AI and Healthcare

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AI in healthcare - benefits and issues

Why AI in healtcare?

- AI has the **potential to transform healthcare** since healthcare is producing **a large amount of clinical and administrative data**
- **This large amount of data can be used for analysis**
- Moreover, research studies have shown that **AI can carry out many key healthcare activities better than, or as well as, humans**, such as **diagnosing diseases,** for example by **analyzing radiology images**

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

AI is sparsely implemented

- Today, AI solutions are **sparsely implemented in practical healthcare**
- Existing AI solutions are **mainly supporting the individual functions in healthcare,** like **radiology and pathology image analysis**

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

Why is AI sparsely implemented? 1(2)

According to Davenport and Kalakota (2019), **two major reasons for AI being sparsely implemented in practical healthcare** are:

- **AI solutions are focusing on limited tasks** and are **rarely integrated into the clinical processes**
- Moreover, **AI is not implemented in electronic record systems (EHR).** Therefore, AI is not part of the system that most healthcare personnel use for their day-to-day work

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

Why is AI sparsely implemented? 2(2)

Panch et al. (2014) **add additional important reasons for AI being sparsely implemented in practical healthcare are**:

- **Healthcare systems are complex and fragmented, and will not easily change as a result of new technology**
- **Healthcare organisations lack the capacity to collect the necessary training data of sufficient quality - while also respecting ethical principles and legal constraints**

(Panch, T., Mattie, H., & Celi, L. A. (2019). The “inconvenient truth” about AI in healthcare. NPJ digital medicine, 2(1), 1-3.)

AI technologies in healthcare

AI technologies in healthcare

Note, according to Devenport and Kalakota (2019), AI is not one technology, but rather a collection of them.

Examples pf AI technologies:

- Machine learning
- Natural language processing
- Rule based expert system
- Physical robots
- Robotic process automation

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

Machine learning

- **Traditional machine learning** is the most common application in healthcare. This application is mostly **using supervised learning**, which **requires a training datasets** to be used to be able to do the work
- Supervised learning systems are **supporting the making of diagnosis**, and **predicting what treatment protocols are likely to be successful** for a patient, **based on various patient attributes and the treatment context**

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

Neural network and deep learning

- A more complex form of supervised machine learning is the **neural network. Neural network** make use of a **network of variables** that **associate inputs with outputs** and create **weights on these associations, in order to predict outcome**
- A **neural network** can also have **variables on many different so called hidden layers**, called **deep neural network** or **deep learning**
- Deep learning has been very successful for identifying **clinically relevant features in imaging data -** beyond what can be perceived by the human eye
- **Deep learning** is also increasingly used for **speech recognition in NLP,** see next slide

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

Natural language processing

- **Natural language processing (NLP) aims to make sense of human language.** NLP **includes application such as speech recognition, text analysis, translation.**
- In healthcare, NLP can, for example, be used for **analyzing unstructured clinical notes** and supporting the **transformation from speech to text**

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

Rule based expert system 1(2)

- **Rule based expert system** - require human experts and knowledge engineers to **construct a series of rules in a particular knowledge domain, which will be the base for the expert system**
- **Rule based expert systems in healthcare - are the base for many clinical decision support system**
- **Rule based expert systems -** are also be **part of many medical record systems (i.e. EHR systems),** for example, they provide **functionality to warn for drug-to-drug interactions**, and **support the physician of making diagnoses**

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

Rule based expert system 2(2)

The limitation of rule based expert systems:

- Rule based expert systems - **work well if the rules are not so many**.
- However, **if number of rules is over several thousand, it is hard to maintain the rules**, for example, **the rules soon start to conflict with each other.**
- Moreover, **if the knowledge domain changes, rules need to change, which may be time-consuming**, especially if the rules are many, and related on each other
- Therefore, **due to this limitations, rule based expert systems are being replaced by systems based on ML algorithms**

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

Physical robots

- **Physical robots - perform pre-defined tasks in factories and warehouses**, like lifting and assembling objects
- Applied in healthcare are **surgical robots –** which can **improve the surgeons ability to see and make tasks more precise**
- **Moreover, physical robots are also becoming more intelligent**, as other **AI capabilities are being embedded in their operating systems**.

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

Robotic process automation (RPA)

- **Robotic process automation (RPA) – record the keyboard and mouse actions of a human being, and repeat these actions automatically**
- **RPA does not involve physical robots** – instead **RPA is a form of software**
- **RPA act like a semi-intelligent user of the systems, following a script or a set of rules based on actions done by human beings**
- **RPA can be used in healthcare for updating patient records, billing or other administrative tasks**
- **Moreover, RPA can be used in combination with other technologies, for example combining image recognition and RPA**, where RPA can be used for extract data from the recognitions of images and update EHR system with this data

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

AI technolgies can be combined

- **AI technologies are being more and more combined and integrated**, for example:
  - physical robots are getting AI-based features
  - image recognition is being integrated with RPA.

