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Use of Artificial Intelligence in Nursing

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Abstract

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Abstract

The purpose of the thesis is to explore the concepts of Artificial Intelligence (AI), its application, advantages, challenges, possible measures of integrating AI into nursing practice as well as the ethical considerations. The thesis aims to seek and analyse the probability of nurses being replaced by AI in the future.

The study was conducted as a qualitative integrative literature review, and a thematic inductive content analysis approach has been implemented. The data was collected from electronic databases and scholarly articles relevant to the research questions. The study approach was a qualitative method to gather information from previous studies and to recognize subject that requires further investigation.

The result of the study revealed that AI tools such as PARO, Giraff, TUG, Robear, Zora, care-O-Bot, and others are being used in monitoring, assisting, medication administration, determining patterns, and preventing physical exhaustion. Integration challenges entail a lack of AI curricula in nursing, a lack of trust, and communication between nurses and AI developers. Ethical aspects of human care such as dignity, autonomy, privacy, safety, data protection, transparency, and acting responsibly are emphasized. AI can be integrated into nursing by introducing “Minimum AI in nursing competencies” in the curriculum, elaborating ethical and legal implications, as well as encouraging multidisciplinary collaboration between nurses and AI developers. As a quote stresses “A better bicycle does not replace the cyclist”, which sums up the idea Nurses are irreplaceable by AI but will function as a helping hand.

Keywords

Artificial Intelligence, Machine learning, Nursing Attitudes, Ethical Issues, Robotics in Nursing

Contents

1 Introduction

Nurses are a critical part of the patient's overall treatment cycle, play an important role in health promotion, illness prevention, and caring for the sick, the disabled, and the dying, and are often the unsung heroes in the health care system. Health professionals are short in supply all around the world, while more than 50% of the current shortage accounts for nurses and midwives. It is also estimated that a huge number of nurses will be retired in the next ten years due to aging. Southeast Asia and Africa have the greatest shortage of nurses. (WHO 2022.) According to the report by WHO (2019), almost 2.6 million people die annually because of bad healthcare practices that could have been avoided easily.

In the contemporary situation, the challenges faced by the nurses include a lack of experienced staff, poor judgment due to inadequate understanding and expertise, proper documentation obligations, ethical distress brought on by organizational limitations, physical fatigue by constantly lifting patients and making numerous trips to obtain supplies for the procedures. In addition, the physical duties add to the nurses' workloads and limit them from delivering direct patient care, increasing family frustration, and pressure to provide quality care to chronically ill patients in short patient admission time. (Stokes &Palmer, 2020). In addition, the Nurses are frequently exposed to obstacles during their shifts like spending a significant amount of time in non-professional work like service or administrative assignments which occasionally necessitates needless walking, small and frequent requests from patients and co-workers, as well as alarms and phone calls. These interruptions act as additional stressors that lower the level of nursing intervention and efficacy. (Ohneberg et al. 2023.)

On the other hand, Artificial Intelligence (AI) has been a hot topic of discussion at every conference, and committee meeting as well as huge numbers of articles and reports have been published to explore their usability in the healthcare system. It is estimated that, by 2025, artificial intelligence could save around $ 150 billion on healthcare costs, in terms of clinical savings, and financial and operational costs (Konasani & Kadre 2021). Also, artificial intelligence technologies are being designed in such a way that they have the potential to share nursing duties, ease the strain on nurses to focus on professional work as well and address the shortage of nurses worldwide (Liao et al. 2023).

According to Statista (2023), the market valuation for artificial intelligence (AI) in healthcare was estimated to be approximately 11 billion dollars in 2021 and the market valuation for AI in healthcare is expected to reach over 188 billion dollars by 2030, growing at a compound annual growth rate of 37% between 2022 and 2030. The report from Exploding Topics (2022), has suggested that searches for AI in healthcare on the internet have been up by 375% in the last 5 years.

On the contrary, China declared its intention to become a worldwide leader in AI by 2030, and the United States issued an executive order in 2019 instructing all federal government agencies to pursue strategic goals directed at advancing AI research and development. These assertions imply that both China and the United States are aggressively investing in artificial intelligence and portraying themselves as leaders in the field. (Robert 2019).

Artificial Intelligence (AI) is being designed to be implemented in the nursing field as well as in medical technology for clinical monitoring and decision-making. The acceptance of AI into the healthcare system is expected to happen at a rapid pace globally due to the internet's strong connection-induced globalization and digitization. Artificial Intelligence (AI) being post-human creations, it is also of prime importance to consider whether the robots will be able to meet the accepted human ethics and nursing ideals. (Erikson & Salzmann-Erikson 2016.)

2 Nursing in General

2.1 Nursing and Compassionate Care

Nursing is defined as "*knowledge of the phenomena of interest (to nurses), namely (why, when, where, and how nurses) collaborate with other individuals as they encounter well-being, illness, and disease in the framework of their environments*". Nursing is about human care, wellness promotion, enabling humanization, and restoring and healing the quality of life in living and dying. The ultimate objective of nursing practice is to improve, preserve, and restore health to lessen and relieve the impact of illness on people as well as to respect human dignity. (Fawcett 2019.)

Compassionate caring has been one of the guiding principles for nurses since the time of Florence Nightingale. It is evident that compassionate caring consisting of wisdom, humanity, love, and empathy serves to improve the overall patient health outcomes, aids client satisfaction, reduces patient suffering, addresses individualized caring needs, and improves job satisfaction for nurses. (Jing Su et al. 2020.)

According to the Walker and Avant method (2005) empathetic feeling, a presence, a sense of touch, sincerity, faith, and cooperation are the essential components that contribute to developing a quality nurse-patient relationship. Furthermore, communicating, appreciating each other beliefs, attentive listening, and maintaining kindness, confidentiality, fairness, and sensitivity are also the additional key components of developing quality nurse-patient relationships. A sound nurse-patient relationship is therefore important to enhance the treatment outcome, patient satisfaction, and compliance with treatment, ensuring patient safety, aiding in empowering patients by integrating in decision-making, as well as fostering a caring environment with mutual respect and empathy. (Allande-Cusso et al. 2022.)

2.2 Challenges in Nursing Care

The Maslach Burnout Inventory (BMI) scale, the scale that determines the burnout level in individuals, identifies that insufficient staffing leads to a never-ending workload, more than 12 hours of long shifts, emotional exhaustion associated with time constraints, varied job complexities depending upon the patients, the nursing job being psychologically demanding, frequent role conflicts between the nurses, limited autonomy, unfavourable nurse-physician relationships, poor leadership and appreciation from the management as well as increased job anxiety are the common challenges faced by the nurses in the

healthcare setting. And, these are the contributing factors leading to burnout, emotional tiredness, depersonalization, and a decrease in the sense of personal success. (Dall'ora et al. 2020.)

Constant job dissatisfaction, physical as well as emotional exhaustion, absenteeism, unexpected outcomes in hospital care, unsupportive and unfavourable nursing environment, high stress, and aging are also the issues faced by the nurses in the current scenario. (Koy & Fisher 2015.)

Notably, the challenges that the nurses are encountering are the nursing personnel shortage, reduced enrollment in nursing schools owing to a lack of effective planning and funding availability, rising early retirement owing to health issues of the working nurses, training, and enrollment barriers, such as a lack of training space, special educational settings, dorms, and clinical practice locations. Importing nurses from foreign nations rather than training local nurses, high assigned workload, and job discontent are influencing nursing staff turnover intention. The increasing workloads and stress level among nurses is affecting the existing nursing staff's mental health as well as the nursing care quality, patient safety, and mortality rate. (Tamata & Mohammadnezhad 2022.)

2.3 Evolution of Technological Adoption in Nursing

Tracing back to the 18th century, nursing was mainly practiced by individuals, of whom a huge proportion were women. Their entire learning of nursing care was through their families, cultural and religious beliefs acknowledged at that time. knowledge and skills were developed over time through the process of trial and error, relying upon the rule of thumb, common sense, learning by doing, and faith. Only the individuals who were trustworthy and with pure intention were involved in delivering nursing care, and they relied more on personal and instinctive comprehension built upon their daily practices rather than on scientific knowledge. (Barnard 1996.)

During the First World War, the nurses learned and improvised the quick process of antiseptic cleansing for the infection in the head, chest, and abdominal wounds. Slowly, they began to understand the importance of empathy and focused more on the development of physical and occupational therapy as well as plastic surgery. As time progressed, numerous innovations have been made in the healthcare sector with the aid of nurses such as automated dispensing, automatic pharmaceutical packages, the use of drug dispensing

carts regarding medication administration, cardiac devices like a total artificial heart (TAH), left ventricular assist devices (LVADS) implantable cardioverter defibrillators, imaging technologies, e-prescribing, and telehealth. The development of telephones has allowed nurses to follow up with patients, offer support to patients with HIV/AIDS, and encourage the patient to adhere to the treatment. The discovery of cameras and web cameras have exponentially improved the nursing care quality in neonatal intensive care, parents were able to monitor their children virtually lowering their anxiety and stress. (Agustin et al. 2019.)

Robots, information, and communication technologies (ICT), and sensors were the top-three technological study trends. Information and communication technologies (ICT) supported the nurses in terms of documentation and maintaining electronic health records (EHR) as well as electronic medical records (EMR). Robots are being tested and developed to assist in organizational, security-related, psychological, educational, therapeutic, or physical tasks. Sensors are being developed to check the patient's movement, behavior, falls, alarms, pumps, and other health-related outcomes. Although nurses did not have a direct role in developing these technological innovations, the way they have adopted and put these technological advances into practice has resulted in huge progress in terms of quality care, patient safety, and improved overall health outcomes. To sum up, the conclusions drawn from the historical analysis show that nurses are the fundamental innovators in the healthcare industry. Nurses have always been at the forefront of innovation, whether it is in the knowledge of treating wartime wounds or the application of technology for global nursing in the present age. (Agustin et al. 2019.)

2.4 Ethics in Nursing Care

Ethics is derived from the Greek word “ethos” describing the character. Ethics are the universal standards of behaviors that serve as a useful guide for determining the individual’s behaviors, reasons, and intentions as well as the moral principles that direct a person’s or a group’s behaviors and actions. The first formal code of Ethics to guide Nurses was issued by the American Nurses Association (ANA) back in 1950. In the year 1953, the first code for nurses was released worldwide by the International Council of Nurses (ICN). The code of ethics provides a non-negotiable ethical standard that instructs the nurses to perform their day-to-day work, establishes clear fundamental objectives and principles, and sets clear ethical responsibilities and obligations to be followed as a nurse. (Geiger & Haddad 2023.)

The Finnish Nurses Association established in 1925 issued the code of ethics for Finnish nurses in 1996, which is classified under six headings namely: 1.) The mission of the nurses; 2.) nurses and patients; 3.) the work and professional competence of nurses; 4.) nurses and their colleagues; 5.) nurses and society, and 6.) nurses and the nursing profession. (Numminen 2010.)

The mission of the nurses is to preserve and promote health, prevent sickness, and relieve suffering. In the nurse-patient relationship, the nurse should humanely treat the patient, ensure their autonomy, and confidentiality, and treat the patient as a valuable human being. Regarding the work and competence of nurses, it emphasizes the nurse's individual accountability for progressing their work and strengthening their professional competence. Delivering quality care to the patient is the shared responsibility of the nurses. The nurse's relationship with colleagues places a strong focus on mutual respect, professional expertise, and the shared responsibility to uphold ethical standards in patient care. The main aim is to cooperate and help each other in making quality decisions regarding patient care. Nurses' relationship with society, emphasizes the importance of nurses taking part in national and international discussions and decision-making concerning people's health, quality of life, and well-being. Nurses are bound to promote family involvement in care, educate and empower people on health-related topics, and collaborate with groups that support volunteers, individuals with disabilities, and patient associations. At last, in nurses and the nursing profession, nurses are directed to fulfill their duties in a dignified and humane manner. It is to be made sure the social and economic working conditions are suitable for the members. The nurses are also responsible for the development of their expertise. (Numminen 2010, 34 – 35.)

Some notable codes of ethics for nurses are to respect their patient's autonomy, beneficence, kindness, and fairness while dealing with the patients. Treating patients with dignity, and compassion, respecting their cultural sensitivity and wishes, and maintaining patient privacy and confidentiality are important factors to be considered. Nurses are also allowed to advocate for their patients' interests and alert the respective authorities in case of any ethical transgressions and conflicts. Human touch, being present, reliability, cooperation, active listening, mutual respect, and acceptance as each patient is unique constitute the critical components to embrace the nurse-patient relationships. (Allande-Cusso et al. 2022.)

3 Introduction to Artificial Intelligence

With the technological revolution and embarkment of Industry 4.0, human mankind has witnessed things that were not even possible a decade ago. From the development of smart and autonomous vehicles to recommendation systems used in websites, and social media, Artificial intelligence (AI) is heavily associated with our daily lives. Though Artificial intelligence has become part of our daily lives, we are still unaware of what artificial intelligence means. A definition given by Elaine Rich as mentioned in Wolfgang (2017) states that “Artificial intelligence is the study of how to make computers do things at which, at the moment, people are better.” Alan Turing, who is often regarded as the founding father of Artificial Intelligence defined AI as “the science and engineering of making intelligent machines, especially intelligent computer programs” (McCarthy 2007). Different authors have provided different concepts of AI and one-size fits all definition of AI is impossible to find. According to Kaplan and Haenlein (2019), Artificial intelligence is a smart system that can analyze external information and utilize that information to achieve certain goals and tasks. However, Mueller and Massaron (2019), have stated that Artificial intelligence has nothing to do with human intelligence and have suggested four ways to determine if the system is Artificially intelligent or not, which are acting humanly, thinking humanly, acting rationally, and thinking rationally.

3.1 Brief History of Artificial Intelligence

Artificial intelligence is said to be first depicted or inspired from the short story called “Run-around”, written by American science fiction writer, Isaac Asimov in 1942. It is also mentioned that during the 1930s Kurt Gödel, Alonso Church, and Alan Turing worked on the essential “foundation of logic and theoretical computer science” which then became the fundamental basis for modern Artificial intelligence development. During the Second World War, Alan Turing invented a “code-breaking machine” called “the Bombe” that helped the British government break “the enigma code” used by the German troops. The system developed by Turing was very advanced at that time and his invention not only inspired other scientists but also gave pace to the development of Artificial intelligence. A series of events took place. (Kaplan & Haenlein 2019.)

Afterward, the development of artificial intelligence saw lots of ups and downs. The next big development happened when researchers began exploring “artificial neural networks”.

Following that, researchers came up with the concept of "Deep learning" in 2015 which gave a rapid pace to the present development of artificial intelligence. (Kaplan & Haenlein 2019.)

