CHAPTER - 4

TECHNOLOGY INTEGRATION IN MEDICAL SURGICAL NURSING

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Abstract

The integration of technology into med-surg nursing practices has ushered in a new era of efficiency, accuracy, and patient-centered care. From electronic health records to telehealth solutions, simulation training, and smart devices, technology is reshaping the way med-surg nurses approach their roles. Technologies like small wearable sensors that collect patient data and electronic management system that streamline process can alleviate time-consuming responsibilities. These efficiencies let

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nurses focus on more critical tasks and quality patient time while reducing the risk of nurse burnout. Nursing integration is the capstone immersion experience designed to provide the student with knowledge synthesis and skills acquired during previous work .Artificial intelligence (AI) technologies like automated data analysis and have helped providers streamline diagnoses, improve accuracy, and forecast patient outcomes. All of these contribute positively to overall patient outcomes and general quality of care. What is Integrated Health Care? Integrated health care, often referred to as interprofessional health care, is an approach characterized by a high degree of collaboration and communication among health professionals .AI can enhance patient monitoring and support predictive analytics. Moreover, through AI-enabled technologies, nurses have the capability to continuously monitor patients' vital signs, detect early warning signs of deterioration and receive real-time alerts .

Key words: Technology, integration, case studies, best practices, evidenced based practices, surgical care, innovations, Artifical intelligence, Robotics . Human applications, accuracy, analysis

4.1 Introduction

The integration of technology into med-surg nursing practices has ushered in a new era of efficiency, accuracy, and patient-centered care. From electronic health records to telehealth solutions, simulation training, and smart devices, technology is reshaping the way med-surg nurses approach their roles. alleviate time-consuming responsibilities. These efficiencies let nurses focus on more critical tasks and quality patient time while reducing the risk of nurse burnout. Nursing integration is the capstone immersion experience designed to provide the student with an opportunity to synthesize the knowledge and skills acquired during previous coursework .Artificial intelligence (AI) technologies like automated data analysis and predictive analysis have helped providers streamline diagnosis, improve accuracy and forecast patient outcomes. Integrated health care , often referred to as interprofessional health care, is an approach characterized by a high degree of collaboration and communication among health professionals. AI can enhance patient

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monitoring and support predictive analytics. All of these contribute positively to overall patient outcomes and general quality of care. What is Integrated Health Care? Moreover, through AI-enabled technologies, nurses have the capability to continuously monitor patients' vital signs, detect early warning signs of deterioration and receive real-time alerts. AI can enhance monitoring patient status continuously and support all patient analytics.

Moreover, through AI-enabled technologies, nurses have the capability to continuously monitor patients' vital signs, detect early warning signs of deterioration and receive real-time alerts. We established the Nursing and Artificial Intelligence Leadership (NAIL) Collaborative, comprising interdisciplinary experts in AI development, biomedical ethics, AI in primary care, AI legal aspects, philosophy of AI in health, nursing practice, implementation science, leaders in health informatics practice and international health informatics groups, a representative of patients and the public, and the Chair of the ITU/WHO Focus Group on Artificial Intelligence for Health. The NAIL Collaborative convened at a 3-day invitational think tank in autumn 2019. Activities included a pre-event survey, expert presentations and working sessions to identify priority areas for action, opportunities and recommendations to address these. In this paper, we summarize the key discussion points and notes from the aforementioned activities.

4.2 Research Objectives

- Identify common technology in Nursing
- Recognize development of technology in nursing
- Implement effective monitoring and assessment of technology in nursing
- Examine case studies on technology implementations in nursing
- Apply Evidence- based best practices in technology in nursing

4.3 Research Methodology

In the research study the researcher has used secondary data. The data has been collected from research papers, published materials, online websites, and survey reports published by various research organisations.

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4.4 Current discourse about AI impact in Nursing :

AI technologies have the potential to propel nursing capabilities and enable nurses to provide more evidence-based and personalized care to their patients. AI technologies have the potential to support responsive and evidence-based nursing practice through the provision of cognitive insights and decision support, for example, through visualization of patient trends that can provide insights for both immediate patient care as well as long-term planning and management. Proponents of AI also point to the potential for AI to free-up time for healthcare professionals to dedicate in improving the relationships with patients

Indeed, the time that can be freed up for nurses can be spent on fostering relational care, supporting nurses' ability to develop broader insights into the contexts of patients' health. Moreover, time that is freed up for nurses can be spent on engaging with recent research and supporting up-to-date knowledge of the evidence to support practice, activities that are among the most common to be put aside for lack of time and opportunity

