SAC Knowledge Hub

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Source: Forbes

Artificial Intelligence in Healthcare

Artificial Intelligence ("**AI"**) is becoming prevalent in our society and is used in various domains to resolve complex issues. Similarly, the adoption of AI in healthcare is growing due to its potential to radically transform aspects in patient care and administrative matters. This technology is being used in settings such as hospitals, clinical laboratories and research facilities to comprehend data which were previously unrecognised by clinical practitioners and healthcare organisations. There are many research studies that indicate AI can perform key healthcare tasks, such as medical diagnosis, as well as or even better than humans. However, the technology still faces limitations in the field and will require more time before it can replace humans for broad medical processes. This report will highlight key milestones in the development of AI technology in healthcare industries, various applications of this technology and how it is applied to the healthcare sector in Singapore.

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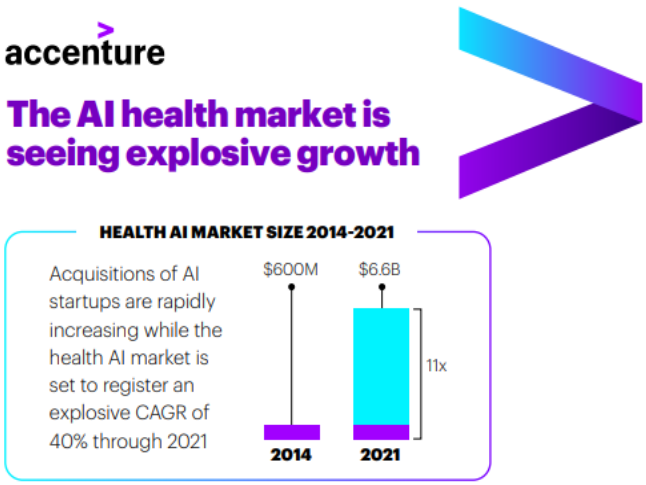
What is AI in Healthcare?

Artificial intelligence ("**AI**") involves the use of complex algorithms and software to mimic the cognitive ability of humans. In other words, AI has the ability to perform specific tasks in an automated fashion, without direct human input. Extending AI to the medical field, it is able to analyse, interpret and perform complicated medical tasks, such as assisting in and/or performing surgical procedures.

The use of AI technology can be applied to mainly the virtual and physical aspects of healthcare. For example, virtual applications may range from maintaining and updating healthcare records to making treatment decisions based on inputs drawn up from the analysis of past records. On the other hand, physical applications involve the use of robots to assist in performing surgical procedures and in supporting rehabilitative care.

Currently still in its infancy, the applications of AI in healthcare still have much room for improvements. Some notable areas of growth may include basic administrative functions like data collection and also more sophisticated tasks such as medical diagnosis or the research of new drugs. There are still many potential avenues yet to be explored, some of which could lead to massive breakthroughs in the healthcare field. As such, the AI healthcare industry is expected to expand greatly over the next few years.

According to Accenture, the AI healthcare market was at US$600 million in 2014 and is projected to grow 11 times to reach US$6.6 billion by 2021 at a compound annual growth rate ("**CAGR**") of 40%.



Source: Accenture Analysis

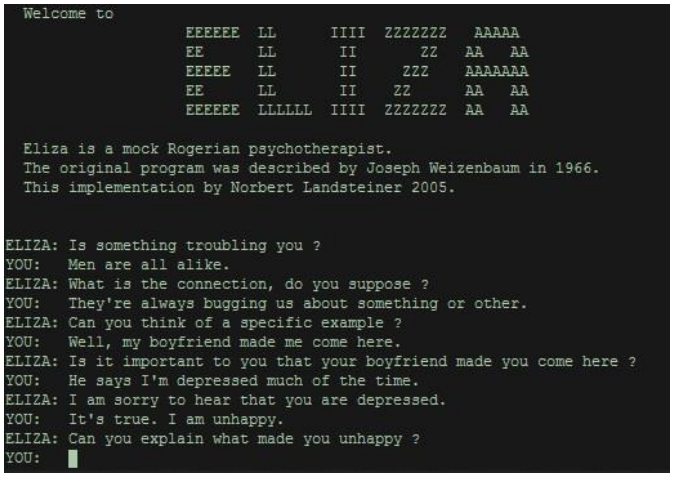
Development of AI

Early Years

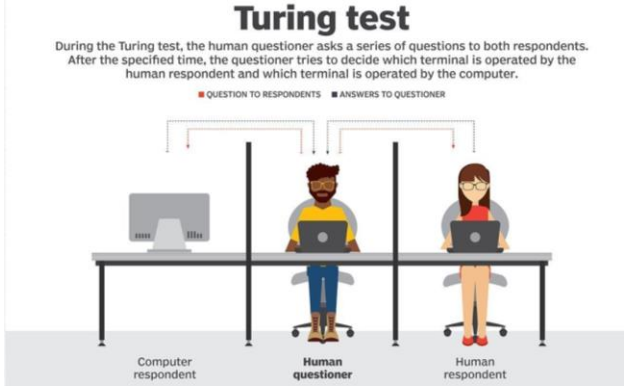
The term "Artificial Intelligence" or "AI" was first coined by a group of scholars at Dartmouth College in 1956. The genesis of the idea of AI was to leverage the potential of machines to solve complex problems unattainable by the human brain.

