

APPLICATION OF ARTIFICIAL INTELLIGENCE IN HEALTH CARE: ADVANTAGES AND CHALLENGES

A Descriptive Literature Review

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Abstract

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| Title of publication Application of artificial intelligence in health care: Advantages and challenges | | |
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| <p>In the background of increasing shortage of effective <i>medical</i> resources, as well as the rapid development of artificial intelligence, artificial intelligence is impacting the healthcare field from many aspects: diagnosis, treatment, follow-up et cetera. A great deal of research of artificial intelligence was implemented in the medical field in late decades.</p> <p>The purpose of this study is to increase the understanding of healthcare workers about Artificial intelligence in healthcare. The aim is to explore the developments and challenges of artificial intelligence in the healthcare field.</p> <p>In this thesis, the research method was a descriptive literature review. This study comprehensively analyzes and summarizes the previous published peer-reviewed literature in the form of a descriptive review. A content analysis was conducted in the data analysis. The research sources in this thesis were systematically collected from three electronic databases: PubMed, CINAHL, Elsevier Direct. Articles selected were from year 2010 to year 2019, published in English, full text, peer-reviewed.</p> <p>The finding claims: the impact of artificial intelligence is profound in the medical field. A series of issues need to be taken seriously, for example, the quality of available medical data, cooperation between humans and machines, and related ethical issues. The substantial solution for the ongoing challenges still need extensive efforts.</p> | | |
| Keywords Artificial Intelligence, nursing, healthcare field, advantage, challenge. | | |

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| Tutkinto Sosiaali ja Terveysalan ammattikorkeakoulututkinto | | |
| <p>Terveyden huollon resurssien pulan ja tekoälyn kehittymisen taustalla. tekoäly vaikuttaa terveydenhuollon kenttään monilta osin: diagnoosista, hoidosta, seurannasta jne. Suuri osa tekoälyn tutkimuksesta toteutettiin terveydenhuollon alalla viime vuosikymmeninä.</p> <p>Tämän tutkimuksen tarkoituksena on lisätä terveydenhuollon työntekijöiden tietämystä tekoälystä terveydenhuollon alalla. Tavoitteena on tutkia tekoälyn kehitystä ja haasteita terveydenhuollon alalla.</p> <p>Tässä opinnäytetyössä tutkimusmenetelmä oli deskriptiivinen kirjallisuuskatsaus. Tämä tutkimus analysoi ja tiivistää aiemmin julkaistun vertaisarvioidun kirjallisuuden kuvaavan katsauksen muodossa. Sisältöanalyysi suoritettiin tietöanalyysissä. Tämän tutkimuksen lähteet on kerätty systemaattisesti kolmesta elektronisesta tietokannasta: PubMed, CINAHL, Elsevier Direct. Valitut artikkelit olivat vuodesta 2010 vuoteen 2019, ne ovat julkaistu englanniksi. Käytettävissä on ollut koko aineisto ja se on vertaisarvioitua.</p> <p>Opinnäytetyö väittää: Tekoälyn vaikutukset terveydenhuollon alaan on laajat mutta tekoälyn kehitys on vielä kovin rajoittunutta. Lisäksi tekoälyn laaja käyttö aiheuttaa sosiaalisia ja eettisiä kysymyksiä. Olennainen ratkaisu meneillään oleviin haasteisiin vaatii vielä laajoja ponnisteluja.</p> | | |
| Asiasana tekoäly, hoitotyö, terveydenhuolto, edu, haaste | | |

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1 INTRODUCTION

There is no generally accepted definition of artificial intelligence. Terminologically, it's used to describe computing technologies, which is similar to the processes associated with human intelligence, such as, "learning and adaptation", "sensory understanding and interaction", "reasoning and planning", "searching and optimization", "autonomy and creativity". Artificial intelligence technology is widely used in different areas. (EPSRC 2019.)

Artificial intelligence is a technology aggregation, not just a single technology. Artificial intelligence has the potential to transform many sides of healthcare. Although major technologies are very different in processing special program and supporting task, they are related with medical field closely. Studies indicated that: at certain medical practice, artificial intelligence presents same level or even better performance than human care provider. (Davenport & Kalakota 2019.)

The number of the world population is increasing by 82 million per year. It means, the world population will be up to 9 billion and 10 billion in the year 2037 and 2057 respectively. (Worldometers 2019.) Moreover, the number of elderly population (age \geq 60 years and over) will overtake the number of young population (age \leq 5 years old) in the year 2020. By 2050, the elderly people of the population is estimated at 2 billion. Twenty three percent of the global death and long-term illness burden are in the stage of over 60 years old. The increased economic burden on the healthcare system and the decreasing wellbeing of the patient and their family members are the clear consequences of it. (WHO 2014.)

In order to achieve sustainable development goals on good health and well-being, UN has held a summit to discuss the opportunities of application of AI in the healthcare field globally. Empower the new technology to benefit the human healthcare and well-being, which is related to "primary care, service delivery, integration and analysis of medical data, and responses to disease outbreaks and other medical emergencies". Projects proposed to provide better healthcare and wellbeing for one billion more people critically by AI applications. (Mead 2018.)

Facing the big challenges in the medical care field, artificial intelligence has the potential to provide better solution, it held authors interests and triggered the exploring of the impact of artificial intelligence on healthcare from nursing perspective. The purpose of this study is to increase the understanding of healthcare workers about the application of Artificial intelligence in healthcare. The aim is to explore the developments and challenges of artificial intelligence in healthcare field.

2 MEDICAL ISSUES

2.1 Workforce in Healthcare

WHO (2017) point out, half of WHO Member Countries report there were fewer than three nurses and midwives per 1000 population, about one fourth report fewer than one nurse and midwife per 1000 population. The Bureau of labor statistics (2019) report, from 2018 to 2028, the growth of employment of registered nurses will be increased by 12%. The reasons for the fast growth can be generally attributed to: an increased aging population require more health care services; growing chronic diseases need more long-term healthcare services; many elderly people prefer to stay at residential care centers or home to get medical care services. These are not negligible reasons for needing more nurses, but the robotic revolution based on artificial intelligence technology will be able to improve this deficiency. Nursing Robots are already used in the healthcare field and provide more effective and safer medical services. (Pepito & Locsin 2018.)

