

academic report

How Artificial Intelligence Can Transform the Medical Industry

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# Introduction

Artificial Intelligence (AI) has commonly been labelled as a disruptive or an intrusive force, invading industries globally (Rasouli, 2020; McCartney, 2023). Regardless of this, AI has the potential to revolutionize the practice of traditional medicine and patient care. Also, its prospective ability to solve the strenuous workforce shortage in the medical industry and reduce costs by, for example, estimating and planning the distribution of resources, makes it beneficial for the future of the industry.

AI has the capacity to alternate multiple different fields of medicine with the application of different subcategories of its technology. Subcategories of AI differ in their specific technical details and include, for example: virtual reality (VR), machine learning (ML), and deep learning (DL) (Moore, 2023). With the capabilities to review extensive data, from patient records and surgical videos to scans and reports, it can process those details and solve problems accordingly (McCartney, 2023). This Academic Report will discuss the recent developments in various specific applications of AI within the medical institution.

# AI in Pharmacology

AI has already been used in pharmacological companies, especially in the research stage. However, the use of AI is not yet well established, and it varies from one company or research institute to another. This indicates that the utilization of AI is in its early stages, while the development of this technology is exceedingly fast (Taekyn & Wonjoon, 2023; Van der Lee & Swen, 2023). The pharmacological industry is on the verge of a technological revolution. Companies may have to reconsider their strategies to make sure that the best course of action is chosen and to find ways of integrating into the rapidly evolving situation. The companies that can adapt to this change proficiently and produce innovations will be the ones that succeed in the future.

## 2.1. Developing new drugs

AI can be efficiently used in the process of discovering new drugs. The process of developing new drugs has traditionally been time-consuming and costly. Many promising projects get discontinued because of the unforeseen obstacles that emerge during the process and those obstacles suggest that the drug being developed will not make it to the final stages (Hughes, Rees, Kalindjian & Philpott, 2010). This has been a great challenge for pharmaceutical companies for a long time, but now, with the use of AI, this can be tackled in a completely new way. AI can be applied in drug discovery to analyze chemical compounds likely to be successful and reach the marketing stages of the process (Van der Lee & Swen, 2023)

One of the more specific obstacles the medical industry must overcome nowadays is the antibiotic resistance in bacteria. If this concern is not adequately tackled, the problem will grow remarkably in the future, and it has the possibility of taking us back to the era before antibiotics (Antimicrobial Resistance Collaborators, 2022). AI has been successfully used to discover new antibiotics. Researchers at the Massachusetts Institute of Technology (MIT) used AI and especially machine learning algorithms, to discover a new molecule that has antibacterial properties like no other existing antibiotic (Trafton, 2020). This molecule is called “halicin”, and it was originally developed as a medicine for diabetes, but with the help of AI, a new way of using it was found (King, 2020). Although “halicin” is still in the research process and has not yet been approved for human use, this works as an encouraging example for the possibilities of AI in the pharmacological industry. When the development of a new drug has progressed to the stage of clinical trials, data mining can be used to assess the proper participants for the trial and later to analyze the clinical data from the trial (Van der Lee & Swen, 2023).

## Medication optimization

The use of medication is not always straightforward or easy. There are a lot of aspects to take into consideration when medical professionals decide on drug therapy. Individual differences and the uniqueness of people mean that proper use of drugs may be good for one but not suitable solution for another. Utilization of AI in optimizing medication is an interesting possibility for the future (Van der Lee & Swen, 2023). VR enables the simulation of biological processes in pharmacy and can increase the accuracy and efficiency of the drug development process. VR could also be used in clinical practice to educate medical workers and patients (Qiulin & Li, 2022).

