Exploring the Challenges and Opportunities of Implementing artificial intelligence in healthcare settings in Nepal: A literature review

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ABSTRACT

Artificial intelligence (AI) has shown effectiveness in various industries, particularly within healthcare sectors. In Nepal, there are limited insights on existing studies regarding technical, financial, human resources, ethical and privacy related challenges of AI in the health sector, and this is the gap our study aims to fulfill. Our study aimed to synthesize empirical studies on the challenges and opportunities of using AI by conducting a systematic literature review. We retained 33 articles published between 2010 and 2023 in the PubMed, Google Scholar, Science Direct and CIHANIL databases. Most of the articles reviewed indicated that there are several challenges related to AI administration into healthcare in Nepal, however there are also an opportunity associated with this relating to cost-effectiveness of the services, increased access to specialized health services, teamwork and decision makings, diagnosis and patient monitoring, and telemedicine. However, findings show that use of AI in healthcare additionally faces several challenges including technical, geographical, economic, ethical and privacy, and human resource related challenges. Our findings recommend that AI has the potential to transform healthcare and while addressing these challenges is important to fully utilize its services especially in rural Nepal.

KEY WORDS

Artificial intelligence, Challenges and opportunities, Healthcare, Rural Nepal

INTRODUCTION

Healthcare including primary care is where the power, opportunity, and future of artificial intelligence (AI) are most likely to be realized in the broadest and most ambitious scale.[1] The rapid increase in clinical data increases an occupational stress of healthcare professionals, affecting their ability to provide quality and effective services.[2] Currently, healthcare professionals are facing variety of occupational pressures from different angle including heavy workloads, administrative tasks, uncertainty about patient care, inadequate social support from co-workers, and a tendency towards emotional reaction, making it severely challenging to adapt to technological changes.[3] Hence, health systems have to radically rethink strategies to ensure that staff are satisfied and actively supported in their healthcare work and provide potential to augment to enhance provider performance, quality and safety.[2]

The modern technologies such as AI and digital health for data analysis are needed to address the challenges relating to the generation of vast amounts of data in healthcare industries. AI has proven a powerful method for the classification of patients and even for predicting disease progression.[4] AI, particularly machine learning and its applications in healthcare have garnered significant attentions especially in developed countries, identifying and forecasting high-risk populations for adverse health outcomes and creating public health interventions for improving patients experience and results, providing value, improving quality, safety, supporting evidence-based decision making and optimizing health system performance.[5,6]

Various research has explored the principles, difficulties, and practical applications of AI-powered machine learning in long-term clinical care, highlighting the challenges and acceptance of AI in digital technology focused in developed countries, however lacking in the low- and middle- income countries (LMICs) such as Nepal.[2,4,5,7-10] The

in-depth analysis of the possibility of application of AI for implementation of digital notifications at point of care, case-based surveillance, interoperability with common systems, bidirectional information flow, open source, contact follow-up management, digital medical record, inclusion of all relevant actors, outcome monitoring, user centered design etc. especially focused on rural areas are lacking in the perspective of Nepal.[8,9,11] Meanwhile, some reports were generated that have analyzed the use of telemedicine and AI focusing on remote regions of Nepal. It is shared that through AI-powered telemedicine platforms, people from distant areas could now receive diagnostic evaluation and consultations, predicating diseases and shaping personalized treatment plans for patients in rural Nepal.[9,11-14] These applications of AI technologies have reported of sparking a revolution in Nepal's healthcare sector, enabling earlier detection of illnesses, and customizing treatment approaches based on individual patient needs, especially in rural areas. These transformative impact has gradually improved healthcare outcomes and narrowed the gap in medical services between remote regions and urban centers in Nepal.[15] However, there is dearth of scientific information relating to comprehensive study on challenges and opportunities related to AI in healthcare especially targeting ethical, human resource acceptability, technological advancement of implementing AI focusing on patients monitoring, requirement of technological advancements in healthcare, medical imaging, diagnosis, treatment in Nepal.

To address this gap, this study answers the following research questions:
RQ1: What are the perceived challenges of implementing AI technology in the healthcare sectors of Nepal especially in rural settings?
RQ2: What opportunities does AI technologies have in the healthcare sectors of Nepal?

