healthcare interventions, and ultimately, reducing health disparities within and across countries.

Culturally-Appropriate Care in Indigenous Communities

Indigenous peoples face higher rates of infant and maternal morbidity and mortality, a larger burden of infectious diseases, greater impacts from social, environmental and lifestyle diseases, and a shorter life expectancy compared to non-Indigenous people.⁵

In Aotearoa New Zealand, there have been efforts to restructure the healthcare system and align it with the principles of *Te Tiriti-O-Waitangi* (the Treaty of Waitangi; New Zealand's founding document of February 6, 1840), which according to the latest interpretations of the Treaty by the Waitangi Tribunal (WAI 2757), include “partnership, participation, protection, equity and options.”¹¹ The New Zealand Health Quality & Safety Commission has also developed a Māori healthcare framework to improve the quality of care for Māori people by integrating Māori cultural safety into healthcare system design and practice.¹² This framework is underpinned by Māori epistemology, ontology, knowledge, beliefs, and values partnership in shared, equal-power relationship between patients and healthcare professionals (HCPs), autonomy in decision-making, and a community- and family-oriented approach.

The above ideas highlight two key factors that are important in improving Indigenous health outcomes:

Indigenous peoples face higher rates of infant and maternal morbidity and mortality, a larger burden of infectious diseases, greater impacts from social, environmental and lifestyle diseases, and a shorter life expectancy compared to non-Indigenous people. Long-term conditions like obesity, hypertension, diabetes, cardiovascular disease, and tobacco use are believed to account for half of the Indigenous health gap. These health inequities among Indigenous people can be linked to unequal social determinants of health such as poverty, education, employment, housing, discrimination, job security, and social and environmental exclusion.

Long-term conditions like obesity, hypertension, diabetes, cardiovascular disease, and tobacco use are believed to account for half of the Indigenous health gap.⁶ These health inequities among Indigenous people can be linked to unequal social determinants of health such as poverty, education, employment, housing, discrimination, job security, and social and environmental exclusion.⁷ In efforts to address these disparities, governments in North America, Australia, and New Zealand have recognized the importance of Indigenous health and made it a priority area for research and healthcare delivery,⁸ emphasizing the need to take into account their unique cultural and historical context and to involve Indigenous communities in the design, delivery and evaluation of healthcare services.⁹ Failure to do so may result in further mistrust in the healthcare system and perpetuation of health and social inequalities for Indigenous people.¹⁰

incorporating the patients' cultural knowledge and belief systems and life history into care,¹³ and promoting shared decision-making (SDM). SDM refers to both parties (the patient and clinician) gathering and sharing information (options, preferences) and making joint decisions about diagnosis and treatment options.¹⁴ SDM represents a middle ground between medical paternalism with fixed and covert value judgements¹⁵ and giving patients sole power,¹⁶ ideally resulting in balancing the power between HCPs and patients. Evidence suggests that by providing culturally-appropriate and -competent care,¹⁷ and establishing an “authentic partnership” between HCPs and Indigenous populations,¹⁸ attitudes towards and engagement in health care can be positively influenced, leading to improved health outcomes.¹⁹

A literature search was conducted to find studies on healthcare interventions that were developed by, for,

and with Indigenous people. Table 1 provides an overview of these studies and whether they incorporated Indigenous knowledge and SDM into their design. Table 1 demonstrates the difference in focus between studies conducted in New Zealand and Canadian communities. The New Zealand studies place importance on integrating Indigenous knowledge, while the Canadian studies highlight the importance of SDM. For instance, the “Kimi Ora” study emphasized the role of regular family and community interactions in reinforcing culturally significant activities, such as meal planning, recipe sharing, nutrition guidance and physical activities to enhance cultural knowledge and community belonging.²⁰ Similarly, the “Lifestyle Intervention” study underlined the importance of food such as seafood, shellfish, puha (sour thistle) and mut-ton bird to Māori.²¹ In contrast, the Canadian studies “Shared Decision-Making in Rheumatoid Arthritis”²² and “Integrated Knowledge Translation Approach”²³ emphasized the importance of communication and relationship-building between patients and HCPs.

