Diagnostic imaging challenges to the poor on the long road to the cancer centre

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Imaging is one of the key pillars on which cancer detection and treatment rely. Yet the poor who constitute the majority of patients in emerging health systems face great barriers to access. Centres with specialist imaging facilities are out of reach. Local facilities are neglected. New generations of X-ray and ultrasound equipment, in combination with digital connectivity are an exciting opportunity for the imaging community and health providers to close this gap. Resource-stratified guidelines, an "essential radiology package" and a new look at imaging work force development are some of the proposed solutions discussed in this article.

Cancer patients in low- and middle-income settings face a host of challenges, including lack of awareness, long delays between onset of symptoms and diagnosis, poor access to treatment, catastrophic health expenditure and lack of access to palliative care. Global cancer care initiatives target these challenges with a range of interventions, from raising awareness in the community to advocating investment in the presence of at least one specialist cancer centre in each country *(1)*.

In high-resource settings, state-of-the-art diagnostic imaging, or radiology, is considered indispensable for the detection, staging and monitoring of the large majority of cancers. High-end imaging modalities, such as Computed Tomography (CT), Magnetic Resonance Imaging (MRI) and nuclear medicine are commonplace, along with interventional radiology treatment options. Over the last two decades, specialist cancer centres and tertiary level hospitals in low- and middle-income settings are increasingly being equipped with these modalities, prompting similar state-of-the-art access to cancer diagnosis and treatment. However, as these modalities require major financial and human resource investment, roll-out on a wider scale is not feasible in many current healthcare systems. Therefore, they will remain inaccessible to a large proportion of poorer populations.

Increasing awareness and early detection are important drivers to improve cancer outcomes. However, many patients in low- and middle-income settings are geographically removed from the major treatment centres and will rely on local and secondary services to manage their disease after early detection. Some resort to alternative therapies, including herbal medicine and spiritual healing. The majority cannot afford the high cost of imaging tests even if they existed in the vicinity, and an estimated 80% of patients currently present with advanced disease in which case it is unlikely that they will benefit from a journey to a specialist centre. Palliative radiotherapy being the only exception for those who can afford it. The challenges these patients face include not only those above, but also a lack of access to high quality, more affordable diagnostic imaging tests closer to home. This particular challenge is rarely highlighted, yet acknowledging and addressing it may play an important role in distinguishing, at the local level, between patients who are most likely to benefit from referral for more complex management and those who are best cared for at their local or regional level. For patients needing referral, but lacking financing, basic imaging can provide useful information for optimizing local care. In this context it is worth highlighting that, from prior experience in tuberculosis programmes, it is a known fact that many patients will not be able to afford even what are considered to be simpler tests such as chest X-rays *(2)*.

To illustrate the problem, Figure 1 shows the view taken from

Figure 1: The long road to the cancer centre – the view from a rural clinic in Malawi *(Credit: Personal collection, E Joekes)*

a rural clinic in Malawi. It is situated along the highway between two large, urban centres. The nearest CT scanner in the public system is 300 km to the north. The nearest functioning MRI and ultrasound service are 200 km in the opposite direction. The nearest X-ray, in the local district hospital, no longer works, whilst the nearest ultrasound machine is collecting dust in a spare room of the clinic. The medical officer who runs the clinic is unable to use it. Therefore, not only patients with symptoms of possible cancer, but all patients have to travel long distances for imaging tests. This scenario is unfortunately not uncommon.

This widespread shortage of functional basic equipment is paradoxically increasingly combined with a growth in high-end equipment at inappropriate levels of care. A severe global shortage of human resources in diagnostic imaging, including in high-resource countries and private centres means that expertise at all staffing levels is diverted to these larger, better equipped and often urban centres, leaving many lower-level facilities in the hands of technicians and clinicians, or abandoned *(3, 4)*. This is a problem across many sectors in healthcare, but it is particularly acute in radiology.

Clinicians and technicians left to run the peripheral services are not imaging experts and may not be familiar with the potential of X-ray and ultrasound as useful modalities in the diagnosis and staging of cancer. They may also struggle to effectively advocate for the strengthening of these services. The implementation of these tests in low- and middle-income settings has traditionally been associated with communicable diseases, obstetrics and acute surgical care. With the increasing global prevalence of cancer, there is a need to expand the evidence base, knowledge and education on how these modalities can also be deployed effectively in the diagnosis, staging and management of cancer patients. This applies not only to healthcare professionals providing the imaging services at rural and district levels, but also to referring clinicians and policy makers, who may be more focused on the implementation of complex, high-end imaging and treatment modalities, so frequently quoted as essential to cancer care.

A further explanation for the underutilization and neglect of basic modalities is the fact that the training and practice of imaging professionals, both medical and technical, is primarily concentrated in centres where more complex imaging modalities are well established. Being shaped by the developed world, radiology and radiography curricula, equipment development, research and literature are heavily biased towards increasingly sophisticated techniques, with the dissemination of guidelines and equipment targeted to the maximum level of care available. X-ray and ultrasound are now viewed as triage tests before further complex imaging, rather than as the definitive test. While this is mostly appropriate in well-resourced settings, it creates an unintentional bias in the recommendation of definitive imaging tests for patients who present to lower levels of care or who are too poor to access specialist care. This bias is also reflected in the World Health Organization (WHO) list of priority medical devices for cancer management *(5)*. The document clearly emphasizes that services should be in line with local and national healthcare capacity and needs, yet relies almost entirely on cancer imaging guidelines derived from high- and high-middle-income settings, distorting priorities by affording the same importance to high-end facilities as well as basic facilities. A lack of awareness within the imaging community of existing resource-stratified guidelines for cancer may also contribute *(6)*.

