Re-think of medical imaging: How could new methods, technologies and work practices impact the post Covid backlog and patient outcomes?

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In March 2020, shortly after the UK went into lockdown Boris Johnson ordered the NHS to cancel all non-emergency treatment. Statistics for the following month showed diagnostic imaging was down 66% on the previous year across all modalities. The Royal College of Radiologists (RCR) and the British Institute of Radiology (BIR) say the backlog created by the virus has "exacerbated" issues linked to a lack of scanners, as well as shortfalls of 6,000 radiologists and radiographers in the profession.

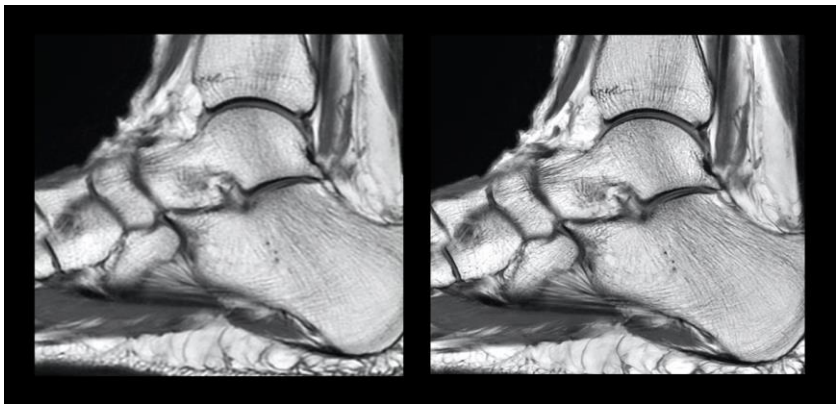
Prior to the pandemic, investment in new and upgraded imaging systems was part of the Government's ambitious cancer targets. The Health Secretary Matt Hancock announced an extra £200 million funding for new cancer screening equipment. With greater access to state-of-the-art CT and MRI, the NHS aims to ensure 75% of cancer diagnoses are made at an early stage (stage one and stage two) by 2028.

The Health Foundation said £1.5bn would be needed to bring the UK up to the required capacity. At the time, the UK had the lowest number of CT and MRI scanners per capita among the EU15 and G7 countries, with less than a third than in Germany. Advanced imaging technology and new working practices may close the gap between availability and demand for diagnostic imaging.

Accelerated Imaging

Due to low inherent signal in Magnetic Resonance Imaging (MRI), innovations are often targeted at reducing the scan duration. For upgrading of legacy systems, replacing 1.5T with 3.0T scanners can improve the signal by 30 to 60%. Newer equipment also comes with improved features, such as lightweight coils for MRI, more space within the scanner, and faster image reconstruction times in CT.

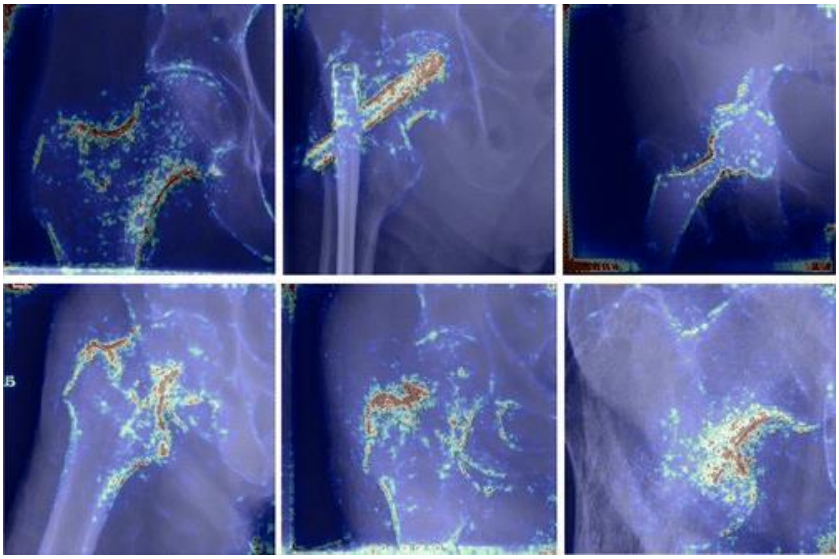
In CT imaging, research studies in compressed sensing, a type of image reconstruction, has shown dose reductions of 80% for near equivalent image quality. Similarly, image denoising based on convolutional neural network reconstructions has halved the noise levels in CT compared to previous iterative reconstruction algorithms. While in MRI, compressed sensing and deep learning techniques can reduce scanning time by 30 to 60%.