Hence, the purpose of this study is to explore the challenges and opportunities of AI in healthcare settings of Nepal by synthesizing empirical studies.

METHODS

We formulated the research question following the PIECOS (population, intervention/exposure, comparator, outcome and study design) and formulated the questions following PRISMA guidelines (preferred reporting items for systematic reviews and meta-analysis) and also the fundamental steps outlined by Wubineh and Gohen.[4,16,17] The authors adhered to the PRISMA guidelines to identify the purpose of review, draft the protocol, defined the inclusion and exclusion criteria, and perform search process in order to extract data and evaluate quality of the articles before synthesizing review.[16]

Defining search strategy

The search strategy and the search string were used to identify the sets of relevant studies and databases. The search considered both the publication year and location and restricted to studies published between 2010 to 2023. The targeted research publications were searched using the databases such as PubMed, ScienceDirect, Google Scholar, CIHANIL, Web of science and Google. We searched literature using both manual and automatic methods using key words sticking to the research questions.

The search sting follows: ("Artificial intelligence" OR "machine learning" OR "digital health") AND ("challenge" OR "opportunity") AND ("healthcare") AND ("telemedicine") and ("digital health"). Additional search items used for challenges are "challenges" OR "problems" OR "difficulties" OR "issue" OR "issues" OR "obstacles" OR "barriers", for AI more terminologies used are "digital health" OR "telehealth" OR "mobile health" OR "remote medicine" OR "telemedicine" OR "distance medicine" OR "eHealth" and for Nepal we used the terminologies "Nepal" OR "rural Nepal" OR "urban Nepal" OR "low-and middle-income country" OR "developing country" OR "South Asia" OR "South East Asia" were used. Snowball method was used to track studies that are overlooked. The details of articles used per year are shown in figure 1.

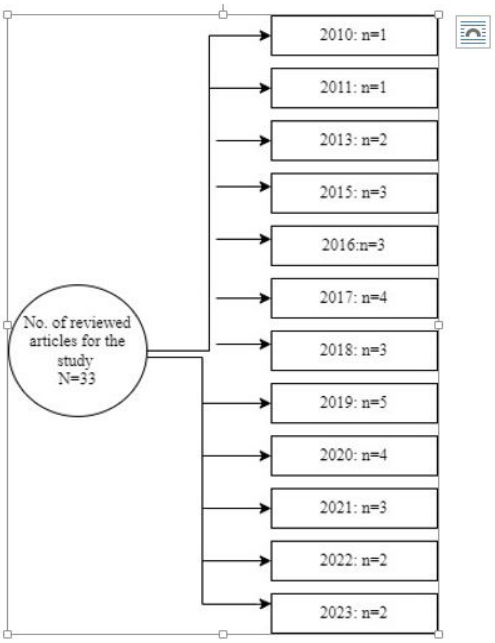

Figure 1. Details of yearly distributions of reviewed articles included in the study

Study selection criteria

We finalized an objective and then discussed the criteria for selecting studies in detail as an approach to extract. Inclusion and exclusion criteria were defined and were filtered to obtain the scientific documents that were not pertinent to the study. The major exclusion criteria followed were: duplicate articles from the multiple sources; articles

without text available; articles not written in English; case studies; articles published before 2010 and the articles that does not describe artificial intelligence/machine learning/ digital health and its challenges or opportunity for health care focused on LMICs. Automatic and manual searches yielded a total of 1467 articles, and 20 of which were duplicates that were resolved before the exclusion criteria were applied for 2272 articles. Then, 50 papers were found after applying the criterion, which was done by reading the papers' title and abstract.[17] Papers are not full length and 33 have been retained for further review.

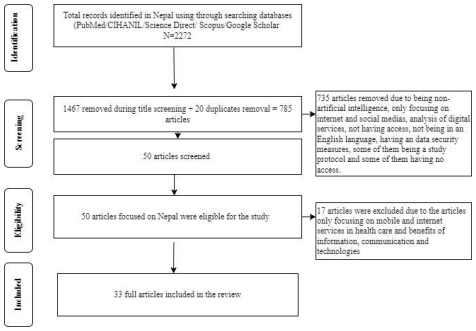

Figure 2. **PRISMA flow diagram**

Quality assessment criteria

An application of the exclusion criteria was followed on the 33 retained articles and were further evaluated using a clear quality checklist that consisted following questions:

a. Are the aims of objectives of the study clearly stated?
b. Are the scope and contents clearly defined?
c. Are the research methods and design well presented?
d. Are the study variables likely to be valid and reliable?
e. Are all the study questions answered?
f. Are the primary studies discussing and stating the finding sclearly?
g. Is the research methodology adequately elaborated?
h. Are the conclusions related to the purpose of the study?
i. Are the limitations of the research clearly stated?