Using the Breast Global Health Initiative (BGHI) resource levels as an example, a maximum level of services is defined as those that are available in highly-resourced systems, applying cancer guidelines that do not take resource levels into consideration *(7)*. Importantly, this maximum level of resources is considered of lower priority than the level required to develop the basic, limited or enhanced levels of care. Treatment and diagnostic capacity should be matched and the level of complexity of imaging tests in line with the overall level of care provided. The BGHI therefore recommends excluding any breast imaging from the basic level, developing ultrasound and/or mammography services for symptomatic patients at the limited level and population screening at the enhanced level. In a region where the lower levels have not been developed, there is little justification to spend a large proportion of the cancer imaging budget on the implementation and maintenance of a breast MRI service, despite MRI being included in the WHO list of essential equipment for cancer management. The budget required to implement one MRI service, including human resources and maintenance, will deliver many more high-quality breast ultrasound and mammography services at the limited level. If investment in MRI at the maximum level is considered appropriate, this will require simultaneous investment in the development of well-equipped and staffed X-ray, ultrasound and mammography services at the lower levels, in line with the breast cancer care pathway as a whole.

Resource-stratified guidelines such as those of the BGHI describe the whole spectrum of prevention, diagnosis and care for one specific type of cancer. Imaging recommendations form only a small part.

Given the overwhelming number of people with lack of access to higher level diagnostic imaging services, there is an urgent need to generate evidence on an expanded role for basic imaging modalities in cancer in low- and lower-middle-income settings, rather than relying on practice informed by high-income settings. Addressing questions such as how the most common types of cancers could be safely and effectively

triaged closer to the community, according to which criteria and by whom; exploring the potential of task shifting and/or automated image interpretation; identifying optimal referral pathways and wider health system implications. This evidence will feed into the development of national or regional resource-stratified guidelines specific to imaging. These guidelines should afford the same importance to high-quality X-ray and ultrasound services at the limited level, as to the CT, MRI and nuclear medicine facilities at the maximum level. They should also reflect the reality that a large majority of patients present late and imaging may not be appropriate at all or should be as non-invasive as possible to avoid further harm and cost to the patient.

For example, if radiographers or clinicians at the limited level were given access to quality ultrasound equipment and the necessary knowledge and training to diagnose disseminated malignancies, this could be recommended as a first approach. Currently, referral for high-end tests, in the absence of such an explicit lower level solution, puts patients at risk of absconding and being lost to palliative care, or catastrophic financial outcomes. The high cost of tests such as CT, MRI and nuclear medicine means that this risk applies not only to those already in poverty, but also to many who are managing, but will end up below the poverty line as a consequence.

As an example, surgical treatment for a patient with suspected bowel cancer frequently depends on the presence or absence of spread of the cancer to the liver. At a time when improvement of surgical outcomes in low- and middle-income settings is considered a global priority, patients and their surgeons at limited and enhanced level centres should have timely access to a high-quality ultrasound service with an appropriately skilled operator to confirm or exclude spread to the liver. This will assist in triage and avoid unnecessary referrals, delay and costs. CT is evidently a more accurate test for the detection of spread to the liver, which is why it is recommended at the enhanced and maximum levels. However, in circumstances where CT is not available, implementing a quality ultrasound service is not only much more feasible and affordable, it also provides an invaluable addition to what would otherwise be a clinical assessment alone and possibly unnecessary major surgery. Asian resource-stratified guidelines for colon cancer take this into consideration by recommending ultrasound, rather than CT *(6)*.

As always, resource-stratified cancer imaging guidelines are only one part of the solution and will mean little without major investment in the required infrastructure, human resource capacity and education. Put together they could form part of a new "essential radiology package", similar to the "essential pathology package" *(8)*. As mentioned above, a major added benefit of this approach is the fact that high-quality imaging facilities at the limited level will also improve antenatal care and the management of many diseases other than cancer, for example, tuberculosis and other lung diseases, surgical emergencies and accidents, cardiovascular and neglected tropical diseases. It is estimated that functional basic imaging services are required to achieve 80% of the health goals of the 2030 Sustainable Development Goals *(9)*.

Historically, X-ray equipment has been a challenge to implement sustainably in lower level facilities due to cost, complex infrastructure requirements, maintenance, and lack of skilled human resources. However, in the last decade, new digital solutions, including computer-aided diagnosis (CAD) and tele-radiology are contributing to overcoming these challenges; opening up opportunities to make X-rays available to a wider population and to link care and education at the limited level with experts at the higher levels. Combined with the development of light-weight mobile X-ray equipment and more robust and affordable fixed equipment, it is high time to revisit the idea that providing quality X-ray services at the limited or even community level is an insurmountable problem.

Similarly, ultrasound equipment has been revolutionized over the last two decades. Much is being written and advertized about low-cost, portable bedside scanners. While these clearly play a useful role in specific situations, they cannot replace the more sophisticated equipment needed for specialist use, such as in the example above. These higher-end machines now provide image quality that can rival with modalities such as CT and MRI, at a fraction of the cost and with none of the associated infrastructure and radiation safety concerns. This does not apply to all cases in cancer care, but it opens up the opportunity to start exploring the possibilities and benefits of implementing these techniques at the limited and even enhanced levels of care. Significant investment in skilled operators will have to be made, but the reach of their work will go well beyond cancer imaging alone. One proposed solution is to develop a new workforce with excellent skills in ultrasound and X-ray, as well as mammography and ultrasound guided biopsy, which could deliver the "essential radiology package". A hub and spoke model would serve developing countries well, with peripheral centres sending cases/images to a central maximum level of care centre. This would bring equitable access to high-level care for all. ■

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