On the other hand, a research claim, more than twelve hours work shift is often required in hospitals, patient's unsatisfactory rate of nursing care will be increased as the nurses working hours get more than thirteen. In addition, as working hours are longer than ten, nurses are more likely to experience fatigue, burnout, and job dissatisfaction. (Stimpfel, Sloane & Aiken 2012.) Another study reports that due to fatigue, daytime sleepiness, inability to recover between shifts, bad sleep quality, nurses reported more decision error reports than fully-rested nurses (Scott, Arslanian-Engoren & Engoren 2014). Long working shift is harmful to nurse's health and well-being, this increases voluntary turnover of nurses and affects patient care negatively as well (Stimpfel al et 2012). Research shows that the developing of health information technology, which is supported by artificial intelligence, will help nurses in multitasking work environment, such as vital signs checking and collection, medication management, infectious illness supervision and so on. Non-value added nursing activities and tasks can be delegated to others in healthcare delivery process, which will reduce nurse workloads. The role of nurse will change, nurses will spend more time with patients. Nurses with technology support will provide health care efficiently and effectively. (Yen, Kellye & Lopetegui 2018.)

2.2 The Insufficiency of the Healthcare System

Patient safety has always been a serious concern in global public health. There is a big chance that a patient is suffering from non-essential harm during receiving treatment. About 50% of them were preventable. It is one of the main factors in causing a global disease burden. (WHO 2019.) One in ten patients experienced unnecessary harm at

some point of healthcare in OECD countries (OECD 2017). The patient harm related with health care includes a series of adverse events and incidents, those relatively high-rate adverse events include misdiagnoses and administrative errors. (WHO 2018.) One practice of artificial intelligence can improve the patient safety during healthcare activities. By means of five and a half years of study, it shows the Electronic Health Records made significant improvement of the quality of clinical notes. One example of the open notes project report patients can review their own notes after the meeting with the doctor, because of those available notes, patients do not only get to know what kind of health care plan has been executed but also get a better understanding of the treatment and health condition, it increases patient's confidence in taking control of own health condition. Moreover, doctors are satisfied with necessary feedback of the notes error from patients. (Bell, Delbanco & Walker 2017.) The Electronic Healthcare Record innovations reduced the click workload and simplified the management of the medical information. Medical staff have more time with patients, it decreased the medical staff burnout and improved patient safety. (Guo, Chen & Mehta 2017.)

The occurrence of adverse events not only affects the patients' health, but also causes plenty of waste of medical resources (WHO 2018). According to the Institute of Medicine report diagnostic mistakes are constant during medical care, there is no effective measure to lower it. Artificial intelligence systems as a utilitarian tool for various diseases' identification, it can provide differential diagnoses and valuable testing recommendations. The vast medical data of physiology, behavior, laboratory and medical image, which combine with the development of machine learning technology, medical providers can get more assistance and patients can get more benefits as well. (Obermayer, Phil & Emanuel 2016.)

One research from OECD countries claim, certain administrative processes were worthless. The costs of administering health systems took up about 14% of health costs across OECD countries, but compared to the average 3%, there is no clear association with health system performance. It means about 11% of costs were no value. (OECD 2017.) Artificial intelligence provide one solution for unneeded medical cost saving and high-quality medical services offering. One E-health telemedicine platform system, pointed to homecare assist and declined hospitalization resources, it is capable to transmit the customer's analyzed data from home to a clinic. Via cloud transportation, medical smart sensors predict the customer's condition based on the substantial medical data. Because the platform combined the outputs of the advanced homecare decision support system and the advanced resources management system, the platform can optimize doctors' and nurses' work activities. (Massaro, Maritati & Savino 2018.)

One study in seven low and middle income African countries shows, healthcare givers make diagnosis wrongly at one quarter to two thirds of the time. More than fifty-five percent of the clinical guidelines were not being obeyed on average. Seventy-two percent of antenatal care, seventy-four percent of family planning services were absent. Seventy-nine percent of sick-child care were under qualified across eight high-mortality countries in the Caribbean and Africa. Nowadays, wrong diagnosis, unnecessary treatment, drug errors, unsafe hospital practice, lack of effective, sufficient medical training or expertise exist in every country. (WHO 2018.) A study evaluated one implementation of artificial intelligence in rural Kenya. Technology is beneficial to the maternal and child health care services in medical resource lacking country. Because integrity of antenatal records are significant improved by cloud-based electronic medical record system, quality and completeness medical information is able to share among outpatient clinic, hospital and public health services, it supports the health decision-making. (Haskew, Rø & Saito 2015.) Besides it assists HIV patients receiving the treatment early and reduces HIV care gaps in Western Kenya (Haskew, Rø & Turner 2015). In medical resource-lacking places, based on artificial intelligence, expert system can support doctors to diagnose and make treatment plans, even can act as human doctor in condition of no doctor available (Reis , Ortega & Silveira 2004).

3 ARTIFICIAL INTELLIGENCE

3.1 Description of Artificial Intelligence

In the Merriam-Webster dictionary (2019), the definition of artificial intelligence: "1. A branch of computer science dealing with the simulation of intelligent behavior in computers. 2. The capability of a machine to imitate intelligent human behavior."

Terminologically, it's used to describe computing technologies, which are similar to the processes associated with human intelligence, such as "learning and adaptation; sensory understanding and interaction; reasoning and planning; search and optimization; autonomy; and creativity." The applications of technology system are broad, such as machine learning, adaptive robotic systems, comprehensive medical data and so on. The application of artificial intelligence technology is widely used. (EPSRC 2019.)

Artificial intelligence, one capacity is able to make the computer or computer-controlled robot to accomplish tasks which relating in intelligent beings. It is widely used in developing the system, which has the characteristics of human intelligence process. For

example, learning from experience, reasoning, distinguishing. As the technology is developing, computer programs perform as good as specialized persons, like medical diagnosis, computer search, handwriting recognition and so on. (Copeland 2019.)