3.2 Types of Artificial Intelligence

Artificial intelligence can be mainly of two types: Narrow (weak AI) and General (strong AI). Strong AI is an advanced system that has human-like or more superior intelligence than humans whereas weak AI is also defined as an intelligent system that can perform only pre-defined tasks and have less human-like intelligence. Strong AI can learn, think, and comprehend things like humans whereas weak AI can only perform tasks on the data they are trained at. (Naidu et al. 1996.) Google's AlphaGo, IBM's Watson, and many speech transcription programs are examples of weak AI where the system must be fed with tons of data and the algorithm will form a pattern from the data, ultimately solving a complex problem. The world is moving towards the development of strong AI and one of the examples could be Open AI, Generative Pre-trained Transformer (GPT-3), or simply chat GPT. (Malone et al. 2020.) The researchers and the programmers are mostly investigating developing more General AI where the machine could learn itself about the problems and then solve them. (Deloitte 2018.)

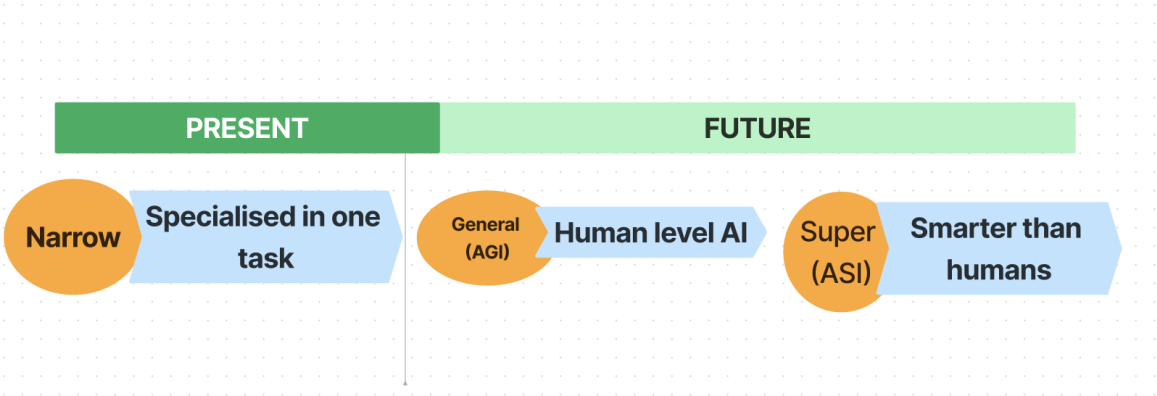

Figure 1. Types of Artificial Intelligence and Their Progression. Modified from (Hardwood et al. 2019)

Artificial intelligence is an umbrella term and is used when machines perform tasks intelligently but to deeply understand the concept of AI, we need to understand the concept of Machine Learning (ML) and Deep Learning (DL). "Deep learning is a subset of machine learning and machine learning is a subset of Artificial intelligence." (Tiwari et al. 2018.)

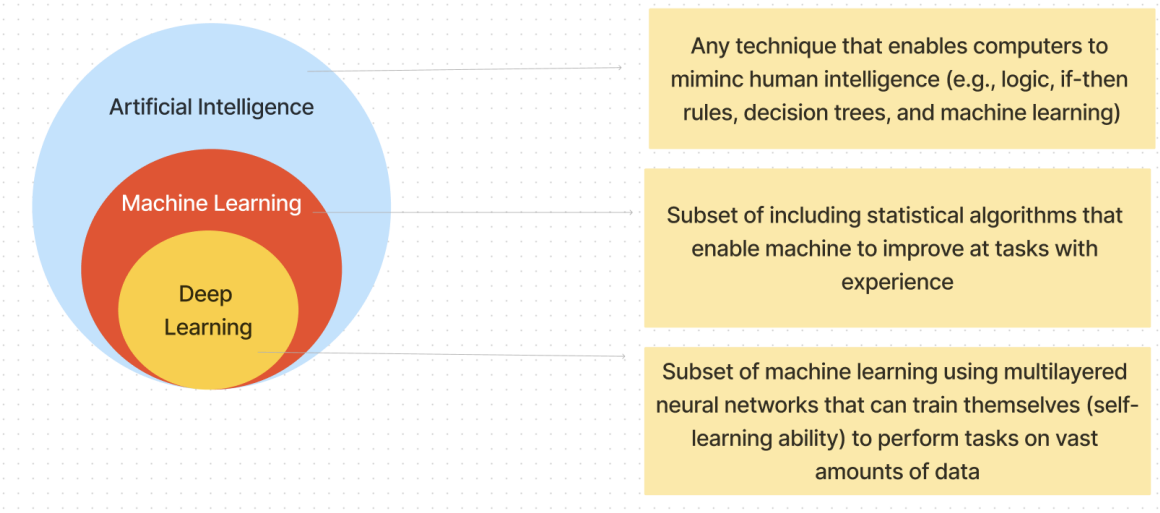

Figure 2. Relationship between AI; ML and DL. Modified from (Busnatu et al. 2022.)

3.2.1 Machine Learning (ML)

Machine Learning (ML) simply means machines learn through different sorts of algorithms. Machine Learning is a subset of AI that uses an advanced statistical algorithm to comprehend large quantities of data (big data) and possibly find a pattern that can be used to gain valuable insights. Big data can constitute any form of data such as images, text, documents, clicks, and so on, which can be stored in a digital form. Basic examples of machine learning include search engines like Google and Baidu, social media feeds like Facebook and Twitter, voice assistants like Siri and Alexa, and recommendation systems like those on Netflix, YouTube, and Spotify (Mannam). Machine learning systems can carry out complex processes by learning from data rather than by following pre-programmed rules since they provide computers the ability to act intelligently when performing certain jobs. (Tiwari et al. 2018.)

There are three types of Machine Learning: Supervised learning, Unsupervised learning, and Reinforcement learning (Mannam). IBM (2020) has defined supervised Machine Learning by the way it trains computers to accurately classify data or predict outcomes using labelled datasets. Label datasets can be defined as labelled pair that has both the input vector of the independent variable and an output vector of the dependent variable. A training set is used in supervised learning to instruct models to generate the desired results. On the other hand, Unsupervised machine learning does not use input datasets and has unlabelled datasets. Due to the nature of Unsupervised machine learning, the algorithm tries to seek

patterns or structures from the input and can be used mostly in exploratory. (Bironneau & Coleman 2019.) Lastly, Dong et al. (2020) have defined reinforcement learning as a type of machine learning algorithm that allows computers to interact with the real world and learn from it simultaneously. The authors have further explained that reinforcement learning divides the real world into two categories - “Agent and environment”. Agent tends to engage with the environment and seeks reward-based feedback, which allows the agent to perform better each time because the agent has been receiving constant feedback. (Dong et al. 2020.)

3.2.2 Deep Learning (DL)

Deep Learning (DL) techniques enable a machine to learn the models required for detection or classification while being provided with a significant amount of raw data. Deep learning is relatively a new concept in the Artificial intelligence field and the term “Deep Learning” was coined in 2008. (Konasani & Kadre 2021.) Deep learning techniques use several models of the data, each with a series of changes that enhance the input characteristics crucial for classification and decrease unimportant variations. Deep learning can be both supervised and unsupervised. (Panch et al. 2018.) Deep learning differs from traditional machine learning in the way representations are learned from raw data. Deep learning enables computational models composed of multiple processing layers based on neural networks to learn data representations with multiple levels of abstraction. (Miotto et al. 2017.) The main concept of deep learning can be narrowed down to artificial neural networks and algorithms that act as a human brain and learn continuously from the input data. (Konasani & Kadre 2021.)

3.2.3 Natural language processing (NLP)

Natural Language Processing (NLP) is a branch of artificial intelligence that transforms human language into a structured and understandable format so that computers can use it for a variety of computer simulations and other tasks. (Deloitte 2018.) Further, Khurana et al. (2022) have defined Natural language processing as a branch of AI and linguistics concerned with teaching computers to understand statements or words written in human languages. Since Computers are incapable of understanding human language and cannot analyze human sentences, they need additional instructions to define human language in a structured way. Natural language processing and machine learning (Deep learning) are the most used AI techniques in healthcare to produce meaningful results. (Deloitte 2018.)

4 Artificial Intelligence in Nursing

4.1 Artificial Intelligence-based Technologies in Nursing

Tess is a psychological AI service or mental health chatbot to provides on-demand support for caring professionals, patients, and family carers. It supports by extending emotional support to thousands of people at need which is affordable and user-friendly. A system that uses natural language processing was created to determine how drugs and bad drug occurrences are related. A recurrent convolutional neural network was trained on a corpus of 505 de-identified clinical notes, and the results were excellent. This learning technique has been used to determine the links between certain prescriptions and negative drug reactions. To monitor senior residents at nursing homes, a sensor that is placed on the floor was created. The elderly people's gaits were examined by the sensor, which was mounted on the floor, and it assisted in monitoring elderly resident's actions to assess their health. For the emergency room, a triage system was developed using the combination of machine learning and the initial nursing assessment which foretell negative clinical outcomes during a visit to the emergency department that outperformed the conventional system in terms of efficiency. (Jeong 2020.)

The development of the Electronic Medical Record (EMR) has significantly improved the documentation quality in nursing care as it minimizes the time consumption of nurses to write reports in paper. Electronic Medical Records (EMR) are digital patient charts designed for internal usage, but patient data privacy and data breaches are some concerns regarding this system. Automated blood pressure machines, basic cardiac monitors, Electronic Health Records (EHRs), smart infusion devices, Bar-coded medication administration (BCMA) systems, wearable devices for remote patient monitoring (patient's vital signs), telehealth technology for virtual visits and consultations, electronic thermometers, pulse oximeters, glucometers for monitoring blood sugar levels, virtual nursing assistants for medication reminders, patient education and scheduling an appointment are the perfect examples of how artificial intelligence devices have been assisting the nurses. (ISNA Bulletin 2020.)

PARO, Giraff, TUG, Robear, care-o-bot, Zora, the Kompaii and RAMCIP, the IVO & Tommy robot, and ARNA are the different types of assistive care robots. These assistive care robots help in processing information and patient data by tracking vital signs, gathering, and analyzing data, offering feedback to medical practitioners, and helping patients with tasks including washing clothes, bathing, and sanitation. They assist in fetching and bringing

types of equipment and supplements and aid in the activities like movement of patients, monitoring and navigating the patients by keeping an eye on them, detecting falls, helping in emergencies, supporting social engagement, cognitive training, and rehabilitative exercises. The telepresence and communication system makes it easier for patients, their relatives, and medical staff to communicate although the patients are not physically there. (Ohneberg 2023.) All these above-mentioned Artificial intelligence-based technologies are described in the result section 7.1 in detail.

Sophia is a social robot that performs a companion function for older adults, Little Sophia is a robot that is designed for kids aged 8 and older and can teach science, technology, maths, and coding and boost emotional engagement, Buddy is used as a home robot, Lynx is used as a home companion, Miko2 is a kid's robot that understands emotion, PARO is an animal therapy robot, Pepper works as a hospital receptionist, Pillo is an AI-powered which serves as health companion, Professor Einstein assists in teaching science and general information, ROBEAR is used as a nursing robot, and Votex is also a programmable robot that also helps kids to learn STEM, Science, technology, engineering or mathematics. (Robert 2019.)

"Boston Dynamics" dog-like robot "Spot" can take vitals from a patient up to two meters away by developing algorithms. UVD (Ultraviolet Disinfection) robots help disinfect the areas, PAL's 'Ari 'robots boots social stimulation, and TIAGo´s (Take it And Go) a dual-purpose robot that helps disinfect and deliver medicine and food to patients. The Pepper robot helps to communicate effectively with both individuals with mental illness and those who are healthy. (Soriano et al. 2022.)

4.2 Challenges in implementing Artificial Intelligence in Nursing

As artificial intelligence applications demand access to vast amounts of patient data, one difficulty is the need for data privacy and security. There is a risk of information loss, leakage, and manipulation, which can jeopardize individual security and confidentiality. Another issue is the possibility of low prediction accuracy, which might result in erroneous or inaccurate predictions. Malpractice concerns are also raised, as developments in telemedicine technology may necessitate appropriate licensing, training, and certifications. There may also be concerns regarding the influence of AI on the healthcare workforce, such as job displacement or changes in the function of healthcare workers. Furthermore, hackers' use of medicolegal algorithms for building autonomous procedures may threaten the

integrity and safety of crucial information. Figure 3 depicts the relationship between AI-based applications and safety concerns. The diagram depicts the various steps of AI implementation in healthcare, such as data collecting, data processing, and decision-making. The diagram also shows potential safety risks, that may develop at each stage, such as low prediction accuracy, data loss, leakage, manipulation, and malpractice concerns. The diagram stresses the importance of safety engineering solutions in addressing these concerns and ensuring the safe and effective application of AI in healthcare. (Ellahham et al. 2020.)

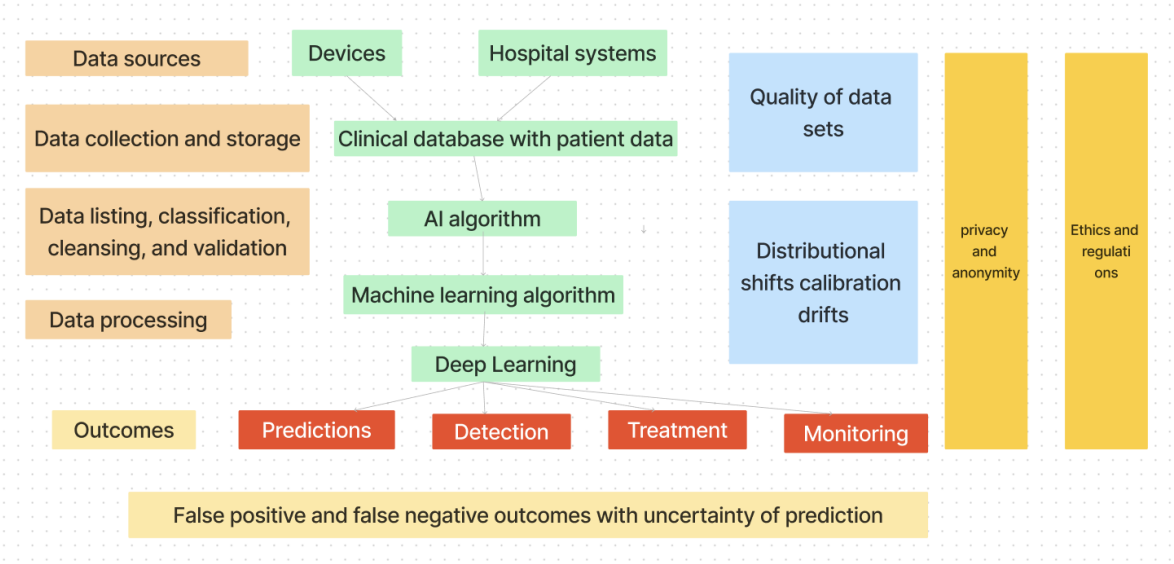

Figure 3. Safety concerns at various stages of deployment of Artificial Intelligence (AI). Modified from (Ellahham et al. 2019.)