Along with the potential or positive outcomes, AI technologies can have unintended consequences that can have a potential negative impact on the nursing profession and on the main aims of nursing practice. For example, there exists the risk for AI to perpetuate or systematically embed existing human biases into systems such as a recent case where a clinical decision algorithm introduced racial bias by prioritizing care for less sick white patients over sicker Black patients in the United States . Beyond impacts on clinical and health outcomes, AI in nursing could also exacerbate the push towards market-driven goals of efficiency. There exists a very real potential to instead reallocate newly freed-up time towards increasing the volume of patients and tasks assigned to nurses. Hence efficiency goals (i.e. quantity of care) run the risk of eclipsing the opportunities that the use of AI in health systems are meant to create (i.e. quality of care).

Such negative impacts are not inevitable. For instance, AI also has the potential to make visible and remove human bias and improve decision making , for example by discovering and quantifying the impact of taken

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for granted variables such as sex, gender, ethnicity, or race (while we recognize that race has no scientific meaning, experiences of racism have clear links to health outcomes), for which our understanding of impacts are emergent . Ensuring the best possible consequences from AI for nursing will depend on which values and priorities end up guiding the development of AI tools, and whether they implemented with an adequate understanding of both their potentials and limitations. on can occur for several reasons, including severe pain disturbed sleeping pattern due to pain, infection, constipation and fluid and electrolyte imbalance.

Placed in nurses' hands, unintended consequences of using AI tools can be direct and serious, reflecting the same concerns discussed by O'Keefe-Mccarthy in their classical discussion of the mediating role of technology in the nurse-patient encounter and the subsequent effects on the moral agency of nurses. Given the potential magnitude of the impact of AI tools, there is an ethical imperative for nurses to have a minimum basic understanding of how these tools come to be developed, what informs them, and the implications of using such tools on their clinical judgement and practice. The responsibility of having a minimum understanding of AI that all nurses must develop is arguably no different from the requirement of nurses to have a basic understanding and competency in the use of any type of new technology or tool that they use in their practice.

Notwithstanding these important implications of AI for the nursing profession, there is a growing, but still a limited critical discourse in the nursing literature (Brennan & Bakken, 2015; Linnen et al., 2019). In the sphere of nursing education, addressing AI remains, largely, absent. Nursing curricula continue to struggle with incorporating basic nursing informatics competencies as part of basic nursing education (Ronquillo et al., 2017; Topaz et al., 2016), which will become more worrisome given the growing interest in using AI tools in health systems. In other words, there is the potential that the challenges that nurses currently face regarding the effective use of and potential for leading innovations in health information technologies can be further compounded if a gap in AI knowledge is added to existing gaps in basic health informatics knowledge.

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Nurses are the group of healthcare professionals who generate the most data in health systems, as they complete the most documentation . Nurses play an important role in collecting data that might be eventually used by AI tools, as evidenced by work that has linked the nature and patterns of nursing documentation practices with patients' mortality. There nevertheless appears to be limited understanding of the link between nursing documentation and how these documents may be used for purposes beyond immediate clinical decision making, administrative reporting and keeping a legal record as taught in basic nursing education. While understanding these aspects of documentation has been sufficient to inform nursing practice in the past, we argue that nurses should also understand the relationship between their clinical documentation and AI. For one, understanding the nature and quality of data that are collected and documented as part of the nursing practice, can and do, directly inform AI tools. Also, AI-based clinical decision support has various levels of uncertainty that requires clinician interpretation . When deciding to follow an AI-based recommendation, nurses serve as the last line of evaluation for the appropriateness of an intervention . Moreover, a significant current challenge is that many nursing educational programmes both in entry-level nursing education and continuing education of professional nurses do not have enough expertise in teaching health informatics and AI technologies to effectively address this gap in AI understanding.

To bridge the educational gap, there is a need to develop a curriculum with 'minimum AI in nursing competencies', a set of domains and concepts that all entry-level nurses should receive as part of their basic nursing education . Some organizations, such as the American Association of Colleges of Nursing (AACN), are moving to a competency-based education with a technology domain crossing over all domains due to the current need for this topic in all levels of nursing education. Similar efforts concurrently need to be made to support the development of these competencies among practising nurses, as well as nurse leaders, where this material can be delivered through continuing education initiatives.

