The role of Artificial Intelligence (AI) in modern medicine

By Dr. R Banerjee

Artificial Intelligence (AI) is being embraced by the medical community; however, there are still some barriers to widescale adoption. This article shows the growing application of AI in modern healthcare and the benefits to patients and clinicians, whilst also looking at what is needed to confirm its place in medical diagnosis.

Artificial Intelligence (AI) has had many false dawns in modern medicine. The radiology community has in the past been cautious, and sometimes dismissive, of AI, automation and decision support tools; however, increased workloads and pressures have brought a newfound alignment of aims. For the first time, we are seeing true collaborative research with harmonised goals.

Patients have begun to embrace Big Data research through the success of UK Biobank and recognise the possible benefits from sharing their data. However, public trust in the use of their personal data for others to benefit is essential, especially in light of recent high-profile misuses of personal information, and general misgivings about the possible use and abuse of big data by large US companies for profit above societal gain.

AI algorithms will help medical staff work to the full potential of their "license". The historical models of test requesting, imaging and reporting will benefit from these algorithms to help test selection and interpretation. Digital image acquisition and reporting, with improved standardisation will help automatic reporting of certain findings, such as early signs of chronic disease or possible abnormalities, including tumors. The role of the radiologist as being a key data scientist at the centre of making a diagnosis has grown – reporting is much more structured, and the skill is now in decision-making, not description or detection.

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MRI

Quantitative MRI has successfully been used in clinical applications for prostate cancer and liver disease, obviating the need for cruder, riskier and costlier methods such as biopsy. These experiences are informative, in that they show the changing pace of innovation, and the scalability of AI in medicine.

The use of imaging, particularly multiparametric MRI (mMRI) in the diagnosis of prostate cancer, has been one of the most widely publicized adoptions of AI in medicine. Previously, the clinical workflow for prostate cancer was to perform a prostate-specific antigen test, a rectal exam followed by an ultrasound-guided biopsy. This, however, has been augmented subsequent to the adoption of imaging in this workflow. Imaging can now identify tumors better and clearer than biopsy, and it has been shown that triaging mMRI might allow 27% of patients to avoid primary biopsies. If this method is used to direct biopsies, it could be possible to detect an additional 18% of clinically significant cancers when compared to the standard pathway, leading to an improvement in patient care and potentially outcomes [1].

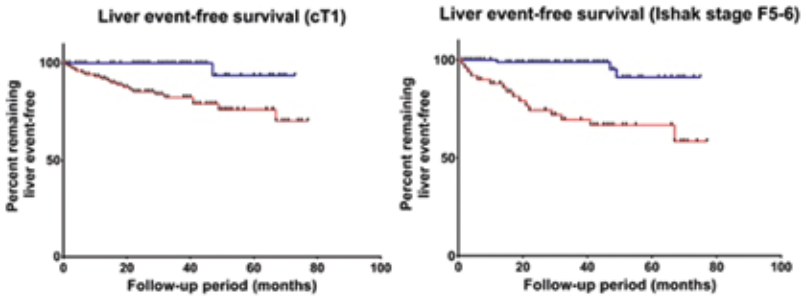

Figure 1 – Smart medical imaging can predict liver disease outcomes as well as liver biopsy does.

Liver disease assessment used to follow a similar paradigm. Clinical suspicion and raised liver enzymes on blood testing would lead to liver ultrasound, followed by liver biopsy. In the last decade, there has been increasing prevalence as well as interest in non-alcoholic fatty liver disease (NAFLD)/non-alcoholic steatohepatitis (NASH) [2]. Alongside this, there have been multiple developments in non-invasive imaging as a safe and scalable technology, needed to identify and stratify patients. Multiparametric MRI has been shown to be equivalent to biopsy in the assessment of disease as well as in predicting clinical outcomes [Figure 1], [3].