The challenge faced by the developers while designing robots for nursing use is to develop robots that respond to natural language, which necessitates the development of advanced natural language processing algorithms. Another difficulty is that robots must be able to recognize and respond appropriately to nursing circumstances, which necessitates the creation of a “Nursing Situation Database” and a “Nursing Response Database”. Furthermore, robots must be able to self-learn and evolve, which necessitates the development of machine-learning algorithms. Ultimately, there are ethical and social issues associated with the use of robots in nursing care, such as the possibility of robots replacing human caregivers and the need to ensure that robots do not replace human caregivers. The demand that robots be created and utilized in a manner that respects patient’s dignity and

autonomy is yet another challenge to artificial intelligence technology developers. (Soriano et al. 2022.)

One of the problems is nurses' lack of trust in AI systems, which might lead to opposition to AI in nursing adoption. Another problem is that a significant amount of data is required to train artificial intelligence systems, which can be difficult to gather in nursing due to the complexity and variety of nursing care. Furthermore, multidisciplinary collaboration between nursing and engineering is required to design and apply artificial intelligence systems in nursing, which can be difficult due to variations in language, cultural background, values, principles, and morals between the two areas. The other challenging issues that must be addressed to ensure the safe and successful use of AI in nursing are associated with ethical considerations such as privacy, security, and accountability. (Soriano et al. 2022.)

The fear that artificial intelligence could outsmart and eventually dominate humans, resulting in job losses for nurses is another huge challenge the nurses might face. The nurses who hold this viewpoint may resist the implementation of AI in health care because it will render jobs obsolete. Artificial intelligence technology is viewed as depersonalizing, dehumanizing, and in paradigmatic contraindication to human care and there is also the risk of replacing human-to-human connections in the same manner that internet interactions have suspended face-to-face socialization. It is also a matter of concern that the assistive robots called carebots, cannot maintain privacy as the private chats with carebots could be assessed by unintended audiences, the carebots might not be able to address the social and emotional needs of the elderly people, the risk of potential for bias in decision-making, manipulative nature, developers not being transparent about the design of the robots. The absence of attention or involvement from nurses in the design, development, and implementation of AI into healthcare practice is one of the problems in using AI in nursing which results in inefficiencies and suboptimal patient outcomes due to a mismatch between the needs of nurses and the capabilities of AI. (Stokes & Palmer 2020.)

Challenges with usability and acceptance as nurses might be reluctant to utilize artificial intelligence technologies since they find it difficult to use or unable to integrate neatly into their workflow. On top of that, if patients are unfamiliar with technology, they may be hesitant to interact with robots or other AI equipment. Implementing artificial intelligence systems in nursing care necessitates careful planning and collaboration among healthcare practitioners, developers, and researchers. This includes making sure the technology is

consistent with current structures and processes, as well as incorporating it into theory-driven research projects. Furthermore, the implementation of artificial intelligence technologies involves significant ethical and legal issues, such as who is responsible for the activities of a robot or AI device, and how patient data is gathered, maintained, and used. Finally, deploying artificial intelligence systems in nursing care can be costly, requiring large resources for training, maintenance, and support. (Ohneberg 2023.)

Nurses are also worried that robots would malfunction and disrupt their harmonious interactions with patients, implying that further research is required to comprehend how to smoothly incorporate robots into nursing workplaces, i.e., a type of effective interaction between humans and robots. Likewise, the implementation of artificial intelligence technologies necessitates nurses' perspectives and experience for biomedical engineers to build robots to cope with complex health concerns. (Chang et al. 2021.)

Lack of knowledge and expertise in artificial intelligence technologies among nurses has been a significant issue in integrating AI into nursing. Many nursing educational programs lack sufficient competence in teaching health informatics and AI technologies to adequately address this AI knowledge gap. The further issue of AI is that it can extend or worsen existing health inequalities. If AI algorithms are trained on data that is not representative of the population, they may be biased. This can result in incorrect forecasts and suggestions, which can have a severe impact on patient outcomes. As a result, it is critical to guarantee that AI technologies are created and applied in an equal and inclusive manner. (Ronquillo et al. 2021.)

The challenges of implementing artificial intelligence technologies also involve the need to strengthen nursing leadership competencies during the process of innovation while building AI solutions that are centered on the true requirements of nursing care. The other challenge is to improve artificial intelligence's role in healthcare quality monitoring in and outside of hospitals in the context of integrated care. The essential ideas of quality healthcare management have not been properly incorporated into the solutions suggested, which should be a focus for nurse managers driving the implementation of AI solutions. Plus, the difficulty of incorporating AI into nursing schools, curricula, and research agendas, and the interdisciplinary partnership among nurses, AI developers, and other healthcare experts remain a critical development. The misalignment between nursing management priorities

and the development of AI technologies is making it difficult for AI developers to grasp the quality issues connected to specific nursing care activities. (Chang et al. 2021.)

4.3 Artificial Intelligence Development in Finland

According to the Ministry of Economic Affairs and Employment of Finland (2017), Finland has been developing artificial intelligence and related knowledge since the start of artificial intelligence concepts. Professor Teuvo Kohonen is regarded as one of Finland's pioneers in the discipline and is well-known internationally for his contributions. Several industries in Finland, including transportation, healthcare, and working life, are predicted to be transformed by artificial intelligence. Furthermore, AI may be used in different fields, including natural language processing, picture and audio recognition, and predictive analytics. Artificial intelligence technologies are also expected to be employed in public administration such as the administration of healthcare and senior care expenditure.

The eight key actions for taking Finland towards the age of artificial intelligence are: Enhancing the competitiveness of companies with artificial intelligence, which entails developing enterprise-driven ecosystems to aid in the use of AI and offering incentives to use AI solutions. The second is utilizing data in all sectors which entails collecting and improving Finnish data resources making My Data available to citizens, and testing data providers to convert data into a product. The third is speeding up and simplifying the adoption of artificial intelligence which includes using the artificial intelligence accelerator to get started, developing areas of free intelligence to build a trial environment, and offering support for the creation of AI solutions. The fourth one is ensuring top-level expertise and attracting top experts which means creating a national AI program to draw top professionals, as well as offering education and training opportunities and fostering international collaboration. (Ministry of Economic Affairs and Employment of Finland 2017.)

The fifth key action is ensuring the ethical and secure use of artificial intelligence including developing ethical AI principles, assuring the security of AI systems, and advocating openness and responsibility. The sixth one is creating a supportive legal environment which entails assessing and revising legislation to assist AI development and use, supporting the adoption of open standards, and ensuring intellectual property rights are protected. The seventh key action is promoting the use of artificial intelligence in public services comprises testing AI solutions in government services, supporting the implementation of AI in decision-making processes, and assuring AI system compatibility. The last eighth key action is

creating a culture of experimentation and innovation which entails fostering a culture of creativity and experimentation in both public and private sectors, as well as fostering possibilities for collaborating and knowledge-sharing and supporting the use of AI in research and development. (Ministry of Economic Affairs and Employment of Finland 2017.)

The study conducted by Laukka et al. (2022), describes the perspectives of nurse leaders and digital service developers on the possible future application of artificial intelligence (AI) in specialized medical care. The potential advantages of AI are by freeing up physicians' time and allowing more connection with patients modifying the traditional working methods in specialised medical care which may result in better patient outcomes and a more efficient healthcare system. AI can be utilized to provide real-time decision assistance to physicians based on patient data, allowing them to make more precise medical decisions. AI can also be utilized to create patient engagement and adherence applications, which can assist patients in better managing their health and enhancing the results of treatment, scheduling appointments, managing patient records, analyzing massive amounts of patient data to uncover patterns, forecast future health outcomes, allowing clinicians to intervene early and prevent illness progression. (Laukka et al. 2022.)

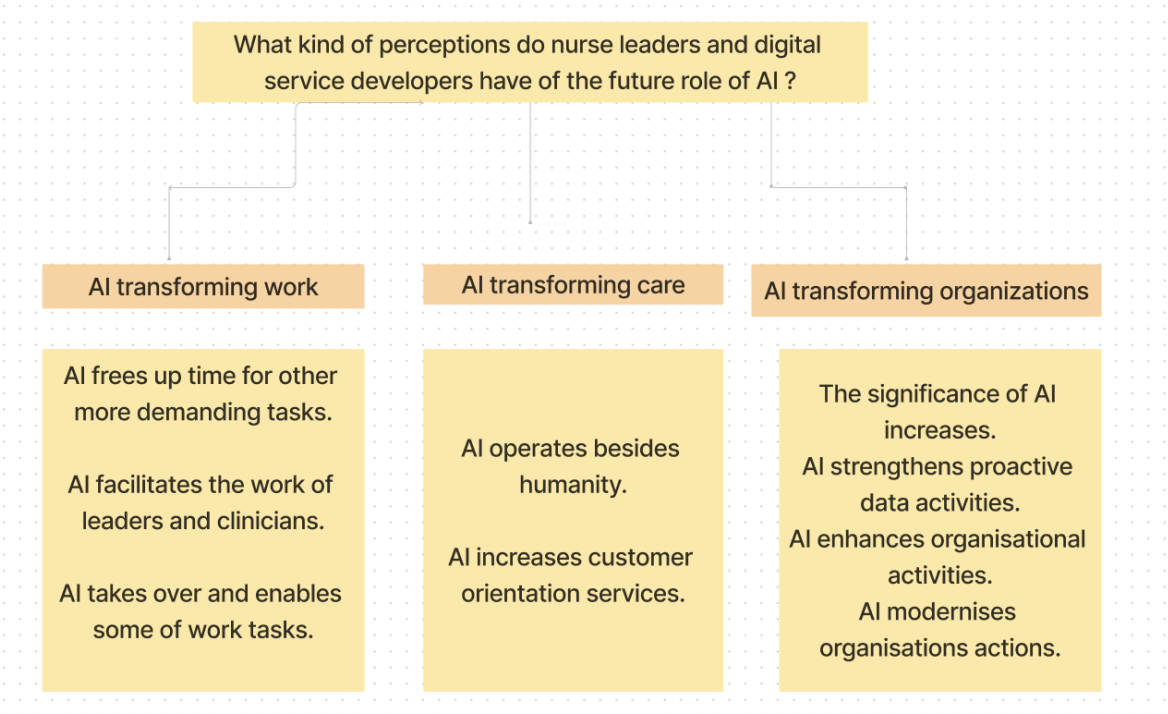

Figure 4. Nurse leaders' and digital service developers' perceptions of the future role of artificial intelligence (AI). Modified from (Laukka et al. 2022.)

In the modified figure 4 from Laukka et al (2022), the study indicated three major content categories addressing nurse leaders' and digital service developers' perspectives of the future use of AI in specialized medical care: AI transforming work, care, and services, and organization. It highlights the interconnection of these themes, illustrating the importance of taking a comprehensive approach to the development and deployment of AI-based solutions in healthcare. AI transforming work covers four subcategories: saving up time, completing regular duties, assisting with decision-making, and enhancing quality. AI transforming care and services focuses on improving patient safety, increasing patient participation, and facilitating remote care. The third, AI-transforming organizations deal with changing the role of healthcare professionals, boosting efficiency, and generating ethical and legal concerns, stressing the possible impact of AI on many parts of healthcare.

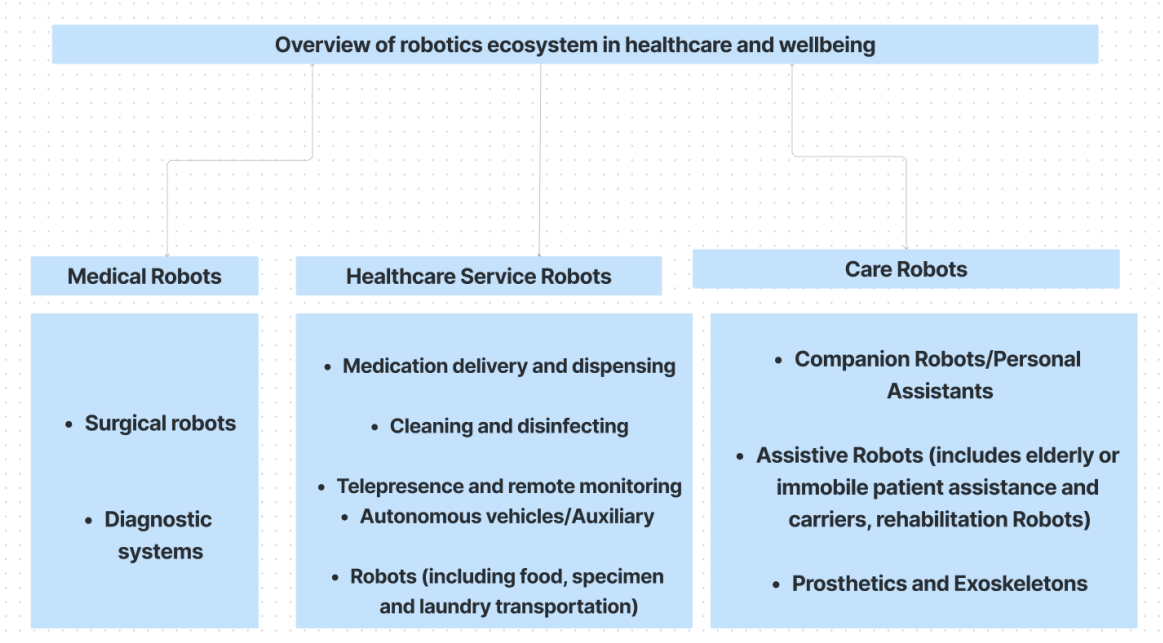

Figure 5. Robotics ecosystem in healthcare and well-being. Modified from (Business Finland 2020.)

Figure 5 explains that medical robots, healthcare service robots, and care robots are the three primary categories of robotics in the healthcare ecosystem, Surgical robots and

diagnostic systems are examples of medical robots. Medication delivery and dispensing, cleaning, and disinfection, telepresence and remote monitoring, and autonomous vehicles/auxiliary robots (including food, specimen, and laundry transportation) are all examples of healthcare service Robots. Companion robots/ personal assistants, assistive robots (including elderly or immobile patient help and carriers, rehabilitation robots), prosthetics, and exoskeletons are all examples of care robots. The hospital and patient end-user groups are specifically targeted in the ecosystem overview, with an emphasis on technologies that allow effective diagnosis, treatments, therapy, and follow-up care. (Business Finland 2020.)

while allowing employees to focus on pharmaceutical advising and increase sales. Evondos which is developed in Salo has created a drug distribution robot that assures high pharmacotherapy standards by guiding homecare clients to take the correct medicine in the specified dose at the exact time. It accomplishes this with both spoken instructions and audible signals, as well as the display of written directions on the device screen with indicator lights. Some of the healthcare robot initiatives are SARA (Social & Autonomous Robotic Health Assistant) developed by four project partners: Forum Virium Helsinki in Finland, Bright cape Holding in the Netherlands, and Technische Universität Berlin in Germany and the Finnish company GIM works on the navigation capabilities of this robot. Similarly, the well-being and health AI & Robotics (AIRo) program, Robots, and the Future of Welfare Services (ROSE) are the prominent healthcare robot initiatives in Finland.

