

Working at the Intersection of Radiology and Global Health Equity

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Equitable access to medical imaging is an essential component of health care. The World Health Organization and United Nations prioritize health and well-being as one of their Sustainable Development Goals, with medical imaging occupying a universally important role in the provision of medical care.^{1,2} For example, healthcare workers in high-income countries (HICs) are increasingly relying on medical imaging, whether in triaging trauma patients, evaluating for infection, managing oncologic treatment, or performing image-guided interventions.^{3,4} However, enormous disparities exist in access to medical imaging in low- and middle-income countries (LMICs).⁵ Broadly, “global health” refers to fields that aim to address health problems across the world, traditionally relying on partnerships between high- and low-resource settings.⁴ Radiology, as a central component in managing care, is not only well positioned but also obligated to participate in global health outreach. This review discusses opportunities for radiology to reduce care disparities across the world, specifically in expanding

access to basic and advanced medical imaging, contributing to human capacity building and mitigation of brain drain, and incorporating principles of medical ethics and research into collaborations.

Access to Medical Imaging

A huge proportion of the global population continues to lack access to radiology services.⁴ For example, computed tomography (CT) scanners are ubiquitous in U.S. healthcare facilities, with 43 scanners per million inhabitants, compared to less than one scanner per million in LMICs.^{3,6} An additional 11.4 CT scanners per million and 5.2 magnetic resonance imaging (MRI) scanners per million of population in LMICs are needed to reach similar levels of access as in HICs.⁵ While many studies promote the use of radiography and ultrasound in LMICs, focusing exclusively on basic imaging modalities will perpetuate disparities between LMICs and HICs. While the utility of radiography and ultrasound is incontrovertible, advanced modalities such as CT, mammography, and MRI are critical to high-quality patient care

and improved population health.⁵ For example, Hricak, et al, used a microsimulation model to estimate that scaling up five diagnostic imaging modalities (ultrasound, X-ray, CT, MRI, and nuclear imaging) for cancer care would avert over 2.4 million deaths and save 33 million life years worldwide between 2020-2030 across all resource settings.³ Scaling up imaging is necessary to realize survival gains and would provide a return of \$179 per \$1 invested.^{3,7} Global health collaborations should plan for incremental incorporation of basic and advanced diagnostic modalities into patient care.

Changing demographics and epidemiology further underscore the need for imaging services. Premature death related to cancers is rising in LMICs, and this trend is expected to continue.⁸ For example, lung cancer had the highest cancer-related mortality in 2020, with an expected shift in incidence and mortality to LMICs, owing to higher prevalence of smoking.⁸ Low-dose chest CT for lung cancer screening in high-risk individuals has been shown to reduce lung cancer-related mortality.⁸ Similarly, Konert, et al, demonstrated a benefit in progression-free and overall survival when newly incorporating positron emission tomography/CT into

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management algorithms of stage III non-small cell lung cancer in their cohort of primarily middle-income countries.⁹ However, access to both CT and nuclear imaging remains limited, hampering population-wide benefits. Similarly, advanced imaging modalities are central to accessing minimally invasive interventions, including obtaining biopsies, managing postpartum hemorrhage, and treating postsurgical complications.¹⁰ Radiology must be prepared globally to meet these demographic and epidemiological shifts, so that inequities are not further perpetuated and widened.

Human Capacity Building and Mitigation of Brain Drain

Ultimately, successful incorporation of medical imaging in LMICs requires a trained workforce, including technologists, radiologists, and medical physicists. The need for these professionals in LMICs is well documented.⁵ For example, there are an estimated 25.9 medical doctors and 152.1 nursing/midwifery personnel per 10,000 people in North America compared to 2.3 and 12.6, respectively, in sub-Saharan Africa.¹ Furthermore, an additional 64.9 radiologists per million population must be trained in sub-Saharan LMICs to reach a level comparable to that of upper middle-income countries.⁵ Observerships, short-term training courses, and virtual platforms are all educational avenues that have been utilized.^{2,5} Training

and capacity building are central tenets of health equity and are acute areas of need for more collaboration between HICs and LMICs.