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Graduate nursing education also would benefit from the creation of opportunities for advanced AI education as well as the formation of sub-specializations in AI under health informatics programs. Specific recommendations are outlined in the summary Table 1 towards ensuring that a curriculum with 'minimum AI in nursing competencies' can be met, with the goal of having all nurses hold basic knowledge and competence related to AI use in nursing.

4.5 Nurses role in all stages of AI:

4.5.1 From development to implementation

Currently, nurses are often end-users of technologies that incorporate AI (e.g. advanced clinical decision support) rather than collaborators in development. As such, there are other calls for nursing: to take the driver's seat in determining which aspects of nursing care can be delegated and to be key actors in introducing AI technologies in health systems In a clinical context, the AI development lifecycle must start with a thorough understanding of the clinical question and clinical workflows, as these ultimately shape the successful use and subsequent impact of these technologies on patient and organizational outcomes. AI development teams should be interdisciplinary, including nurses, to ensure that contributions of computer science and engineering members of teams are grounded in clinical realities of the provision of patient care.

Nurses' contributions to all stages of the AI development lifecycle become crucial when recognizing the intertwining of the consequences accompanying the use of AI in nursing (both positive and negative) with the foundational underpinning of the nursing profession as being concerned with beneficence towards patients, communities, and populations, and advocacy for social justice. Patient, family, and community advocacy and the promotion of person-centred care comprise foundational functions of the nurse. As such, nurses are uniquely positioned to propose how the impact of AI should be measured in terms of nursing and patient outcomes. It is through active participation in all aspects of the AI development lifecycle that unique insights from nursing can contribute to the thoughtful development and use of AI that optimize

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potential benefits and minimize potential negative consequences for patients, communities, populations, healthcare systems and the nursing profession.

4.6 Strategies and opportunities AI in Nursing:

AI algorithms can automate administrative tasks , prioritize patient needs and facilitate seamless communication in healthcare team (Stokes &palmer 2020).This enable nurses to focus more on direct patient care and ensures the efficient and coordinated delivery of health care services

Nurses need to be meaningfully (rather than tokenistically) involved and contribute as key members of AI development and implementation teams in health systems. While nursing can contribute in many ways across the AI development lifecycle, we have identified three potential distinct and important informant/communicator roles that can be contributed by nursing. These include: (a) delineating clinical problems; (b) serving as intermediaries between the clinical and technical spheres; and (c) incorporating features of relational practice (Dykes & Chu,). Nurses' expertise and deep familiarity with working closely with patients should be tapped into, to better delineate clinical problems that AI technologies aim to address. For example, when predictive algorithms are being developed from clinical data, nurses can contribute with practice-based perspectives to technical teams (often consisting of engineers, computer scientists, user interface design experts, etc.) to understand why some data elements are missing or incomplete (e.g. poor documentation of social risk factors) (Navathe et al., 2018) and offer potential strategies to address these shortcomings. Closely related is the potential for nurses to serve as key intermediaries between technical experts developing solutions and nurses as clinical end-users (Dykes & Chu, 2020). These two groups speak very different professional languages and nurses educated in AI concepts are perfect for bridging this vocabulary gap. Finally, nursing expertise in relational practice (i.e. understanding and focus on the quality of human relationships) represents a unique strength to contribute to the AI development lifecycle.

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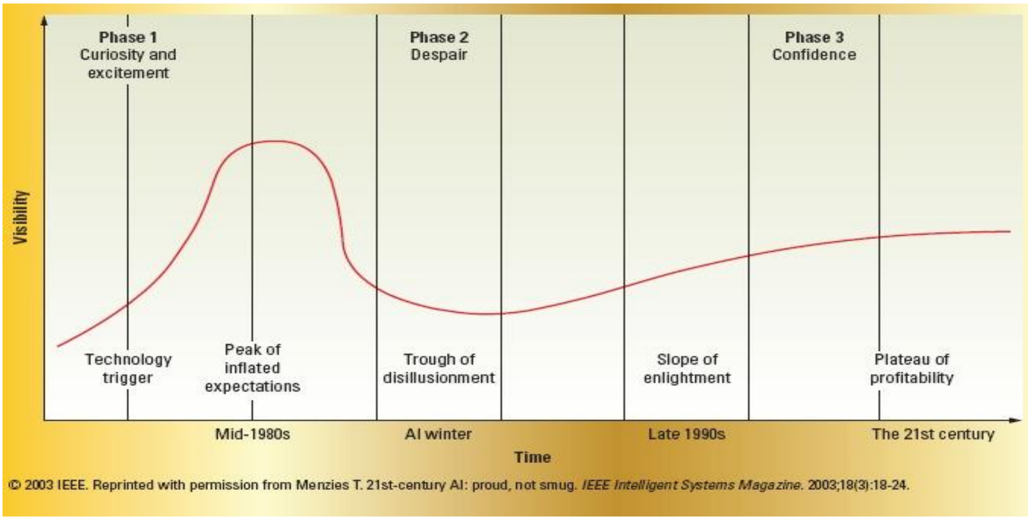

