Application of Artificial Intelligence Technologies in the Field of Nursing

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Introduction

Nursing discipline, an indispensable part of healthcare delivery, has a critical role for the professional healthcare team, and furthermore, it is in a testing process with AI (AI) technologies in the century we are in, to once again prove its claim to be an agent of change. With a multidisciplinary approach, nurses can use AI technologies as a tool and improve nursing science, moving care service much further than it is today (Kikuchi, 2020). It would be useful to briefly address the issue across health services before moving on to the issue of implementing AI technologies in the field of nursing.

Artificial Intelligence Technologies and Healthcare

The prolongation of life expectancy brings with it an increase in chronic diseases, treatment, and care costs. Limiting costs is critical for sustainable health systems. AI has the potential to provide strong support for the sustainability of healthcare systems by keeping costs at more affordable levels (Higgins & Madai, 2020; Kumar & Chauhan 2021). AI technologies that mimic the cognitive functions of mankind using analytical techniques on massive data with superhuman power are bringing a paradigm shift to healthcare. We have only just begun to see the effects of AI on healthcare. In the coming years, this effect is expected to increase and deepen (Jiang et al., 2017). Healthcare is an area full of opportunities for AI applications. For example, AI technology can do in seconds a complex process that demands a long period of time and labor of humans, such as the analysis of huge sizes of data belonging to millions of patients. AI applications save health professionals from vexatious procedural work, enabling them to further divert time, energy, and capabilities to people while performing risk assessments of clinic inpatients and accelerating the implementation of measures. All of this means a better patient experience with healthcare, lower costs, and rational use of resources. AI technologies and algorithms can be a unique support tool for overcoming limitations in the diagnosis of diseases and prediction of risks. Therefore, there is a growing interest in AI applications in the healthcare field. AI applications and research in healthcare generate a

wide range, and the field attracts the attention of service providers and consumers as well as investors. Today, there are examples of AI applications in use, and many of them are in the process of pilot work and development (Ross et al., 2019; Davenport & Kalakota, 2019). Some of the applications of AI in the field of health include: (Alugubelli, 2016; Big data, 2016; Nahid & Kong, 2017; Rong et al. 2020; Thakur et al., 2020):

- Retinopathy screening
- Staging in breast cancer
- Reduction of postpartum depression
- Risk assessment in patients and predicting negative health outcomes
- Estimating the effectiveness of treatment in cancer patients
- Workflow applications that will save time for clinicians
- Mission control-command centers
- Virtual clinical assistants
- Robot surgeon assistants
- Radiology, pathology

Artificial Intelligence Technologies and Nursing

It is necessary to address the place and importance of nursing care in health systems before moving on to the issue of the use of AI technologies in nursing services. Human beings are the focus of nursing care and are its only area of interest. The care service offered by the nursing discipline includes holistic and often personalized scientific and professional initiatives offered to healthy and sick individuals. The physiological requirements of the healthy person are often unchanged, although the content and presentation of nursing care, which has a strong relationship with the physiological condition, is highly variable from patient to patient. The various requirements of a person that can be met by nursing care are formed within the framework of his/her cultural, religious, social, psychological, physiological, and many other characteristics. This in turn leads to the care offered to each patient/healthy individual becoming specific, not resembling that of another. The discipline of nursing offers such specialized care to a wide range of people (indeed all age groups and all people with varying health conditions) at any time. Moreover, this service is provided in line with values and principles such as respect, protection of human dignity, privacy, compassion, justice, and equality. Failure of nursing service delivery could mean blockage or even collapse of the entire healthcare system (Erim & Cevirme, 2018; Unsal, 2017; White, 2002).

Over time, many factors have caused nursing care to take shape. Changing human requirements and expectations, as well as technological advancements, are at the forefront of these factors. AI, yet a new technology for many disciplines, is also discussed with a poor interest in nursing. It is apparent that AI technologies will contribute to nursing care, but there are strong objections to proficiency to replace nurses over time and deliver personalized care in line with the needs of the patient and values/principles (Akgerman et al., 2022; Buchanan et al., 2020). Many questions arise such as whether AI can provide emotional support to a patient diagnosed with a deadly illness, if a robot nurse can communicate therapeutically, and how and how much this pattern of communication can affect the patient. Every new technology inherently holds risks. It is recommended to examine the application outputs at hand for the integration of AI technologies into nursing care. Nurses must be present in the assessment of how outputs offer value/contribution based on clinical experience. Training in the field of AI is needed for nurses to be ready for multidisciplinary studies (Frith, 2019). The perception of nurse groups on AI is generally positive. A study conducted in Turkey revealed that health workers, including nurses, have a positive perception of AI. According to the study, 85.4% of respondents said that AI is useful for healthcare, 52.3% had high hopes for AI applications in healthcare, and 64.3% did not see any AI-related risk related to their jobs (Ankara et al., 2021).