Drivers of Healthy Behavior in Indigenous Communities: The Motivation-Opportunity-Ability Framework

The design of culturally-appropriate health care and the principles of SDM, including patient autonomy and partnership, have the potential to drive positive behavioral changes and health outcomes.³⁰ The Motivation-Opportunity-Ability (MOA) framework, well established in organizational behavior and management research,³¹ has, to the best of our knowledge, not yet been applied in the context of Indigenous healthcare interventions. The MOA framework aims to explain behavior change by considering the individual’s willingness to act (motivation), their perception of their environment (opportunity), and their skills or knowledge related to the action (ability).³² For instance, in the case of diabetes prevention or management, changes in patients’ behavior (i.e. physical activity and food choices and consumption) are likely to be influenced by their willingness and ability (know-how) to change under the right circumstances. The MOA framework was applied to the six reviewed studies on health interventions in Indigenous communities to examine the presence of these key success factors. Table 2 provides an overview of these studies according to the components of the MOA framework.

Motivations: Goals and Incentives

Motivation is reflective of an individual’s goals, drive and willingness to engage in a certain behavior.³⁹ This

is particularly evident in health-related behavior, as people may be motivated to improve their health to create positive effects in their lives, regardless of external factors. For instance, medical interventions rely on patients’ willingness to actively monitor and manage various aspects of their health, including diet, lifestyle, and medication.⁴⁰ However, in cases when patients lack internal motivation, this can result in failure to adhere to a treatment plan or medication regime.⁴¹ To counter this, certain interventions have sought to employ motivation techniques, especially external motivation, to help participants achieve their desired outcome. For instance, the “OL@-OR@”⁴² and “Mana Tu”⁴³ programs allowed participants to select their own lifestyle goals and challenges (i.e. personalize their goals), which are crucial to reduce or prevent diabetes-related complications.⁴⁴ Other methods involved using motivational messages and personalized feedback on how individuals were progressing on their goals (“OL@-OR@”; “Mana Tu”), or leveraging social pressure from family, friends or experts (“OL@-OR@”; “Lifestyle Intervention”; “Kimi Ora”) to encourage participants to take ownership of their goals.⁴⁵ Involving the participants’ family or community in their progress has been found to be a particularly effective way to motivate individuals, as it provides them with a platform to share their challenges and successes with their support network. This also benefits the family and community, who may be facing similar challenges.⁴⁶

Ability: Training and Development

Ability in this context refers to the extent to which participants have the necessary skills or capabilities to engage in changing their behavior to achieve an outcome.⁴⁷ Many of the aforementioned programs were launched to inform and educate participants, to put in place training and development plans, as well as to provide participants with tools to make meaningful decisions. To further this end, information sessions were held to brief participants about their progress and teach them essential skills such as measuring their heart rate (“Lifestyle Intervention”) as well as offering culturally tailored tips on eating, exercising, sleeping, and managing stress (“OL@-OR@”).⁴⁸ The most common approach was to employ skilled community case workers to discuss clinical, social, and psychological issues associated with the participants’ condition (“Mana Tu”).⁴⁹ These community case workers received training in motivational interviewing, cultural safety, and health literacy, and provided a range of essential services (“Mana Tu”). For example, in the “Integrated knowledge translation approach”