To train the AI to optimize medication, it needs large pools of patient data, and the use of this data comes with legal constraints. Patient data is not readily available for the companies, and the use of it comes with ethical concerns. Van der Lee and Swen cite the article ‘A computational platform integrating a mechanistic model of Crohn's disease for predicting temporal progression of mucosal damage and healing’ to introduce the idea of using a “digital twin” to represent the real-life patient, and with the use of AI and this “digital twin”, the drug dosage could be optimized and personalized, and the side effects would be minimized (Van der Lee & Swen, 2023: 34). If companies and research centers had broad access to different data pools, this would benefit the whole industry and help to develop drugs faster and more efficiently (Lluka & Stokes, 2023: 87). However, this noble thought may conflict with the work that is done in profit-making pharmacological companies, since there is pressure to maximize the profits.

## Companies adopting revolutionary technology

The pharmaceutical companies will undergo a fundamental technological change that has already begun. Competition and collaborations between rival companies will be the main characteristics in this development. Depending on the strategy a company has decided on, they will likely experience either early entrants benefit of deeply comprehending the basic technology behind AI and its subcategories or late entrants benefit of learning the applications without the groundwork (Taekyun & Wonjoon, 2023).

Aspects to take into consideration with the fast-pacing technological revolution mainly focus on the input data and include, for instance, the integration of the data used, matters of privacy, and regulatory compliance. Results for the use of AI and its subcategories are only as good as the data used, so the human interpretation of the results will always remain (Qiulin & Li, 2022; Van der Lee & Swen, 2023).

# AI in Surgery

The recent developments in AI have made it possible to introduce this type of technology as a quotidian occurrence in the operating room. The idea of AI being used as a tool in surgeries, has been around from the late 1950s (Beyaz, 2020) but has evolved over time into a much more complex theoretical and more recently a practical objective. The rate at which AI has transpired from being used for the first time in orthopedic surgery via a ROBODOC system in 1992 (ibid.), to now with the STAR system preforming successful intricate surgery on animals without any human intervention (Graham, 2022), has been gradual. Despite the resistance from medical professionals in doubt and threatened by the technology, AI has the inherent future of enhancing the business of surgery and becoming a widespread practical assistant in surgical operations.

## 3.1 Benefits in surgery

As the cost of healthcare is increasing with an unrealistic rate regarding the sustainability and management of the industry, AI could potentially save countless billions in surgical expenses, by creating a more labor-saving and cost-effective way of conducting surgeries as well as aftercare. Recently Stanford researchers tested ChatGPT’s capabilities through a study with a simulated version of the US Medical License exam, and the chatbot passed successfully (Strong, 2023). This proves that AI does possess the required attributes to interpret demanding medical situations and respond accordingly. Thus, through guiding surgeons during difficult situations, AI could further the efficiency and effectiveness of performing operations and making decisions. With the guidance of AI, the surgery can also become safer, and the risk of complications can be reduced closer to none. A safer surgery method is currently being researched in an international project, with the aim to create a safer way of conducting laparoscopic cholecystectomies by projecting an overlay on the surgeons screen during operation and utilizing AI to offer next steps and safe operating areas in addition to alerting the surgeon about the mistake they might be about to make (McCartney, 2023). In addition, AI could be used as an educational tool for the benefit of future surgeons at various levels, further cutting costs and improving the fields level of expertise.

## 3.2 Limitations in implementation

Although the progression pace has increased, the full reach of AI’s capabilities has only been explored on the surface. The impediment to achieving the full scope of abilities is the adamant attitude from some acclaimed surgeons, who are afraid of being vanquished by the new technology. Although to some extent reasonable, with studies indicating AI as more successful than humans in respect of performing surgery, this concern is disregarded by experts who believe that the absolute replacement of humankind from the operating room is highly unlikely, due to the necessity of experience and long-term results of traditional methods (Beyaz, 2020; McCartney, 2023). The immanent issues regarding regulations, ethical matters, and accountability related to complications during the surgery, are also of concern. As well as the obstacle of the framework that is needed to deploy AI, currently being behind on its developmental stages compared to the ML (McCartney, 2023). These predicaments make AI propitious, yet ambivalent. Nonetheless, healthcare professionals that realize the power AI holds are investing into the technology and as the Grand View Research (2023) recently forecasted, the global market is expected to grow at compound annual rate from approximately 4 billion in 2023 to 7 billion by 2030 in USD, with the growth rate of 9.4% starting from the year 2024, as shown in the figure 1.