Locsin & Ito (2018) proposed a 5-item categorization so that technologies used in healthcare can be easily identified;

- Human-complementing technology such as mechanical prosthetics and biological organs.
- Technological machines that assist the nursing activities to improve the quality of patient care in operating rooms and clinical settings.
- Robots that work directly to meet nursing care demands, mimicking nurses' activities.
- Sampling human qualities in the potentials of cybernetic organisms.
- Technology that increases the human abilities of organic/biological versions in Chimeras.

For AI applications to become part of nursing care, nurses first need to know about AI technologies and embrace their use in the field of nursing. The realization of this is possible if the pioneer nurses, who are interested in technology, turn their attention to AI and participate in research and studies in this field. The integration of AI into nursing care undoubtedly requires the cooperation of different disciplines (Akgerman et al., 2022). To make full use of AI technologies in the future, starting from today, scholars, clinician nurses, and IT specialists should work together from the very beginning of the technological design process. Thus, using the power of AI technologies, a better, faster,

and safer care service can be introduced (Sensmeier, 2017).

How AI practices will affect the nursing profession is a topic that has been talked about. As humanoid robots are popular today, it is debated whether they can replace nurses. If we look at this discussion from a broader perspective, the potential impacts of AI on the nursing profession can also be discussed. Robert argues that AI technologies are not an alternative for nurses, but a support tool that will ease the workload and improve the quality of care. While nurses have already failed to reach the desired number of employment, AI technologies could become a new area of work, perhaps in order not to dislodge them. The nurse may be a quality control specialist who provides feedback to designers in the development of technological care systems/tools, assessing their care experience and outcomes. Whether patient outcomes are meaningful, whether there is an unexpected outcome, whether there are variables that remain lacking in the decision mechanism, whether the results are reliable, or whether the practice is sufficient, can be answered most accurately by a nurse (Robert, 2019). Here are some of the expectations and drawbacks of the integration of AI technologies into the nursing field (Locsin & Ito, 2018; Pepito & Locsin, 2019; Sendir et al. 2019).

Expectations

- Increasing the care safety
- Diversification of methods and tools used in care
- Increasing efficiency in nursing practices
- Creating more time for face-to-face interaction of nurses as AI technologies lighten work
- Increasing the time allocated directly to the patient by reducing the time spent on routines

Drawbacks

- Will devices/systems using AI technologies, in practice, have autonomy like nurses? Will the robot nurse, for example, work independently of the human nurse?
- Will nurses be held responsible for technological errors related to AI applications? / To what extent will they be held responsible?
- Can AI technologies replace nurses in the future? For example, would humanoid robot nurses put real nurses out of business?
- Can AI give the “human touch” the nurse provides, making people feel important and valuable?

Use of Artificial Intelligence in Nursing Education

AI is a relatively new concept for nursing education. Effective and therapeutic communication is one of nursing's indispensable skills. Classical nursing training can remain limited in teaching effective communication abilities to conduct with real patients in a variety of situations. In various scenarios with AI algorithms, different patterns of communication can be experienced over and over again and educational effectiveness can be assessed at short notice. Communication simulations are used as complementary training tools in the current curriculum (Cetin & Eroglu, 2020). Treatment and care processes mostly require nurses to make quick and effective decisions. This, in turn, is based on practice, observation, research, and evaluation skills. The learning environment and various factors associated with scholars can lead to the failure of targeted skills in nursing education to develop sufficiently in students. It is generally thought that AI can be used effectively in the field of education. AI-powered simulation and games make learning easier for nursing students (Akgerman et al., 2022; Harmon et al., 2021). In this book, although the topics of AI and augmented reality in the field of nursing are addressed in separate chapters, they are actually often intertwined with one another. One example is the combination of AI algorithms and augmented reality technologies that recognize student qualities in virtual reality applications used in nursing training and develop interaction accordingly (Jorissen & De Boi, 2018; Plotzky et al., 2021).