Table 1

Summary of Intervention Studies on Indigenous Populations

Program	Purpose	Area /Country	Cultural Knowledge and Community	Shared Decision-Making (SDM)
OL@-OR@mHealth ²⁴	A mobile health program, — co-designed with Māori and Pasifika communities focusing on diabetes management — aimed to support individuals and their communities in adopting healthy lifestyle behaviors.	Diabetes/NZ	Co-designed with Māori and Pasifika communities, the digital app contained information about activity groups to promote wellbeing through cultural concepts, messages, and imagery.	
Lifestyle intervention ²⁵	Health intervention focusing on developing a community program for Māori suffering from type 2 diabetes.	Diabetes/NZ	Co-designed with Māori to support individuals adopting health lifestyle changes through understanding the importance of food and through partnerships with key leaders in the Indigenous diabetes community.	
Kimi Ora ²⁶	This family (<i>whanau</i>)-centered program aimed to ensure no worsening of HbA1c and to improve wellbeing for Māori with diabetes or pre-diabetes in low-income households.	Diabetes/NZ	Designed and implemented a family-centered, community-based lifestyle program with two Māori communities.	
Mana Tu “to stand with authority” ²⁷	Developed in response to ethnic and social inequities in type 2 diabetes rates and outcomes to address system-, service- and patient-related factors that impact on the family’s ability to manage type 2 diabetes.	Diabetes/NZ	Co-design with Māori and drawing on Māori knowledge (collective vision, aspiration, and purpose of Māori communities) to support people with poorly controlled type 2 diabetes health outcomes.	
Shared Decision-Making in Rheumatoid Arthritis “Not deciding alone” ²⁸	Focused on how an early rheumatoid arthritis (RA) Patient Decision Aid (PtDAs) enables shared decision-making between Canadian Indigenous patients and healthcare providers.	Rheumatoid Arthritis/Canada	Engaged with elders, healers, and knowledge keepers, to gain support in developing a cultural adaptation of a shared decision-making tool.	Treatment decisions were informed by clinical, family, and societal factors. SDM can support culturally-congruent care.
Integrated Knowledge Translation Approach ²⁹	Aimed to enhance participation in cancer care decisions in Inuit communities by using an integrated knowledge translation approach.	Cancer/Canada	Partnership with an Indigenous community to represent Indigenous worldviews and traditional knowledge leading to the development of a community-based SDM strategy.	SDM strategy supported by community workers to enhance participation in decision about cancer care.

study,⁵⁰ community support workers were paired with a participant to share decision making around their goals, challenges, and options, as well as facilitate a connection to the community’s cultural knowledge and values (“Shared Decision-Making in Rheumatoid Arthritis”).⁵¹ Moreover, they were able to help commu-

nicate with and gain access to specialized clinical care, population health activity (“Network Hub in Mana Tu”) and other health services such as dietitians and exercise trainers (“Lifestyle Intervention”).⁵²

Table 2

Summary of Intervention Studies on Indigenous Populations

Intervention name (authors)	Motivation	Ability (Training and development)	Opportunity (Digital capability)	Impact
OL@-OR@mHealth ³³	Self-directed goal setting. Motivational messages. Sharing with community.	Culturally tailored tips on eating, exercising, sleeping, stress, and weight management.	Lifestyle trackers to monitor progress.	H&WB: Adherence to health-related behavioral guidelines HE: Well-being through cultural concepts.
Lifestyle intervention ³⁴	Sharing with community Indigenous Diabetes Educator as motivator.	Participants learned how to measure and calculate heart rate in group sessions. Regular contact and monitoring by dietician, and exercise trainer.		H&WB: Reduced risk of diabetes development; lifestyle changes. HE: Transparency of and involvement in Shared Decision making.
Kimi Ora ³⁵	Community support to share concerns and successes.	Screening and evaluation in groups.		H&WB: Improve HbA1c levels; well-being HE: Being in control of their health.
Mana Tu “to stand with authority” ³⁶	Self-directed goal setting (based on initial assessment). Regular feedback on goals.	Visits from case worker (Kai Manaaki) to discuss clinical, social and psychological issues. Network Hub provides access to and connects quality clinical care, population health activity and services.	Information platform (Mohio) to monitor progress.	H&WB: Improved clinical outcomes; HE: improved social determinants of health.
Shared Decision-Making in Rheumatoid Arthritis “Not deciding alone” ³⁷	Patient decision aid helped patients focus on knowing what matters most and choose the best option.	Patients are encouraged to talk to an Elder or healer to engage in traditional ceremonies.	Patient decision aid to provide transparency of information flow and communication between participant and doctor.	H&WB: increased effectiveness of rheumatoid arthritis management HE: Transparency of and involvement in Shared Decision making.
Integrated knowledge translation approach ³⁸	Sharing with support worker/HCP/family.	Community support workers paired with participant: “Not Deciding Alone.”		H&WB: Wellness in cancer care HE: Transparency of Shared Decision making.