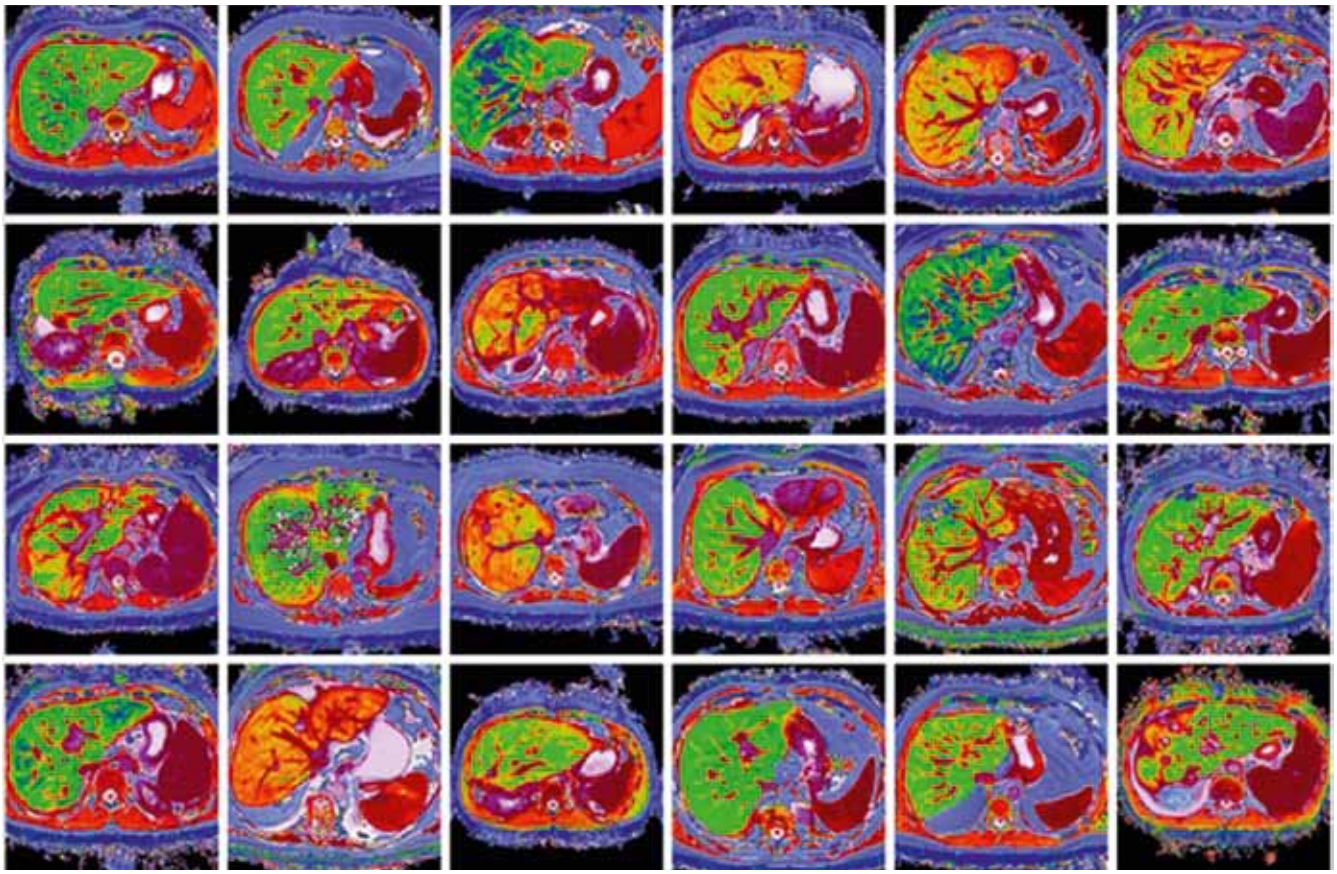

Figure 2 – Multiparametric maps showing iron-corrected T1 (cT1) levels in participants' livers.

As cross-sectional scans are available, imaging allows the physician to see an increased sample. Quantitative analysis further provides the clinician with more information to support their diagnosis, without putting the patient at risk or in pain. This method is currently being tested in the clinical pathway in large European trials, to measure cost-effectiveness as well as the reduction in unnecessary biopsies, with the aim of echoing in the success of mMRI in prostate cancer.

Clearly, imaging techniques have to be validated in clinical trials against older methods, and much of this work has been done or is in progress for prostate and liver applications. The EU's Innovative Medicines Initiative (IMI) and the USA's Foundation of the National Institutes of Health (FNIH) both lead large consortia with industry and regulators to validate these new methods prior to clinical adoption. True value is demonstrated by generating compelling data - that the imaging is more useful than previous biomarkers in making a diagnosis, in predicting clinical outcomes as well as making treatment decisions. These data usually come from predictive outcome studies or from randomized controlled trials with health economic analyses, rather than direct head-to-head biomarker comparison studies. After all, to be better than a current standard, a new test cannot agree with it perfectly as this demonstrates equivalence, not superiority. These are also the data needed by healthcare payers, especially in the USA, to justify reimbursement for a new technology or biomarker.

The next phase of adoption for new imaging methods is for non-radiologists to appreciate the value of their outputs. Medical imaging is insufficiently taught to medical students, in comparison with laboratory diagnostic disciplines such as histopathology, hematology and biochemistry. Modern medical education should reflect the increasing use of bedside and point-of-care ultrasound, and diagnostic cross-sectional imaging. The increasing use of MRI for evaluating chronic conditions, such as back-pain and musculoskeletal injuries, has opened the door to primary care and non-medical referral pathways. This in turn has led to the need to transform large descriptive radiology reports into decision tools that can be used to determine which treatment pathway to follow, or whether secondary care involvement is required. The decisions and pathways involve a range of healthcare workers, most of whom are not versed in the intricacies of MRI reporting; who are however able to act on clinical decisions outputted from the imaging tests, such as physiotherapy as opposed to surgery.

