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Artificial Hype

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Artificial Intelligence in healthcare: What is versus what will be

Artificial intelligence will alter healthcare as we know it, augmenting some jobs and outright replacing others. Though we can't be sure when this will happen, what's most important for now is understanding what AI is and what it isn't.

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At medical conferences and in hospital cafeterias, few topics come up more frequently, or cause more confusion and speculation, than artificial intelligence (AI).

Proponents of AI promise that machine learning will reduce the administrative burden of medical practice and dramatically improve patient health. Critics warn that AI will depersonalise medicine and put physicians out of work, perhaps someday soon.

Neither assertion is likely in the short-run; both speak to a need for greater understanding within the medical community about the promises, pitfalls and practical applications of artificial intelligence.

What is and what isn't Artificial Intelligence?

Today's healthcare technology firms and digital device manufacturers hype their latest innovations as "AI." However, most applications powering medical practice and research today rely solely on human-generated algorithms and data analytic tools. Of course, the computers on which they are housed can perform impressive calculations at breakneck speeds, but the science behind them doesn't involve true machine learning.

Artificial intelligence and its newer, more powerful design, "deep learning," rely on neural networks, which are almost exactly what they sound like. These complex analytic tools use webs of analytic software that are layered on top of each other to simulate (and even expand upon) the functions of the human brain. Using multilevel or "meta" analysis, a computer's neural networks find patterns that even the designers of the application were not aware existed.

AI applications already demonstrate advanced comparison capabilities, which today carry the promise of ever-more sophisticated pattern recognition and visual diagnostics in the future. Deep learning tools can quickly process images of varying levels or layers, separating aspects such as colour, size, and shape before integrating the totality of information. Using huge volumes of data, AI systems identify hundreds of minute differences, which are then combined to provide new insights and more accurate conclusions. Although these specific functions are only now beginning to surpass the speed and ability of humans, the conceivable applications in healthcare are endless.

AI might someday radically transform diagnostic medicine to the point it can identify cancer at the single-cell level. Exciting projections like these have led many entrepreneurs and futurists to declare that machines will someday take over complex diagnoses entirely. Today, however, the most commonly used computer applications do not feature deep learning as with AI.

By segmenting the three most promising applications – human-generated algorithms, data analysis and true "artificial intelligence" – we can better understand the potential of each to improve healthcare and the obstacles standing in the way of their broader implementation.

1. Data analytics: Not AI, but lifesaving nonetheless

Combining statistical analysis and powerful computers capable of retrieving huge amounts of data in a matter of seconds, data analytics help doctors extract and act on massive quantities of clinical information in real-time. This enables faster and more successful responses in clinical settings.

Think of data analytics in healthcare as a team of physician assistants, racing around the hospital at lightning speeds to assess the status of patients, review their laboratory work and examine the data streams coming from their beside monitors. These assistants would also be tasked with simultaneously comparing this information against a pre-established set of criteria to predict which patients were at greatest risk of having an unrecognised, life-threatening medical problem or experiencing a serious clinical decline in health status in the near future. Of course, even if humans were capable of this task, the costs would be enormous. Instead, computers have taken on this task to the benefit of thousands of hospitalised patients.

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The division of research inside the nation’s largest physician organisation, The Permanente Medical Group, created an algorithm that possesses this incredible utility. Using all pertinent data generated through patient monitoring, laboratory studies and physician input, the algorithm is able to determine which Kaiser Permanente patients currently in a medical or surgical unit will most likely experience a deterioration in health and need to be transferred to the ICU within 24 hours (Hu et al. 2016).

Traditionally, clinicians have made these kinds of determinations twice a day, during morning and evening rounds. The computer performs this same function 24/7 and uses data from 650,000 hospitalised patients, 20,000 of whom previously required this type of ICU transfer, to do so. All this information proves superior to human intuition or individual experience, making the machine much more accurate than its physician counterparts.

The researchers who developed this predictive analytic model did so with incredible precision. They were able to identify the 1-2% of all hospitalised patients whose medical condition will deteriorate that night or the next day and require admission to the ICU.

When the computerised application finds an individual who fits these criteria, a text alert is sent to the responsible physician who immediately checks on the patient and intervenes before any serious clinical deterioration can occur. Thanks to data analytics, patients in these situations are 75% less likely to die.