Figure 1. Technology trigger to plateau of profitability

A literature search reveals that there are a variety of AI definitions, with some more focused on technologic attributes whereas others describe human aspects of intelligent machines. A description of AI by Sara Castellanos, technology writer for *The Wall Street Journal*, captures the essence of what it aims to deliver: "Artificial intelligence encompasses the techniques used to teach computers to learn, reason, perceive, infer, communicate, and make decisions similar to or better than humans.". AI isn't one technology, but rather a collection of technologies that perform various functions depending on the task or problem being addressed. Often when people refer to AI, they're speaking about one or more of these computing technologies that you may already be using in your work for functions such as staffing optimization or at home for functions such as thermostat and lighting control. AI isn't a new technology. Its roots began in 1956 when Stanford University computer scientist John McCarthy coined the term while leading the Dartmouth Summer Research Project. Since then, the AI field has experienced many ups and downs. (See Figure 1.) Historically, we didn't have the computational power and supporting technologies to process vast amounts of data, which caused doubt in AI's ability to ever deliver on expectations.

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Beginning in 2011, the field started to see leaps in progress, with advances in computer processing capabilities, access to large data sets needed to train AI systems and the ability to process them, and discoveries in algorithm designs that are the foundation for AI processing. (See *Algorithms—the building blocks of AI*.) An example is the successful use of graphics processing unit chip technology, originally designed for the gaming industry, to help accelerate the development of AI applications in self-driving vehicles and healthcare. This technology brought new processing power to computer scientists at a reasonable cost, opening up opportunities for AI experimentation. Also in 2011, computer scientist Andrew Ng proved that computers can learn what an otbject is without being told what it represents. His research used 10 million online videos of cats; over time, the computer learned what a cat was. This breakthrough technology is used today in speech recognition systems.

Figure 2. The Rotham index captures Nursing Assessment Data

Yale New Haven Hospital (YNHH) nursing was an early adopter of the Rothman Index, a tool that reflects patient acuity and risk. Director of Nursing Professional Practice Dr. Judith Hahn, Strategic Analytics

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Innovation Scientist Dr. Joan Rimar Sr., and Clinical Informatics Manager Leslie Hutchins highlighted what it takes to introduce new algorithms into nursing and interprofessional practice. In a personal communication, Hutchins described the goal of YNHH technology implementations as "providing the right advisory, at the right time, so we can look at what's meaningful information to achieve desired patient outcomes."

Rothman Index scores are calculated using electronic medical record (EMR) data associated with 26 variables, including 11 nursing assessment metrics, displayed in graphs. The introduction of the Rothman Index was accompanied by skepticism about its validity and reliability to produce actionable results. The technology initially didn't have ample peer-reviewed literature to convince nurses and other clinicians that the results would make a difference in patient care. However, research now suggests that Rothman Index performance is positively impacted by nursing assessment data, so the potential for nurses to impact patient care is significant. At YNHH, nurse SWAT teams use the Rothman Index to identify at-risk patients. A SWAT team is a group of experienced nurses trained in critical care, advanced cardiovascular life support, and trauma care. SWAT teams now receive immediate warning notifications on mobile phones when the index indicates patient deterioration. The SWAT team reviews the EMR and, as needed, assesses the patient and collaborates with clinical nurses and medical staff on pertinent aspects of care. SWAT nurses describe themselves as "a second set of eyes." The data used to generate the index are derived from routine nursing documentation. Timely input of nursing assessment data is critical to the calculation and value of index scores because the index updates in real time from the EMR. For acceptance and continuous use of the index, clinicians may need an "a-ha" moment when they discover that the data do make a difference when working with their patients and families. For example, at YNHH palliative care team members found Rothman Index graphs useful in goals of care discussions. (See Figure 3)