Notes: H&WB =Health & Well-being, HE=Health Equity.

Opportunities: Digital Technologies

Opportunity refers to the extent to which external circumstances facilitate or inhibit engaging in a particular behavior.⁵³ We discuss the notion of opportunity as the last component of the MOA framework, since people's motivation and abilities are shaped by the environment they are in, which can either enhance or diminish their motivations and abilities.⁵⁴ This paper focuses on the role of digital technologies in healthcare, as these technologies play an important role in our everyday lives, creating great opportunities as well as significant challenges, especially for Indigenous communities. For instance, Indigenous communities are likely to show higher resistance towards these technologies, which could explain the low level of technology use in these six studies reviewed. In New Zealand, the Digital Council of Aotearoa New Zealand (digitalcouncil.govt.nz) provides advice to the government on utilizing digital and data-driven technologies in an inclusive and representative way and aims to further reduce the gap between Māori and non-Māori. Interest in new technologies such as the internet of things (IoT), virtual reality (VR), digital assistants (e.g. Chatbots, Avatars), blockchain, and the like has grown in recent years as part of the Fourth Industrial

Revolution (FIR).⁵⁵ FIR has the potential to bring both opportunities and risks to businesses, customers, governments, and society. Digital technologies are also transforming healthcare to address the complexity of healthcare operations and meet the changing needs of patients and HCPs.⁵⁶ In Table 3, we present a classification of FIR technologies with an overview of their capabilities, purpose and use, key challenges and potential biases in Indigenous populations, and potential solutions.

First, Big Data technologies, such as sensors and Internet of Things (IoT) devices, can help HCPs collect and process large volume of diverse (text, speech, image, and video) information in digital formats at speed. Through these technologies, HCPs can detect patients' needs and communicate more effectively with them. Three of the six studies reviewed (OL@-OR@, Mana Tu, Decision Needs and Strategies for SDM) used some form of technology (mobile, digital platform) to collect and record data, monitor and track health progress, share information with stakeholders and facilitate communication with them.

Second, machine learning (ML) applications refer to algorithmic interpretation and learning from data by identifying patterns in the data without the need

Table 3

Digital Technologies, their Purpose, Challenges and Potential Solutions

Digital Technologies	"Big Data" Applications (e.g. Sensors and wearables).	Machine Learning Applications.	AI-based Applications.
Use and Purpose	Collecting and processing patient information through wearable technologies.	Identifying patterns in data and predicting outcomes.	Sensing and responding to individual patient needs and circumstances.
Capability	Information Collection & Processing at Speed.	Analysis and Learning.	Adaptation and Intelligence.
Challenges & Potential Biases in General/Indigenous Communities	Willingness to share information. Consenting to data collection for a particular purpose. Bias in data (measurement error, missing data, under-represented communities).	Transparency of and trust towards algorithms and algorithmic decision-making. Biased datasets will likely lead to underdiagnosis in under-served populations (e.g. diet and exercise in prediction depression, Adair and Lopez 2020).	Developing culturally appropriate, personalized strategies. AI poses risk when ranking treatment options when transferring knowledge from one ethnic group to another (Broome et al., 2020).
Potential Solution	Artificial Intelligence (AI) teams to be inclusive .	Assessment and auditing of algorithms for greater transparency and trust .	Infusing knowledge and values of Indigenous communities for equity .