In the 1960s, MIT professor Joseph Weizenbaum developed the world's first chatbot, ELIZA. By using a "pattern matching" and substitution technique, ELIZA was able to simulate conversation and give users an illusion of communication between human and machine. In truth, ELIZA was running on "scripts", which allowed it to process user inputs and reply following the rules and directions of the script despite not having contextualise any events.

One of the most famous script was a simulation of Rogerian psychotherapist. The script, DOCTOR, could respond to user inputs with non-directional questions. Some people claimed that ELIZA was one of the first programs to pass the Turing test, which is a test of a machine's ability to exhibit intelligent behaviour similar to a human.



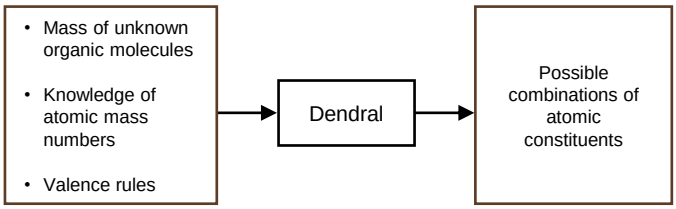
Source: Wikipedia



Source: TechTarget

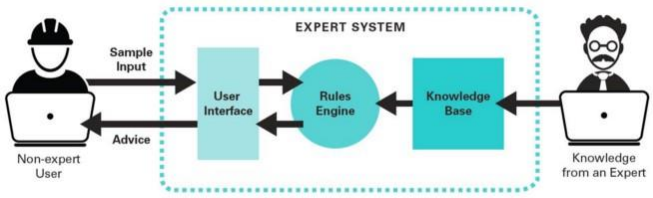
Major Milestones

At around the same period, a team from Stanford University initiated a project in AI named Dendral. The primary aim of the project was to develop a software to help organic chemists to identify unknown organic molecules through the analysis of their mass spectra and chemistry knowledge. Unlike ELIZA, Dendral is an expert system which was programmed to make decisions like a human expert by reasoning through bodies of knowledge.



Source: SAC Capital

Further building on from Dendral, MYCIN was an expert system developed in the 1970s that was capable of identifying infection-causing bacteria such as in the case of meningitis and bacteremia, and was able to recommend antibiotics accordingly. MYCIN was even capable of adjusting the dosage according to the patient's body weight.



Source: medium.com

During the 1990s, there were major advancement in the field of AI such as machine learning, data mining, natural language understanding, and virtual reality. During this period, AI demonstrated vast potential to match up to the cognitive ability of humans by competing and surpassing world-class players in strategic and tactical games. Some other uses include deep sea exploration and space exploration.

Today

As AI continues to evolve, its usefulness is no longer restricted by human cognitive abilities. The technology has proven that it is able to outperform its by accomplishing tasks that are beyond the human capabilities. Two of the major aspects of AI today are Natural Language Processing ("**NLP**") and Machine Learning ("**ML**"). NLP involves the use of AI to analyse human language data. NLP allows AI to read, interpret and understand the human languages. Some of the applications include translation, detecting emotion, information extraction and question answering.

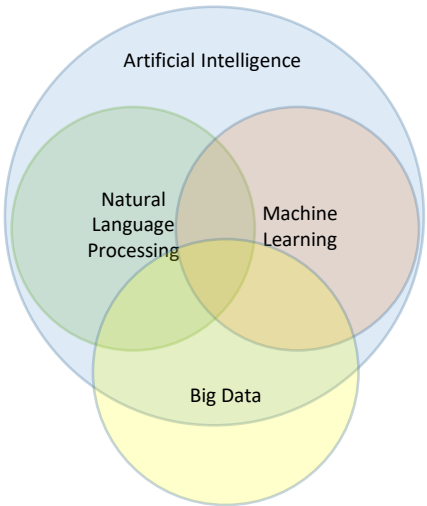


Source: smartsheet.com

On the other hand, ML is an application of AI that focuses on the ability to automatically learn and improve from experience without being explicitly programmed to do so. ML is often used to improve the function of NLP.

Another concept that is closely linked to AI is big data. As its name suggests, big data are sets of extremely large amounts of data which could be analysed to reveal patterns, establish trends and form associations between two sources.

Together with the many other aspects of AI, these three concepts allow AI to continue to improve and make it more useful for our daily lives.



Source: SAC Capital

Applications of AI in Healthcare

In the field of healthcare, the use of AI technology is becoming more prevalent. Some of the notable applications include automated workflow assistance, medical risk prediction, AI-assisted robotic surgery, medical image analysis and drug discovery.