Use of Artificial Intelligence in Care Service

Questions are being discussed on what should be the role of a nurse in the R&D activities for the integration of AI technologies into the care service and how nursing practices should be shaped. These questions may require philosophical and deep debate. Nursing care in general is a systematic process consisting of steps of evaluation, diagnosis, purpose planning, implementation, and evaluation of outputs (Ay, 2008). Some of the highlights of nursing care purposes targeted by AI approaches are direct care support, support for the organization of care, risk estimation and prevention for the patient, and support for those in need of care. A deeper look at the uses of AI in the nursing care service can also list many items. Some of these include activity and health practices, care support in the geriatric population with dementia, coordination of care and communication, patient assessment and identification of nursing care needs, prediction and prevention of fallings, risk assessment for the prevention of decubitus ulcers, early identification of pathophysiological findings in the patient, preparation of nurse work lists, and health and quality of life of caregivers. Additionally, studies are being done to test the functionality of the technological tool developed in all these areas that are sampled, as well as to investigate nurses' perceptions of AI applications with the aim of enhancing and improving the real patient/nurse experiences (Seibert et al., 2021).

AI can provide support to the nurse in long procedural processes and the complex process of care. A significant portion of nurses' shifts is spent on reporting processes. AI can allow the nurse to save time in these inefficient and lengthy procedural processes. Moreover, it can provide a reliable decision support system service in care by quickly analyzing the vast number of parameters belonging to the patient (Akgerman et al., 2022; Alugubelli, 2016). In fact, real technological practices like Robear can please nurses as much as patients. Robear, the nursing care robot, supports nurses in physically exhausting and time-consuming jobs such as moving a patient out of bed, putting them in a wheelchair, and making in-bed rotations to prevent decubitus ulcers (Szondy, 2018).

Figure 1 Robear: Nursing Care Robot Designed To Serve Japan's Aging Population (Szondy, 2018)

In Robear's design, it is seen that the visual features of the robot come to the fore along with its functionality. This design may be intended to create visually positive human perceptions. On the other hand, in another project, roboticists focused more on the robot's functionality than the visual feature and developed Cody who give the patient a bed bath and simulated the nurse's hygiene application (King et al., 2010).

Figure 2. Cody who can autonomously perform the movement of wiping the patient just like a nurse (King, 2010: https://www.youtube.com/watch?v=0ac2qwStrdo).

Robots that interact directly with humans, especially AI technologies, seem to be successful in demonstrating procedural technical skills based on knowledge and promise

much better for the future. Although the developments motivate the discipline of nursing for innovative practices, the criteria for "ensuring human touch," which is at the core of nursing care, seems not to be abandoned. For this reason, the extent to which AI can learn humans, and to what extent it can understand emotions from facial expressions and develop appropriate autonomous responses will determine the future of humanoid AI technologies. (Locsin & Ito, 2018).

In healthcare systems in general, nurses' workload is intense and employee numbers are restricted. The problem of patients getting restricted services by failing to adequately see nurses can be overcome with virtual nurses. The virtual nurse application that was developed in collaboration with Boston Medical Center and Northeastern University has features that can meet patients' cognitive care requirements (Figure 3a, b).

Figure 3-a. A virtual nurse establishing health communication with the patient (Bickmore et al., 2009)

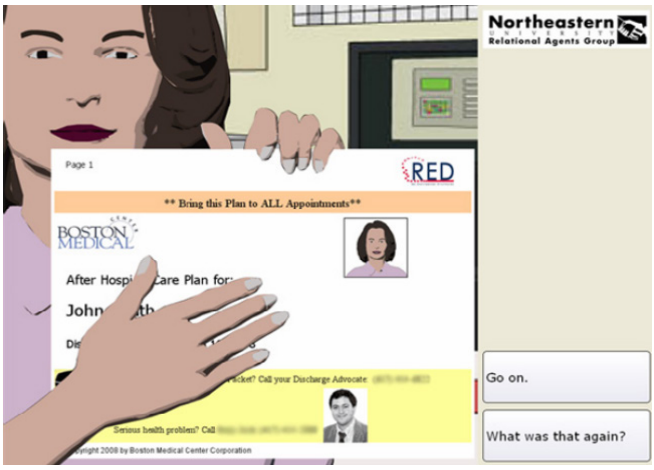

Figure 3-b. Virtual nurse application interface (Bickmore et al., 2009)