The falling prices of cross-sectional imaging (£400, or approximately € 460, for an abdominal MRI in London, New York or Tokyo, including reporting fees) make it more scalable and accessible for chronic disease patients. Ten years ago, MRI was reserved for neurological conditions and suspected spinal cord compression, and medical emergency for oncology patients. The number of indications has grown exponentially, and the sophistication of questions posed for MR providers has

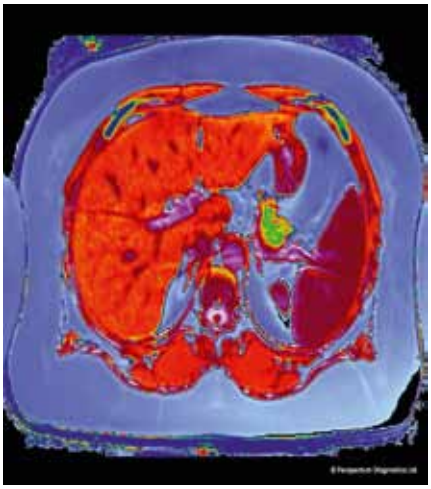

Figure 3. High level of iron-corrected T1 (cT1)

increased. Additionally, clinical pathways are now emerging which can simplify the role and scope of complex imaging, such as MRI in liver disease [Figure 2, 3] and assessment of suspected Transient Ischemic Attacks (TIAs).

In both cases, front door and primary care physicians are requesting and acting on rapidly reported anatomical and tissue characterisation data to guide their treatment decisions. Some examples include:

- Inflamed liver in AIH
- Inflamed brain in TIA
- Inflamed heart in myocarditis

THE IMPORTANCE OF PATIENTS

For AI in medical imaging to truly grow and impact on patient care, the main barrier is well-curated and complete data from patients with their consent. Deep learning techniques applied to patient groups can identify hallmarks and patterns that can be used to diagnose and stratify patients. There are regulatory paths forward to commercialize the algorithms, and the FDA in particular favours digital health solutions. However, this can lead to a tension – why would patients consent for companies to access their medical records, if the consequence is higher-costing healthcare, albeit with some greater insight? This tension can be resolved with true partnership between patients, doctors and healthcare innovators, wherein patients are aware of their importance in agreeing to donate parts of their health records for use in big data collection and algorithmic generation; doctors are happy to declare the limits of their expertise and identify areas where AI can be helpful; and AI scientists are willing to listen and address the specific questions posed to them. Some argue that, for the 'greater good', one can circumvent patient consent for data and aggregate anonymized images for deep learning. This has two flaws.

First, anonymized data can never be linked to clinical outcomes, so algorithms generated from them can never be tested as being predictive, which is what clinicians and patients, as well as healthcare providers, are really interested in.

Second, at a time when the importance of sensitive personal data ownership and stewardship has been eroded, it is important to emphasise the importance of consent and trust, especially in applied healthcare research. Even if a lawyer advises that one can act without consent, it is always preferable to act with consent. This also nudges AI healthcare researchers into engaging directly with patients in truly collaborative, and thus more meaningful, applied research to address real clinical problems. Genetic information is now readily being communicated to patients by central providers, such as Illumina and 23&Me. This has resulted in a shift in the patient-doctor relationship, with more accessible information in the patient's hands - a true innovation in the information age.

ENGAGING POLICY-MAKERS

In the UK, there has been a huge political shift towards digital radiology and smart diagnostics. This is driven by increasing patient demand, without a matched increased growth in workforce or resources. Put simply, there are not enough radiologists and pathologists to meet rising demand, so the appeal of AI, improvements to workflow and automation is very clear. More recently, the appointment of a Health Secretary with good understanding of technology and innovation, and the adoption of a Life Sciences Strategy to build the UK economy, have stimulated investment and focus in this area, with GE Healthcare in particular supporting a digital transformation in how radiology is done and perceived by the healthcare community. A National Consortium for Intelligent Medical Imaging (NCIMI) has been formed, with collaborators in 11 different National Health Service (NHS) hospitals, to build and test smart imaging tools. Commissioning groups in the UK, and healthcare payers more widely, have shown willing in adopting cost-saving technologies - especially if they are developed to addressed patient-centric problems. I am thus optimistic about clinical adoption if the development of AI in medicine is done in a trustworthy and transparent fashion.

Adoption will be further driven by newer therapies in an era of precision medicine. As more and more treatments are available, it is clear that better phenotyping and genotyping of disease may influence treatment choices, and patient outcomes from those choices. Thus, the ability to use AI is cost-saving not just in diagnosis, but more so in determining which patient(s) should benefit from newer, often costlier, therapies. For example, we know that imaging guides the decision of what type of cardiac intervention to utilise in coronary artery disease, and also in the management of aortic aneurysms. In the future, choice of immunotherapy for liver cancer and prostate cancer may depend more on imaging parameters of disease than histology. The UK government, Perspectum Diagnostics and GE Healthcare have made substantial investments in the delivery of a pipeline of AI tools for standardised imaging for the NHS, to be delivered within 3 years.

In summary, this is a great time for the AI community, healthcare and patients to work together for the common good, developing innovative solutions from big data to improve the diagnostic yield of modern radiology, for all our benefit.

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