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A SWOT analysis of artificial intelligence in diagnostic imaging in the developing world: making a case for a paradigm shift

Abstract: Diagnostic imaging (DI) refers to techniques and methods of creating images of the body's internal parts and organs with or without the use of ionizing radiation, for purposes of diagnosing, monitoring and characterizing diseases. By default, DI equipment are technology based and in recent times, there has been widespread automation of DI operations in high-income countries while low and middle-income countries (LMICs) are yet to gain traction in automated DI. Advanced DI techniques employ artificial intelligence (AI) protocols to enable imaging equipment perceive data more accurately than humans do, and yet automatically or under expert evaluation, make clinical decisions such as diagnosis and characterization of diseases. In this narrative review, SWOT analysis is used to examine the strengths, weaknesses, opportunities and threats associated with the deployment of AI-based DI protocols in LMICs. Drawing from this analysis, a case is then made to justify the need for widespread AI applications in DI in resource-poor settings. Among other strengths discussed, AI-based DI systems could enhance accuracies in diagnosis, monitoring, characterization of diseases and offer efficient image acquisition, processing, segmentation and analysis procedures, but may have weaknesses regarding the need for big data, huge initial and maintenance costs, and inadequate technical expertise of professionals. They present opportunities for synthetic modality transfer, increased access to imaging services, and protocol optimization; and threats of input training data biases, lack of regulatory frameworks and perceived fear of job losses among DI professionals. The analysis showed that successful integration of AI in DI procedures could position LMICs towards achievement of universal health coverage by 2030/2035. LMICs will however have to learn from the experiences of advanced settings, train critical staff in relevant areas of AI and proceed to develop in-house AI systems with all relevant stakeholders onboard.

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1 Introduction

1.1 Diagnostic Imaging

Traditional diagnostic approaches rely on a patient's symptoms and associate them with clinical conditions that may have symptoms similar to those observed [1]. In contrast to clinical pathology which involves diagnosis using biopsy samples from patients, diagnostic imaging techniques provide images of patients that can be reviewed to make a clinical diagnosis. Diagnostic imaging is therefore largely non-invasive while clinical pathology is invasive.

Diagnostic imaging utilizes ionizing (plain X-rays, computed tomography (CT), and nuclear medicine) and non-ionizing (magnetic resonance imaging (MRI) and ultrasound) radiation-based technologies [2] to generate images of the internal parts of the human body and organs for purposes of evaluation to diagnose, monitor, or treat medical conditions. Diagnostic imaging plays a central role in disease management and helps to ensure that countries achieve the objectives of sustainable development goal 3 (SDG 3). However, there is an acute shortage of diagnostic imaging equipment in low and middle-income countries (LMICs). Current estimates hold that only 1 CT scanner serves about 1 million patients in LMICs compared to about 40 scanners serving about 1 million patients in high-income countries. The disparity is even greater for MRI and nuclear medicine equipment, in addition to a huge shortage of personnel in these specialties [3].

In the face of these shortages, the demand for imaging services is on the increase in the developing world in areas such as radiotherapy planning, image-guided interventions, and tumor sampling for pathology work-up [2], in addition to the core roles of accurate and timely diagnosis and disease monitoring. Advances in imaging technologies that meet the healthcare demands of developing countries are therefore urgently needed.

1.2 Artificial Intelligence

Artificial intelligence (AI) was first conceptualized by Alan Turing in 1950 when he developed the concepts of machine learning, genetic algorithms, reinforcement learning, and the Turing test [4]. The term "artificial intelligence" was subsequently created by a team of scholars in 1956 at a Dartmouth College conference [5].