Could pathologists soon be replaced by robots?

By Harry Adams

The relentless advance of technology has worrying implications for workers, regardless of occupation. With robots outnumbering people 14 to 1 in some factories[1], the progression of robotic automated machines into fields of work as superior alternatives is no longer a science-fiction proposition. It's a palpable reality, so burgeoning that the Office for National Statistics (ONS) has provided a tool allowing workers to calculate their individual risk of replacement[2]. The apparent inevitability of certain jobs being rendered obsolete by technological innovation leaves pathologists in a precarious position; does being a medical practitioner, at lowest risk of replacement according to the ONS, provide a necessary shield from the advancing tide of technology? Are the nuances of decision making in pathology unachievable for machines? Or do the processes involved lend themselves towards automation, perhaps for the betterment of patient care?

The malleability of pathology throughout history has often reflected a willingness to embrace medical innovation[3][4]. Since the advent of the histopathologist in response to the microscope, sub- specialties and novel methodologies have emerged in tandem with human advances[4]. More recently, the adoption of digital pathology techniques has streamlined workflows significantly[5]. The desire to continually improve clinical accuracy and efficiency fuels this modernisation.

Just as surgeons have been aided, not replaced, by robotic-assistants[6][7], the development of benign robotic 'tools' without agency logically poses no threat to the future of pathologists. The role of the pathologist would be protected in the operation and interpretation of the technology. Should Artificial Intelligence (AI), defined by Dr John McCarthy as 'the science and engineering of making intelligent machines',[8] provide machines with decision-making agency, the role of the pathologist becomes less well defined.

AI replacement of pathologists may have cost efficiency, offsetting design and production costs with savings on the training and wages of pathologists. The ability to multitask would also have evident time saving capabilities. Historically, AI technology has been fundamentally unable to match the human brains capacity for self-improvement and worldview re-interpretation[9]. Recent technological developments have offset this distinction, foreshadowing the additional consideration of AI-improved diagnostic decision making. Artificial neural networks, influenced by neuronal interconnections in the brain, have proven essential to the evolution of AI systems capable of learning and matching clinical expertise[10].

The study by Yamamoto et al. trialling modern AI technology in the interpretation of unannotated histopathological images revealed its promise, whilst illuminating the uncertain future for pathologists[11]. Deep learning algorithms, enabling machine learning, accurately identified key image features, acquiring explainable knowledge to the same accuracy as humans. Notably, the AI deciphered previously unrecognized features, providing more accurate prognostic indications than the human-established Gleason score. With the algorithm not requiring persistent human input and identifying features pathologists cannot, its potential as a viable alternative is readily apparent.

However, as Misbah et al. succinctly described, a pathologist is not limited to diagnostic evaluation[3]. Direction of laboratories, offering clinical insight, assurance of high standards and direct coordination of patient care form just a few daily considerations. These processes are fundamental to the provision of laboratory led services and appear less compatible with automation.

The clinical interpretation of results exemplifies a duty requiring preservation. As testing becomes more streamlined and less reliant on human input, direct-to-consumer (DTC) testing becomes a realistic prospect[12]. With a DTC model of care, the emphasis of result interpretation shifts from the pathologist and doctor in charge of care to the patient. Although this practice is useful in certain diseases requiring direct patient management, like diabetes mellitus, its dangers are evident. Test results, such as Prostate Specific Antigen (PSA) levels, require context and clinical experience for accurate interpretation[13]. Home testing of these non-specific biomarkers could mean benign fluctuations leave people believing themselves destroyed by cancer one day and in remission the next.

Similarly problematic is the nature of culpability following adverse medical events. The adoption of moral responsibility is fundamental to how doctors, institutions and families respond to medical error[14]. It facilitates forgiveness, acceptance of loss and critical analysis to ensure mistakes do not recur. It is essential therefore in assuring high standards of care. Who assumes responsibility when an automatous pathologist misses a diagnosis? If we can learn anything from the development of self-driving cars, manufacturers will be split as to where culpability lies[15][16].

The trialling of AI technology is progressing in other medical specialties. AI, taught mammography features by deep learning algorithms, produced significantly more accurate breast cancer predictions than radiologists[17]. Here again, the ability to spot imperceptibly subtle features allows superiority over the human eye, meaning images can be interpreted in entirely novel ways.

Although abstract interpretations can have value, they pose complications. There is the potential for a developing disconnect between how machines and clinicians understand information[18]. Do doctors need to understand how a diagnostic algorithm arrives at a decision? Or should they just trust it to be correct? Furthermore, as deep learning algorithms develop they incorporate more and more information, perhaps at the expense of accurate diagnosis. If the data sets used to train the algorithms are themselves invisibly skewed, downstream diagnostic decisions can be compromised.

Much of the rhetoric surrounding this debate has a partisan ‘us or them’, ‘pathologists vs robots’ edge, but this is simplistic. Complementary approaches can be formulated and adopted, utilising contrasting strengths. Synergism between pathologists and AI has many notable advocates, with Yamamoto et al. believing it to be beneficial to patients and clinicians alike[11]. Careful and considered adoption could, for example, use AI’s ability to sort through multiple images simultaneously as a screening tool, isolating findings in most urgent need of human clinical appraisal.

Could pathologists soon be replaced by robots? Although total replacement appears an impossibility, the inexorable progression of AI technology will undoubtedly alter the practice of pathology over the coming decades. The laboratory of the future may bear little resemblance to the laboratory of today. To paraphrase Curtis Langlotz’s comments on radiology, AI won’t replace pathologists, but pathologists who use AI will replace pathologists who don’t[18].

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