After screening and in-depth analysis, the factors that affected the findings were further divided into the categories relating to reporting, rigor and creditability. Purpose, clarity and coherence of the studies were accessed based on reporting. The relevance of the studies was also evaluated based on research questions being addressed. The final factor for determining creditability was assessed from the significance and logic of the results and conclusions of the studies. The quality checklist form was developed and given on a numerical scaled numbered 0 for "no" and 0.5 for "somewhat" and 1 for "yes".

Data extraction

We carefully reviewed 33 selected studies to gather vital information based on the objectives. In order to accurately extract information and data from each study, we created a data matrix that included essential information such as the study authors and years of publication, reference, aim of the study, geographic site, research methods, design, population, outcome measure, exposure measure analysis, major findings, strength and limitations that are required to answer the research questions. The broad range of topics relating to AI/machine learning/digital health techniques, challenges encountered with using AI/machine learning/ digital health in Nepal and its challenge and opportunities.

Data synthesis

In order to effectively organize and present the results of the primary studies to address the research questions, data synthesis was performed. Since this study is qualitative, desk review analysis in nature, we performed a synthesis of the data collected based on the purpose of the research and the results of the selected primary studies. We analyzed both individual studies and the collection of studies to identify patterns or similarities, by classifying the studies with similar meanings under a single concept.

RESULTS

Challenges of AI in health care in Nepal

The AI adoption is still in its developing stages in Nepal compared to global landscapes, however is swiftly spreading in healthcare.[9,18] AI is playing a significant role beyond immediate consultations contributing to extensively predicting diseases and sharing personalized treatment plans for patients. In some of the remote regions of Nepal, AI has become a pivotal tool in transforming healthcare accessibility.[7] Through AI-powered telemedicine platforms, patients in distance are now receiving diagnostic evaluations and consultations without the need to travel long distances.[11] This advancement had ensured the medical expertise being readily available and accessible to those who might otherwise struggle due to geographical constraints. The transformative impact is gradually improving healthcare outcomes and narrowing the gap in medical services between remote regions and urban centers in Nepal. Beside these facilities, there are several challenges of AI in healthcare in Nepal which are elaborated below:

Geographical constraints and adaptation challenges

The difficult geography, mountainous, isolated, inaccessible sparsely populated regions is reported as one of the challenges faced in implementing AI in healthcare services in Nepal.[11,19] The mountainous regions is resulting difficult transportation resulting hindrance in AI in healthcare system such as installation of mobile towers, computer devices and also resulting maintenance difficulties.[11] Additionally, adaptation of new technology by the human resources makes it difficult to train the senior health workers who believes on traditional medicine and face-to-face consultation with patients rather than on technological video consultation.[20] It is also challenging from patient side

to convince the human resources about the benefit of AI system in healthcare.[21]

Economic challenges

The second major challenges for introducing AI in healthcare in Nepal is economic support especially for buying expensive equipment, high charges for the installation of equipment's, training staff and health workers of different levels.[8,22-25] The AI in healthcare in Nepal is heavily dependent on funding, donation and volunteers and if funding stops, the whole project gets stopped and terminated.[20] While installing new and advanced technologies are extremely expensive for Nepal.[14,25,26] Additionally, recruitment of human resources and retention of the experts is financially challenging in Nepal.[11]

Lack of supportive policies and accountability of data

The other challenge of AI in Nepal is lack of supportive policies and accountability.[9,12,20,27] The political instability, rapid transfer of skilled healthcare workers, and lack of government support in terms of promotion, compensations and bonus salaries to the healthcare workers are the major issues for sustainability of telemedicine services.[11,12,27,28] There is not clear division of roles relating to who should be held responsible if an AI system makes an error or any technological issues appears.[18] There is need for laws and regulatory mechanism in Nepal to regulate AI in order to reduce its malicious use and address infringement of intellectual property rights. The AI in Nepal will also need human oversight limiting security risks and inaccuracies as possible.[8]