to define these relationships *a priori*.⁵⁷ Third, artificial intelligence (AI)-based applications go beyond ML-based ones by the algorithm's ability to customize information and knowledge from one patient to the next and from one context or condition to another. For example, AI algorithms can assist clinicians and patients in creating customized diets and exercise plans based on an individual's cardiovascular risk by recognizing and adapting to their goals and preferences.⁵⁸ Although there was limited use of technologies in our reviewed studies, this could be due to

proper oversight or understanding of how they work, leading to biased and unfair treatment. To avoid this, the data used for AI applications should be inclusive and representative of minority or Indigenous populations so that the proposed health interventions can be tailored to, and matched with, the populations of interest.⁶² Algorithm audits assess the impact of algorithms on stakeholders' rights and interests, and can reveal biases, effectiveness, and transparency, among others.⁶³ It is important to regularly assess and monitor algorithms used in healthcare to promote fair and

Indigenous health equity aims to achieve equal opportunities for all social groups, with selective focus on improving conditions for marginalized communities. This study found six studies (four from New Zealand and two from Canada) that focused on Indigenous interventions for managing diabetes, cancer, and rheumatoid arthritis. We reviewed their design principles and key success factors, including the role of digital technologies, that contributed to the effective implementation of these programs, and developed a framework of all previously unearthed components

growing concerns around healthcare privacy and sovereignty (i.e. collection, ownership and application of data) in both the general population and Indigenous communities.⁵⁹

Whilst each of these three technologies has its own challenges, we attempt to provide some solutions on how to overcome them. For instance, big data applications require people to be willing to share their information for a particular purpose. Lack of data about particular communities can inherently create biased datasets, which will make it difficult to create useful (unbiased) ML or AI-based applications. To offset the biases resulting from non-inclusive, non-representative data, a culturally diverse AI development team should be established. Culturally-diverse team members are likely to better anticipate the needs, requirements and choices of different communities and can offer appropriate solutions to represent their needs. Inclusivity of AI teams will likely help eliminate or mitigate the extent of bias inherent in the data.⁶⁰ The challenge in ML applications lies in building transparency into the algorithm and analyzing the potential biases. When this level of transparency is lacking, it can lead to institutionalized discrimination and inequitable outcomes for diverse social or cultural groups in medical decisions.⁶¹ This can occur when the algorithms are used to make decisions without

equitable outcomes for all patients. We propose that by conducting audits, the inner workings of algorithms can become more transparent, leading to increased trust in their use. Finally, the challenge in AI applications lies in employing technology that can respond to individual patient needs in a culturally-appropriate manner. For example, AI-powered chatbots or virtual assistants can be used to provide information about treatments, risks and benefits in a way that is easily understood and accessible for Indigenous people in remote areas. We propose that for AI tools to provide personalized and culturally-appropriate and -relevant responses, it is crucial to integrate Indigenous knowledge, language and terminology into AI technologies, which, in turn will help reduce inequity across communities. In conclusion, we propose that incorporating diversity within AI teams (Big Data technologies), conducting algorithm audits (ML technologies), and Indigenous knowledge integration (AI technologies) can lead to beneficial outcomes. This includes reducing bias in data, increasing algorithm transparency and trust, and promoting enhancing health equity.

Conclusion

Indigenous health equity aims to achieve equal opportunities for all social groups, with selective focus on improving conditions for marginalized communi-