3.2 Development of Artificial Intelligence

Kwaśnicka (2005) said, artificial intelligence was originated in 1943, McCulloch and Pitts create “intelligence” by neural network, but the term “artificial intelligence” was not proposed at that time. (Furmankiewicz, Soltysik-Piorunkiewicz & Ziuziański 2014, 552.)

In 1955, Allen Newell and Herbert Simon wrote a set of problem solving computer simulation program “The Logical Theorist”. The program simulates the thinking activity of a person to prove the symbolic logic theorem and successfully proves some mathematical theorems. It was the first successful artificial intelligence system in history. (Dick 2013.)

The term “artificial intelligence” was first formally proposed by an American computer scientist in 1956, whose name was John McCarthy. John McCarthy invented a computer programming language LISP in 1958. LISP has extraordinary significance and value in the field of artificial intelligence and has been used until now. (Furmankiewicz et al 2014, 552.) Newell (1959) declared: Newell and Simon made a pioneering start of Heuristic search, they applied this technology into logic theorist program and general problem solver. Bledsoe & Chan (1976) said Selfridge and colleagues did the foundation work of complex applications in the computer vision field, for example: face recognition. Reddy (1976) pointed out in the late sixties, natural language processing begun applied into computer program. (AI100 Standing committee and study panel 2016, 51.) In 1966, a computer scientist Joseph Weizenbaum created a computer program ELIZA. ELIZA program can make machines communicate with people in natural language text. (Weizenbaum 1966.) Samuel (1959) claimed Samuel invented one checkers-playing program, that is improving itself by self-playing, this is one example of machine learning system. Rosenblatt(1957) declared: Rosenblatt established a computational model of biological neurons based, which was Footstone of artificial neural network area. (AI100 Standing committee and study panel 2016, 51.)

By the 1970s, there has been further breakthrough in the field of artificial intelligence, the expert system came out in this period. The earliest manufactured expert systems were DENDRAL and MYCIN, whose creators of them were Colmerauer and Edward Shortliffe. (Furmankiewicz et al 2014, 552.) The expert system is a program system with a lot of specialized knowledge and experience. It is an important part of artificial intelligence operation. It can imitate the decision-making process of human experts to figure out

complicated problems that require human experts to solve it. MYCIN was one of the earliest created expert systems and also the earliest medical expert system. It can be used for the diagnosis of infectious blood diseases and recommendations for the treatment of the disease. (Oluwafemi & Ayoola 2014.)

By the 1980s, as there was no significant practical Achievement in the field, the interest in artificial intelligence was dropping and shortage of capital source as well. Nilsson called it: the period of "artificial winter". (AI100 Standing committee and study panel 2016, 51.)

By the 1990s, artificial intelligence came to a turning point of developing progress. scientists focused on research of artificial intelligence related to real-world issues, such as medical diagnosis. (National Science and Technology Council 2016, 5.) Artificial intelligence can imitate human intelligence at a different level, machine learning and deep learning are branches of artificial intelligence. Machine learning systems use data at the basic level, deep learning is one type of machine learning, which use structures to build models. (Wang & Preininger 2019) Around 2010, driven by 3 factors: the available of big data, powerful computer capabilities and improved machine learning algorithms. The improvements of artificial intelligence were significant, for example, image recognition program empowered by artificial intelligence, the error rate reduced from twenty-six percent to three point five percent during 2011 to 2015. (National Science and Technology Council 2016, 6.) In 2015, deep learning listed by Scientific American as one of "world changing ideas"(Scientific American 2015). With the increasing awareness of artificial intelligence by humans and technology companies, artificial intelligence presents different functional forms depending on the needs of a particular fields, for example, robotics, computer games, genetic algorithms and deep learning, etc. (Furmankiewicz et al 2014, 553-554.)

4 PURPOSE, AIM AND RESEARCH QUESTIONS OF THE STUDY

In this thesis, the purpose is to increase the understanding of healthcare workers about the Artificial intelligence in healthcare area. Via the review, the aim is to explore the developments and challenges of artificial intelligence in healthcare field.

Based on previous literature, this thesis will raise the following questions:

- 1 What are the advantages of artificial intelligence in healthcare?
- 2 What are the challenges of artificial intelligence in healthcare?

5 METHODOLOGY

5.1 Method and Data Collection Process

The literature review is an academic paper that organizes, screens, analyzes and comprehensively refines a large number of studies on a subject, profession or topic. It is a highly concentrated literature work. The literature review reflects the current state of affairs, recent developments, academic insights and recommendations of a sub-discipline or important topic in a particular field. It also reflects new developments, trends, levels, principles and technologies. It also contributes to cross-disciplinary and interdisciplinary research. The researcher generally does not publish personal critical opinions and suggestions, but objectively and generally reflects the facts. (Bolderston 2008, 87; Snyder 2019, 334.)

There are 4 methods of literature review: narrative review, descriptive review, vote counting and meta-analysis. Figure 1 shows the emphasis of the review methods. (King & He 2005.)

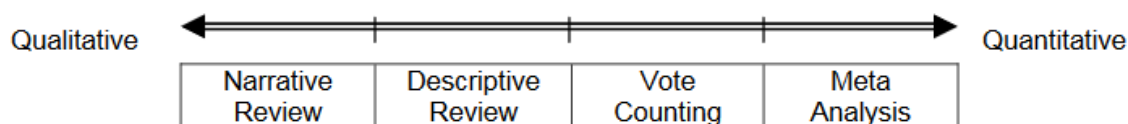


Figure1. Review Methods on a Qualitative-Quantitative Continuum

(King & He 2005)

Descriptive review can represent the current fact of a research domain. It is conducted by introducing relevant papers, coding on certain research characteristics, for example, publication time, research methodology, established theory, research findings. In the form of frequency analysis, the author handles an single study as one data record and discerns trends among those research articles. (King & He 2005.)

This thesis will be conducted in the form of descriptive review. Descriptive review is designed to identify, assess, analyze and explain knowledge on a specific topic. The reviewer needs to select specific and topic-related articles to analyze and acquire information and further refine the topic. (Stern 2014, 55.) A comprehensive search of literature was the core way for data collection in this thesis. Electronic scientific databases were used for the search of literature, including PubMed, CINAHL and Elsevier Direct. Search terms were determined by the topic and questions of this thesis. The specific keywords used in the literature search were “Artificial intelligence”, “Healthcare”, “Nursing” and “Challenge”. The search scope was limited to published time

between years 2010 - 2019, to get the latest development related to both artificial intelligence and healthcare area. The set keywords were used as the initial search without the limitation of the keywords located. Based on the initial search result, a secondary search is performed to obtain more qualified literature.