Source: Accenture analysis

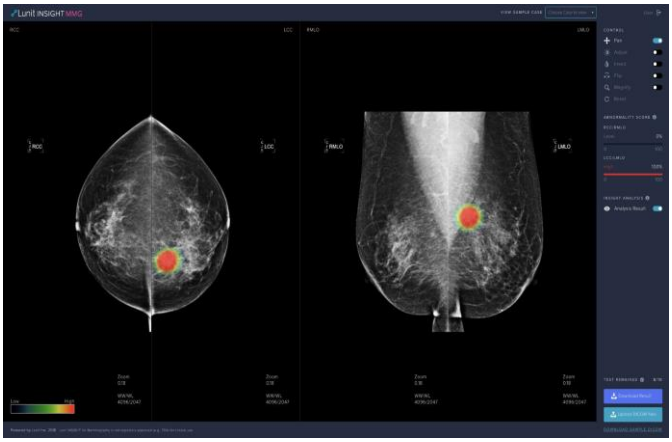
Medical Diagnosis

Through the use of statistically based ML models to analyse the enormous amount of medical data, AI is able to recognise healthcare patterns that could be used to build analytical models that could detect the onset of diseases. Effectively, AI is able to determine if a patient has a certain disease even before the patient has developed any evident symptoms.

One of the most common use is in cancer diagnosis. Traditional radiology methods were found to obtain false negative almost 30% of the time and according to research from the American Cancer Society, mammograms reviewed by medical practitioners also often resulted in wrong diagnosis, causing 1 in 2 healthy women to get false cancer positive results. The application of AI in cancer diagnosis has immensely improved the accuracy of the results.

In 2013, a group of South Korean scientists from KAIST University developed an AI program named LUNIT. LUNIT was able to identify cancer cells using x-ray and mammography images to diagnose lung and breast cancer at a remarkable accuracy of 97%.

Additionally, LUNIT can review mammography images 30 times faster than a doctor. The use of LUNIT has significantly refined the cancer diagnosis process by improving the accuracy and speed as well as reducing the need for unnecessary biopsies resulting from false positive results.



Source: LUNIT Inc.

Automated Workflow Assistance

Many administrative duties in the healthcare sector are increasingly being performed by AI. Administrative procedures such as clinical documentation, medical records management and claims processing can be managed more efficiently and cost-effectively through the use of AI. For example, healthcare organizations are deploying chatbots in replacement of call centres to address basic queries and perform menial tasks such as appointment booking. Leveraging AI in this area can also help to remove human error and decrease unnecessary waiting time. A study conducted by Business Insider Intelligence showed that 30% of healthcare costs arise from administrative tasks. The automation of such tedious and menial tasks helps to not only reduce the workload of healthcare workers but also speeds up the process in a cost-effective manner.

Wearable Technology and Health Apps

Consumer wearables refer to smart devices that are worn in close contact with the users' skin and are capable of tracking and collecting users' data, such as fitness trackers, smart health watches, wearable electrocardiogram and blood pressure monitors. Integrated with AI, these wearable technology can detect, collect, analyse and transmit users body signals such as vital signs, steps walked, calories burned and time spent exercised. A recent report by IDTechEx cited that the wearable technology market reached a size of over US$50 billion in 2019, double its size in 2014. Wearable technology is commonly paired with consumer health apps to facilitate user experience.

While consumer wearables are mostly used to track and collect the users' health data, health apps provide the platform for users to manage and monitor their health habits and lifestyle. Together, wearable technology and health apps enable individuals to proactively manage their lifestyles and to take responsibility for their personal health and well-being.

In 2019, insurance group AIA partnered with local telecommunications provider Singtel to introduce a wellness app called StepUp. Based on the number of steps taken daily over a month, the platform allowed customers to redeem rewards, such as free local mobile data and vouchers. This was part of AIA's bigger effort to raise awareness on healthy living and to encourage active lifestyle.

Over time, health data collected could be further analysed by medical professionals, who could then better understand the health habits of the individual. This could allow for the prevention of chronic conditions arriving from unhealthy lifestyle. Collectively, data collected could also draw trends in the population and help in strategising health policies that would be more well suited for the general public.

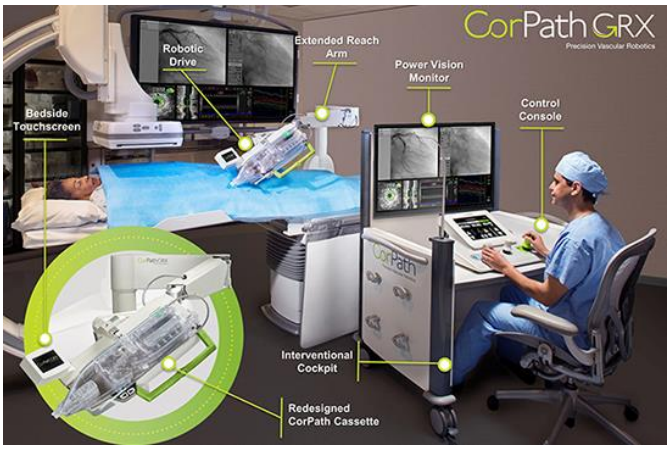
More advanced wearables can also allow healthcare workers to remotely monitor patients and thus to administrate treatment in a timelier manner. An example would be BioHarness, a wearable device produced by Zephyr Anywhere that is attached to the chest. BioHarness can track patients' health conditions by the minute and will send a message to the smartphones of healthcare professionals-in-charge when irregular readings are recorded. This allows patients to be monitored remotely and also for timelier intervention should the patient's condition deteriorate suddenly. Additionally, this can also free up resources and capacity of healthcare professionals to attend to patients with more urgent needs.