5 Aim, Purpose, and Thesis Question

Aim: With the advancements of Industrial 4.0, technologies are becoming better every day. With the widespread use of technologies across different industries, the efficiency of human input has only increased and has produced better results. On the other hand, the Medical/Nursing field is one of the critical areas where people's lives are deeply associated. According to the article published by WHO, almost 2.6 million people die annually because of bad healthcare practices that could have been avoided easily. A simple human error/negligence could cost the life of an individual. Therefore, the author wanted to explore more ways in which the health care system (most particularly; nursing care) could be strengthened and what sort of transformation would be required to reduce the mortality rate. After thorough research, the author concluded that Artificial intelligence might play a big factor in nursing care and could be a way to decrease anomalies in the medical field. Thus, the thesis aims to increase the knowledge of how the integration of artificial intelligence in healthcare can benefit nurses in the patient caring process.

Purpose: The purpose of the thesis is to explore whether nurses are replaceable by artificial intelligence-based technologies in the future based on the previous literature.

Thesis Questions

1.) How artificial intelligence is being used in Nursing?
2.) How can nurses integrate Artificial Intelligence into their practice?
3.) What are the ethical considerations for the use of Artificial Intelligence in Nursing?

6 Implementation and Methodology

6.1 Literature review

A Literature review supports the theoretical basis of a proposed study, demonstrates the existence of a research problem, explores how the research adds new understanding to the body of knowledge, or authenticates the methodologies and procedures for the proposed study. Literature reviews are crucial in determining what sort of previous studies have been done regarding the topic, assessing the degree to which a particular research area discloses any comprehensible trends or structures, combining empirical findings on a specific idea to support evidence-based practice, creating new models and concepts, and recognizing subjects or inquiries that need more investigation. (Pare & Kitsiou 2017.)

Narrative review, descriptive or mapping review, scoping review, systematic review, umbrella review, realist review, and critical review are the different types of literature review. The descriptive literature review's main goal is to search for interpretable trends and gaps in the literature regarding established ideas, hypotheses, methods, and conclusions. (Pare & Kitsiou 2017.) The main goal of the thesis was to gather the necessary information about Artificial Intelligence (AI), types of artificial intelligence and its ethical considerations, history, development, technological adoption in the nursing field, and how artificial intelligence is shaping its usability in the nursing field to enhance the better patient result. For the thesis, the descriptive literature review, more specifically integrative literature review is thus deemed suitable to proceed.

An integrated literature review is a special type of review that offers a more thorough understanding of a particular phenomenon or healthcare issue by summarizing earlier empirical or theoretical research. It is called integrative review because it integrates information from many sources, including both quantitative and qualitative studies, to offer a more comprehensive understanding of a given topic. Integrative reviews aid in advancing nursing science, guide initiatives in practice, research, and policy, and advance theory. The main objective of the integrative literature review is to point out gaps in the literature, point out discrepancies or inconsistencies in the results, and offer suggestions for further study. (Whittemore & Knafl 2005.)

The main objective of an integrative review is to solve the field fragmentation by facilitating the synthesis of knowledge from various research trajectories, offering novel perspectives

and chances for academicians who are interested in the subject to create new research initiatives that might not have originated from a single community of practice. This can be accomplished by integrating new approaches and concepts from many study communities and presenting significant findings in an unbiased way. An integrative literature review looks at what, how, and why the subject has been explored in each community and uses methods from other knowledge-synthesis tools to collect and assess studies, outline the current state of the field, assess study findings concerning constructs, and draw conclusions about how and explores why a subject should be studied in the future. (Cronin & George 2020.)

The five generic steps involved in conducting the literature review articles include the creation of the research question(s) and objective(s), the literature searching process, screening for exclusion and inclusion criteria, the data extraction, and the examination of the data. (Leite et al. 2019.)

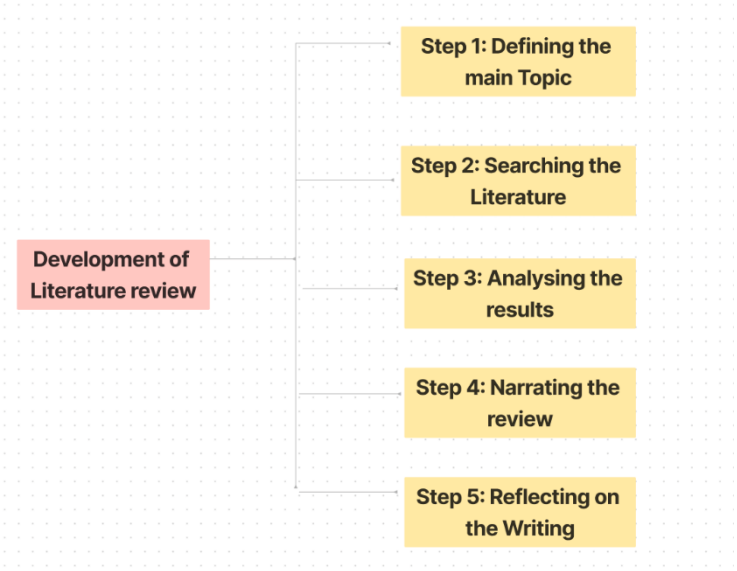

Figure 7. Steps for Development of Literature Review. Modified from (Leite et al. 2019)

To complete the thesis, the illustrated Figure 7 which entailed the clear steps of the literature review was considered. Based on this framework, we began by defining the thesis topic entitled “Artificial Intelligence in Nursing”. After having a core idea for the thesis topic, we embarked on finding suitable articles that would answer our research questions through the electronic databases. In addition to the electronic databases, two books were also used to deeply explore the concept of artificial intelligence. Advancing to the third step, we analyzed and short-listed the best-fit articles for our thesis by going through the findings, results, and

discussions. For the fourth stage, we started with the freewriting strategies to generate valuable ideas and enhance comprehension of the information from the articles, followed by editing, citing, and proper referencing. During this phase, we planned a specific timeline to accomplish the desired outcome in a specific time. For the fifth stage, we started to analyze and proof-read the thesis in a detailed manner to identify whether we were able to connect the dots between the thesis questions and answers, examining if we succeeded in interpreting the core content of the chosen articles and most importantly whether we were able to make our thesis comprehensible even for the non-technical person.

6.2 Data Search and Collection

The articles used for the thesis have been gathered from electronic databases such as PubMed, EBSCO - Academic Search Elite, EBSCO CINHAL, and Sage Journal. A couple of suitable articles were also chosen from Google Scholar to support the theoretical part of the thesis. To dive deep into understanding the concepts of Artificial Intelligence, its background, and types of Artificial Intelligence, two books from the library have also been studied namely Machine Learning and Deep Learning using Python and TensorFlow and Introduction to Artificial Intelligence.

The search for suitable articles and materials started in the Spring of 2023 more specifically from February onwards after developing the thesis plan and formulating research questions. Taking advantage of the college electronic databases, huge amounts of articles were explored and at the same time, the articles were selected regarding their relevancy, suitability, and currency. Most of the writing, editing, and revising has been done in the summer and autumn of 2023. In between the literature search and writing process about two to three meetings have been done with the guiding teacher.

The keywords that have been used to search the article were formulated from the research questions. Nursing, Nursing attitudes, artificial intelligence, robotics, use of artificial intelligence in nursing, AI in nursing, and ethical issues were the keywords used during the literature search process. Boolean search operators such as AND and OR were also used to explore the wide possibilities of articles.

For PubMed, the search words such as the use of AI in Nursing, ethical issues, AND use of artificial intelligence in nursing care, nurses' attitudes AND artificial intelligence in nursing, artificial intelligence in nursing AND ethical issues were used. The results were limited from

the years 2005 to 2023, English, free-full text, which yields a total of 260 articles, out of which only 11 articles were selected.
The information was searched from EBSCO Academic Search Elite with Robotics in Nursing as a keyword, with English, free full text, and 2011 to 2023 as limitations. This produced 12 articles out of which only two articles were selected.

With the use of EBSCO CINHAL, Nursing care, AND artificial intelligence, AI in nursing AND ethical issues were used as keywords while English, free full text, and years ranging from 2006 to 2023 were the limitations. It generated a total of 67 articles, from which only 5 articles were selected.

The used search words for Sage journals were Nursing AND Artificial Intelligence, with English, free full text, nursing research article, and the year 2010 - 2023 being the limitations. It led to 47 articles, of which only 3 were suitable for our thesis.

In a nutshell, a total of 21 articles have been selected and were used to answer our research questions. Table 1 summarizes the search words, limitations, the number of articles produced, and the number of articles selected for the thesis. The articles were inspected for their relevancy, appropriateness, currency, consistency, and reliability. With the thorough exploration of the title, study design, interpretation of results, and conclusions and following our strict inclusion and exclusion criteria, these 21 articles were thus selected.

Database	Search Words	Delimitations	Results	Number of selected articles
PubMed	Use of AI in Nursing	English, free full text, 2012 - 2023	132	2
PubMed	Ethical Issues and Use of Artificial Intelligence in Nursing Care	English, free full-text, 2012 - 2023	63	2

PubMed	Nurses Attitudes AND Artificial Intelligence in Nursing	English, free full text, 2005 - 2023	44	4
PubMed	Artificial Intelligence in Nursing AND Ethical Issues	English, free full text, 2005 - 2023	21	3
EBSCO Academic Search Elite	Robotics in Nursing	English, free full text, 2011 - 2023	12	2
EBSCO CINAHL with full text	Nursing Care AND Artificial Intelligence	English, free full text, 2009 - 2023	20	4
EBSCO CINAHL with full text	AI in Nursing AND Ethical Issues	English, free full text, 2006 - 2023	47	1
Sage journals	Nursing AND Artificial Intelligence	English, free full text, Nursing, Research article, 2010 - 2023	47	3
Total Articles				21

Table 1. Searched Databases

6.3 Inclusion and Exclusion Criteria

Inclusion criteria	Exclusion criteria
Study published between 2005 - 2023	Study published before the year 2005
Studies exclusively published in English	Studies published in other languages except for English
Free, full text available	The paid articles, only abstracts available

Articles relevant to nursing care	Articles relevant to doctors and other medical personnel
Peer-reviewed, credibility and reliability of the article	Articles that were not to be credible and reliable

Table 2. Inclusion and exclusion criteria

The articles that are free, full-text, available in English, and published between 2005 - 2023, which are peer-reviewed, credible, and reliable regarding our research questions have been selected. The topic concentrates on the use of artificial intelligence in nursing, therefore the articles prioritizing solely on the nursing care practice have been selected. The collected materials were collected to show the growth of artificial intelligence in nursing from the past few decades so, the timeline from 2005 to 2023 was optimal to fully understand the phenomenon.

The articles published before the year 2005 were excluded because the articles did not have up-to-date information regarding the development of artificial intelligence technologies in the nursing field. Articles that were published in other languages and those articles which were subjected to charge were excluded as well. Artificial Intelligence not only developing in the nursing field, but it is also developing to help doctors, pharmacists, radiologists, and other healthcare professionals. Since the main concern of our research is related to nurses, articles specifically written for other healthcare professionals have also been excluded.

6.4 Content analysis

Content analysis is a research technique that is used to examine qualitative data such as audio, video, photos, and text. It entails categorizing and evaluating communication content, such as text, photos, or audio, in a systematic manner to discover patterns, themes, and meanings to get quality insights into the attitudes, beliefs, and values of the people who wrote the text. The social sciences, especially nursing science research frequently employ content analysis, which can be utilized in both qualitative and quantitative research. The process of content analysis encompasses several processes, including choosing the data to be analyzed, specifying the coding categories, coding the data, and deriving conclusions. The purpose of content analysis is to offer a methodical and impartial way to categorize and measure phenomena. (Elo et al. 2014.)

Important elements of content analysis include themes and codes. Codes are labels or tags that are applied to bits of data to help categorize and arrange them. Themes are the fundamental ideas or concepts that arise from the data. A coding scheme is a system of codes or categories used in content analysis to systematically examine and classify data into informative categories or themes that can be applied to respond to research questions. Conceptual, thematic, narrative, discourse, semiotic, qualitative, and quantitative analysis are the types of content analysis. The research topic, the type of data being analyzed, and the study objectives all influence what type of content analysis is the best fit for the research. (Elo et al. 2014.) This thesis uses a qualitative thematic content analysis approach more specifically, a thematic inductive content analysis approach which is described below.

Thematic content analysis is a systematic and objective method involved in finding and examining themes or patterns in the qualitative data, categorizing the data in accordance with those themes, and finally evaluating the data to establish the connection and patterns between the data. The two types of thematic content analysis are inductive and deductive content analysis. The goal of thematic inductive content analysis is to locate themes in the data without the use of pre-existing categories or theoretical frameworks. Due to the exploratory character of this method, it enables the formation of potential new ideas. This method is useful when there is little existing knowledge about the subject or when the data is complex and challenging to classify. On the other hand, the thematic deductive content analysis identifies themes in accordance with a pre-existing theoretical framework or set of categories. This approach puts previously held theories or hypotheses to the test. This method is helpful when there is a well-established theory or structure that is appropriate to the research questions. (Lacy et al. 2015.)

According to Elo et al. (2014), the processes involved in doing thematic inductive content analysis are familiarizing with the data by reading multiple times to spot the impressions or patterns, producing an initial descriptive code list to capture the main ideas and themes in the data, looking for themes and grouping them together with the codes that would be appropriate according to the issues of the research questions. Followed by reviewing and refining themes to make sure they are cohesive, distinct, and pertinent to the research question. The next step is to define and name the themes that represent their essence in the data, then implement the coding scheme to the remaining data and code each segment of the data in accordance with the pertinent codes and themes. The last step is to conclude

the result by interpreting the themes and patterns found in the data. This entails outlining each theme in detail and offering instances from the data to support each theme.

For the thesis, a total of 21 articles were selected from four databases. With the aid of thematic inductive analysis, the selected articles were read thoroughly multiple times and we tried to spot the initial descriptive patterns, themes, and codes to capture the essence of each 21 articles. Then, the themes were created by listing the order headings, simplified phrases, and the different categories used in those articles. Through detailed investigation, the codes were then grouped into their respective themes. While grouping the codes into their respective themes, the codes were reviewed and refined a couple of times to ensure they perfectly aligned with the research questions. The found codes were broken down into small units such as words, phrases, and short sentences to convey ideas like the usability of artificial intelligence in nursing, machine learning, telehealth, and telemedicine, the ethical issues associated with it, prospects of artificial intelligence, data protection and confidentiality, nurse's viewpoint, collaborative reforms of robotics into nursing. The thematic analysis of the thesis is mentioned in Table 3. The themes and codes that didn't match the outcome of the research questions were eliminated.

Themes	Code
Artificial intelligence	• Machine learning algorithms • Deep learning • Natural language processing • Robotics and automation • Electronic health records • Virtual assistants • Telehealth and telemedicine
Application of artificial intelligence	• Related to monitoring and surveillance. • Decision making • Communication and documentation • Improved accuracy and efficacy • Personalised care plans • New roles and responsibilities of nurses • Reduced workload and burnout • Increased access to care
Future application of artificial intelligence in nursing care	• Predictive analytics • Need to develop personalised care plan.