MRI of an ankle showing conventional (1:59 min) vs. deep learning reconstructed images (1:18 min). Reproduced from gehealthcare.co.uk.

AI supported diagnosis

A new NHS AI Lab supported by a £250 million investment from the Government aims to boost the role of AI within the health service. In clinical trials AIs have shown outcomes as good as the leading doctors at spotting lung cancer, skin cancer and more than 50 eye conditions. There are many excellent applications of AI technology, but more work is needed to ensure to ensure these systems are safe and can be used ethically at scale. In orthopaedics, researchers have shown the decision making of AIs when evaluating x-rays improve the diagnosis of hip fractures made by doctors.



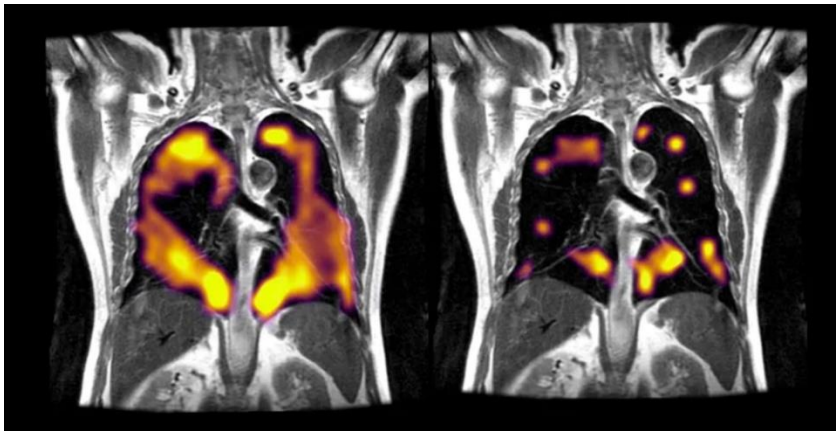
Maps created by the AI showing its decision-making process when evaluating hip x-rays. These images can be used for training and increase the speed and confidence of diagnostic reports. Reproduced from radiology.ucsf.edu.

Dr Nicola Strickland, president of the Royal College of Radiologists, said: "I expect radiologists to be leaders in using AI algorithms to assist them, provided they can see evidence that these AI algorithms have been developed using large enough, properly curated data and rigorously validated and tested."

Imaging Covid-19

AI has been used in acute Covid-19 where lung X-rays and CT can predict if patients are likely to recover, require admission to intensive care or ventilation. This work has helped allocate resources and improve patient outcomes during the pandemic. More research is required to understand the impact of long-Covid as one in 20 people are likely to suffer from Covid-19 symptoms lasting more than 8 weeks.

A recent study in which patients inhale xenon gas during an MRI scan has identified damage not picked up by conventional scans. In patients who reported breathlessness, the scans showed signs of lung damage - by highlighting areas where air is not flowing easily into the blood. Lung damage identified by the xenon scans may be one of the factors behind long Covid.



In the scarred lungs, on the right, there are much larger areas of darkness, representing parts of the lungs that are having difficulty transporting oxygen into the blood stream. Reproduced from oncology.ox.ac.uk.

Working Practices

Imaging patients with active Covid-19 has also posed a challenge as staff are required to wait a safe period of time for air exchange prior to disinfecting surfaces. UV disinfection robots may help decontaminate areas more quickly, without exposing staff to airborne coronavirus. UV-C ultraviolet light is used to destroy the virus by damaging its RNA, so it can't multiply. While hazardous to humans, the robots are self-driving and can navigate around a room exposing surfaces to ultraviolet light and safely inactivating airborne coronavirus and other pathogens.

Integration of new tools are also reshaping clinical practice. Following a stroke urgent brain imaging is performed to show areas of the brain with reduced blood flow. Instead of applying time-based treatment rules, imaging allows doctors to plan treatment of stroke patients based on individualized brain tissue status. A significant shift towards precision medicine can lead to better outcomes for patients, with more discriminant interventions.

Investment in new and upgraded imaging systems, equipped with state-of-the art technology will help increase the number and quality of diagnostic imaging studies. Integration of AI within healthcare may facilitate high quality reporting, faster diagnosis and new image-based treatments.