Source: Zephyr Anywhere

Robotics

The is one of the earliest and perhaps most important application in the healthcare industry. Robots have been used in the field for more than 30 years. Simple laboratory robots can aid clinicians in the execution of repetitive tasks in areas such as rehabilitation and physical therapy while more complex robots can even perform surgical procedures all on their own. The most common usage today is robot-assisted surgery. Some of the more complex procedures executed with robotic assistance include removal of brain tumours, retina surgery, total knee replacements and even heart surgery. An example is the use of CorPath GRX, in which surgeons can perform surgical procedures remotely using joysticks.



Source: Corindus

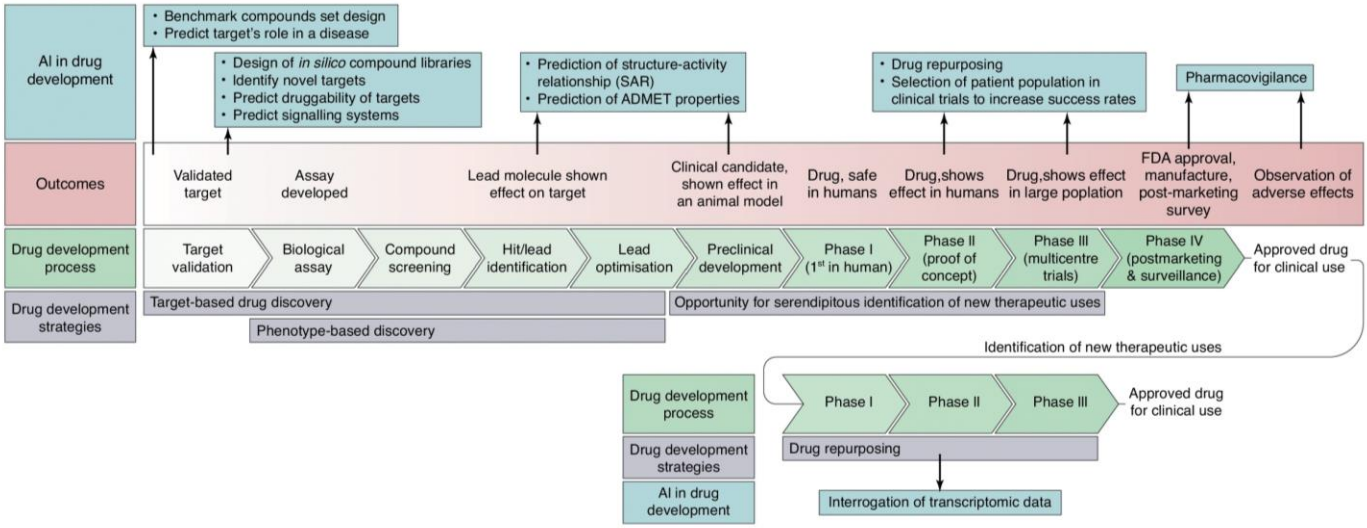
The use of robots in surgical procedures can result in more precise and effective process. An example is minimally invasive surgery. During the surgery, the use of a robot can make smaller incisions which results in decreased blood loss in the surgical process and faster healing time.

Research and Drug Development

Traditionally, drug development is a costly and lengthy process with a high rate of failure. According to the California Biochemical Research Association, only 5 in 5,000 drugs that have begun pre-clinical trials will make it to human testing. Thereafter, only 1 in 5 of them will manage to gain approval for human use. Furthermore, it takes an average of 12 years for a newly developed drug to be ready for patient use and costs an average of US$359 million to develop a successful drug.

Facing the high attrition rates in drug development, the use of AI in the various stages of the process can hugely improve the efficiency of new drug development.