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Description automatically generated**

Figure 1 U.S. Surgical Robots Market (Surgical Robots Market Size, Share &Trends Analysis Report by Application (2023)

# AI in Prediction

With the recent rapid pace of development in technology, AI-driven predictive models have emerged as a transformative force within healthcare. The significance of predictive AI in healthcare lies in its ability to foretell certain diseases and anticipate an impending outbreak when provided with sufficient related data.

## Disease Prediction

Predictive AI has evolved to the extent that it can forecast the probability of illnesses in patients by analyzing multiple datasets such as lifestyle, health records, and genes (Graber-Stiehl, 2023). Cancer and epilepsy are two notable diseases that, with the help of AI, can be mitigated prior to a diagnosis.

### Cancer

It is generally believed that cancer is one of the deadliest diseases today and a major health concern for the public. Moreover, certain types of cancer, i.e.: pancreatic cancer, often go undetected until it is too late for effective treatment (Placido, Yuan, Hjaltelin, Zheng, Haue, Chmura, Yuan, Kim, Umeton, Antell, Chowdhury, Franz, Brais, Andrews, Marks, Regev, Ayandeh, Brophy, Do, Kraft, Wolpin, Rosenthal, Fillmore, Brunak & Sander, 2023). As of now, there has yet to be an effective tool to screen for cancers overall. This absence will not only affect clinical decision-making, but also poses a risk to the well-being of patients. AI-driven predictive tools will enable doctors to identify patients at the highest risk of cancer and provide timely treatment (Pesheva, 2023).

Implementing AI-based screening tools in healthcare can be more cost-effective as early detections and prompt treatment of diseases will help reduce the overall expenditure. Because cancer in the early stages is difficult to detect, patients have to undergo multiple invasive procedures for a definitive diagnosis. Such processes are expensive for both the patient and the health facility. With the help of AI, clinicians can single out those who have a higher risk of cancer and perform testing procedures on them, thereby saving costs and resources (ibid.).

In the case of breast cancer, AI has been shown to be more accurate than the traditional methodology of predicting risk of developing cancer from 0 to 5 years. The traditional procedure uses a risk score calculated by various sources of information of the patient which is not always readily available whilst AI can produce results in a matter of seconds when provided with mammograms. When combining both the traditional risk score method and AI-based tools, the accuracy of predicting breast cancers showed a considerable increase (Arasu, Habel, Achacoso, Buist, Cord, Esserman, Hylton, Glymour, Kornak, Kushi, Lewis, Liu, Lydon, Miglioretti, Navarro, Pu, Shen, Sieh, Yoon & Lee, 2023). The precision and enhanced speed of AI will help minimize human error and improve overall efficiency.

### Epilepsy

Epilepsy is another condition known for its unpredictability. Patients suffering from this have to live with the psychological strain of an unexpected seizure. In this regard, people have shown a great interest in a tool that can foretell when an epileptic episode is going to occur (Stacey, 2018).

An AI-driven seizure prediction tool will help provide an early warning system for epileptic people and their caregivers to take preventive measures, which includes medication or lifestyle adjustments to minimize possible damage. This can be done by monitoring electroencephalogram signals recorded over a period of 30 days for the best results (ibid.).

By forecasting seizures in advance, AI can help contribute to an improved quality of life for patients suffering from epilepsy. Knowing the safe times and increased seizure risk time can help alleviate anxiety and fear of an unexpected episode, thereby enhancing the overall well-being of patients.

Another advantage of AI in seizure prediction is individualized treatment. By analyzing patient data, AI can tailor a treatment plan specifically for each person, optimizing its effectiveness. Patients can also actively change how they want their seizure warnings to be, either “more specific or more sensitive”. Thanks to AI, epileptic patients can have a more personalized treatment plan.