Of course, there are occasional false alarms just as there are patients who may experience complications without warning. But the solution has proven far more accurate and reliable than the old way of doing things. As a result, hundreds of lives have been saved each year since its introduction.

2. Algorithmic computerised applications: Providing consistent, evidence-based care

A second solution, also commonly mistaken with “AI” is an algorithmic approach to care. Using clinical experts from each medical specialty with evidenced-based solutions, algorithmic approaches define specific pathways that lead to superior outcomes for patients. Applying the algorithms consistently has been shown to improve medical outcomes compared to doctors who rely on intuition and personal experience alone. Although computer-driven and physician-determined approaches seem unrelated, they share similar characteristics.

The process of becoming a doctor requires memorising thousands of “algorithms,” perhaps better thought of as little forks in the road (or nodes) along the journey toward a diagnosis or clinical decision. The subsequent path taken is the result of a “yes-no” conclusion.

Imagine, for example, treating a patient who is having trouble breathing. The first question on the algorithmic-tree might be whether the person has a fever. If yes, the algorithm takes you in one direction, toward a series of infectious aetiologies. If not, it takes you in a different direction towards even more branch points, these ones separating heart failure from a blood clot in the lung from an allergic reaction and so on until all possibilities have been exhausted and the proper conclusion reached.

And this is where computers excel. The longer the algorithm, the easier it is for the human mind to overlook or skip important questions (branch points) or omit potential diagnoses, leading to the wrong conclusions. But a computer algorithm never forgets.

It’s easy to see why many people confuse these high-tech pathways with artificial intelligence. In algorithmic-based applications, the computer appears to be taking in data and providing recommendations, similar to AI, but there is a difference. Rather than the analytic pathway being generated through computerised neural networks, they’re created by humans, similar to data analytics. As such, they can't be better or smarter than the physicians who develop them. But having been created by clinical experts, they're proving to be far superior to the judgment and abilities of most clinicians.

Many of the nation's highest-performing medical groups are now using these advanced information technologies to achieve superior clinical outcomes, outperforming their health-system peers and competitors.

Look, for instance, at the difference among medical groups and physicians in the effective control of elevated blood pressure (hypertension), the leading cause of strokes. Based on data from the National Committee for Quality Assurance (NCQA), the highest-performing medical groups help patients achieve normal readings 90% of the time. Doctors without these types of computerised solutions achieve normal readings only 55% of the time (Jaffe et al. 2013).

Though computers have helped many health-care-delivery systems achieve nation-leading quality outcomes, not all doctors embrace them. Physicians don't like it when anyone (or anything) tells them how to practice. For years, doctors have dismissed algorithmic applications as "cookie cutter" medicine. It takes strong physician leadership within medical groups to help fellow doctors get over this hurdle and realise that following evidenced-based recommendations leads to improved medical outcomes. Helping doctors recognise this is a crucial role for physician leaders.

Individual physicians and healthcare systems that have yet to embrace algorithmic care (and whose quality outcomes lag) have been able to get away with it for some time. But as patient expectations grow and transparency in healthcare becomes paramount, it's unlikely doctors who underperform today will be able to get away with it for much longer.

3. This is Artificial Intelligence in healthcare today

The pathologist examines a tissue slide to determine if a patient has cancer. The radiologist confronts a similar decision when looking at a mammogram. The dermatologist inspects a lesion and must determine whether it is melanoma. The ophthalmologist looks for signs of diabetes in a scan of blood vessels taken from the retina.

These are all important decisions that impact whether a patient will live or die. And yet, contrary to what most people believe, the diagnostic accuracy of today's clinicians is far from perfect. And because people and machines use fundamentally different approaches to reach diagnostic conclusions, AI is currently outperforming humans on a statistical basis in each of these diagnostic fields.