Technological advancement challenges

Lack of basic internet and telephone service in healthcare organizations is hindering video consultations among health professionals.[29] Furthermore, there was insufficiently trained staff at the local health centers who could encourage the services towards AI and digital health.[30] There is also lack of specialists for teleconsultation that has discouraged the AI in healthcare and interrupted the whole AI system.[11] Sometimes, the misdiagnosis due to interrupted phone and internet connections are also reported to be major challenge.[31-34]

Lack of awareness and expertise in AI technologies

The accessibility of enormous measures of information and technologies relating to AI passing on totally different kinds of data of every individual patient requires a new expert profiled human resources and clinical information researcher for particular guidance for doctors and patients. This is currently lacking in the setting of Nepal.[25,26] The accuracy of an algorithm in performing a task or reaching a diagnosis is of paramount importance and the process algorithm follows to reach a diagnosis should be transparent and humans should be able to understand and interpret how the technology arrived at the decision. Yet, this skill is somewhat missing in the health professionals of Nepal.[30] There is often a lack of understanding among the general population and also some of the health professionals about the potential benefits and limitations of AI technologies in healthcare, leading to unrealistic expectations that can make issues among health care professionals to adopt the AI technologies.[8]

Perception on unreliability and trustworthiness of AI technologies

Technological challenges possess an obstacle in the transition from conventional computer architectures to AI architectures in Nepal.[8,11] Deploying AI infrastructures such as graphic processors, special-purpose AI chips, field-programmable gate arrays etc. requires advanced computing and storage devices to offer AI applications which are appearing very complex and expensive in the low resource healthcare settings of Nepal.[13,24,35] The opaqueness and complexity of AI algorithms pose significant challenge to run AI in healthcare system in Nepal leading to mistrust in technologies. Additionally, some healthcare professionals including paramedics lacks adequate knowledge and focus on digital technology, that limits the adoption of AI in healthcare in Nepal.[12,14,27] The technology-related concerns are prevalent among the administration units of hospitals and pose a challenge to AI systems.[9]

Ethical challenges and privacy

Electronic health record (EHR) is vital for using AI in healthcare and data has become an important resource in the 21st century where patients should have confidence that both the government and the commercial sector will treat their data with due care and attention.[18] Receiving informed consent from patients and possibly, sharing the gains from monetizing healthcare data is crucial, however Nepal lacks an infrastructures to collect high quality data. In Nepal, EHR is still uncommon though certain organization have begun using it and Nepal is encountering several difficulties in effectively overseeing the use of AI technology particularly through the absence of rules and regulations raising ethical issues, particularly regarding the protection of data, biases, within algorithms, and unequal access to digital resources.[8,11,14,20] Integration of AI in medicine presents a wide range of challenges in terms of privacy and ethics, including issues with patient data protection, ethical boundaries of innovations, and an actual impact of technology on healthcare workers. Despite the promising vision outlined in Digital Nepal Framework, Nepal lacks in-depth consideration regarding ethical aspects of AI. This deficiency also highlights the urgent need for legislative reforms that could govern the deployment of AI more efficiently and ethically.[9,19,35-37]

Healthcare providers and professionals' liability

While AI systems are crucial to be user-friendly, their integration into routine clinical practice could lead to health care professional becoming too dependent on the AI technology and be less willing to double-check results

and question errors.[4,18] The healthcare workers could face challenges when learning to use technologies, as everyone have different level of interest and literacy related to technologies and limited hands-on experience using AI application in practice. Although the vision of personalized medicine will be effective, the health care professionals may face heavy algorithmic ambiguity.[9] Additionally, the lack of skilled workforces such as IT specialists for providing technical training to health workers about video consultations is a major challenge in Nepal.[28] Additionally, patients sometimes do not feel comfortable for making video consultation.