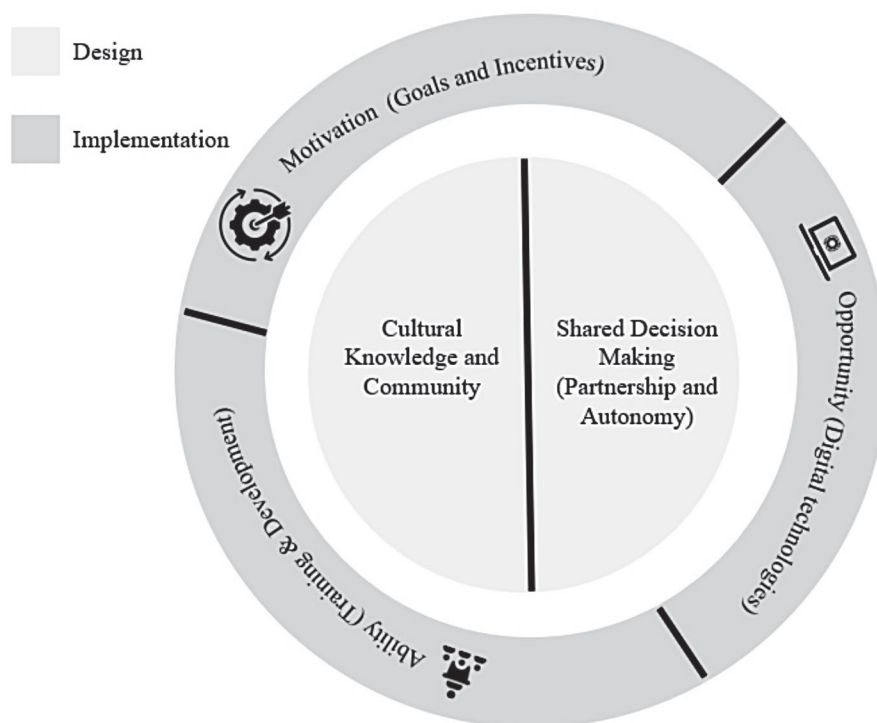
ties.⁶⁴ This study found six studies (four from New Zealand and two from Canada) that focused on Indigenous interventions for managing diabetes, cancer, and rheumatoid arthritis. We reviewed their design principles and key success factors, including the role of digital technologies, that contributed to the effective implementation of these programs, and developed a framework of all previously unearthed components (see Figure 1). Figure 1 highlights the relevance of two particular components (cultural knowledge and community and shared decision-making) in the design phase, and underlines the role of motivation, ability and opportunity in the implementation phase. This paper assessed efforts to create culturally-appropriate health interventions for Indigenous communities, and offers two contributions to researchers. *First*, our research has developed a new conceptual framework (see Figure 1) by unearthing key components in the design and implementation of Indigenous Health Interventions. In particular, our review unearthed that research teams in different countries employed different focal concepts to approach health interventions in Indigenous communities, namely integrating and reinforcing Indigenous knowledge and strengthening community belonging, and encouraging shared

decision-making and better partnerships between patients and HCPs. Furthermore, this study used the Motivation-Opportunity-Ability framework to explore the success factors of the reviewed studies. It was found that motivational techniques such as personalized goal setting, motivational messages, personalized feedback and social pressure were employed, alongside initiatives to educate and train participants through information and skill development. We believe our proposed framework can provide guidance to international research teams in developing and implementing culturally-appropriate, technology-enabled healthcare interventions in Indigenous communities, reducing health disparities globally.

Second, by examining the role of digital technologies on motivation and ability to improve Indigenous health, this study found that only half of the studies utilized these tools, with very limited functionality. In particular, this study highlighted that different technologies can address different aspects of Indigenous health equity by providing solutions for lack of accuracy in data, lack of trust towards algorithms and lack of equity between communities. Thus this study suggests that addressing individual aspects of Indigenous health equity through inclusivity of AI teams, algo-

Figure 1

Framework for Designing and Implementing Indigenous Health Interventions



rhythm audits and Indigenous knowledge integration is likely to result in equitable Indigenous health and healthcare.

Positionality

Some of the authors of this paper (Potaua Biasiny-Tule, Hemi Edwards and Hiria Te Rangi) have a Māori ancestry, who share a commitment to achieve health equity with Indigenous Māori peoples.

Note

The authors have no conflicts to disclose.

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