In the second retrieval, the keywords were included in the field is limited to the abstract section. Browsing through the title and abstract of the literature, to understand their topic and purpose, and eliminating irrelevant or non-compliant articles according to the inclusion and exclusion criteria were conducted. Inclusive criteria are for studies to be selected in a reliable, objective and consistent manner. Exclusion criteria describe a number of factors that are excluded from the selected studies. (Garg 2016, 642.) Inclusion criteria motivate reviewers to effectively and accurately access relevant data in vast resources. Reviewer's accurate description of inclusion criteria allows readers with a better understanding of the subject of the literature review. Inclusion criteria and exclusion criteria determine which studies would be selected or not. Inclusion criteria are often determined by the topic and the question of the review. It should be based on the theme, questions and objectives. (Stern 2014, 55-56.) Table 1 presents the inclusion criteria and exclusion criteria that were used for data collection in this thesis. Table 2 presents the results of literature screen.

Table 1 Inclusion and exclusion criteria for this study

| Inclusion Criteria | Exclusion Criteria |
|--|--|
| Studies published between 2010 and 2019 | Studies published more than ten years ago |
| Studies published in English | Articles in any other language except English. |
| The objective of the articles focused on the topic of the impact or challenge of artificial intelligence in healthcare | The purpose of studies is not related to both artificial intelligence and healthcare information |
| Included studies must be related to the application of AI in healthcare (medical or nursing area) | Articles are not based on research or evidence, without references indication |

| | |
|--|--|
| Literature could be read in full-text | Article focused on only Healthcare or AI |
| Included articles must be a research paper | |

Table 2 Data screen summary

| Key words | Database | Initial search result | Second retrieval result | Final Chosen |
|--|-----------------|-----------------------|-------------------------|--------------|
| Artificial intelligence AND Healthcare | PubMed | 3,017 | 107 | 4 |
| | CINAHL | 612 | 75 | 0 |
| | Elsevier Direct | 4,787 | 138 | 1 |
| Artificial intelligence AND Nursing | PubMed | 564 | 5 | 1 |
| | CINAHL | 90 | 5 | 1 |
| | Elsevier Direct | 1,166 | 101 | 0 |
| Artificial intelligence AND healthcare AND challenge | PubMed | 2,969 | 21 | 2 |
| | CINAHL | 83 | 48 | 0 |
| | Elsevier Direct | 3,212 | 84 | 1 |
| Artificial intelligence AND Nursing AND Challenge | PubMed | 20 | 7 | 0 |
| | CINAHL | 8 | 4 | 0 |
| | Elsevier Direct | 756 | 15 | 1 |
| Total | | 17,284 | 610 | 11 |

5.2 Qualified Research Articles

Although the abstract section of the article already provide researcher with enough information to decide whether the article is usable, a critical evaluation of full text is necessary. Researcher will need to do a critique for articles in full text to evaluate and determine whether the article is suitable. Reviewing the article from beginning to end, checking whether the article is complete through finding out the key terms: Aim, purpose, problems, methods, analysis or results, and conclusions. Those key terms provide an outline of the article's content. Checking whether the article is consistent is also necessary. A consistent literature article must be proceeding clearly and logically. Linking the article to own thesis question and using the inclusion criteria when reading the article, a researcher will decide if the article read can be used to support the thesis question. (Wood & Ross-Kerr 2011, 67.)

After the data screening and data selection, 11 suitable articles were selected. All of the chosen articles are published peer-reviewed research and with a complete procedure. All of the articles were read in full text. Seven of the chosen articles were published in the year 2019. 3 articles were published in 2018, and 1 article was published in 2015. All of the chosen articles topics are related to the use of artificial intelligence in healthcare field. In three articles artificial intelligence was utilized to support the nursing care. Three articles focus on the challenges of artificial intelligence in healthcare field. The remaining 5 articles examine the application, opportunities and challenges of AI in different aspects related to healthcare, which mentioned aspects including mental health care, primary healthcare, palliative and supportive care and healthcare safety. Their themes and findings are related to the topics and issues of this thesis and could support the thesis questions.

All of these chosen articles were read and assessed, and a description about the articles is presented in a table. The content of description includes research title, author/s, publication, published date, aim of study and the result of study. This table is placed in the Appendix 1.

5.3 Data Analysis

Data analysis is aimed at providing answers to the thesis questions. After the steps of data search and data selection, data analysis is a necessary means of extracting valuable data from the original data. The plan for data analysis comes from the research questions, type of research, method of collecting data and valuable data. These factors mentioned above will determine how a researcher can analyze the data. (Wood & Ross-

Kerr 2011, 247.) The 11 chosen articles mentioned in the previous section were the analysis objects in the process of data analysis in this thesis. Content analysis was chosen as the data analysis in this thesis. Qualitative content analysis is one of the most common data analysis techniques of descriptive research (Vaismorari, Turunen & Bondas 2013, 401).

The process of the content analysis included three steps: preparation, organization and reporting. In the step of preparation, researcher will be familiar with the overall content of every article, selecting the meaningful content as an analytical unit from the article. The analytical content will be related to the thesis topic and questions. (Vaismorari, Turunen & Bondas 2013, 401.)

In the step of organization, researcher will make the analytical contents from unstructured to structured, make highlight for the meaningful contents that will be analyzed further, make marks for those contents with similar meanings and write the code that represents the content meaning. The code could be a word or sentences and accurately represent the meaning of the original content. (Brown 2010, 41.) In addition, the categories and subcategories based on the study questions are created. Categories and subcategories are used to attribute analytical content. Then different codes are sorted into corresponding category. When all of the codes represent analytical contents from unstructured have been structured, the data analysis process moves to the step of reporting. (Wood & Ross-Kerr 2011, 251.) The last step of data analysis is reporting, which present the process of analysis and the results through models, categories, conceptual maps or story line (Vaismorari, Turunen & Bondas 2013, 402).