Opportunities to use AI in healthcare in Nepal

The technological revolution through AI could have a great impact in Nepal. The opportunities in this study are based on the concept that the services delivered by AI to deliver quality health services regardless of distance and time using technologies. The major opportunities of using AI in healthcare depicted in Nepal are:

Diagnosis and patient monitoring providing cost-effective treatment

If AI produces low-cost solutions that are otherwise too expensive for most people in Nepal, it will be very effective. In Nepal, AI algorithms have been successfully applied in some of health care and medical domains, as decision support tools for diagnosis to prognosis using predictive analysis applications.[9] Application of deep learning is being investigated in a range of health fields and diseases, such as radiomics, neurosurgical imaging, skin lesions, tumors, chest pain, and so on.[38] The diagnosis of various diseases such as breast cancer, drug discovery, therapy selection, and stratified care delivery could be also used in Nepal. The data from different sources in various formats (text, image, and numerical video) can be combined to make well-informed diagnosis or prognosis decisions.[9] AI could be used in many ways in Nepal from diagnosis, triage, to treatment and care planning. For instance, the ability to predict a risk in a patient of having to undergo prolonged mechanical ventilation can improve patient outcomes and reduce intensive care unit cost and could be replicated in Nepal. AI can aid in the development of new treatments, advancing healthcare research and innovations.

Cost-effective treatment in terms of reduced travelling costs with no excess consultation fee was reported.[13,39] The rural areas patients require to visit specialist consultations, which was reported to be reduced when AI in healthcare is introduced reducing high cost out-of-pocket payment. With face-to-face consultation, the patient were reported to be adequately treated through mobile tele dermatology and neonatal birth asphyxia.[9,10]

Epidemiology and clinical trials

AI could add other dimensions to the discipline of Epidemiology and clinical trials in Nepal.[9] The use of large data sets to seek out the relative influence of a range of determinants on a patient group to access the prevalence and incidence of rare disease could be done by using AI. The epidemiology and clinical trials aim to offer evidence-based guidance to promote a transparent appraisal of new therapies. AI based health interventions could be used to systematically assess to demonstrate their effectiveness. The AI could help journal editors, peer reviewers and readers to understand, evaluate and critically assess the design and risk of bias in a clinical trial.[8,31,32]

Increased health seeking behavior and access to the service

Several studies conducted in rural Nepal reported of increasing health seeking behaviors of rural health patients and found to be more focused on their health issues.[10,11,19,39-43] From the AI powered digital counselling, the mental health status of patient improvement is reported in the far western region of Nepal.[11,37] Improvements of health outcomes were also reported in the diseases such as diabetes, maternal health, childcare in rural areas of Nepal because of the affordable and accessible services, that encouraged patients to use the service.[44]

Drug development

One specific opportunity of AI in Nepal could be for the drug development process. AI could be used for the analysis of the large amounts of data on drug interactions and identification of new drug targets accelerating drug discovery, allowing researchers to identify potential drug candidates more quickly and at a lower cost and can be replicated in Nepal.[45] AI will also analyze data on drug candidates to identify the most promising compounds for further development.[46]

Teamwork, decision-making and virtual health assistance

The AI will generate healthcare providers with strong communications, shared decisions-making, progress evaluation and coordinated actions.[41] AI chatbots can be used in Nepal in order to handle problems related to coordinating and scheduling medical appointments, sending reminders, and notifying providers of a patient's condition based on symptoms.[47] AI can also help identify patient symptoms, and provide them with appropriate care recommendations including self-care advice or a referral to health care facilities.[48] Additionally, AI can help patients to manage their medications by providing reminders and alerts for medications and follow-ups.[49]

DISCUSSION

This review article explores the major challenges and opportunities for implementing AI in the health care program in Nepal and way forward. The most recognized barriers for implementing AI in healthcare are related to financial, geographical, technical human resources, ethical and privacy related challenges including the technological

barriers related to internet problem, lack of electricity, power cuts and network crisis.[20] Furthermore, lack of competent human resource and sufficient technology and infrastructure crisis were major challenge especially in the mountain regions of Nepal. The problem in Wi-Fi connectivity, inadequate telephone network and mobile phone penetration for running AI in healthcare has also become a huge challenge for implementation of smooth AI services in Nepal.[50] The expensive expertise of IT professionals is another part to be focused and overcome by the Government of Nepal. The study conducted in other Asian countries Bangladesh and India reported about similar issues for broad bank for quality of video consultation.[51-55]

Furthermore, in Nepal, less than 85% of the household have electricity access and are facing challenges of load shedding for several hours, multiple times a day especially during the winter season. The rural Nepal is also not away from this load-shedding and are mostly dependent upon small solar power systems for power supply. This hampered the services.