Utilisation of AI in the drug development process

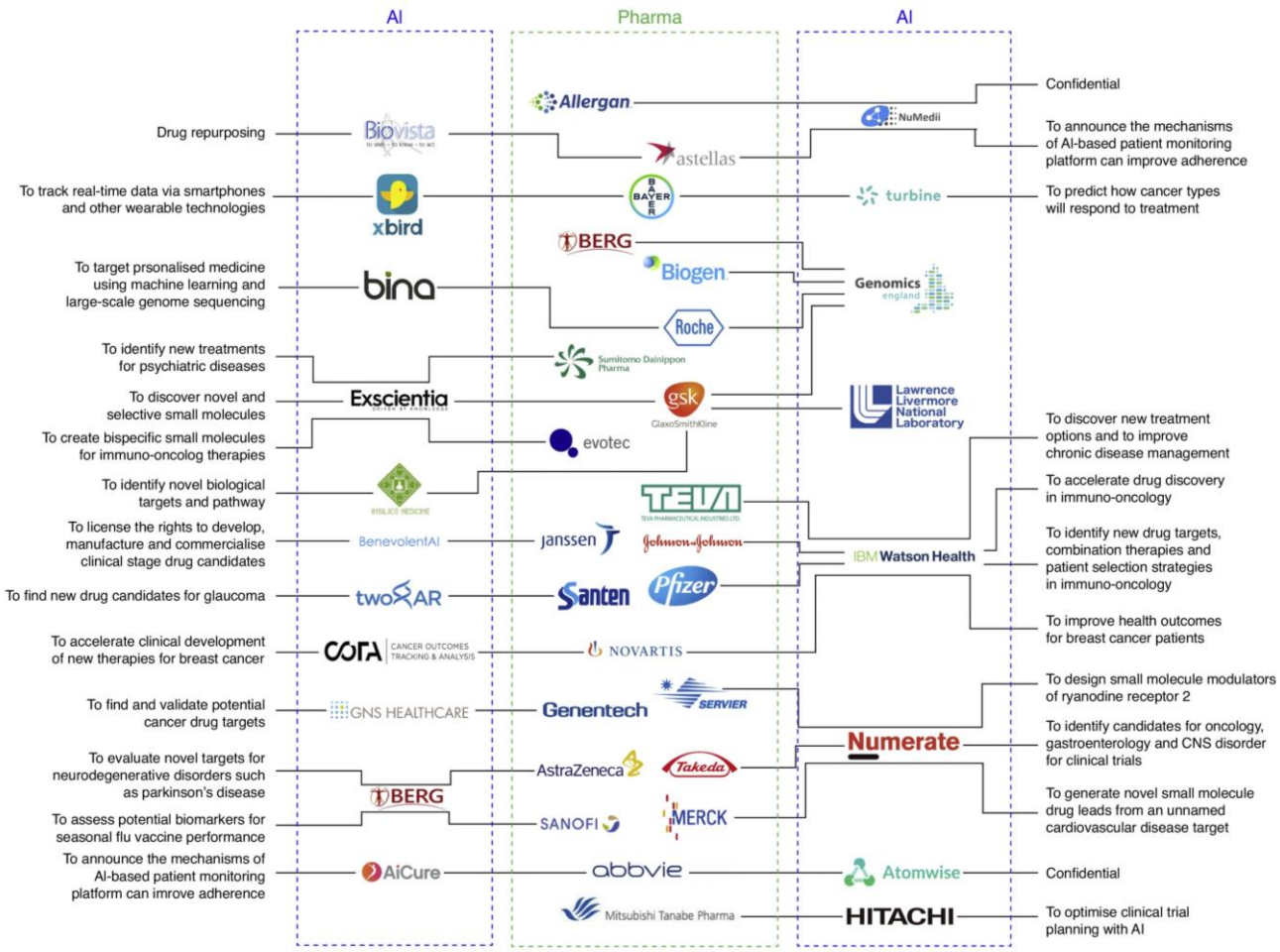


Source: Artificial intelligence in drug development: present status and future prospects by Kit-Kay Mak and Mallikarjuna Rao Pichika

Drug Discovery Today

In recent years, numerous partnerships have been formed between the pharmaceutical industries and AI companies in an effort to develop better healthcare tools, including the development of new drugs. Experts believe that AI would change the pharmaceutical industry and improve the drug development process.

Partnerships between AI and pharmaceutical companies



Source: Artificial intelligence in drug development: present status and future prospects by Kit-Kay Mak and Mallikarjuna Rao Pichika

Drug Discovery Today

AI in Healthcare in Singapore.

AI in Health Grand Challenge

Launched in 2018, AI in Health Grand Challenge is an initiative started by the Singapore government with an aim to encourage research and development in AI. Organised by AI Singapore, the contest challenges local enterprises to build AI applications capable of contributing to Singapore's goal to reduce the number of hyperglycemia, hyperlipidemia and hypertensions patients by 20% by 2024. According to the Ministry of Health, these three conditions dubbed the "three highs" are expected to affect 26% of the Singapore population in 2020 or 1.5 million Singaporeans. The top three teams were granted S$5 million each in 2019 to continue their research and a final selected finalist is expected to receive investment of up to S$20 million.

BRAIN

Integrated Health Information System ("**IHiS**"), a technology agency for the public healthcare sector, was formed to develop platforms for the collection and analysis of health data. IHiS has constructed a Business Research Analytics Insights Network ("**BRAIN**"), which is able to compile large pool of data from numerous sources and sort them into different profiles. The information serves as the backbone for population profiling. For example, in combating diabetes, BRAIN can be used to gather demographic information on current patients and high-risk groups, such as their localities. Such information could be used by the government in policy planning, such as deciding areas for building of certain healthcare facilities.

Selena+

Jointly developed by Singapore National Eye Centre's Eye Research Institute and National University of Singapore's School of Computing, Selena+ is a system that detects eye conditions using AI. Traditionally, retinal images were processed by human graders across three levels of checks. The primary grading process, which consists bulk of the menial work, is set to be replaced by machines. By taking over the tedious primary grading process, Selena+ can tremendously improve the efficiency of eye checks. Having undergone an initial trial period in November 2018 across a few polyclinics, the system processed over half a million images in a few months. The adoption of Selena+ resulted in quicker eye check-up process for the patients, reducing the waiting from an hour to approximately three minutes. Put to the test in multiple trials, Selena+ shows that it can function as good as, if not better than, a trained grader. The system is set to be deployed across Singapore by 2022 to help detect eye conditions.