All chosen articles in this thesis were repeatedly read throughout to fully understand the meaning of content. While reading the articles, content related to the “Advantages” and “Challenges” were highlighted with different colors as meaningful data. Writing down of simple words or phrases as open code based on the meaning or potential meaning of the highlighted content was done. Different codes are grouped into categories based on the meaning or attributes they represent. Codes with similar meanings are grouped into the same category. The questions raised in this thesis are about the advantages and challenges of artificial intelligence in the healthcare field. Therefore, two main categories were set according to the thesis questions: “Advantages” and “Challenges”. The main “advantages” category was subdivided into three categories, which are “Clinical health care aspect”, “Outside the hospital/Individual environment aspect” and “Non-Patient-oriented aspect”. The main “Challenges” category was divided into four sub-categories: “Medical ethics”, “Clinical safety issue”, “Humanistic concern” and “Pre-clinical

consideration". Table 3 and table 4 below show the meaningful data obtained from the content analysis of the selected articles. These meaningful contents were represented by open coding and have been sorted from unstructured. An example of how the category "Challenges of artificial intelligence in healthcare" were sorted is presented in appendix 2.

Table 3 Category: Advantages of artificial intelligence in healthcare

| Open Coding | Sub-category | Main category |
|---|--|---|
| Medical and nursing diagnostic support Treatment / Intervention support Serving assistant / Reduce workload of nurse Rehabilitation support Promote disease prevention & risk monitoring Health information management | Clinical health care aspect | Advantages of artificial intelligence in healthcare |
| Virtual assistant Assistive individual health management | Outside the hospital / Individual environment aspect | |
| Medical cleaning support Assistive medication | | |

| | | |
|---------------------------------------|-----------------------------|--|
| development | Non-patient-oriented aspect | |
| To be utilized transport of equipment | | |

Table 4 Category: Challenges of artificial intelligence in healthcare

| Code | Sub-category | Main category |
|---|----------------------------|---|
| Regulation issue Interpretability & Explain ability Client data privacy & Anonymity | Medical ethics | Challenges of artificial intelligence in healthcare |
| Avoid medical errors by AI: Prescribing, diagnosis & intervention | Clinical safety issue | |
| Human-computer interaction problem Transformation of client-caregiver relationship | Humanistic concern | |
| Data integrity Repeated evaluation & verification Need of specialized medical information Data guidelines for patients | Pre-clinical consideration | |

The next chapter presents the results, focusing on these two main categories in detail. Sub-categories will be presented separately in bold letters.

6 RESULTS

6.1 Advantages of Artificial Intelligence in Healthcare

Clinical healthcare aspect

The current application of artificial intelligence in healthcare is common to support clinical behavior through the analysis of medical data. Most of the studies mentioned that artificial intelligence technology is useful in disease diagnosis. Artificial intelligence technology can analyze medical images to identify specific diseases, distinguish benign and malignant diseases. It helps doctors quickly obtain disease information, provide a more accurate disease diagnosis, thus saving time for disease treatment. (Wang & Preininger 2019, 17-18; Ellahham, Ellahham & Simsekler 2019 2-3.)

Artificial intelligence has played an important role in disease prevention. Combining artificial intelligence analysis models with social media, human behavioral data can be used to identify risks of mental illnesses. (Wang & Preininger 2019, 19.) Artificial intelligence analysis has been applied to identify the risk of suicide among the patients with psychiatric disorders, or among specific population, such as prisoners and soldiers (Fonsekas, Bhat & Kennedy 2019, 956).

In the process of nursing assessment, some wearable devices based on artificial intelligence have been used to monitor and analyze the patient's vital signs (Ellahham et al 2019, 3). Artificial intelligence technique has been used for patient monitoring, nurse can more easily correct real-time information about patient, for example, blood pressure, heart rates, saturation, body temperature, blood glucose and sleep quality. Nurses can get rid of frequent manual monitoring and avoid multiple interruptions to patients with artificial intelligence techniques, which improve healthcare quality and patient satisfaction. (Reddy, Fox & Purohit 2018.)

A study about applying artificial intelligence to support decision making in nursing showed that artificial intelligence technology helps nurses to collect and record patient data more accurately and faster. An artificial intelligence based nursing data system can deduce a nursing diagnosis guideline to assist nurses in making a clinical decision. Compared to the manual nursing diagnosis, the time taken for nursing decision-making assisted by artificial intelligence system was reduced by nearly half. In addition, the quality of patient care and nurse job satisfaction has also improved. (Liao, Hsu, Chu & Chu 2015, 146.)

Whether artificial intelligence technology is applied to medical diagnosis, disease risk prediction or nursing decision-making, healthcare data is an essential decisive element. An electronic health records can provide reliable health information for artificial intelligence analysis. Electronic health records system based on artificial intelligence can be used to collect the clinical health data by doctors and nurses. Electronic health records system contains patient clinical information, which is collected and recorded by doctors and nurses. It facilitates the organization and management of medical information. (Wang & Preininger 2019, 18.)

In addition, intelligent robot can be a powerful nursing assistant in clinical. In the United States, a carrier robot has been proposed and designed for patients with mobility difficulties, for example a patient with back pain. Intelligent carrier robot moves patients from bed to wheelchair or help to change position when it receives command from the nurse through smart touchpad. It helps to solve the moving difficulty of special patient, also greatly release the physical burden of nurses. (Maalouf, Sidaoui, Elhadj & Asmar 2018, 593.)

Outside the hospital / Individual environment aspect

In the individual environment, artificial intelligence techniques can play the role of a virtual assistant. People in need can carry artificial intelligent wearable device or sensor to get self-health situation in real-time. Some artificial intelligence platforms are utilized for reminding and guiding individual daily care activities, like a virtual secretary remind user take medicine or inform health alert when necessary. (Reddy, Fox & Purohit 2018.)

Artificial intelligence is beneficial for an individual in disease self-management. A study of "Nurse Chatbot" mentioned that a healthcare Chatbot with artificial intelligence system has a positive impact on mental health to the care receiver. A mental health Chatbot can effectively reduce depression symptoms in patients with depression. (Hernandez 2019, 26.) In Singapore and Japan, a companion robot is used for company to elderly with mild dementia. It provides emotional support to care receivers and improve personal self-confidence and reduce loneliness. (Maalouf et al 2018, 594.)