Disparities in medical imaging are perpetuated by a lack of local training programs and infrastructure, as well as the phenomenon known as “brain drain”. Brain drain is the migration of highly skilled and educated people from one country to another, especially from lower-resource to higher-resource environments.¹¹ Studies have shown increasing numbers of physician emigration from LMICs, and the US is one of the main beneficiaries of this trend, with a reported 60% of international medical graduates from LMICs.^{11,12} The reasons for this migration of medical professionals are multifaceted and may include better training opportunities, local conflict or political instability, higher financial remuneration, and desire to practice at the highest level of their degrees.^{11,12}

The result of emigration is persistent workforce shortage, resulting in persistent inequities that further incentivizes immigration. While brain drain can be partly attributed to local policies, resource allocation in LMICs, and merit-based immigration systems of HICs, it is also an ethical dilemma resulting from the inequitable transfer of human capital between regions. Global efforts are needed to build local capacity and promote business and industry partnerships for sustainable practices.^{4,12} Building capacity in LMICs is a multifaceted endeavor that requires better training programs,

improved infrastructure and working conditions, and advocacy to increase national health expenditure.

Global health initiatives should always seek to collaborate with a local champion, whether an individual or institution, in whom resources can be invested.^{5,13} A focus on developing strong local affiliations and training programs can also help avoid many of the ethical dilemmas that can arise from medical service work. One example is the successful creation of an interventional radiology training program in Tanzania, built upon a combination of a strong local partner, recurrent short-term exchanges of healthcare professionals from HICs, and virtual programming.¹⁴ Several other organizations and institutions support global health outreach and education, as well as the foundation of global health equity tracks in residency training programs, to address these disparities. These organizations include the Radiological Society of North America, American Society of Radiologic Technologists, and RAD-AID International. Furthermore, the rising interest in global health among radiology trainees is promising and should be supported as a component of training programs and job opportunities.¹⁵

Role of Ethics and Research in Health Equity

Global health outreach, no matter how well-intentioned the mission, will inevitably face ethical dilemmas and unintended consequences. An

in-depth description of medical ethics is beyond the scope of this article; however, several principles and frameworks should be followed to inform ethical decision making.^{4,13} A classical, albeit Western-based, framework of medical ethics includes the principles of non-maleficence, beneficence, autonomy, and justice, although numerous other ethical principles, such as solidarity, privacy, equity, and transparency, can be included to promote culturally informed practices.^{4,16} While a mere understanding of ethical principles does not ensure that best practices are upheld, these frameworks should serve as a foundation of global health partnerships.

Research is also a vital component of promoting global equity in radiology. For example, partnerships between researchers in HICs and LMICs are essential to understanding disease trends, developing treatment strategies, and addressing disparities in access to imaging services.^{3,4} Parachute research, the act of extracting data from LMICs by individuals from HICs without proper acknowledgment, should be discouraged and replaced by engaging local stakeholder in all research projects, beginning with deciding research topics. Not all data from HICs can or should be extrapolated to LMICs, so research can help inform innovative, sustainable models for building high-quality imaging services in lower-resource settings, including incorporating artificial intelligence solutions.³ One example is the PERTAIN trial, which specifically incorporated LMICs to assess the potential benefit of nuclear imaging in lung cancer treatment.⁹ Moreover, research is a critical element of improving practice standards and supporting training, education, and professional development.³ Ethical considerations and inclusive research collaborations are foundational tenets of building equity through global radiology.

Progress in global health imaging faces many challenges, including deficient imaging equipment, unequal access to radiology services, inadequate training, and insufficient data and standards. While these disparities contribute to worse health outcomes in LMICs, they also represent opportunities for change and engagement. Radiology has the dual mission of strengthening imaging services and human capacity building, a mission that should be informed by local collaboration and an understanding of medical ethics.

While not all of us in radiology may directly engage in efforts to improve global health, we have a collective responsibility to understand medical imaging's role in health equity, raise awareness of persistent disparities and ethical considerations, and support our colleagues who do participate in these efforts.

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