	• Need of smart home and environments
Limitations of artificial intelligence in nursing care	• Lack of human touch, understanding and empathy • Potential for errors • Irritation to patients due to continue monitoring
Ethical issues	• Privacy and security • Bias and discrimination • Autonomy and control • Accountability and responsibility • Transparency and explainability • Human oversight and intervention • Algorithmic fairness and accuracy

Table 3. Themes and Codes of Content Analysis

7 Results

7.1 How artificial intelligence is being used in Nursing?

In the current scenario, Artificial Intelligence (AI) is revolutionizing the nursing practice and healthcare delivery. Artificial Intelligence has helped nurses in terms of human cognition, care coordination, drug management, patient monitoring and establishing quality clinical decisions, documentation, recognizing signs and symptoms, evaluating socio-economic determinants of health, and indicating care coordination initiatives for the patients. Artificial Intelligence algorithms are designed in such a way, that they can examine medical images, outline anomalies, interpret electrocardiograms (ECG), and evaluate data from wearable devices and sensors to identify falls, seizures, or fluctuations in the heart rate or blood pressure. (Swan 2021.)

Artificial Intelligence enhances patient outcomes and boosts the productivity of the nurses using Virtual AI, which consists of deep learning applications in informatics that aid in image processing and documenting the electronic health records (EHRs). In addition, AI is best at finding patterns and trends through electronic health records by examining the patient's X-rays and MRIs which help nurses to make better decisions about patient care, helps them in identifying patients who are at high risk of developing serious complications in the future and analyses the possible drug interactions or contraindications. Artificial intelligence also helps nurses and other healthcare professionals by analysing relationships between preventive or therapeutic measures and patient outcomes and ensures effective and efficient care delivery by reducing the cost and time associated with disease diagnosis and management. (Ellahham et al. 2019.)

In terms of post-operative nursing care, the conventional method of postoperative nursing care has not been able to catch up with the patient's expectations. To modify and upgrade the methods of post-operative nursing care, intelligent medical data analysis technology has been introduced. The Intelligent medical data analysis technology integrates the use of big data and artificial intelligence to contribute significantly to the advancement of nursing practice and the efficiency of post-operative care. This technology equips nurses with more precise and effective patient information by pre-processing important medical data. With the use of mobile devices and widescreen projection equipment, this technology can gather, analyze, and highlight the patient's data, which enables nurses to completely comprehend the patient's post-operative diagnosis and treatment needs and helps to formulate the

patient-specific nursing care plan. It supplies nurses with timely and accurate information enabling them to have better judgments, give patients higher-quality treatment, address patient nursing needs, and respond to postoperative emergencies to ensure quick recovery after the surgery. (Duan & Lin 2022.)

A schematic representation of an intelligent nursing system based on an intelligent medical data analysis system in Figure 8 represents that, this intelligent system comprises the display part, the application part, and the data part. The display component, which is at the top of the diagram, oversees communicating with nursing staff and exporting pertinent data to various display platforms including mobile devices and widescreen projection equipment. The display part uses the logic functions offered by the application part. The application part is also referred to as the business logic layer. It oversees handling and examining information gathered from postoperative patients by using the cutting - edge medical data analysis technology to optimize routine nursing tasks, raise the standard and effectiveness of postoperative nursing care, and finally to attend the patient's nursing demands. The third part, called the data part oversees gathering and archiving information from post-operative patients. The data component has a database that houses patient data, including their medical background, diagnosis, and course of therapy. The data component also has a data analysis module that analyses patient data using sophisticated medical data analysis technology and produces reports. (Duan & Lin 2022.)

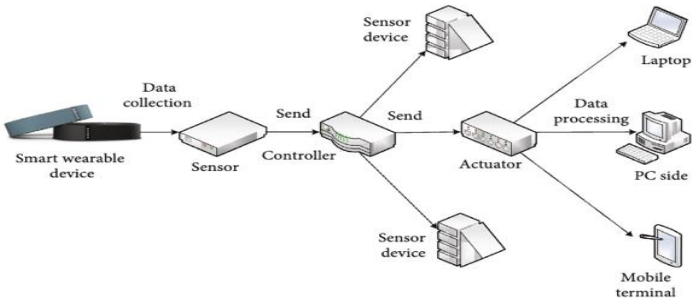

FIGURE 1: IoT-based intelligent medical data analysis framework.

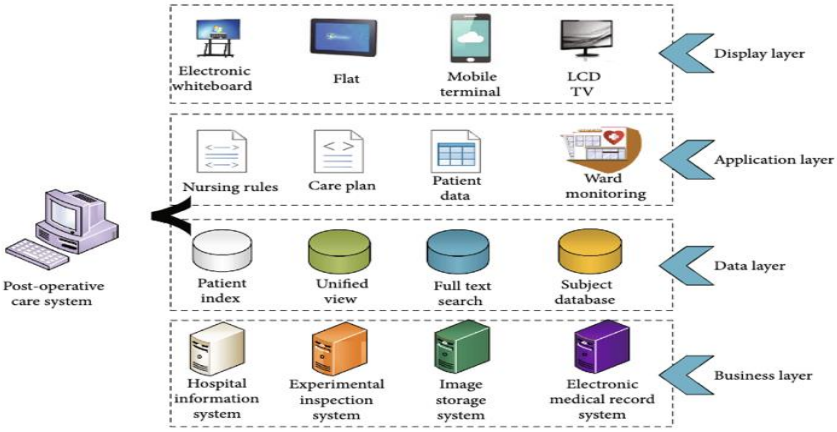

FIGURE 2: Intelligent nursing system after surgery.

Figure 8. Intelligent nursing system after surgery (Duan & Lin, 2022)

Women's health nursing sector has also been influenced using Artificial Intelligence technologies. For instance, artificial intelligence has been used to determine prenatal nursing interventions based on pregnant women's nursing records and predict the risk of developing postpartum depression. AI is also being used to predict the risk of delivery based on the age of the pregnant women, determine the demands for nursing care among older women with physical limitations, and forecast the chances of developing breast cancer before and after menopause. (Jeong 2020.)

With the sophisticated growth of technologies, artificially intelligent robots have been developed to address problems like staffing shortages and prevent physical exhaustion and paperwork obligations. For instance, "Fetch and Gather Robots" help nurses gather supplies, robots like Robear, and supports to lift heavy patients to lessen the physical strain placed on the nurses. Artificial intelligent robots are also capable of diagnosing, feeding, bathing, and changing bandages even better than human nurses. MY SPOONTM robot assists with feeding, while robot bathtubs deliver automatic soaping and showering. (Stokes & Palmer 2020.)

Artificial applications have been created to follow and monitor patients in hospitals and those living independently at home supporting nurses to spot changes in patients' situations and deliver prompt interventions. AI technologies can categorize patients' activities and coordinate care among various clinicians and places so that the nurses can prioritize the need for care to be given. The creation of apps that can track and monitor patients and consumables in hospitals can assist nurses in more effectively managing their resources and cutting waste. In addition to this, socially assistive robots, or health care assistant chatbots have been developed to benefit socially and emotionally to those patients with mental health issues. This can assist nurses in lessening their workload and enhancing the quality of life for their parents. Predictive analytics is a subset of artificial intelligence, that makes predictions based on statistical models. It has been used in healthcare to better allocate resources, identify high-risk patients, and forecast patient outcomes. (Chang et al. 2021.)

The assistive robots are used in these six areas: Processing of information and patient data, helping with everyday tasks, fetch and bring functions, telepresence and communication, monitoring, safety and navigation, and complex assistance systems. In the processing of information and patient data, the admitted patient information is entered into a robotic system and by using the follow-me function, the robotic system directs patients to the proper department, including testing departments, directs both visitors and patients as well as to channel requests. The Terapio robot was created for nursing or medical rounds allowing for patient data entry and progress display while accompanying staff during walk-throughs or rounds. The Pepper robot was employed to instruct the patients about magnetic resonance imaging. Assistive robots are built to maintain the affected people's freedom while also making daily living easier. The iRobot and ED robots were created to offer audio-visual instructions on how to carry out tasks. For those with dementia or mild cognitive impairment, the ED robot was created which instructs users on how to wash their hands and make tea. The NAO robot provides objects to people at home who have neuromuscular illnesses by reaching for them. (Ohneberg et al. 2023.)

Assistive robots that help in fetching and bringing foods and beverages include the i-merc robots which make it possible to provide dietary items and Care-o-bot 4 is an inpatient long-term care robot that provides residents with little food and beverages. The robot TUG delivers the pharmaceutical orders to the ward staff and these kinds of robots are stocked

by the pharmaceutical personnel. The nursing staff at the appropriate ward orders the necessary medications, which are then delivered by the WDBOT robotic system. Together with the nursing specialist, the robot distributes the medications to the patients after collecting them and the nurse verifies the medication's distribution on a tablet out of an abundance of caution. In the oncology ward, its objective was to move radioactive materials. To prevent infection and lighten the stress on medical staff, these assistive robotic devices aim to limit physical touch between patients and employees by supplying drinks, food, or medications to the patients using automated systems. These systems were created and put through testing for the clinical management of COVID-19 patients. (Ohneberg et al. 2023.)

The intelligent nursing trolley such as the CASERO is operated by smartphone to transport laundry or wound supplies to the desired location. The Giraff robot provides robotic communication between medical staff, caregivers, family members, and patients ensuring enhanced communication for patients with dementia or cognitive impairment. The IVO & Tommy facilitated the communication between the nurses and patients during COVID-19 thus lowering the risk of infection. The IVI & Tommy robot also can read vital signs in the patient's room using an integrated camera. The Silbot robot allows for daily monitoring of general well-being and psychological state. The Pearl robot manages meal and drink reminders in addition to medication reminders and personal hygiene reminders to the patients. The ARNA robot offers a navigation function by helping patients to move around safely, offering stability by acting as a walking aid and carrying and lifting goods including oxygen equipment, IVs, and drains. The targeted patient group to use this robot system are those in acute in-patient settings throughout the postoperative phase. (Ohneberg et al.2023.)

The complex assistive robots perform various functions of service, communication, safety, social involvement, and employment. The Kompaii robot can notify a control center in case of an emergency or remind users to take medications. The RAMCIP robot helps to record the fall events, employs video telephony in addition to entertainment features including music, games, and meteorological forecasts, and transports light objects to the individual example water or medications. The Care-o-Bot 3 robot was created especially for inpatient long-term facilities and patient homes. Simple pick-up and drop-off services are provided, drinks are served, people are addressed immediately, and entertainment is provided through memory games and music, and notify emergency call centre in case of a fall in the home setting. (Ohneberg et al.2023.)

SOPHIA is an illustration of a social robot designed as a companion for senior citizens that shows the possibility of technological developments to enhance how robots operate. After being refurbished in 2018, the movement feature has been added and she is the first robot to be granted a citizen of Saudi Arabia. Robots are being developed to enhance therapeutic telemedicine applications, reduce suicide rates, perform ambulation assistance, vital signs assessment, medication administration, and infectious disease prevention, and enable nurses to devote more time to their patients than to non-nursing tasks. To help healthcare workers who are at "high risk for infection due to routine patient interaction by handling of contaminated materials, and challenges associated with safety removing protective gear" interdisciplinary teams are developing the TRINA "Tele-Robotic Intelligent Nursing Assistant." (Robert 2019.)

7.2 How can nurses integrate artificial Intelligence into their practice?

The study carried out by Swan (2021), examined the registered nurses, practical nurses, and nursing faculty attitudes, understanding, and opinions on the use of artificial intelligence in nursing and healthcare. The result was that only 30% of the participants were aware of how artificial intelligence is employed in nursing practice, despite most people believing that artificial intelligence will revolutionize nursing and health care. This study also suggested that nurses need to have the necessary knowledge, abilities, and competencies in this field to effectively use artificial intelligence and deep learning in nursing and health care. Nurses can integrate artificial intelligence technologies by learning the requisite information, abilities, and competencies for working with AI, incorporating them into daily practices, and engaging in further study and training in disciplines like clinical decision, support, machine learning, and data analytics. Participating in conferences, workshops, online seminars, and related events as well as reading pertinent literature, and keeping the most recent advancements in AI and associated technologies are also effective measures of integration.

The study conducted by Jeong (2020), suggests that currently there is no curriculum specifically addressing the use of artificial intelligence technologies for nursing students and addresses the need to include these topics in nursing schools. The inclusion of contents such as the basics of AI, electronic hospital records and data, how artificial intelligence is applied to clinical decision-making, and the ethical and legal implications of artificial intelligence would help nurses to fully comprehend the idea of new technologies. Furthermore, the article suggests the implementation of topics such as big data, algorithms,

machine learning models, deep learning, Python, TensorFlow, and Keras coding exercises might uplift the nurse's attitudes toward integrating artificial intelligence in nursing. Understanding AI's guiding principles and potential uses in nursing care can help nurses incorporate it into their daily work.

Some notable loopholes are brought by the implementation of artificial intelligence in the Nursing care process. The conceptual disparity between nursing management priorities and the creation of AI applications is one of the most significant gaps found which generally refers to the gap between nursing management priorities and the development of AI applications. The other notable gap in innovation system performance refers to the system vulnerability caused by the system's lack of resources and the lack of communication from top healthcare experts about their requirements for advancing healthcare through AI technology. To make sure that AI technologies are in line with nursing management aims, one of the primary recommendations is to improve communication between healthcare workers and AI developers which entails holding frequent conferences, workshops, and meetings where nurses and AI engineers can exchange ideas and work together to build AI technology. Creating shared vision and purpose statements is another idea to help match AI applications with nursing management priorities which entails establishing a common understanding of the aims and purposes of AI-based healthcare and nursing management systems. Expanding the funding for AI development and application, creating nurse-specific AI education programs, and encouraging multidisciplinary collaboration between nurses, AI developers, and other healthcare specialists can help artificial intelligence to be integrated into nursing practice. (Chang et al. 2021.)

Nurse-robot engagement can be improved by focusing more on robot-induced advantages such as time-saving and energy conservation. Therefore, when speaking with nurses in charge of robot introduction, hospital management should emphasize the benefits of robotics and focus on building healthcare robots that save users more time and energy. Receiving hands-on training to introduce robots to the workplace, familiarize themselves with how the robot function, and reaffirm the advantages of robotics to nurses, educating the healthcare personnel about the merits of robot implementation and most importantly the nurses' perceptions of robots are crucial in converting their inventiveness into higher levels of involvement. Therefore, it is essential to increase healthcare professionals' involvement with robots to inculcate in them a favorable attitude. (Liao et al. 2023.)

Artificial intelligence-based technologies may produce false and uncertain interpretations and recommendations of the patient's data and to effectively fill this knowledge gap in AI, many nursing educational programs lack the necessary experience in teaching health informatics and artificial intelligence technologies. To successfully mitigate such problems, a curriculum with "minimum AI in nursing competencies" can be created so that all entry-level nurses can obtain AI technologies idea as a part of their fundamental training in nursing. Nursing researchers need to investigate the different types of AI technologies that can improve nurses' critical thinking and care skills and should identify the required skills and knowledge required to use these technologies. This can be achieved by hiring expertise in health informatics and technology development for nursing educational programs and continuing education. (Ronquillo et al. 2021.)