Assistive robots can be used for taking care of user daily activities. They are especially uses among those people who need a daily care assistant but might without family member support, such as elderly and handicapped people. An example of an assistive robot is smart walker. Smart walker can detect obstacles on the road and build a visual map of the surrounding environment, providing users with more convenient and safer walking solution. (Reddy, Fox & Purohit 2018; Maalouf et al 2018, 592.)

Non-patient oriented aspect

An artificial intelligence-assisted care program has been developed by Stanford University, which contains an intelligent hand hygiene system for doctors and nurses. This intelligent hand hygiene system can help clinical personnel to do a perfect hand hygiene and protect from hospital infection as much as possible. (Amisha, Malik, Pathania & Rathaur 2019, 2329.)

Artificial intelligent technology is being used for drug discovery and development. Artificial intelligent cryptography has been used to predict potential interactions between drugs and toxic side effects of drugs. This is helpful to speed up the process of clinical drug research. (Reddy, Fox & Purohit 2018.)

6.2 Challenges of Artificial Intelligence in Healthcare

Medical ethics

Most studies have emphasized that in the application of artificial intelligence in healthcare, it is necessary to consider issues of medical ethics. Even in the existing medical regulations, sometimes medical responsibility is not completely clear and fair when medical accidents occur. More and more artificial intelligence products intervene in the medical field, but its related responsibilities are also in the vague phase. (Reddy, Fox & Purohit 2018; Vellido 2018, 13.) In order to ensure the benefits and safety of artificial intelligence in healthcare, a complete medical regulation for the artificial intelligence needs to be established. A healthcare provider has the responsibility to consider the effectiveness of artificial intelligence in healthcare intervention and to comply with current regulations. A complete clear regulation is the restriction and protection of the clinical behavior of healthcare workers. (Vellido 2018, 13; Keskinbora 2019, 281.)

The health data privacy and anonymity is another common challenge of artificial intelligence in healthcare. Since the core of artificial intelligence techniques for healthcare is medical data, the individual's data may be at risk of privacy leakage during the data collection, storage and sharing process. Ensuring data security is a huge challenge and responsibility for all stakeholders. Health care workers need to be trained in the health data security and privacy. (Ellahham et al 2019, 5; Vellido 2018, 12.)

In addition, the interpretability and explaining the ability of artificial intelligence needs to be considered. Despite the many advantages of artificial intelligence, its application in the medical field is far from universally accepted. One reason is the lack of

interpretability of artificial intelligence in some ways. (Vellido 2018, 14.) Some behaviors of artificial intelligent cannot be explained clearly, people don't understand how artificial intelligent algorithm works. In clinical care, if a healthcare worker is not able to understand how artificial intelligence makes medical decision and its outcome, it is difficult to explain the decision making to patients. (Reddy, Fox & Purohit 2018; Vellido 2018, 14.)

Clinical safety issues

Most existing research on artificial intelligence points out that precise algorithms are one of the advantages of artificial intelligence. However, the accuracy of artificial intelligence algorithms is not totally one hundred percent. It means that artificial intelligence may cause the clinical bias and errors. (Wang & Preininger 2019, 23.) Bias in artificial intelligence technology may directly or indirectly cause clinical misdiagnosis or wrong treatment plan, which may have worse consequences than traditional medical errors. Health caregivers have to clear that they are the final medical decision makers, they need to balance the pros and cons without over-reliance on artificial intelligent tools. (Maalouf et al 2018, 596; Ellahham et al 2019, 5; Wang & Preininger 2019, 22.)

Humanistic concern

There are two challenges from the perspective of humanism, one is the relationship between the artificial intelligent machine and the patient, and the other is the relationship between the patient and the health care worker. With the increasing application of artificial intelligence in the medical field, especially the application of intelligent robots may result in the less communication between health caregivers and patients. (Nwosu, Sturgeon, McGlinchey, Goodwin, Behera, Mason, Stanley & Payne 2019, 1109.) Humanoid intelligent robots perform tasks by simulating human behavior, but it has no ability to express emotions. It means that intelligent machines have no ability to observe and feel the real-time emotions of patients. The intelligent machine without empathy may lead to fear and mistrust in patients when performing task. (Maalouf et al 2018, 594; Nwosu et al 2019, 1108.)

Pre-clinical consideration

High quality medical health dataset is a key part of successful operation of artificial intelligence in healthcare. A meaningful dataset is the core supporting accurate analysis of artificial intelligence technology for healthcare. The challenge of this stage is the limitation of the clinical dataset. (Wang & Preininger 2019, 22.) Medical health data

contains pathological knowledge, medical imaging, personal health information of patients, and so on, any incomplete or inaccurate data may lead to errors or bias of artificial intelligence techniques in healthcare. To establish a vast and high quality medical health dataset, it requires the cooperation among the technical experts, healthcare workers and patients. (Allahham et al 2019, 4.)

Before the artificial intelligence products are applied in the clinical or provide services for patients, they must be repeated evaluation and clinical validation to ensure products effectiveness and safety. The health caregivers need to be completely familiar with and understand the artificial intelligence products characteristics and working mechanism. Doctors and nurses have to learn knowledge about artificial intelligence, which is different from the medical and nursing care knowledge. Simultaneously, relevant guidelines for patients is also essential. (Keskinbora 2019, 281.)

7 DISCUSSION

7.1 Discussion of Findings

The aim of this thesis is to explore the advantages and challenges of artificial intelligence in the healthcare field. The descriptive review conducted in this thesis answers the proposed questions by categorizing artificial intelligence in healthcare into two main categories: Advantages and challenges. The two main categories branched into three subcategories for advantages and four subcategories for challenges of artificial intelligence in healthcare. Each subcategory has been described in detail throughout this literature review. The thesis questions have been answered based on the findings of 11 articles.