Discovery AI

Discovery AI is a 'sandbox' idea launched by National University Health System ("**NUHS**"). The aim is to create a platform to tie different AI tools togethers to maximise the usefulness of the enormous amount of hospital data. Set to be deployed across NUHS network of hospitals, such as National University Hospital, Ng Teng Fong General Hospital and Jurong Community Hospital, Discovery AI aims to transform the work of the healthcare workforce. By minimising the time taken to retrieve, collate and review patient and healthcare data, health professionals can be freed up to engage in other pressing duties such as direct patient care and decision making.

Discovery AI also aims to build up an intricate network of patient data, which will provide doctors with an overview of every single patient in the hospital. Through the network, doctors can access information of a patient, such as basic demographic, medical condition history and length of stay. The AI system built could even predict the probability of a patient being re-admitted. This will allow doctors to take measures to prevent such occurrences through more targeted and better treatment decision.



Source: Channel News Asia

Another example of AI being deployed in the hospital is a contactless vital signs monitor. This technology can read and monitor a patient's heart rate and blood pressure remotely and even when the patient is asleep. This not only reduces the man-hours it takes to collect vitals but also allow patients to enjoy uninterrupted rest.

Challenges of AI in Healthcare

Loss of jobs

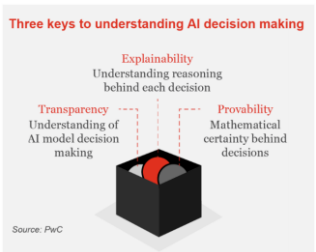
According to a research by the American Hospital Association, 40% of non-clinical tasks and 33% of clinical work could potentially be replaced by AI. With AI being increasingly used in all areas of the healthcare supply chain, some activities that were traditionally performed by humans can now be replaced by machines, such as medical record maintenance. Some examples could be the maintenance of medical records and parameters taking of patient during triaging.

While having these new technologies may cause certain job losses, it will also in return create new openings such as the facilitation of AI in healthcare. For example, healthcare workers could now be tasked to ensure integrity of the data being fed into the AI program. Some other high-skilled roles can also be created, such as data scientists, AI engineers and data entry experts.

Even though AI can perform many human tasks with greater efficiency and accuracy, patients may still prefer face-to-face interactions. This is because relationships and soft skills such as care and empathy will continue to be important aspects of healthcare, something that AI is unable to replicate at this juncture.

Blackbox decision-making

In many instances, AI arrive at a decision based on the inputs and some formulated algorithms that were fed to the system. While a doctor can furnish documents and provide justifications for their decisions at the various stages of treatment from diagnosis to discharge, AI cannot do the same. The lack of explainability, transparency and provability make it difficult for human to understand the decision making process of AI. Moreover, data remains the driving force of many AI system. The lack of information or overreliance of historical data could potentially result in erroneous prediction and inaccurate diagnosis.



Source: PwC

Data Privacy Issues

The use of big data is the foundation of many AI programs. However, given that these data are often collected through a variety of different sources, including medical records, pharmacy records and information from wearables, this may increase the risk of an information leakage.

By nature, healthcare data is highly sensitive information and should be kept private and confidential. For AI to be fully integrated into the healthcare system, sufficient defensive measures should be in place to protect these healthcare data from hacking threats. Due to the rapid pace of technological development, cybersecurity has not been able to keep up in the healthcare space and is in need for further improvement. According to a report from Protenus, over 41 million patients' records were breached in 2019, which is almost 3 times of 2018 figures.

In addition, the collected data often come from different sources and arrive in different forms. Fragmented and incompatible data can increase the probability of errors when used in a predictive AI and having to process these data increases the overall cost to use the AI system.

Limitations of AI functions

There are still areas in healthcare that AI not be able to replace. Medical professionals, especially doctors, are required to obtain the necessary qualifications and licenses before they are qualified to look after patients as well as to give out medical advices and diagnosis. Although data, measurements and analytics are important aspects of a doctor's job scope, setting up a diagnosis and attending to a patient are not linear processes. It requires creativity and problem-solving skills that robots and AI are still currently unable to achieve and replace.

Furthermore, according to a study conducted by Massachusetts General Hospital, it was found that strong patient-doctor relationships can induce positive effects on patient health and its effect is comparable to common treatments such as taking aspirin daily to prevent heart attack. Due to informational asymmetries, patients can only rely on the doctor's expertise and judgement in the treatment process. AI is unlikely to replicate this physical relationship exists between humans.