An inpatient at the clinic is able to receive services from a touchscreen and kiosk with wheels about the discharge care plan. The virtual nurse was specifically designed for health communication of patients with inadequate health literacy, and the interface included two different female nurse characters. Ninety-four percent of the patients who used the virtual nurse said it was easy to use the system and reported high levels of satisfaction. (Bickmore et al., 2009). The prominent advantages of receiving service from

such a nurse are that the patient can reach the nurse on any day and at any time of the day and has the right to repeat the service as many times as he/she wants.

The use of AI in creating electronic health records could mean lightening time-consuming clinical turnaround work for nurses. AI-powered software that recognizes the voice of the nurse rather than the keyboard is far more practical and efficient to use. With each passing day, voice and facial recognition technology are evolving. This technology can be used by the nurse to prepare a patient care report and share it with both the patient and the other nurse who will take over the shift (Clancy, 2020).

One of the most discussed topics is whether AI-based nursing care systems and tools can appeal emotionally to people. Are learning machines callous helpers that fail to emulate the skill of empathy? The results of a study conducted with elderly people who are at the forefront of the vulnerable groups are interesting and promising. Baby seal robot PARO, which works in an aged care facility, serves elderly people with dementia.

Figure 4. Baby Seal Robot, PARO (Shibata, 2012)

The elderly people were seen contacting PARO and being emotionally affected by this communication, for example laughing during communication. Elderly people's touching and fondling of PARO was considered the result of active interaction. In the study, it was concluded that PARO is effective in reducing the loneliness of the elderly, also, with its positive psychosocial effect, it can be used in the elderly with dementia (Shibata, 2012; Takayanagi et al., 2014). The capacity of AI technologies to be available to conduct nursing activities, as well as how much to adhere to the principle of "first, do no harm" is a subject of discussion in the field of nursing. Because during nursing practices, cases can arise in which sick/healthy individuals may be harmed. The nurse's taking such a risk may lead to a conflict of conscientious and professional values. An incident in the United States has also raised unease about the use of AI in healthcare. Alexa, Amazon's AI-powered virtual assistant, told a 10-year-old girl "Plug in a phone charger about halfway into a wall outlet, then touch a penny to the exposed prongs" as challenge advice (NTV Haber, 2021).

Nursing and Humanoid Robots

Whether humanoid robots can replace nurses in the future has also been debated nowadays. Today, robots can learn to imitate the various skills of nurses. Robots' mimicking capabilities are limited by simple processes for today. In the future, we may be discussing the interaction of fully autonomous humanoid robots equipped with quantum computers with biological nurses (Locsin & Ito, 2018). This possibility, combined with the problem of chronicled inadequacy in the number of nurses, brings to mind the question of whether AI technologies will take the place of nursing and nurses. The response to this problem in terms of patients can mean more nurses and better care. On the other hand, what it means for the nursing profession is the threat of unemployment. That threat seems unlikely, at least for the immediate future. Because nursing care requires subjective, interaction-based, patient-specific, and holistic performance (Coban et al., 2022; Horton et al., 2007). It is inconceivable that smart machines perform as high as "human-nurse" in performing such performance while providing services to human beings that are complex and sensitive (Sendir et al., 2019). Seeing AI technologies as a valuable tool that facilitates nurses' jobs and provides support for care, not a threat to the nursing profession, would be far more beneficial for the nurse and the vast audience of people it offers services. Otherwise, nursing discipline may have to brave a more likely and dangerous threat, such as an inability to meet customer audience expectations if it perceives AI technologies as a threat (Pepito & Locsin, 2019).

Artificial Intelligence Research in Nursing

One of the important issues in AI research in the field of nursing is that the information in the data sets used by algorithms for decision-making and implementation skills should be accurate, valid, and reliable. Considering laws and regulations regarding the protection of personal data legally, incomplete or erroneous entry of data into the system can affect the proper functioning of algorithms. Data privacy and security, the integration of the sensors used in the system, and the lack of physical care impediments are among other issues studied. Despite all these confounding factors, developed prototypes and systems produce positive results. A systematic review published in 2020 reveals the importance of AI technology to nursing science. The 17 nursing studies examined in the review study have shown that AI technology delivers high performance for research purposes. The review highlighted that AI technology is a powerful tool for developing the science of nursing (Kikuchi, 2020).