The integration of artificial intelligence into nursing practice can be established by ensuring that artificial intelligence technologies are created and implemented in healthcare companies with clear guidelines, norms, and processes, researching the type of AI technologies required to improve the critical thinking and caregiving abilities of nurses, investigating the effects of AI on nursing workflow and patient outcomes, examining how equity and social justice issues can be taken into account while designing and creating AI systems, promoting collaborative and participatory research methods in health AI studies to take advantage of nursing knowledge in relational practice, and creating organizational mechanisms that allow nurses to participate in all phases of AI development. Conducting research to determine the best approaches to incorporate AI technology into nursing practice and to assess how these technologies affect patient outcomes, educating and training nurses about AI technology use and its possible effects on patient care and nursing practice are also possible measures favoring the integration. (Ronquillo et al. 2021.)

7.3 What are the ethical considerations for the use of Artificial Intelligence in Nursing?

According to Stokes & Palmer (2020), there are two core concepts of caring. The first concept to deliver effective patient care it is important to establish a sound relational and reciprocal connection between the moral agents. The second idea is considering experiences, pursuing self-reflection, and making judgments that are sensitive to situational variances. Also, nursing professionals strongly believe caring to be their fundamental attribute, standards, and ethical obligation. Nurses are always envisioned to be the deliverers of compassionate, sound, and empathetic care. The article describes the

ethics associated with caring in these three ideas namely Tronto's view, Held's view, and Vanlaere and Gastman's view.

7.3.1 Tronto view

Tronto highlights four fundamental components of caring: Attentiveness or awareness, responsibility, competence, and responsiveness. The first element of caring is attentiveness which is an ethical trait that enables the establishment of a meaningful understanding of a patient's needs. The second element is being responsible for the patient's needs and formulating a strategy to fulfill their needs. This equates caring is how the plans are put into action. The third element is competence, which is believed to be a moral obligation, that the person would accept the duty of providing care without having the necessary qualifications. In the fourth component, the individual obtaining care and the reciprocal nature of the relationships required for caring are both important factors. The patient receiving care will certainly respond by notifying whether their caring needs have been addressed or not. (Stokes & Palmer 2020.)

7.3.2 Held view.

Held suggests that compassionate caring is both a value and a practice that requires appropriate attitudes. Caring is defined not only as an individual mindset but also as the characterization of social relations. The caring practice teaches us the proper manner of responding to the needs of the patients and why we should respond in a particular way. Meanwhile, the caring practice grows with time, accompanied by the right attitudes rather than a sequence of isolated activities. Held view establishes people to be relational and interdependent entities, for whom caring, and trust are deeply connected. Caregivers can ensure their trustworthiness through caring acts, expressions, and appropriate attitudes toward the care receivers. (Stokes & Palmer 2020.)

7.3.3 Vanlaere and Gastmans view

The essential idea of Vanlaere and Gastmans' interpretation of caring is that caring entails more than just being attentive and sensitive to the feelings of others. Care is believed to start from emotion which is necessary for the caregivers to behave in a morally responsible way. This view relies on a personalist approach to the ethics of care as they believe, people care since failing to do so can lessen the potential caregiver and recipient of care's personhood and personality. The personalist viewpoint limits care to the tangible

requirement of an “actual human being.” This approach necessitates the caregiver to behave responsibly by considering and assessing the relationship between people, the vulnerability of the individuals, and the environment in which caring occurs. (Stokes & Palmer 2020.)

According to the study by Nielsen et al. (2022), who conducted interviews with nurses, patients, and relatives enquiring about dignity, autonomy, personal privacy, relationship level, safety, organizational matters, and positive aspects as possible ethical concerns while deploying artificial intelligence technologies in nursing. According to their findings, participants are concerned about their dignity as they wonder how the usage of a robot would influence people’s or institution’s sense of value or reputation. When touched by a robot rather than a human caregiver, the patient may feel less deserving and less acknowledged as a human being. One of the participants justified “The patient may feel subjected to mass processing because at the moment a robot arm is mainly known as part of the production line in the automobile industry.” Regarding autonomy, the participants were worried that using the robot may restrict their freedom of choice or their capacity to make healthcare decisions and asked, “What if the robot wants to do something that I don’t want it to do?”

Regarding personal privacy, the nurses and patients are concerned about the possible negative drawbacks in the robot setting. The robot’s need for cameras and microphones, and what sort of information might flow via the robot’s sensors such as recordings of private conversations or photographs of patient’s personal areas. It is also of concerning issue, who may have ownership of the data and whether it could be used to track and hold them liable for their job. Physical safety is about the robot’s ability to cause injury to patients or nurses, robot’s capacity to navigate hurdles, prevent collisions, and its ability to handle patients with varying physical states, and highlights the importance of safety features like emergency stop buttons and fail-safe mechanisms to avoid harm. Psychological safety is concerned with the robot’s probable impact on the psychological well-being of patients and nurses such as if the robot has the potential to deliver emotional support and empathy as well as whether it might completely replace human contact. Also, it is questionable time to ensure that the robots can handle the emotional demands of the patients optimally. (Nielsen et al. 2022.)

Accountability emphasizes on the requirement for definitive boundaries of accountability in the robot's creation and use. It addresses the importance of having clear norms and regulations in place to guarantee that robot is utilized ethically and responsibly. They also emphasized the necessity of transparency in the development process and incorporating stakeholders in decision-making. Transparency is necessary in the development and use of the robot while treating patients. It is worth communicating clearly about the robot's capabilities and limitations, as well as the dangers and benefits of using it and how important it is to involve patients and caregivers in the development process so that their wants and concerns are addressed. Bias is another major ethical concern, and artificial intelligence systems must be built to prevent reinforcing existing biases in healthcare. (Nielsen et al. 2022.)

One of the main important ethical considerations is that AI should not violate nursing's essential principles, usurp elements of caring that can only be effectively performed by humans, and it should support, open, or increase possibilities for nurses to contribute the distinctively human components of care. Additionally, when considering whether to deploy AI devices, nurses should examine the physical and emotional demands of patient care, including direct and indirect care. The other ethical concern is that AI devices could dehumanize patient care, diminish patient autonomy, and worsen health inequalities. Nurses must additionally think about the ethical aspects of utilizing AI technologies, such as privacy, confidentiality, informed permission, and accountability. Ultimately, nurses should think about the possible benefits and threats of employing AI devices such as the ability of AI devices to enhance patient outcomes, minimize errors, and boost productivity. (Stokes & Palmer 2020.)

Tronto's ethical caring view highlights the significance of understanding and responding to others' needs, as well as creating and maintaining relationships based on trust and respect. However, Tronto stresses AI may not fully comprehend the moral significance of assuming responsibility for the well-being of another, as well as the moral significance of failing to adequately carry out one's duties, which is a crucial component of caring. Held's ethical view of caring points out the crucial role of empathy and compassion in caring, as well as the need to identify and respond to everyone's unique needs and perspectives. However, AI may be incapable of caring because caring requires the right attitudes, which artificial intelligence technology lacks. The ethical concept of caring according to Vanlaere and Gastmans draws attention to the essence of acting responsibly, given the determination of

the correct nature between individuals, the fragility of people, and the situation in which caring occurs. However, AI may be unable to deliver responsible and context-specific care since it does not possess the ability to grasp everyone's unique requirements and vulnerabilities. (Stokes & Palmer 2020.)

The ethical considerations include gaining consensus from caregivers or nurses, guaranteeing data privacy and security, addressing concerns about the potential replacement of nurses by technology, and weighing the consequences of using humanoid designs for hardware hosting intelligent technologies. Moreover, it is of prime importance to comprehend the fundamental reasons and goals for creating algorithms, as well as the learning mechanisms and their potential to meditate, because AI-generated knowledge should not be regarded as universally applicable. In addition, the ability of algorithms to hamper nursing actions and trigger a decline of human dignity, sample bias illustrated by AI technologies, correlational false positives, and concealed prejudice, as well as the principles and goals of organizations creating massive datasets should be thought of as critical ethical considerations within a discussion on implementing AI in nursing. (Seibert et al. 2021.)

The utilization of robots in healthcare generates worries about autonomy and control as the patients might fear that their autonomy is being jeopardized if they are cared for by a robot rather than a human. Taking advantage of robots in healthcare may entail the collecting and storage of sensitive patient data which raises the ethical issues with confidentiality and privacy. It is critical to keep this data private and to keep patients aware of how their personal information is being utilized. In addition, the robots used in healthcare must ensure they are secure, trustworthy, and liable. If a robot malfunctions and injures a patient, issues regarding who is to blame arise. The deployment of robots in healthcare has the potential to worsen existing disparities in access to care as the patient who cannot afford or obtain robotic care might be left behind untreated. So, the ethical principles of equity and accessibility should be considered while implementing artificial intelligence technologies in Nursing. (Ohneberg et al. 2023.)

8 Conclusion

The study aims to expand the knowledge of how the integration of artificial intelligence in healthcare might aid nurses in the patient caring process, to figure out the possible challenges, and finally to dig deep into the ethical considerations for employing AI in nursing. Based on an integrative literature review of the 21 different articles, it can be concluded that with the help of deep learning and natural language processing, artificial intelligence (AI) is helping nurses in terms of human cognition, care coordination, drug management, patient monitoring, establishing quality clinical decisions, documentation, recognizing signs and symptoms, identifying falls, seizures, or fluctuations in the heart rate or blood pressure. Artificial intelligence technologies are best at finding patterns and trends through electronic health records (EHRs), analyzing possible drug interactions or contraindications, determining the prenatal nursing interventions based on pregnant women's nursing records, predicting the risk of developing postpartum depression, predicting the risk of delivery based on the age of the pregnant women, determining the demands for nursing care among older women with physical limitations and forecasting the chances of developing breast cancer before and after menopause. AI addresses problems like staffing shortages and prevents physical exhaustion and paperwork obligations. Chatbots have been developed to benefit socially and emotionally to patients with mental health issues. allocate resources, identify high-risk patients, and forecast patient outcomes. AI performs assistive functions such as fetching and bringing equipment and supplements, aids in the activities like movement of patients, monitors and navigates the patients by keeping an eye on them, helps in the emergency room, supports in social engagement, cognitive training, and rehabilitative exercises, reduction of suicide rates, perform ambulation assistance, vital signs assessment, medication administration, infectious disease preventions, and enabling nurses to devote more time to their patients than to non-nursing tasks.

PARO, Giraff, TUG, Robear, Care-o-Bot, Zora, the Kompaii, the RAMCIP, the IVO & Tommy robot, ARNA, ED robot, NAO robot, WDBOT robot, the i-merc robots, and the CASERO robot are the different types of assistive care robots. The monitoring other examples of AI devices are Tess, Electronic Medical records (EMRs), Electronic Health Records (EHRs), smart infusion devices, Bar-coded medication administration (BCMA) systems, wearable devices for remote patient monitoring(patient's vital signs), telehealth technology for virtual visits and consultations, electronic thermometers, pulse oximeters, glucometers, virtual nursing assistants for medication reminders, patient education and

scheduling an appointment are the perfect examples of different AI-based technologies implemented in nursing care till date.

The challenges of implementing artificial intelligence technologies entail the risk of information loss, leakage, and manipulation, which can jeopardize individual security and confidentiality. Lower prediction accuracy, malpractice, job displacement by robots, hackers' use of medicolegal algorithms, patients' dignity, and autonomy, and the possibility of malfunctioning and disrupting the harmonious interactions with patients are the ethical risks linked with AI-based technologies in nursing. The implementation of AI in nursing necessitates the development of advanced natural language processing algorithms and demands the creation of a "Nursing Situation Database" and a "Nursing Response Database" which is costly and time-consuming to develop. The lack of trust in AI systems is viewed as a depersonalizing, dehumanizing, and paradigmatic contraindication to human care as there is also the risk of replacing human-to-human connections, fear that artificial intelligence could outsmart and eventually dominate humans, and the requirement of large resources for training, maintenance, and support further increases the challenges. Lack of knowledge and expertise in artificial intelligence technologies among nurses, plus the difficulty of incorporating AI into nursing school, curriculum, and research agendas, and the interdisciplinary partnership among nurses, AI developers, and other health care experts remain a critical developmental challenge to overcome.

The nurses can integrate AI into their caring process by learning the requisite information, abilities, and competencies for working with AI, incorporating them into daily practices, and engaging in further study and training in disciplines like clinical decision, support, machine learning, and data analytics. Developing a curriculum specifically addressing the use of artificial intelligence technologies for nursing students that teaches the basics of AI, electronic hospital records and data, application of AI in clinical decision-making, the ethical and legal implications, big data, algorithms, machine learning models, deep learning, Python, TensorFlow, and Keras coding exercises to enhance the comprehension about artificial intelligence. Expanding the funding for AI development and application, creating nurse-specific AI education programs, and encouraging multidisciplinary collaboration between nurses, AI developers, and other healthcare specialists. Also, a curriculum with "minimum AI in nursing competencies" can be created so that all entry-level nurses can obtain AI technologies idea as a part of their fundamental training in nursing. Focusing more on robot-induced advantages such as timesaving and energy conservation and learning to

Implement AI in healthcare with clear guidelines, norms, and processes can increase the positive attitude of nurses towards AI.

The ethical considerations that should be considered while developing and deploying AI into nursing comprise dignity, autonomy, personal privacy, relationship level, safety, organizational matters, positive aspects, and transparency. The AI-based technologies should not violate nursing's essential principles or usurp elements of caring that can only be effectively performed by humans, and they should support, open, or increase possibilities for nurses to contribute to the distinctively human components of care. Ultimately, as the quote by Koen Van Leemput stresses FCAI (2023), "A better bicycle does not replace the cyclist, and AI won't replace doctors", this sums up the idea that nurses are irreplaceable by AI-based technologies but rather function as a helping hand for providing quality nursing care in the future.

9 Discussion

9.1 Ethics and reliability

The Finnish Advisory Board on Research Integrity is abbreviated as TENK. It is appointed by Finland's Ministry of Education and Culture. It oversees updating the standards for responsible research conduct and dealing with suspected violations of research conduct in collaboration with the Finnish research community. RCR is an abbreviation for Responsible Conduct of Research. It describes the principles and attitudes that underline the responsible research process. The goal of RCR is to guarantee that research is conducted in an ethically sound manner. The principles and attitudes that guide the responsible conduct of research are referred to as research ethics. (TENK 2012.) The ultimate purpose of research ethics is to promote the highest standards of scientific research and make certain that research is performed in an ethical, responsible, and societally helpful manner. (Elo et al. 2014.)

The goal of research ethics is to ensure that research is carried out in an ethically acceptable, trustworthy, and legitimate manner. This includes doing research with integrity, attention to detail, and precision as well as utilizing procedures that comply with scientific requirements and are morally sustainable. Being open and honest about the research's aim and objective by explaining the goal of the study and the methods utilized, as well as being upfront concerning any possible conflicts of interest. Giving credit to the effort and accomplishments of other researchers by correctly referencing the publications to appreciate and recognize the researcher's accomplishments and the value they deserve in carrying out their work is of prime importance. Adhering to scientific knowledge standards when planning and conducting the research, reporting the research results, and recording the data gathered during the research is yet another crucial part of research ethics. In addition, acknowledging the participants' privacy and confidence, acquiring informed consent, assuring the participants are not harmed in any manner, being open about the research's goal and procedures, and adhering to the scientific knowledge norms constitute the research ethics. (TENK 2012.)