## Outbreak Prediction

With the increasing threat of infectious diseases and the aftermath of COVID-19, the role of AI in outbreak prediction has grown bigger than ever. This technology holds the power to revolutionize the way the world responds to outbreaks, offering a proactive approach to prevent the spread of contagious diseases.

One of the key strengths of AI in outbreak prediction is its ability to detect potential threats. By analyzing various data sources, i.e.: epidemiological data, social media, and environmental factors, AI can recognize patterns that may indicate a new infectious disease. This early detection can enable authorities to take precautionary measures to prevent the disease from spreading further and minimize loss (Allam, Dey & Jones, 2020).

However, AI relies heavily on massive datasets, which means that a delay in information delivered to the AI will lead to a delayed prediction result. The importance of data-sharing is exemplified by two companies which have utilized AI for pandemic predictions, BlueDot and Metabiota (ibid.).

# 5. AI in Diagnostics

Despite all past accomplishments in the medical industry, effective diagnosis remains a global concern. In the United States of America (USA), specifically, it is reported that diagnostic errors are the most common cause of medical errors. They occupy approximately 60 percent of all errors and an estimated 40,000 to 80,000 deaths annually (National Academies of Sciences, Engineering, and Medicine, 2015). The number of human errors in diagnostics has made AI-based diagnostic tools essential in order to enhance healthcare performance. In fact, recent AI breakthroughs have demonstrated the capabilities to revolutionize major healthcare diagnostic components, namely medical imaging, and clinical practice.

## 5.1 Medical Imaging

In recent decades, numerous medical imaging techniques, namely computed tomography (CT), mammography, and X-ray, have played an important role in establishing early diagnosis (Brody, 2013). Traditionally, the interpretation and analysis of these images are conducted by healthcare professionals. However, this may pose a significant challenge due to “the complexity of the various disease mechanisms and the underlying symptoms” (Alowais, Alghamdi, Alsuhebany, Alqahtani, Alshaya, Almohareb & Albekairy, 2023: 3). However, while conventional diagnostic procedures are often limited by the specialized skills of each individual, ML-based systems are not subject to the same constraints. To be specific, ML is a branch of AI that uses data as an input resource. The accuracy of this technology depends largely on the quantity and quality of the input data, thereby being able to tackle diagnostic challenges and complexity (Myszczynska, Ojamies, Lacoste, Neil, Saffari, Mead, Hautbergue, Holbrook & Ferraiuolo, 2020). Additionally, the application of predetermined algorithms also produces a result (classification or regression) that is generally difficult for humans to achieve. For example, it can be challenging to discern malignant cells in microscopic images by merely examining the images; nevertheless, this task can be accomplished easily by employing ML(Ahsan, Luna & Siddique, 2022). Furthermore, DL, which is a subset of ML, added layers utilizing Convolutional Neural Networks (CNN) and data mining techniques that help identify data patterns. These are highly applicable in identifying key disease detection patterns among big datasets, which further improves diagnostic performance (ibid.).

Even though AI is still in the early stages of being fully utilized for medical diagnosis, increasing data is emerging regarding its application in diagnosing various diseases, such as breast cancer. A recent randomized controlled trial investigating the use of AI in mammography screening has discovered that AI-driven screening detected 20% more cancers and exceeded the minimum safety threshold compared with standard double reading without AI, all without impacting the false positive rate. This suggests that procedures supported by AI for screen-reading are both accurate and safe (Lång, Josefsson, Larsson, Larsson, Högberg, Sartor, Hofvind, Andersson & Rosso, 2023). Another study was conducted in South Korea, the USA, and the United Kingdom (UK) comparing AI diagnoses of breast cancer with those made by radiologists. Results indicate that the AI algorithm developed with extensive mammartography data showed better diagnostic performance in breast cancer detection compared with radiologists, achieving 90% versus 78%, respectively (Kim, Kim, Han, Kim, Han, Nam, Lee & Kim, 2020).

