



# Artificial intelligence in radiology: how will we be affected?

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## Introduction

Artificial intelligence (AI) has come to the forefront of conversation amongst radiologists. Popular culture has often portrayed the far-fetched perils of AI e.g. sentient machines seeking human domination. Whilst absurd, there is an element of truth in that AI has the potential to revolutionise the way we work in the twenty-first century.

## Definitions

Since radiologists are not computer science trained we should attempt to familiarise ourselves with several key terms. Artificial intelligence is ‘the capability of a machine to imitate intelligent human behaviour’ [1]. Machine learning concerns ‘the question of how to construct computer programs that automatically improve with experience’ [2]. Deep learning is a class of machine learning ‘concerned with algorithms inspired by the structure and function of the brain.’

## Silicon Valley

The big step for AI has been ‘deep learning’, which involves feeding computer systems large amounts of existing data to, in essence, make decisions based on examples. Silicon Valley has implemented this in autonomous driving, facial recognition, playing games, online assistants (e.g. Apple’s Siri) and

language translation. Notably in 2017, AlphaGo, a board-game-playing AI system developed by Google DeepMind, beat the top-ranked player [3].

Within healthcare, DeepMind has collaborated with Moorfields Eye Hospital in the UK to analyse eye scans for signs of disease resulting in blindness [4]. DeepMind has also joined forces with University College Hospital in London to develop an algorithm to diagnose head and neck cancer on CT and MRI [5]. Israeli-American start-up MedyMatch also plans to use AI to diagnose stroke on CT and envisage its software being used within the emergency department as well as the radiology reporting room. MedyMatch has already secured a licensing agreement with IBM Watson Health and collaboration with Samsung [6]. The recent Radiological Society of America (RSNA) 2017 conference was dominated by industry conversations regarding AI with further announcements of partnerships between technology and healthcare companies.

## Computer-aided diagnosis

Computer-aided diagnosis (CAD) has filled a gap prior to AI. CAD is a complementary tool used by clinicians as an adjunct. Tools may include image processing, image feature analysis and data classification. The routine detection of breast cancer on mammograms has been enhanced by CAD. CAD has also been used in the differential diagnosis of lung nodules and interstitial lung disease on CT [7]. Limiting CAD is that alone, it does not possess the level of ‘intelligence’ made possible by deep learning.

## Potential benefits

As hospitals rely increasingly on imaging, the reporting workload increases. So an AI system that could reduce the daily workload of the radiology department would be beneficial and keep up with the demands of providing a quality hospital service. It would be useful if AI could confidently filter out

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normal plain films and flag up abnormal films for review. Question-specific AI could be used in CT/MRI for example in identifying malignancy.

In the early stages, AI would likely be limited to a software tool to be activated by the user. However, in time, with users becoming comfortable working with AI, it may be granted autonomy to report simple scans. It would be likened to an autopilot for doctors and could innovate in the same way.

## Impact on neuroimaging

AI solutions for neuroimaging are being sought particularly in MRI projects such as the large-scale Human Connectome project, which aims to map the connectivity of the brain [8]. Another example is the BRAIN initiative, launched by President Barack Obama, to better understand brain function [9]. Stroke AI projects have attracted state funding in the USA in addition to that of industry mentioned earlier. Since stroke treatment is time critical, a proposed triage role could enable rapid decision-making [6, 10].

## Regulation and access to data within the National Health Service (NHS)

Philanthropist and Tesla CEO Elon Musk had warned industry of the risk of unregulated AI and the need to be ‘proactive rather than reactive’ in establishing regulatory bodies [11]. He noted that the biggest risk to his autonomous car system would be a hack taking control of a vehicle. However the UK government’s recent report, ‘Growing the artificial intelligence industry in the UK’, suggested only guidelines for AI governance and not regulation [12].