Unethical and deceptive actions that jeopardize research and may invalidate research results are referred to as research misconduct. It includes presenting fraudulent data or conclusions to the research community, misappropriating the work of other researchers, and misrepresenting the work of other researchers as one's own. Research misconduct entails fabrication, falsification, plagiarism, and misappropriation. Fabrication means

presenting observations or conclusions in a research report that were not obtained with the procedures stated in the study report, falsification is changing or omitting data or outcomes so that the research is not accurately portrayed in the research report, plagiarism is the use of someone else's ideas, words, or work without giving them fair credit. Finally, misappropriation is stealing or mishandling research materials, equipment, or other resources. (TENK 2012.)

While completing this thesis on the topic of **"**Use of Artificial Intelligence in Nursing", we stressed following the ethical guidelines set by TENK and LAB University of Applied Sciences. As mentioned in TENK (2012), the research aim, purpose, and research questions were developed openly and by giving attention to details, so that the research encounters every aspect of artificial intelligence, nursing, and challenges associated with the implementation of AI in nursing, application of AI in nursing, integration of AI into nursing, and the ethical considerations. The core ideas have been planned in a sequenced and simple manner, which facilitates even the non-technical reader to understand each concept and leaves readers intrigued about the future of AI in nursing. The thesis consists of different sections and their subsections connecting the dots to shed light on the research questions. The content included in these sections and subsections are written from the articles obtained from credible databases such as PubMed, EBSCO Academic Search Elite, EBSCO CINHAL with full-text, and Sage journals as mentioned in Table 1. To acknowledge and appreciate the work of the researchers, all the text, images, and information obtained have been cited properly according to the LAB thesis guidebook and are mentioned in references to establish the authenticity and integrity of the research.

To validate and omit the unethical and deceptive actions leading to heinous acts called research misconduct as mentioned in TENK (2012), the research has avoided presenting fraudulent conclusions, misappropriation, misrepresentation, fabrication, and plagiarism. Since the research is qualitative research, the principal methodology of literature review has been followed. The information relating to artificial intelligence, machine learning, deep learning, integration of AI in nursing, challenges of AI in nursing, and types of AI devices used are presented accurately without any falsification and fabrication. None of the data, statistics, tables, and images have been modified from the original research to prevent the falsification of the data. The information obtained has been paraphrased, and quoted, and the original author(s) have been credited and cited accurately to avoid plagiarism. In addition to preventing misappropriation, the stealing or mishandling of the research

materials has not been done for any purpose rather proper referencing has been placed according to the LAB thesis guidelines.

Trustworthiness is the degree of trust in the data, interpretation, and procedures implemented to ensure the quality of a study, which is also referred to as the rigor of the research. In qualitative research, trustworthiness is critical to prove the relevance and reliability of the findings. Without trustworthiness, the findings may be unreliable and invalid, and readers may lose faith in the findings. The trustworthiness of research is examined by its credibility, dependability, confirmability, transferability, and authenticity. Credibility relates to one's belief in the validity of the study and thus its findings. Prolonged involvement with participants, continuous observation if suitable to study, peer-debriefing, member-checking, and reflective journaling, considering alternative explanations, negative case analysis, evidence of repeated evaluation of the data, and returning to review it numerous times builds up credibility. (Connelly 2016.)

The consistency and stability of findings across time and research are referred to as dependability. Keeping comprehensive records of all decisions and analyses, addressing inter-rater reliability and audit trails supports the evaluation of dependability. Confirmability relates to how impartial and free of prejudice the research findings are. Approaches such as reflexivity and peer debriefing can be used to assess this. The degree to which study findings can be applied to other situations or demographics is referred to as transferability. Purposive sampling and thick description approaches can be used to assess this. The main purpose of this approach is to evaluate the quality of qualitative research studies, highlight strengths and flaws in the study design, and assess the relevance and applicability of the results to specific situations or groups. (Luciani et al. 2020.)

Following the standard as in Luciani et al. (2020), to enhance trustworthiness we have focused more on conducting the data search process in a methodical, in-depth, and transparent manner to locate studies that are relevant to the thesis aim, purpose, and research questions. For this, the systematic process of choosing suitable databases, and formulating exclusion and inclusion criteria were employed extensively as presented in Table 1 and Table 2 respectively. Demarcation of these criteria further enhanced our credibility. Data search and collection took quite a while to find the relevant information. After reading the materials multiple times to select the most relevant information for our research questions, the themes and codes were also developed as illustrated in Table 3 as

a part of content analysis for systematic data extraction and synthesis. To establish credibility the CRAAP method was used to assess the currency, relevance, authority, accuracy, and purpose of each before proceeding forward with the thesis. Those articles suspected of failing to meet these five criteria were not selected and those articles meeting the criteria were chosen. As suggested by the supervisor, the copyright issues of the articles were also thoroughly examined before putting the images in the thesis.

In addition, Joanna Briggs Institute (JBI) critical appraisal instruments were utilized to examine the research quality to strengthen the trustworthiness and reliability of this thesis. JBI qualitative research appraisal tool is frequently used by researchers, practitioners, and decision-makers as it offers a complete and systematic way to evaluate the quality of qualitative research. The tool is centered on a set of ten questions that address critical parts of the research design, such as the consistency and adequate suitability of methodological decisions in qualitative health research as well as reporting on those decisions. Every question generates a “Yes”, “No”, “Unclear” or “Not Applicable” response with space on the appraisal form for comments. (Luciani et al. 2020.)

In our study, we used five different Joanna Briggs Institute (JBI) critical appraisal instruments to critically appraise the twenty-one articles selected to answer the research questions. They are the Text opinion studies critical checklist denoted by (&), analytical cross-sectional sectional checklist-noted by (%), systemic review and research synthesis checklist denoted by (#), qualitative research checklist denoted by (!), and Quasi-experimental studies checklist denoted by (€). Quality assessment of the text and opinion studies were evaluated on a scale of 1–6, in analytical cross-sectional studies were evaluated on a scale of 1–8, in qualitative research studies were evaluated on a scale of 1–10, systemic review and research synthesis studies were evaluated on a scale of 1–11, and quasi-experimental studies were evaluated on a scale of 1–9. The articles were considered and selected as an inclusion criterion if the score in quality assessment was 60 % or more. The critical appraisal checklist used in the study is mentioned in Appendix 2,3,4,5,6, and the quality assessment of all the articles is mentioned in Appendix 7.

9.2 Further Research

Artificial Intelligence in Nursing is in its developing stage, if given proper direction and if this research field is nurtured effectively, the advantages are surely expected to surpass its challenges. The thesis has explored the concepts of machine learning (ML), deep learning

(DL), and natural language processing (NLP), and their interconnections into building something magical component entitled artificial intelligence (AI). The thesis also discussed the possible challenges that AI might introduce, the development of AI in nursing to date, integrative ways in nursing practice, its implementation, and ethical considerations. The detailed research gave us the idea that the collaboration between two distinctive disciplines artificial Intelligence and Nursing would benefit hospitals and nurses, and most importantly its contribution to quality nursing care would be commendable but it does come with shortcomings that should be tackled.

Further research should be done by emphasizing how the concepts of artificial intelligence can be integrated into the nursing curriculum in a simple yet effective way, that would enhance the nurses' perceptions about its implementation, methods of use, it's ethicality. In the future, it is also crucial to consider how the disparity between nursing management priorities and the creation of AI development can be solved. This simply means there seems to be a communication gap between the nurse managers and the AI developers. Hence, in the future, it would be appreciable if further research could be done to identify the reasons behind the communication gap between the nurse managers or responsible nurses with AI developers, methods, and strategies for developing strong communication between these two parties.

Long term impact of assistive robotic systems should be researched continuously. Researching patient outcomes, employee satisfaction, and cost-effectiveness would be interesting to know. On top of that, ethical and legal considerations associated with artificial intelligence could be explored more as well as potential solutions to address these concerns.

Importantly, the patient and staff attitudes towards artificial intelligence could be researched more to understand in greater depth. This could entail qualitative research on the experiences of patients and employees using these technologies, as well as surveys or focus groups to gather suggestions. Finally, greater study on the potential of AI to improve nursing education and training is required, including the development of simulation and training programs that use AI technology.

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20Artificial%20Intelligence%20%28%20PDFDrive.com%20%29.pdf?sequence=1&isAllowed=y

Appendices

Appendix 1. Studies included in the literature review.

Authors, Publication, year	Purpose of the study	Research design	Main results
Seibert, K., Demoff, D., Bruch, D., Schulte-Althoff, M., Furstenau, D., Biessmann, F., & Wolf-Ostermann, K Application Scenarios for Artificial Intelligence in Nursing Care: Rapid Review. 2021.	The article summarizes different applications of AI in Nursing on an evidential basis. It also explores and addresses AI-related themes such as ethical, legal, and social contexts in nursing care.	The authors have used a variety of research designs to conduct the study. They have used qualitative and quantitative methods, along with systematic reviews and discussions of different papers/literatures.	The article concludes that there is a huge potential for AI in nursing but encourages further studies to concentrate on nursing-specific aims and real-world usefulness. It advocates for a more in-depth examination of ethical and legal issues and enhanced stakeholder participation.
Robert, N. How artificial intelligence is changing nursing. 2019.	The article highlights how AI can provide value to the clinical team, mainly nurses and patients, in three different healthcare applications, such as clinical, financial, and operational areas.	Article	The article exclaims that AI will be more practical in the future, and nurses will have to learn how to integrate AI tools into their practice. The article also sums up that Nurses will become more tech-oriented which will

			help them take better care of patients, most importantly, AI will not replace nurses; it will only make their work more diligent.
Soriano, Gil P., Yasuhara, Y., Ito, H., Matsumoto, K., Osaka, K., Kai, Y., Locsin, R., Schoenhofer, S., & Tanioka, T. Robots and Robotics in nursing 2022.	This article explores important ideas about robots from the viewpoint of nursing principles and automation in nursing. It also investigates the differences between people and healthcare robots and how they can act as collaborators. In addition, the article present cases of challenges related to robot development.	Systematic Literature Review	The article presents the idea that robots and robotics can play a major role in Nursing and are suitable to complement the understaffing problem. However, the authors have warned us to be aware of ethical/privacy concerns due to the use of robots and have urged for further collaborative studies.
Ronquillo, C., Peltonen, L., Pruinelli, L., Chu, C., Bakken, S., Beduschi, A., Cato, K., Hardiker, N., Junger, A., Michalowski, M., Nyrup, R., Rahimi, S., Reed, D., Salakoski, T.,	The main objective of the study is to establish a global consensus on nursing and AI by summing up important discussions, priorities, and findings. It offers tangible recommendations for the moral,	The research design incorporates workshops/conferenced conferences, qualitative research techniques, and collaborative consensus building.	This article meticulously presents the idea that nurses must actively take part in developing AI from the beginning. As major stakeholder, nurses should be aware of the data they collect and the

Salanterä, S., Walton, N., Weber, P., Wiengand, T., & Topaz, M. Artificial intelligence in Nursing: Priorities and opportunities from an international invitational think-tank of the Nursing and Artificial Intelligence Leadership Collborative. 2021.	trustworthy, and secure implementation of AI technology in nursing within the current paradigms.		AI technologies they use. The articles also suggest tangible and actionable steps to develop more secure AI and how nurses can play a major role in shaping and leading technical development.
Ng, Zi., Ling, Li., Chew, Han., & Ying, L. The role of artificial intelligence in enhancing clinical nursing care: A Scoping review. 2021.	The main aim of the article is to provide a summary of the ways artificial intelligence has been applied to enhance clinical nursing care.	Systematic literature review	The main result of the study suggests that AI can play a positive role in clinical nursing care, but more research and regulations are needed to shape the progress of AI.
Buchanan, C., Howitt, M., Wilson, R., Booth, R., Risling, T., & Bamford, M. Predicted Influences of Artificial Intelligence on the	The article explores the new developments in artificial intelligence-powered health technologies and how they are used in the following areas: Administration, clinical practice,	The authors have used scoping review methodology. Multiple databases like MEDLINE, CINHAL, EMBASE, PsycINFO, and the Cochrane Database were used, and the data were analyzed using a	The study discusses emerging AI technologies such as predictive analysis, smart homes, virtual health care assistants, and robots. It further states that Nurses cannot be seen as

Domains of Nursing: Scoping Review 2020.	policy, and research in Nursing. In addition, it also assesses how it will affect the nurses' roles and responsibilities as well as compassionate nursing care over the next ten years.	thematic analysis approach.	being replaced by robots; AI-powered health solutions might improve nursing practice; and it suggests that the nurse should develop proactive plans for maintaining person-centered compassionate care in the ear of AI.
Liao, G., Huang, T., Wong, M., Shyu, Y., Ho, L., Wang, C., Cheng, T., & Teng, C. Enhancing Nurse-Robot Engagement: Two-wave survey study. 2023.	The purpose of the study was to investigate how nurses evaluate assistive robots in a setting where nurses evaluate intelligent technologies. The objectives of the article were also to determine the elements that affect nurse-robot interaction and to offer insights to artificial intelligence-based technology developers.	The study used a 2-wave follow-up design and surveyed registered nurses in operating rooms at a large-scale medical center in Taiwan. The first wave was performed from October to November 2019, and the second wave was conducted from December 2019 to February 2020, following up with the participants.	The key finding is that the nurses' engagement with robots is significantly influenced by the attitude they have towards the robots, which is supported by the idea that the more advantages the robots possess, the more nurses are in favor of using them. The study suggests that AI developers should develop the finest robot functionalities by lowering the maintenance issues of the robots.