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

AI application areas in healthcare

AI application areas

Example of AI application areas in healthcare:

- Diagnosis and treatment
- Patient engagement and adherence
- Administrative activities

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

Diagnosis and treatment 1(3)

- **IBM's Watson has received a lot of attention** for its **application in diagnosis and treatment area**, particularly **cancer diagnosis and treatment**
- Watson consisted **of a set of 'cognitive services', employing a combination of machine learning and NLP technologies**
- However, **IBM's Watson's application in healthcare has not been a success**:
  - Watson has **not been able to handle different types of cancer**
  - Watson has also **been hard to integrate into care processes and systems**

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

Diagnosis and treatment 2(3)

Other examples of the use of AI for diagnosis and treatment:

- Several organizations **work on ML based solutions** to better **understand the how different genetic variants of humans will response to different treatments, such as drugs and protocols.**
- Organizations are also **working on ML based solution to predict populations at risk of particular diseases, high-risk conditions** or to **predict hospital readmission**

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

Diagnosis and treatment 3(3)

Drawbacks of using AI in the application of diagnosis and treatment:

- **To embed AI-based diagnosis and treatment recommendations into clinical workflows and EHR systems has not been successful**
- According to Davenport and Kalakota (2019), "**such integration issues have probably been a greater barrier to broad implementation of AI than any inability to provide accurate and effective recommendations**"

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

Patient engagement and adherence 1(2)

- **Patients engagement in their own well-being and care are important for receiving better outcome** in healthcare
- **The major problem is that the patient may not make necessary behavioral adjustment,** that is, **does not follow a course of treatment** or **take the prescribed drugs**

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Patient engagement and adherence 2(2)

- **Therefore, <u>ML and business rules engines can be used to support patient engagement and adherence, by</u>**:
  - sending message alert to patients,
  - providing targeted content given the patients' status and characteristics,
  - tailoring recommendations by comparing patient data to other effective treatment pathways for similar cohorts
  - nudging patient behavior in a more anticipatory way

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

Administrative activities

Different AI technologies can be used for administrative tasks:

- **RPA can be used for a variety of applications in healthcare**, like **managing medical records**
- **NLP can be applied in chatbots for patient interaction**
- **ML could be used to verify whether millions of insurance claims are correct**, for example, by applying probabilistic matching of data across different databases

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

Healthcare workers

Implication for healthcare workforce 1(2)

- According to Davenport and Kalakota (2019) estimate that **it will take 20 years before will see any substantial change in healthcare employment due to AI**
- **Instead, there is also the possibility that new jobs for working with AI technologies are created**

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

Implication for healthcare workforce 2(2)

- The area where **most healthcare jobs will be automated** are those dealing with **digital information, radiology and pathology**
- **However, for example, not even radiologist jobs will not disappear in the near future**, and maybe **not in the long term either – see next slides**

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

Implication for radiology 1(2)

- Today, **radiology AI systems can only perform single tasks.**
- **Radiology AI systems cannot fully identify all potential findings in medical images.**

  Radiologist are still needed for that
- **Radiologists also do a lot of other thing than just read and interpret images**:
  - radiologists **relate findings from images to other medical records and test results**
  - radiologists **consult with other physicians** regarding diagnosis and treatment
  - radiologists **discuss procedures and results with patients**
  - radiologists **define the technical parameters of imaging examinations**. The parameters need to be tailored to the patient's condition

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

Implication for radiology 2(2)

- **Moreover, for employing full scale AI-based image work**:
  - **clinical processes need to be changed**, which will take time
  - **an aggregated repository of radiology images is required for training the AI system**, but such **an aggregated repository is lacking today**
  - **changes in medical regulation and health insurance contracts for automated image analysis are needed**

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

A brief summary

To summarize 1(2)

- The **greatest challenge to AI** is to **ensure its adoption in daily clinical practice.**
- **There are a number of challenges to overcome to achieve this.**
- Therefore, Davenport and Kalakota (2019) **estimate that we will see a limited use of AI in clinical practice within 5 years and more extensive use within 10**

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)

To summarize 2(2)

- Moreover, "**AI systems will not replace human clinicians on a large scale, but rather will augment their efforts to care for patients**".
- According to Davenport and Kalakota (2019) **it might take 20 years before will see any substantial change in healthcare employment**

(Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94)