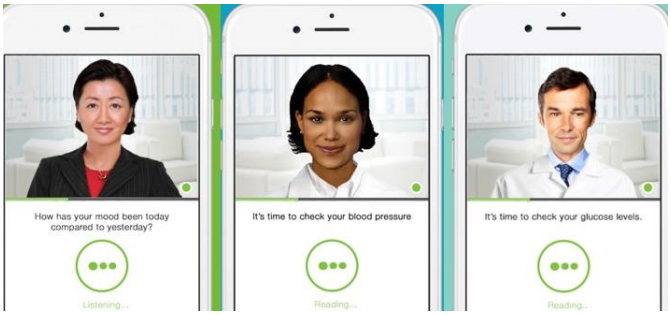
What's Next?

Incorporation of Unstructured Data

Most of the current AI programs focus on the analysis of structured data, such as electronic recordings, images and physical examination notes. However, there are still a large amount of unstructured data, like handwritten medical memos that are useful, but not a major part of the analysis. Understanding these unstructured data can provide more insights and potentially further improve the accuracy of the AI predictive outcome. In-depth analysis of written hospital memo can also provide key details on the reasons behind a treatment decision, which will be instrumental to the formulation of the algorithm on the decision-making process.

Virtual Nurses

Just like virtual assistants such as Amazon Echo and Google Assistant, virtual nurses are likely to be a mainstay in the future healthcare scene. Virtual nurses are envisioned to mimic the role of a caretaker, who is capable of watching over the patients, reminding patients to take their medication, provide advices on vitals signs and even answering queries from the patients.



Source: Mobi Health News

Acceleration of Research and Development

As mentioned earlier, the partnerships between AI and pharmaceutical companies are likely to accelerate the development of new drugs. With the help of AI, the healthcare industry is likely to experience an acceleration in terms of development of medical knowledge and treatment methods.

AI-powered Predictive Care

In the future, we can also expect AI to enable mobile applications to have real-time conversations with users. With the help of historical data inputs, the AI mobile application will initiate conversations with people that are currently battling an illness or are at risk of developing one. For example, the app will advise patients with depression or anxiety to talk to friends and family or even seek help from a counselor to prevent the patient's condition from worsening. Diseases like glaucoma and ovarian cancer can also be easily detected through non invasive techniques. These algorithms for early detection are still in the works, but after perfection, the app will have an accuracy of 89% to 92%.

Comprehensive Surgery Guidance

With technological advancement of AI, robots in operating rooms will not only be limited to hand movements assisting surgeons. We can expect these robots to offer guidance towards diagnosis and interpretations of complex medical conditions. Data from surgeries across the world will be fed into the system, allowing these machines to offer vast amounts of guidance. Before each procedure, surgeons will be able to better prepare ahead of time which can help to reduce human errors.

Conclusion

Artificial Intelligence is transforming the healthcare industry positively. From more accurate medical diagnosis to better patient care, AI will continue to enhance patient experience and healthcare expertise. Moving forward, we expect the technology to continue being an integral part of the healthcare sector. With AI's intelligent architecture and ability to function without constant human inputs, it will be able to overcome many complexity and challenges that humans previously faced. However, the delivery of healthcare cannot totally be replaced by AI as human elements in patient care are still irreplaceable. As such, in the near future, a system that incorporates both technological innovations and human care will remain the ideal hybrid model.

Examples of Publicly Listed Companies with AI Healthcare Involvement

Alibaba Group Holding Limited (NYSE: BABA) Alibaba Cloud, a subsidiary of the Alibaba Group, invented the AI ET Medical Brain. The technology offers a wide range of AI-based solutions for the healthcare industry, including drug development, medical imaging, improving the accuracy of detection and minimising wrong diagnosis.

UnitedHealth Group Inc (NYSE: UNH) Optum, the health services arm of UnitedHealth, is utilising AI to collect data to predict illnesses like heart conditions. Doctors can better diagnose patients based on all the information and parameters from past visits.

Pfizer Inc. (NYSE: PFE) The company is utilizing IBM's immuno-oncology AI technology to allow the body's immune system to battle cancer cells. The company also uses AI technology to process published medical papers at a much faster rate than humans, thereby allowing for faster and better discoveries of drugs

Merck & Co, Inc. (NYSE: MRK) The company is utilizing machine learning AI software to speed up the drug development process. The technology allow researchers to extract useful information from huge data bases, predict properties of useful compounds and generate leads from new compounds.

AstraZeneca PLC (LSE: AZN) The company aims to use AI to analyse over 2 million genome sequences in the next few years to identify areas of the genes that are responsible for different diseases. This will enable for better targeted treatments and to better select patients based on their personal particulars, resulting in more effective clinical trials.

Eli Lilly (NYSE: LLY) The company has partnered with BenevolentAI to crunch data from its past clinical trails which enable them to discover that rheumatoid arthritis drug might be useful to treat Covid-19 patients. As of June this year, the company has started on phase 3 clinical trail with 400 Covid-19 patients.

Intuitive Surgical Inc (NASDAQ: ISRG) The company invented the da Vinci robotic surgical system, which aims to increase the adoption of robots to conduct minimally invasive surgery. The system has performed over 7.2 million surgical procedures and is expected to increase with demand from older individuals.

Vertex Pharmaceuticals (NASDAQ: VRTX) The company adopts technology which aims to see AI-discoveries of new drugs and treatments, which would enable pharmaceutical researchers to develop new drugs at a much faster pace as well.