Another study conducted in Taiwan reported that the nursing diagnoses predicted by the AI-assisted system for the patient reached 87% of the compliance rate with diagnoses recommended by the nurses. Despite this high rate, the system's diagnostic deficit can lead to patient harm. On the other hand, the same study highlighted that nursing diagnoses may be incomplete or inaccurate due to the excessive workload of nurse capacity

and that the associated patient is also at high risk of harm. Research on the use of AI technologies in the field of nursing should continue and problems should be addressed to alleviate nurse workload and support quality of care. The most common problems in the field of nursing diagnostic research were reported to be the spoken language, the quality and quantity of the information, and the diversity of the values obtained (Liao et al., 2015). For the use of AI technologies in the field of nursing, we mentioned the need for nurses to have a multidisciplinary perspective and to receive training on AI technologies. Recommendations for nurses to gain experience in the integration of AI algorithms into nursing practices are listed as follows (Robert, 2019).

- The team should be ready to learn new ways and collect and use patient data.
- Nurse experiences for integration are local and specifically valuable. The usefulness of the technology implemented and other nurse interpretations of the experience should be taken into account in the development of the technology.
- Vehicles should be easy to use and an emphasis should be placed on intuitive assessment of outputs.
- Developed technological tools should provide benefits for the patient and nurse, enabling the nurse to spend more time face-to-face with his/her patient.

The Ethical Dimension of the Use of Artificial Intelligence in Nursing Care

The most prominent areas of ethical discussion are the issues such as accession to and use of data of patients through algorithms mentioned in the previous chapter, making accurate and complete care decisions, protecting the principle of "first, do no harm" and usefulness to the patient, maintaining the preferences and choice rights of those receiving services, ensuring consent, sharing responsibility for harms incurred (Kikuchi, 2020).

Technological progress always comes with new problems and challenges. A multidisciplinary approach is needed to overcome the problems experienced, as is the case with the development of AI technologies. In practice, following existing laws and new statutory regulations, necessary updates should be provided for the data at hand, the provided service, and parties (patient, care providers, physicians, nurses, etc.). The current AI practices must be strictly controlled to maintain patient-centered care that is inclusive and respectful of patients' needs, and necessary precautions must be taken. It should be ensured that the patient is actively included in the care and that the right to choose is protected, which is constantly emphasized in the nursing process (Amann et al., 2020).

It is inevitable that the use of AI-powered technological systems in healthcare will bring with it ethical problems. Biomedical ethical principles in approaching current or possible problems can provide an appropriate ethical framework. In this context, the four basic ethical principles are autonomy, benefit, "first, do no harm" and justice (Bali et al.,

2019; Gillon, 2015). Ethical discussions mostly center around the diagnosis of diseases and prediction of disease/complications based on algorithmic analysis of risk factors. The belief that algorithms are more objective than humans is expressed as an ambitious view that can lead to ethical problems. Yet most physicians are willing to use AI technologies in diagnostic and predictive processes related to their jobs in general (Morley et al., 2020). Nursing care is also carried out over-diagnoses today. There are also risk diagnoses for complications and other disturbances, which are largely based on estimates (Ay, 2008). Thus, the use of AI-based decision support systems in diagnostic and predictive processes in the field of nursing, as well as in the field of medicine, and similar ethical issues are possible.

Conclusion

AI has entered the nursing profession quite late compared to industrial organizations where routine procedures are repeated. It is also impossible to say that there is no integration yet, especially in nursing fields where the human factor is the main determinant, such as patient care and nursing education. A lot of care activities are directly related to human life, and nurses should also be part of the multidisciplinary team in the design, implementation, and evaluation processes, particularly ethical and technical dimensions, to avoid facing an outcome against people depending on the use of AI. As in any field, it seems inevitable that AI will invade the nursing field and that there will be several requests from those receiving services. Nursing discipline should not be left behind the age and should be able to produce safe and adequate answers to incoming requests.

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