Chang, H., Huang, T., Wong, M., & Ho, L. How Robots Help Nurses Focus on Professional Task Engagement and Reduce Nurses' Turnover Intention. 2021.	The study digs deep into how using robots can assist nurses to concentrate on their professional duties and lower their desire to leave the profession (turnover intention), ultimately leading to an increased job satisfaction and health.	The study used a two-wave research design. The first wave was conducted during October and November 2019, while the second wave was conducted between December 2019 and February 2020 as a follow-up survey for the first wave participants.	The study suggests that the deployment of robots in the healthcare facilities can lower nurses' intentions to leave their nursing career as well as raise the overall job satisfaction. It also clarifies how the robot-enabled concentration on nursing work and robot-reduced concentration on non-professional work can affect nurses' overall positive feelings towards their health and job.
Erikson & Salzmann-Erikson. Future challenges of Robotics and Artificial Intelligence in Nursing: What can we learn from monsters in popular culture? 2016.	The main purpose of the study is to explore how "Monsters" (People's fear of technological advancement) could help to comprehend people's perspectives and the use of technological advancements, particularly in robotic	It is a conceptual article that examines the connection between monsters in popular culture and technological advancements. also uses the qualitative approach to analyze and interpret the meanings.	The study suggests the best way to improve the design of the new robots and their implementation is by gaining deep insights into how people view and interact with technology. The article suggests the need for further studies regarding the

	medical and surgical devices.		empathic protocols that directly link to the future of nursing robotics.
Togni, G., Erikainen, S., Chan, S., & Burley, S. What makes AI 'intelligent' and 'caring'? Exploring affect and relationality across three sites of intelligence and care. 2021.	The main purpose of the study is to investigate the relationship between affect, relationality, and "intelligence" when technology is introduced to humans in healthcare settings. It highlights the ideas of "AI " and "Ethical Machines", outlines the challenges and opportunities as well as focuses on three dimensions of intelligence.	The article represents a qualitative literature review as well as an interdisciplinary conceptual analysis combining the authors' expertise in medical sociology and anthropology.	Being an interdisciplinary conceptual analysis, the article does not present us with specific results. But it addresses the potential opportunities and challenges due to AI in healthcare settings and elaborates the three dimensions of "Intelligence" - physical, interpretive, and emotional.
Stokes, F & Palmer, A. Artificial Intelligence and Robotics in Nursing: Ethics of Caring as a Guide to Dividing Tasks Between AI and Humans. 2020.	The main purpose of the study is to provide an analytical view on how AI and Robotics can be integrated into nursing care while carefully examining any ethical considerations that may arise. Further, the article explains the potential benefits as well as the disadvantages of	The article uses a combination of systematic literature review and conceptual design as its research design.	The article concludes that while AI can potentially enhance efficiency and quality of nursing care, its advancement is nowhere near that of human care, touch, and compassion. The article summarizes that nursing care is a critical matter, where using AI will pose an ethical threat, and it

	robotics and AI in nursing care.		is of utmost importance to utilize nurses in caring for the patient while AI will assist in making nurses' tasks easier.
Ohnberg, C., Stöbich, N., Warmbein, A., Rathgeber, I., Mehler-Klamt, A., Fischer, U., & Eber, I. Assistive robotic systems in nursing care: a scoping review. 2023.	The main objective of the study is to provide us with a brief concept of “assistive robotic systems”, and how these technical systems can be utilized to help nurses in their daily tasks.	Systematic literature review	The article concludes that, even though assistive robotic systems for nursing care are developing, their adoption is still in its early stages. While nursing personnel and care receivers are involved in research and testing, their involvement should continue during real-world usage. The study also emphasizes the need for more family participation in technological development.
Nielsen, S., Langensiepen, S., Madi, M., Elissen, M., Stephan, A., & Meyer, G. Implementing ethical aspects in the	The purpose of the study is to assess what are the main ethical considerations, requirements, and concerns that must be considered while	The study method used was qualitative, with focus groups, one-on-one interviews, and advice from experts.	The article plays a critical part in identifying ethical issues that might arise during the usage of robots, and it is mostly related to patient safety and

development of a robotic system for nursing care: a qualitative approach	developing the robotic system.		privacy. The nurses are worried that integrating robots would increase their workloads and would require more effort from their side. On the other hand, families are worried that the patients might not receive appropriate care. The study has also suggested involving entire stakeholders such as nurses, families, and patients while developing the robots.
Johnson, S. L. AI, machine learning, and ethics in health care	The main idea of this article is to provide an overview of AI technology and provide insights into how AI and ML can enhance nursing care while examining different factors. The article also tries to shed light on potential errors and ethical considerations that might arise while integrating AI. Further, the articles	The article summarizes the concepts presented in Annual 59th Conference of the American College of Legal Medicine in Los Angeles in February 2019.	The main conclusion from the paper is that experts from different industries such as health, law, and ethics should share information internationally to create more sound AI/ML models which will help in the uniform development of AI in healthcare. Before integrating AI, consultation with doctors and health

	aim to provide suggestions on how AI can help nurses to provide high-quality care to patients.		experts is a must, and timely regulations should be made.
Ann Swan, B. Assessing the Knowledge and Attitudes of Registered Nurses about Artificial Intelligence in Nursing and Health Care	The primary goal of the study was to examine nurses' competence and opinions toward artificial intelligence (AI) in nursing and health care.	The research study design is a prospective survey design where the author collected data from the period of September 2019 to February 2020 through an online national survey.	The survey result in the article concludes that nurses are optimistic about the changes that AI will bring to the healthcare industry but only a small percentage of nurses are fully aware of how AI could be used practically. The result also expressed that nurses' perception over time related to AI will change and they will benefit from AI in their daily tasks.
Duan, N., & Lin, G. Effect of Intelligent Medical Data Technology in Postoperative Nursing Care	The key objective of this research is to evaluate and investigate the impact of intelligent medical data analysis technology in postoperative nursing, with the goal of modifying current	The research design involves a literature review, data collection, and advanced machine learning models for data analysis.	The main conclusion of the study demonstrates that machine learning techniques are effective at assessing postoperative care data, especially in cases involving orthopaedic surgery. The use of advanced

	postoperative nursing practices.		clinical information technology in postoperative nursing boosts productivity and patient outcomes.
Spring, B. Nursing 2.0: Care in the Age of Technology	The main goal of the article is to explain how technological advancements impact nursing care.	Article	The main findings of the article interrelate the relationship between nurses, technology, and ethics. The article argues that technologies such as AI will rapidly transform the healthcare industry and proper programs must be implemented for nurses to provide them knowledge of AI and other technologies.
Jeong, G. H. Artificial intelligence, machine learning, and deep learning in women's health nursing.	The article attempts to answer questions such as what AI is, how it will enhance nursing care, should AI be incorporated into nursing practice and most importantly how AI can help positively influence women's health.	Literature review	The article concludes that AI will be helpful in nursing care, especially for women's health. For example, AI can better predict about the complications that may arise during pregnancy, discover postpartum depression, breast

			and cervical cancer, and others. Moreover, the article also suggests that; it is time to re-think the curriculum taught to nurses and the author has urged to include AI courses for nursing students.
Ellahham, S., Ellahham, N., & Simsekler, M. C. E. Application of Artificial Intelligence in the Health Care Safety Context: Opportunities and Challenges. 2019.	The article reviews the importance and use of AI in nursing. The article aims to provide more in-depth knowledge of AI in healthcare contexts and provides suggestions on how AI can be utilized more safely.	Literature review	The articles forecast that AI-augmented clinicians will rapidly evolve in the future and AI will greatly impact the health industry. It is, therefore, suggested by the author that regulations should be made, and we should try to take more advantage of AI in treating patients.
Liao, P.-H., Hsu, P.-T., Chu, W., & Chu, W.C. Applying artificial intelligence technology to support decision-making in nursing: A case study in Taiwan.	The major goal of the research is to investigate how artificial intelligence (AI) can help nurses make better decisions and increase clinical precision.	The research methods include a literature review, the development of a predictive model, and a set of questionnaires.	The article suggested that AI could be a fascinating tool in nursing where it could help nurses make diagnoses more accurately. As per the article, the agreement percentage of the diagnosis made by

2015.			the AI system and nurses is 87%, which tells us the revolutionary impact of AI in nursing.
Majekodunmi, A. Artificial intelligence: Current and future impact on general practice. 2021.	The main purpose of the study is to explore present and future applicable scenarios of AI, more focused on primary care.	Literature review	The article emphasizes that the world hasn't yet seen the tremendous benefits of AI. The article suggests that in the future, AI could be used to perform the repetitive tasks performed by general practitioners and can even make better diagnosis. The article raises concerns over ethical issues of AI and has urged all the involved stakeholders to develop it rationally.

Appendix 2. JBI Critical Appraisal Checklist for Systematic Reviews and Research Syntheses

JBI CRITICAL APPRAISAL CHECKLIST FOR SYSTEMATIC REVIEWS AND RESEARCH SYNTHESES

Reviewer_____ Date_____

Author_____ Year_____ Record Number_____

		Yes	No	Unclear	Not applicable
1.	Is the review question clearly and explicitly stated?	☐	☐	☐	☐
2.	Were the inclusion criteria appropriate for the review question?	☐	☐	☐	☐
3.	Was the search strategy appropriate?	☐	☐	☐	☐
4.	Were the sources and resources used to search for studies adequate?	☐	☐	☐	☐
5.	Were the criteria for appraising studies appropriate?	☐	☐	☐	☐
6.	Was critical appraisal conducted by two or more reviewers independently?	☐	☐	☐	☐
7.	Were there methods to minimize errors in data extraction?	☐	☐	☐	☐
8.	Were the methods used to combine studies appropriate?	☐	☐	☐	☐
9.	Was the likelihood of publication bias assessed?	☐	☐	☐	☐
10.	Were recommendations for policy and/or practice supported by the reported data?	☐	☐	☐	☐
11.	Were the specific directives for new research appropriate?	☐	☐	☐	☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info ☐

Comments (Including reason for exclusion)

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Appendix 3. JBI Critical Appraisal checklist for Text and Opinion papers

JBI CRITICAL APPRAISAL CHECKLIST FOR TEXT AND OPINION PAPERS

Reviewer_____ Date_____

Author_____ Year_____ Record Number_____

	Yes	No	Unclear	Not applicable
1. Is the source of the opinion clearly identified?	☐	☐	☐	☐
2. Does the source of opinion have standing in the field of expertise?	☐	☐	☐	☐
3. Are the interests of the relevant population the central focus of the opinion?	☐	☐	☐	☐
4. Is the stated position the result of an analytical process, and is there logic in the opinion expressed?	☐	☐	☐	☐
5. Is there reference to the extant literature?	☐	☐	☐	☐
6. Is any incongruence with the literature/sources logically defended?	☐	☐	☐	☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info ☐

Comments (Including reason for exclusion)

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Appendix 4. JBI Critical Appraisal for Qualitative Research

JBI CRITICAL APPRAISAL CHECKLIST FOR QUALITATIVE RESEARCH

Reviewer_____ Date_____

Author_____ Year_____ Record Number_____

	Yes	No	Unclear	Not applicable
1. Is there congruity between the stated philosophical perspective and the research methodology?	☐	☐	☐	☐
2. Is there congruity between the research methodology and the research question or objectives?	☐	☐	☐	☐
3. Is there congruity between the research methodology and the methods used to collect data?	☐	☐	☐	☐
4. Is there congruity between the research methodology and the representation and analysis of data?	☐	☐	☐	☐
5. Is there congruity between the research methodology and the interpretation of results?	☐	☐	☐	☐
6. Is there a statement locating the researcher culturally or theoretically?	☐	☐	☐	☐
7. Is the influence of the researcher on the research, and vice- versa, addressed?	☐	☐	☐	☐
8. Are participants, and their voices, adequately represented?	☐	☐	☐	☐
9. Is the research ethical according to current criteria or, for recent studies, and is there evidence of ethical approval by an appropriate body?	☐	☐	☐	☐
10. Do the conclusions drawn in the research report flow from the analysis, or interpretation, of the data?	☐	☐	☐	☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info ☐

Comments (Including reason for exclusion)

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Appendix 5. JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies

JBI CRITICAL APPRAISAL CHECKLIST FOR ANALYTICAL CROSS SECTIONAL STUDIES

Reviewer_____Date_____

Author_____Year_____ Record Number_____

	Yes	No	Unclear	Not applicable
1. Were the criteria for inclusion in the sample clearly defined?	☐	☐	☐	☐
2. Were the study subjects and the setting described in detail?	☐	☐	☐	☐
3. Was the exposure measured in a valid and reliable way?	☐	☐	☐	☐
4. Were objective, standard criteria used for measurement of the condition?	☐	☐	☐	☐
5. Were confounding factors identified?	☐	☐	☐	☐
6. Were strategies to deal with confounding factors stated?	☐	☐	☐	☐
7. Were the outcomes measured in a valid and reliable way?	☐	☐	☐	☐
8. Was appropriate statistical analysis used?	☐	☐	☐	☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info ☐

Comments (Including reason for exclusion)

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Appendix 6. JBI Critical Appraisal Checklist for Quasi-Experimental Studies

JBI CRITICAL APPRAISAL CHECKLIST FOR QUASI-EXPERIMENTAL STUDIES

Reviewer_____Date_____

Author_____Year_____ Record Number_____

	Yes	No	Unclear	Not applicable
1. Is it clear in the study what is the cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)?	☐	☐	☐	☐
2. Were the participants included in any comparisons similar?	☐	☐	☐	☐
3. Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	☐	☐	☐	☐
4. Was there a control group?	☐	☐	☐	☐
5. Were there multiple measurements of the outcome both pre and post the intervention/exposure?	☐	☐	☐	☐
6. Was follow-up complete and if not, were differences between groups in terms of their follow-up adequately described and analysed?	☐	☐	☐	☐
7. Were the outcomes of participants included in any comparisons measured in the same way?	☐	☐	☐	☐
8. Were outcomes measured in a reliable way?	☐	☐	☐	☐
9. Was appropriate statistical analysis used?	☐	☐	☐	☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info ☐

Comments (Including reason for exclusion)

Appendix 7. Evaluation of the Quality of Studies

Study		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Total
Ellahham et al. 2019.	&	Y	Y	Y	Y	Y	Y						6/6
Liao, P-H et al. 2015	%	Y	Y	Y	Y	Y	Y	Y	Y				8/8
Majekodunmi, A. 2021.	&	Y	Y	Y	Y	Y	Y						6/6
Ohneberg et al. 2023.	#	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	10/11
Nielsen et al.2022.	!	Y	Y	Y	Y	Y	N	N	Y	N	Y		7/10
Jeong, G. 2020	&	Y	Y	Y	Y	Y	N						5/6
Swan, B.A 2021	%	Y	Y	N	N	N	N	Y	Y				4/8
ISBN Bulletin. 2020	&	Y	N	Y	N	?	?						2/6
Duan & Lin. 2022	%	Y	Y	N	N	N	Y	Y	Y				5/8
Johnson, S. 2019	&	N	Y	Y	Y	Y	N						4/6
Seibert et al. 2021.	#	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	9/11

Robert, N. 2019	&	N	Y	Y	Y	Y	N						4/6
Soriano et al. 2022.	#	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	9/11
Ronquillo et al. 2021.	!	N	Y	Y	Y	Y	N	N	Y	N	Y		6/10
Ng et al. 2021.	#	Y	Y	Y	Y	Y	N	Y	Y	N	N	N	7/11
Buchanan et al. 2020.	#	Y	Y	Y	Y	N	Y	Y	N	Y	Y		8/10
Liao, G.Y et al. 2023.	€	Y	Y	N	N	N	Y	Y	Y	Y			6/9
Chang et al.2021	!	Y	Y	Y	Y	Y	N	N	Y	Y	Y		8/10
Erikson & Salzmann-Erikson. 2021.	&	Y	N	Y	Y	Y	N						4/6
Tongi et al. 2021.	&	Y	Y	Y	Y	Y	N						5/6
Stokes & Palmer. 2020.	&	Y	Y	Y	Y	Y	N						5/6

Q = Question, Y = Yes, N = NO,? = Unclear

& = JBI critical appraisal checklist for text and opinion studies

% = JBI critical appraisal checklist for analytical cross-sectional studies

= JBI critical appraisal checklist for systemic review and research synthesis studies

! = JBI critical appraisal checklist for qualitative research studies

€ = JBI critical appraisal checklist for quasi-experimental studies