Teladoc Health Inc (NYSE: TDOC) The company provides virtual healthcare services. With the use of AI, it is able to predict, screen, diagnose and even automate drug delivery to patients, making it more efficient.

Ping An Healthcare and Technology Company Limited (SEHK: 1833) The company regards AI as one of its core technologies. The company utilises a series of AI solutions which enable early predication of diseases such as Influenza and diabetes. Furthermore, the company deploys deep learning, data mining and biometrics to enable it to perform complex healthcare tasks such as decision making and facial recognition.

Raffles Medical Group Ltd (SGX: RFMD) The company's AI initiatives include the streamlining of dispensary and transactions for patients, creating better omnichannel experience when patients shop for medical products. all medical records can be digitised and unified. They aim to see better engagement and productivity and improve the quality of patient care.

Alcidion Group Limited (ASX: ALC) The company uses AI to help improve clinical workload efficiency and patient safety. The company recently launched Miya MEMRe, which allows healthcare providers to review their current activity and caseload, be alerted of urgent issues and also access patients records on the same platform. This technology has seen great success with its recent implementation with the NHS.

Clearbridge Health Ltd (SGX: CBH) The company utilizes AI technology to create an avenue for the delivery of Precision Medicine (PM) to countries in the ASEAN region. The creation of PM can be attributed to the Deep Belief Neural Network in machine learning. It takes into account the patient's individual profile like their genes and the external environment, thus allowing doctors to derive a better targeted treatment.

ResApp Health Limited (ASX: RAP) The company has used machine learning technology to come up with accurate algorithms which can diagnose diseases based on cough and respiratory sounds. The technology is able to match the patient's sound to a huge database of sound recordings with know clinical diagnoses. As the platform is based only by sound and does not require physical interactions with the patient, diagnosis via smartphones is also made possible through high quality built-in microphones incorporated in these devices.

Selected Financial Statistics

Company	Tkr & Exch	Mkt Cap (S$'M)	Last Px (SGD)	Revenue: Latest FY (S$'M)	Gross Profit: Latest FY (S$'M)	GM: Latest FY	NI / Profit: Latest FY (S$'M)	PM: Latest FY	EV/EBITDA: Trailing 12M (X)	P/E: Latest FY (X)	P/E: Trailing 12M (X)	P/B: Latest FY (X)	P/B: Trailing 12M (X)
Alibaba Group Holdings	BABA US	1,054,201.8	389.62	100,389.0	44,776.1	44.6%	29,431.3	29.3%	24.7	30.8	43.8	4.9	6.4
UnitedHealth Group Inc	UNH US	416,040.9	438.5	330,326.9	78,570.2	23.8%	18,878.0	5.7%	13.4	20.5	18.5	4.8	4.7
Pfizer Inc	PFE US	274,405.7	49.4	70,592.9	56,653.0	80.3%	22,198.2	31.4%	9.4	17.5	15.2	3.4	3.1
Merck & Co. Inc.	MRK US	265,423.5	104.9	63,895.1	44,644.7	69.9%	13,427.0	21.0%	15.9	17.6	13.6	8.9	7.0
Astrazeneca Plc	AZN LN	194,071.7	147.9	33,262.5	26,549.7	79.8%	1,821.1	5.5%	21.3	98.0	66.1	10.1	11.6
Eli Lilly & Co	LLY US	170,949.9	178.7	30,446.3	24,006.1	78.8%	11,347.2	37.3%	21.9	23.0	19.8	48.3	26.0
Intuitive Surgical Inc	ISRG US	109,395.8	930.6	6,109.2	4,242.7	69.4%	1,881.5	30.8%	41.0	51.5	84.2	8.3	8.7
Vertex Pharmaceuticals Inc	VRTX US	74,911.6	288.1	5,678.6	4,931.4	86.8%	1,605.3	28.3%	40.9	47.9	26.0	9.3	6.8
Teladoc Health Inc	TDOC US	38,491.9	266.4	754.8	503.1	66.7%	-134.9	-17.9%	N/A	N/A	N/A	6.0	7.4
Ping An Healthcare And Techin	1833 HK	20,955.9	18.3	1,000.3	231.3	23.1%	-144.9	-14.5%	N/A	N/A	N/A	5.6	10.1
Raffles Medical Group Ltd	RFMD SP	1,454.2	0.8	522.0	N/A	N/A	60.3	11.5%	17.9	30.1	28.8	2.2	1.7
Alcidion Group Ltd	ALC AU	120.1	0.1	17.3	4.5	26.0%	-2.9	-16.5%	N/A	N/A	N/A	4.8	4.2
Clearbridge Health Ltd	CBH SP	90.2	0.1	21.5	N/A	N/A	-10.5	-48.8%	N/A	N/A	N/A	1.6	1.4
Resapp Health Ltd	RAP AU	61.8	0.1	0.0	0.0	N/A	-7.9	#VALUE !	N/A	N/A	N/A	18.4	8.8

As at 4 November 2020
N/A: Not Applicable
Source: Bloomberg, SAC Capital

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