## 5.2. Clinical Practice

Clinical laboratory testing plays a crucial role in providing essential information for the diagnosis, treatment, and monitoring of various diseases. The integration of AI offers promise to transform this kind of testing, enhancing speed, precision, and overall efficiency in laboratory procedures. In fact, multiple ML systems have been developed to discern, categorize, and quantify microorganisms, as well as predict clinical outcomes (Peiffer-Smadja, Dellière, Rodriguez, Birgand, Lescure, Fourati & Ruppé, 2020). For instance, in the diagnosis of malaria, research conducted by Go, Kim, Byeon and Lee revealed that utilizing ML algorithms in conjunction with digital in-line holographic microscopy (DIHM) enabled an effective detection of malaria-infected red blood cells without the need for staining. This AI-driven tool is significantly rapid, sensitive, and cost-effective in the diagnosis of malaria (Go, Kim, Byeon & Lee, 2018).

Moreover, AI also stands as an asset for healthcare providers in the emergency department (ED). This department often faces challenging difficulties from the rising burden of diseases, greater demand for time and health services, higher societal expectations, and increasing health expenditures (Panch, Szolovits & Atun, 2018). Integrating algorithm support and automated decision making into this process is necessary for solving these problems by enhancing efficiency and accuracy, optimizing ED flow measurements and resource allocation (Jiang, Jiang, Zhi, Dong, Li, Ma, Wang, Dong, Shen & Wang, 2017). More specifically, AI algorithms, through the analysis of patient data, can play a pivotal role in assisting with the prioritization of patients based on urgency, effectively addressing high-risk cases, minimizing waiting times, and streamlining overall patient flow (Gandhi & Sabik, 2014).

## 5.3. Case Study

A study conducted by Wamba-Taguimdje, Fosso Wamba, Kala Kamdjoug, and Tchatchouang Wanko in 2020 delves into a case where healthcare providers experience business advantages through the integration of AI. In this article, United Healthcare Services (UHS), a network of hospitals in New York, USA, sought to improve its operational efficiency. The organization then decided to adopt an AI application tool named Computer-Assisted Physician Documentation (CAPD), provided by Nuance Communication. This technology facilitates physicians in verbally expressing progress notes and the history of present illness, with the AI transcribing these notes in real time through the cloud speech recognition system of Nuance. Integrated into the system of UHS, CAPD reportedly provides real-time intelligence to physicians by automatically presenting clarifying questions during the documentation and diagnostic process. This CAPD tool is further linked with the Cerner Document Quality Review (DQR) tool, which autonomously assesses the presence of clinical evidence supporting a more precise diagnosis. Regarding the results, according to Nuance, their healthcare AI system resulted in a 36% improvement in the identification of UHS of severe illness cases and a 24% enhancement in mortality risk assessment. UHS also reported a noteworthy 69% reduction in transcription costs year over year, equating to actual savings of $3 million (Wamba-Taguimdje, Fosso Wamba, Kala Kamdjoug & Tchatchouang Wanko, 2020).

# Conclusions

As established, AI has endless possibilities in advancing the traditional way of providing medical care to patients and therefore optimizing the industry as a whole. Issues that arise with new technology and changes in an industry are inevitable, and AI is no exception to this. However, these problems have been addressed from multiple perspectives. While most are still hypothetical, such solutions are promising and feasible in the near future. Furthermore, as mentioned previously, since AI has proven itself as being more efficient and advanced than humans in terms of medical capabilities, the technology offers considerable promise to complimenting professionals so as to improve medical performance, rather than replacing the experienced physicians.

With regard to the healthcare business, companies working in the medical field face the challenge of adopting this new technology. Companies that fail in this process could disappear completely while the ones that succeed will be the eventual winners. In other words, the emergence of AI provides businesses with a plethora of possibilities, and it is necessary that companies would be able to adapt and capture these opportunities for first-mover advantages.

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