From the literature search findings, artificial intelligence technology is gradually penetrating the healthcare field. In the clinical aspect, artificial intelligence has been used to support clinical decision making, disease prediction, health caregiver assistive, and healthcare management. (Amisha et al 2019; Ellahham et al 2019; Reddy, Fox & Purohit 2018.) Artificial intelligence algorithms give healthcare worker decision supporting and recommendations. Most of the findings indicated that the auxiliary role of artificial intelligence can help reduce the workload of doctors and nurses and improve healthcare quality and patient satisfaction. (Reddy, Fox & Purohit 2018.) Outside of hospital, artificial intelligence can play the role of a private assistant. It helps to take care of who lives alone and needs help, such as elderly and disabled people. (Reddy, Fox & Purohit 2018; Maalouf et al 2018.) Artificial intelligence technology is also involved in clinical drug research and speeds up its development (Reddy, Fox & Purohit 2018).

In addition, artificial intelligence related nursing care is mainly used in nursing process: nursing assessment and nursing diagnosis. An artificial intelligent tools support the nursing decision making, and assessment of patient's vital signs in automatic in real-time. (Liao et al 2015.) An artificial intelligent robot plays the role of a nurse assistant to take care of patients, releasing the burden of nurses (Maalouf et al 2018).

Regarding the challenges of artificial intelligence in healthcare, the findings indicated that the common concerns are medical ethics, clinical safety issues, health caregiver-patient relationship, and preclinical preparation (Wang & Preininger 2019; Maalouf et al 2018; Nwosu et al 2019). The current situation is unclear regulation for artificial intelligence in healthcare, incomplete health data set, fuzzy technology outcome, and healthcare worker and patient lack of understanding of artificial intelligence. Those

factors mentioned above may lead to adverse clinical consequences: The patient's safety is at risk by machine, misdiagnosis or wrong intervention, deteriorating health caregiver-patient relationship, even serious medical incident. (Nwosu et al 2019; Ellahham et al 2019.)

As a result, the findings showed that artificial intelligence has been considered as a good tool to improve the quality and efficiency of medical care, release the workload of health workers and satisfy the need of humankind. However, artificial intelligent technology in healthcare field is still in its immature stage. If the existing deficiencies cannot be overcome, it may also bring negative effects. (Amishar et al 2019.)

7.2 Reliability and Validity

Reliability in content analysis refers specifically to stability, reproducibility and accuracy in the coding or corresponding content. Stability can be evaluated by set codes in multiple times for the same content by the same person. Reproducibility can be proven by code and classify the same content by different person. Accuracy refers to the extent to which content classification comply with a standard. (Wood & Ross-Kerr 2011, 209.) The validity of content analysis refers to whether the categories comply with the results and whether the results can be summarized to form a universal theory (Houser 2012, 252).

The process of this thesis was based on the theoretical guidance of literature review. The data collection process was clear and explained in the thesis. The qualified articles and correspondent contents were assessed multiple times by reviewers. Findings were categorized and clearly answered the thesis questions.

7.3 Ethical Consideration

Scientific literature is the result of academic research, it is beneficial for other researcher to replication and propulsion. Research and scientific writing keep strictly within the ethical guidelines. It is important to keep scientific advancement. (Carver, Dellva & Emmanuel 2011.) In this thesis, the research sources were collected from three academic databases: PubMed, CINAHL, Elsevier Direct. Articles selected by two main categories were according to the study questions. This literature review does not involve human beings as participants during data collection process, but involved in published studies. With respect to the copyright issues, all references were under the guidelines of graduation theses of Lahti University of Applied Sciences. The sources of studies were clearly indicated in this thesis. A list of references was added to the end of this article.

7.4 Limitation

This thesis explored the artificial intelligence from the perspective of nursing. They are the direct effects of artificial intelligence in medical area. The thesis does not discuss the indirect impact of artificial intelligence on medical field, the impact of artificial intelligence on medical research area: new medication discovery.

This thesis was done for a nursing Bachelor's degree project, thus the acknowledgements of artificial intelligence are limited. The data which is analyzed in this study were based on very limited database as well. Thus, the perception of the cognitive integrity of the impact of artificial intelligence technology in the medical field is flawed and inadequate.

This thesis, due to very limited sources searched from nursing field and data samples being very small, thus, the results about the artificial intelligence technology effect in nursing domain were unavoidably incomplete.

7.5 Conclusion

In conclusion, artificial intelligence has been partially applied in health care but it is still in its immature stage. Doctors and nurses are still the ultimate decision makers and executors of health care, and artificial intelligence perform auxiliary functions. As the development of technology are rapidly growing and the inefficiency and deficiency of the medical resources exist widely, the impact of artificial intelligence may be even more profound in the medical field. However, a series of issues need to be taken seriously, for example, the quality of the available medical data, cooperation between humans and machines, and related ethical issues. Based on those issues, more questions will be raised regarding the rapid development of technology innovation, for instance, who has the right to own those valuable data (Government, investment capital, research institution, big technology company, hospital, individual person)? How to balance conflicts among stakeholders? Who has the right to get the most benefits from the utilization of data in the medical field and so forth. Artificial intelligence which applies into the medical field requires systematic regulation and policy. The leadership of decision making should participate in health system as well. Substantially to solve those questions posed by artificial intelligence, great efforts are needed for sure in the near future.

Most existing research has pointed out the benefits of artificial intelligence for health care, while few studies focus on medical accidents caused by artificial intelligence tools.

The current data on the strengths and weaknesses of artificial intelligence in healthcare is asymmetry, it may lead to people with one-sided understanding of artificial intelligent healthcare. As recommendations for further related research, the weaknesses of artificial intelligence in healthcare and the application of artificial intelligence in the nursing field need to be studied in the future.

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APPENDICES

Appendix 1

1.Title: Societal issues concerning the application of artificial intelligence in medicine

Arthur/s: Vellido, A

Publication: Journal of Kidney Diseases

Year: :2018

Aim: Discuss a number of specific issues of social relevance affecting the use of AI in medicine. To reflect on how all these issues affect medical applications of AI and ML.

Result: AI and ML are attracting much interest from the medical community as key approaches to knowledge extraction from data. Issues of social relevance with an impact on medicine and healthcare include (although they are not limited to) fairness, explain ability, privacy, ethics and legislation.