Some articles also reported about the lack of technological skills among the healthcare workers additionally, also lacked the willingness to learn, and almost impossible for convincing to learn about new technologies. Similar, results of staffs being resistant to adapt new technologies were reported by the studies conducted elsewhere.[51]

Apart from technological issues, Nepal is a country with tremendous ethnic, linguistic and genetic diversity within a small area, highlighting the importance of EHR and AI. However, the algorithms and processes behind AI are not localized to fit local populations and practices patterns in Nepal and require rigorous tests for bias according to different patient cohorts. The process should continue even after the applications are introduced into practice. Nepal should also make a strategic decision and balance competing interests and values, that will include information relating to how to overcome an issue of privacy, accountability, intellectual property rights, and transparency. Understanding the broader perspective and changes regarding privacy concerns in healthcare is crucial in the perspective of Nepal. Hence, the EHR database could be used extensively in rural healthcare settings in Nepal that will allow personalized approach to medicine by improving diagnosis and predicting individual therapy responses, within clinical research and practice and would be revolutionary if successful utilizing the local technological resources.

The healthcare workforce plays an important role in "educating" the new AI technologies and in their proper use. Hence, the health workforce of Nepal should be fully aware of the strength and limitations of AI in Nepal. The educational curricula at the undergraduate and postgraduate level should include health informatics and statistics. Nepal should develop mechanisms to keep track of and utilize global developments in AI. A major task would be to digitalize health records and access high quality, anonymized and de-identified data. The country should also start utilizing the IT sector to develop local solutions. The healthcare education system in Nepal must take up the challenge in creating healthcare professionals who can help in the development and can work together with AI to optimize the quality of provided healthcare. Thus, training should be provided to the healthcare workers and start awareness raising initiatives among the patients. The study conducted in India and Pakistan also emphasized about the paramedics lacking technical trainings which hinders the services.[56,57]

Funding plays a major role in supporting AI in healthcare and, in the context of Nepal, is a major factor of sustainability and motivation among healthcare workers. Though the Government of Nepal has planned to expand the AI facilities, a separate budget is not allocated and also never falls into the priority list. Studies from Bangladesh and other parts of Nepal found the similar findings relating to funding challenges.[11,51,58]

The Government of Nepal should also take a step to develop a National AI strategy that may guide the effective implementation of health interventions in Nepal.[35] Nepal's Interim Constitution of 2007 addresses health as a fundamental right, stating every citizen having the right to basic health services free of cost however, the reality is far cry.[59] Unfortunately, only 61.8% of the Nepalese households have access to health facilities within 30 min with significant rural (59.0%) and urban (85.9%) discrepancy.[59] Hence, evidences have highlighted the importance of AI in healthcare and education systems among health care workers and medical related professionals. Moreover, knowledge should be established to coach, train and facilitate the human resource to make the health system technological friendly, and motivate health workers to uptake new technology. People centered approach should be focused by the Government in order to improve the health, quality and safety of health services, thereby helping the country to achieve universal health coverage within the country.[60]

The major strength of the study are the findings based on peer-reviewed journal articles. Our findings may guide the top-level policy makers and health planners including the Ministry of Health in Nepal. There are also several limitations in this study. First, the literature search was done in selected databases using key search teams which might not have captured all the published articles and relevant studies. Further exploration of additional databases is required incorporating more keywords. Second, the findings were limited to English, and did not consider articles published in Nepali.

CONCLUSION

This study highlighted several challenges and opportunities in the use of AI in the healthcare industry. We found many AI solutions in healthcare are currently under development or already in use elsewhere and can be applied to Nepal. The country could explore such developments and apply them locally in more extensive ways. The policymakers, healthcare providers including both public and private organizations, universities to put an effort into staying up-to-date and tracking global development in the AI field. The Nepal should also start growing its own AI expertise to develop national solutions relating to healthcare solutions. The local resources such as training human resources to work in AI, providing access to computer power and technological advancement is required to be emphasized. The data protection should be ensured avoiding the perpetuation of social biases is crucial for the responsible and equitable implementation of AI in healthcare.

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