Surprisingly discussions amongst UK clinical radiologists regarding the impact of AI have been relatively slow. In 2016, the Royal College of Radiologists (RCR) first held a forum acknowledging the emergence of AI in imaging and explored ways of accessing NHS data [13]. Since then a Radiology Informatics Committee at the RCR has been formed as well as representation at the Select Committee on Artificial Intelligence in UK Parliament [14, 15].

Developing AI requires access to large volumes of data. In the UK, this has been challenging particularly within the NHS. In July last year, an independent panel ruled on the recent controversy over an app DeepMind developed to identify patients at risk of acute kidney injury. The panel found the agreement between DeepMind and the Royal Free Hospital Trust to be illegal and contained ‘deficiencies’ as it did not safeguard patient data [16]. This case should serve as a warning for the future; though ultimately if data were accessed via the correct routes, the wealth of data stored within the NHS would be a great resource for AI.

## Threat to jobs

We must acknowledge the media opinions regarding the threat computers pose in taking away the job of the clinical radiologist, as proposed by Andrew Ng, an expert in AI at Stanford [17]. Ezekiel Emanuel, known for his role in the Affordable Care Act, ambitiously predicts that we will see the first computers replace radiologists within the next 4–5 years in articles for *N Engl J Med* and *J Am Coll Radiol* [18, 19]. Whilst his expectations may be optimistic given the numerous barriers AI will face, it could be a distant possibility.

In contrast to traditional medical research models which require clinician supervision, investigators of AI imaging will likely be driven by computer scientists. This may restrict research input of a radiologist, which may sit uncomfortably.

## Psychological, educational and organisational readiness

Psychologically, we have become familiar with AI in our day to day lives, from mobile phone voice assistants to autonomous driving. Therefore it is reasonable that radiologists try incorporating AI into their workflow. It remains unclear how we would manage or react to discrepancies between radiologists and AI. Further into the future, autonomous reporting may pose a challenge in gaining acceptance from within the radiology community, let alone other medical specialities.

A survey of radiologists and trainees by Collado-Mesa et al. has suggested a lack of education and awareness of AI [20]. It involved an anonymous questionnaire returned by 66% of a group of 104 trainees and attending radiologists at a single residency program. Thirty-six per cent of radiologists, as demonstrated in this survey, may have never read any medical articles relating to the subject of AI. In spite of this, 29% of those surveyed used AI tools daily at work. Also trainees may hold concerns regarding the threat of AI to job security and are more likely to learn more about this topic. Furthermore it highlighted a need for educational resources as AI could enhance training. The above article from the JACR reminds us of the need to promote AI amongst the radiological community including technicians and undergraduates. Responsibility lies with leaders such as universities, national/international societies, journal editors and other teaching organisations.

The technology industry has shown preparedness by driving investment into developing AI, as demonstrated at RSNA 2017. Industry will have to prove firstly that the programs work and secondly that they improve outcomes. Predictably hospitals will be the intended purchasers of radiology AI, some of which may be reluctant to spend money on unproven technology, particularly within publically funded systems such as the NHS. Uncertainty remains surrounding the degree of processing required to run these advanced programs and

hospitals may not be prepared for additional network requirements.

## Discussion

There is a recent upsurge of AI in radiology spearheaded by Silicon Valley. This has resulted in collaborations between radiology AI start-ups and multinational corporations along with dedicated AI discussions at the most prestigious radiology platforms. If viable AI comes into use, the radiologist's daily workload will change; though it is difficult to predict whether this change entails a more focussed radiologist role or whether less radiologists will be required. It is important to stress that the implications of AI are speculative. Uncertainty remains whether AI can even perform to expectations or meet the accountability and regulation necessary to be approved. As radiologists consider the future challenges of working with AI, we should be encouraged by our past adaptability to the introductions of MRI and intervention for example. AI has the potential to change the landscape of modern clinical radiology and it will be necessary to keep up with developments.

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## Compliance with ethical standards

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## Methodology

- performed at one institution

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