2.Title: Medical ethics considerations on artificial intelligence

Arthur/s: Keskinbora, KH

Publication: Journal of Clinical Neuroscience

Year:2019

Aim of study: Discusses AI in terms of the medical ethics issues involved, both existing and potential.

Result: From the perspective of medical ethics, the existing problem of artificial intelligence in healthcare is the lack of complete laws and regulations to ensure safety. Excessive legal constraints will prevent the potential benefits that artificial intelligence can provide to the medical area.

3.Title: Robotic technology for palliative and supportive care: Strengths, weaknesses, opportunities and threats

Arthur/s: Nwosu, AC., Sturgeon, B., McGlinchey, T., Goodwin, CD., Behera, A., Mason, S., Stanley, S & Payne,TR.

Publication: Journal of Palliative Medicine

Year: 2019

Aim of study: Examine the possible future impact of medical robotics on palliative, supportive care and end-of-life care.

Result: The opportunities of robotics in palliative, supportive and end-of-life care include a number of assistive, therapeutic, social and educational uses. A number of technical, societal, economic and ethical factors need to be taken into account.

4.Title: Application of Artificial Intelligence in the Health Care Safety Context: Opportunities and Challenge

Autor/s: Ellahham, S., Ellahham, N & Simsekler, MCE

Publication: American Journal of Medical Quality

Date: 2019

Aim: To shed light on such opportunities and challenges; Reviews AI in health care along with its implication for safety

Result: Safety of AI in health care is focused on predictions and outcomes based on predictions in so far. Strategies for safety of AI and ML in health care are evolving and are not yet fully developed.

5.Title: Network diffusion and technology acceptance of a nurse chatbot for chronic disease self-management support: a theoretical perspective

Author/s: Hernandez, JP

Publication: The Journal of Medical Investigation

Year: 2019

Aim: Explore the 'Nurse Chatbot' for chronic care on the benefits of increasing patient/client access to healthcare information and maximizing the potential of AI to bridge the 'demand-supply gap' of human healthcare providers

Result: The technical feasibility of developing and implementing a 'Nurse Chatbot' is realistic based on the available evidence of chatbot designs and chatbot-delivered/mediated interventions

6.Title: AI in health: State of the art, challenges, and future direction

Author/s: Wang, F & Preininger, A

Publication: Yearbook of medical informatics

Year: 2019

Aim: Review the current state of AI in health, along with opportunities, challenges, and practical implications.

Result: Technologies have enabled the development of AI-assisted approaches to healthcare.

7.Title: Applying artificial intelligence technology to support decision-making in nursing: A case study in Taiwan.

Author/s: Liao, PH., Hsu, PT., Chu, W & Chu, WC.

Publication: Health Informatics Journal

Year: 2015

Aim: Investigate the use of artificial intelligence to generate nursing diagnoses.

Result: Artificial intelligence tech could enhance the accuracy of collecting and recording data. An effective information system could reduce the workload of healthcare providers, increase the time healthcare providers directly spend on patients, improve the quality of healthcare, and ensure patients' safety in medical treatment.

8.Title: Artificial intelligence-enabled healthcare delivery

Author/s: Reddy, S., Fox, J & Purohit, MP.

Publication: Journal of the Royal Society of Medicine.

Year: 2018

Aim: Explore how healthcare system can be developed based on a realistic assessment of current AI technologies and predicted developments.

Result: Artificial intelligence needs to consider "soft issues" while promoting the development of the medical field. Fair and open access to data, medico-legal responsibilities in decision making and equitable distribution of benefits have to be addressed.

9.Title: The utility of artificial intelligence in suicide risk prediction and the management of suicidal behaviors

Author/s: Fonseka, TM., Bhat, V & Kennedy, SH

Publication: Australian & New Zealand Journal of Psychiatry

Year: 2019

Aim: Explore the role of artificial intelligence in optimizing suicide risk prediction and behavior management.

Result: Based on the observed benefits to date, artificial intelligence has a demonstrated utility within suicide prediction and clinical management efforts and will continue to advance mental healthcare forward.

10. Title: Robotics in Nursing: A Scoping Review

Author/s: Maalouf, N., Sidaoui, A., Elhajj, IH & Asmar, D

Publication: Journal of Nursing Scholarship

Year: 2018

Aim: Discuss different tracks in which robots are used in nursing.

Result: The field of robotics in nursing is evolving fast to cope with the need for help in caregiving, especially for the elderly and individuals with disabilities.

11. Title: Overview of artificial intelligence in medicine

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Aim: Gives a broad overview of AI in medicine, dealing with the terms and concepts as well as the current and future applications of AI.

Result: Many of artificial intelligence applications are still in their infancy and need to be explored and developed better. Medical professionals also need to understand and acclimatize themselves with these advances for better healthcare delivery to the masses.

Appendix 2 Formation of “Advantages of artificial intelligence on healthcare” category

| Quote | Open coding | Sub-category | Category |
|--|--|-----------------------------------|--|
| <p>Adaptive-network-based fuzzy inference system model can effectively derive the differential guidelines for nursing diagnoses of similar symptoms to assist nursing staff in making nursing diagnoses. Subjective cognitions and judgments on the part of nursing staff can be reduced to decrease unnecessary working time and to increase the accuracy of nursing diagnoses. (Liao et al 2015)</p> | <p>Nursing diagnosis support</p> <p>Decision making</p> <p>Improve accuracy</p> <p>Save time</p> | <p>Clinical healthcare aspect</p> | <p>Advantages of artificial intelligence on healthcare field</p> |
| <p>Artificial intelligence tech can be a great assist in routine clinical practice and research. Quick and easy access to information, increased outreach, and reduction of errors in diagnosis and treatment of disease are the key benefits of AI. (Ellahham et al 2019)</p> | <p>Auxiliary medical diagnosis</p> <p>Reduction of misdiagnosis</p> <p>Speed up diagnosis</p> | | |
| <p>Machine learning algorithms are now being used to predict the development of septic shock and aid diagnosis and treatment of chronic obstructive pulmonary disease patients and many other specialist decisions. (Wang & Preininger 2019)</p> | <p>Prediction of disease</p> <p>Treatment support</p> <p>Diagnosis support</p> | | |