In general, doctors rely on heuristic principles to reach their conclusions. Since our brains can't retain the full details of tens or hundreds of thousands of images, we apply a few shortcuts to make our determinations and diagnoses. Pathologists, for example, diagnose cancer when the cells from the specimen are primitive in form, demonstrating excessive mitotic division and invading the surrounding tissue. Similarly, dermatologists worry about melanoma when a pigmented skin lesion has multiple colours and irregular edges. These alterations in form and structure do correlate with malignancy, but can be seen in benign lesions, as well. Furthermore, not all cancers demonstrate each of these abnormalities, and some fail to display any of them. As such, diagnoses in medicine remains inexact when seen through the eyes of humans.

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Visual pattern recognition software using AI's analytic tools, however, applies a different methodology to making the correct diagnosis. Rather than using these "rules of thumb," high-speed computers compare each new specimen to the thousands scanned before. And unlike the human mind, the machines are capable of including hundreds of factors and assigning a relative mathematical weight to each. As a result, they are already proving to be 5% to 10% more accurate than physicians in a growing number of areas, such as in the diagnosis of pneumonia (Rajpurkar 2017; Stanford News 2017; Standford Medicine News 2018).

With AI becoming more sophisticated, advancements are forthcoming in a growing number of diagnostic fields, including: radiology (CT, MRI and mammography interpretation), pathology (microscopic and cytological diagnoses), dermatology (rash identification and pigmented lesion evaluation for potential melanoma), and ophthalmology (retinal vessel examination to predict the risk for diabetic retinopathy and cardiovascular disease).

Despite the success of these AI applications, it may take a decade or more for them to replace physicians in clinical practice. Trust remains a big barrier in the adaption and implementation of AI approaches. Patients have believed in the diagnostic acumen of doctors for centuries. But when it comes to a doctor's ability to interpret certain studies, such as mammograms and pap smears, the results can be far from trustworthy. Overall, humans fail to find approximately 1 in 5 breast cancers. Similarly, the current sensitivity of a Pap test is only about 70 to 80%.

As a result, doctors often hedge their findings with phrases like, "most consistent with," "can't rule out," or "follow-up studies recommended." Substitute an AI application for a doctor and patients become less trusting and less forgiving, even if the computerised interpretations are more consistently correct.

Unlike applications that use AI to diagnose visual images, technology alone is currently unable to make the kinds of diagnoses doctors reach in their offices, based on a patient's history and physical exam. The reason is not technical since the AI applications could use the same methodology for clinical diagnosis as in visual pattern recognition. Instead, it's the lack of accurate and comprehensive data upon which to make its determinations. AI can't be any better than the information it's provided. Unlike slides, photographs, and X-rays, which are exact, medical records, including electronic ones, are not.

Most electronic records are designed for billing purposes, not medical care. And as doctors get increasingly busy, they tend to copy and paste their own notes or those of their colleagues, rather than taking the time to document the history and physical findings with 100% completeness and accuracy. Unfortunately, this paucity of time is unlikely to improve soon.

Conclusion

Those in the technology space are familiar with Moore's Law, an observation made by Intel co-founder Gordon Moore that the number of transistors on a chip doubles every one to two years Applying this insight more broadly, we might expect that computer speeds will double at least another five times over the next 10 years. Computers 30 times more powerful than those of today will support machine-learning tools and inexpensive diagnostic software that far outpace what any human alone can accomplish and dwarf what currently exists.

Whether doctors will celebrate or rue these advances remains to be seen. But regardless of their enthusiasm or resistance, the future is coming. As deep-learning software further establishes the best medical approaches, diagnoses, and treatments for hundreds of medical problems, patients will become the beneficiaries. Over time, they will be able to use a variety of computerised, algorithm-based tools to care for themselves, just as they manage so many other aspects of their lives today. And when such possibilities become realities, be it one, two or three decades from now, AI and the other associated technologies will permanently disrupt healthcare as we know it. ■

KEY POINTS

- ✓ Both proponents and critics of AI are overly confident in their predictions and conclusions about the specific impact AI will have on healthcare
- ✓ Most technologies labelled "AI" today aren't actually artificial intelligence
- ✓ In contrast to AI, applications that fall in the categories of data analytics and human-generated algorithms are already improving medical outcomes
- ✓ In some medical specialties, artificial intelligence is already 5 to 10% more accurate than humans at making diagnoses
- ✓ Adoption and implementation of AI are inhibited by the lack of trust patients, and doctors have in these sophisticated technologies. At some point, this too will change

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