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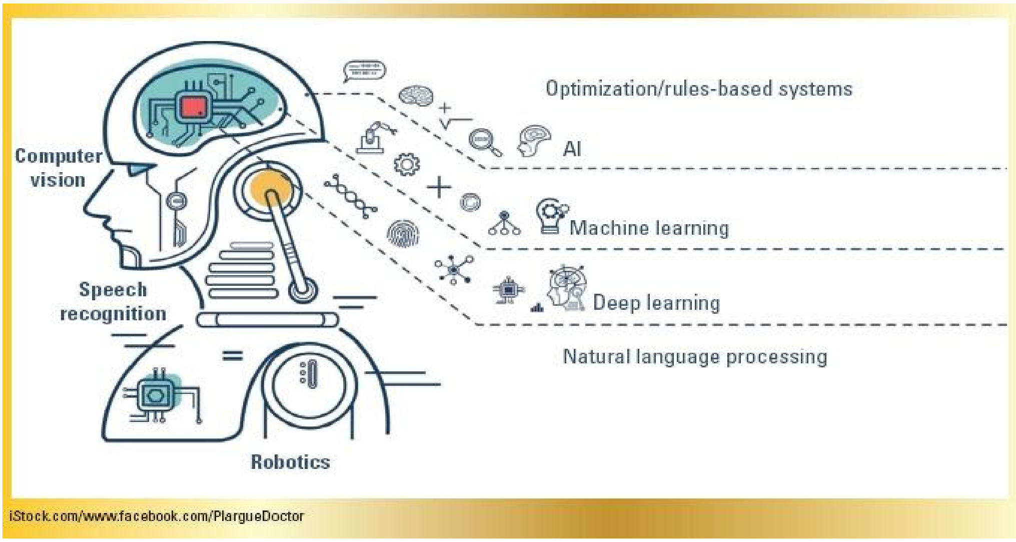

Figure 3: Robotic functionality in various perspectives

A term used interchangeably with AI is *cognitive technology*, such as the famous Watson computer that won the *Jeopardy!* Challenge in 2011. Following this success, Watson was trained in 13 different types of cancer by experts at Memorial Sloan Kettering Cancer Center. One function of Watson is to rank evidence and provide patient-relevant, evidence-based treatment options. Vice President of IBM Analytics Steven Astorino describes cognitive computing as the "ability of computers to simulate human behavior of understanding, reasoning, and thought processing."

Machine learning is a frequently used technology in which computers act intelligently on a specific task or problem without being explicitly programmed. The computer uses algorithms to derive knowledge from data and interprets data for itself. As more data are presented to the machine learning application, the computer learns from the data and corrects outputs. Machine learning can be supervised, unsupervised, semi supervised, or reinforcement learning depending on the kind of data being input into the program and the type of outputs that can be expected.

Another term encountered in AI is *deep learning*—a subset of machine learning. This computer science approach involves networked algorithms called *neural networks* because the inspiration for their

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creation was how neurons are networked in our brain. In deep learning, a set of mathematical instructions such as an algorithm, which is called a *node*, works like a neuron to fire the algorithm, process it as instructed, and pass its information to another node in the computer. That algorithm is then used as input by another node in the neural network. Data move through the nodes in a direction specified by the algorithm. A deep learning model can contain billions of nodes embedded in many layers. For context, Ng's model for computers learning to identify cats contained over 1 billion connections.

4.7 Continuous professional development on AI and emerging technologies

Ensuring nurses remain well-informed about the swift advancements in AI is vital for lifelong learning. Nurses can actively participate in ongoing professional development programs and partake in workshops, webinars, or conferences focused on AI in healthcare (Randhawa & Jackson, 2020). The flexibility of self-paced learning is readily accessible through online platforms and resources, including AI-oriented courses and educational websites. Collaborating with AI experts and interdisciplinary teams can provide invaluable insights (Abuzaid et al., 2022). Facilitating knowledge sharing and keeping abreast of developments via professional networks and journals is key to ensuring that nurses are continuously informed and equipped to leverage the latest AI innovations in their practice. To equip nurses with AI skills, dedicated training programs and resources are essential . These can encompass structured courses or workshops covering AI fundamentals, applications in nursing practice, and hands-on training with AI tools. Online modules, e-learning platforms or mobile apps offer accessible, self-directed learning opportunities. Collaborative efforts with universities, industry partners and professional associations can facilitate the creation of comprehensive training programs (Ahuja et al., . Furthermore, mentorship programs and shadowing experiences with AI experts can enhance practical knowledge and skill development for nurses looking to integrate AI into their practice .

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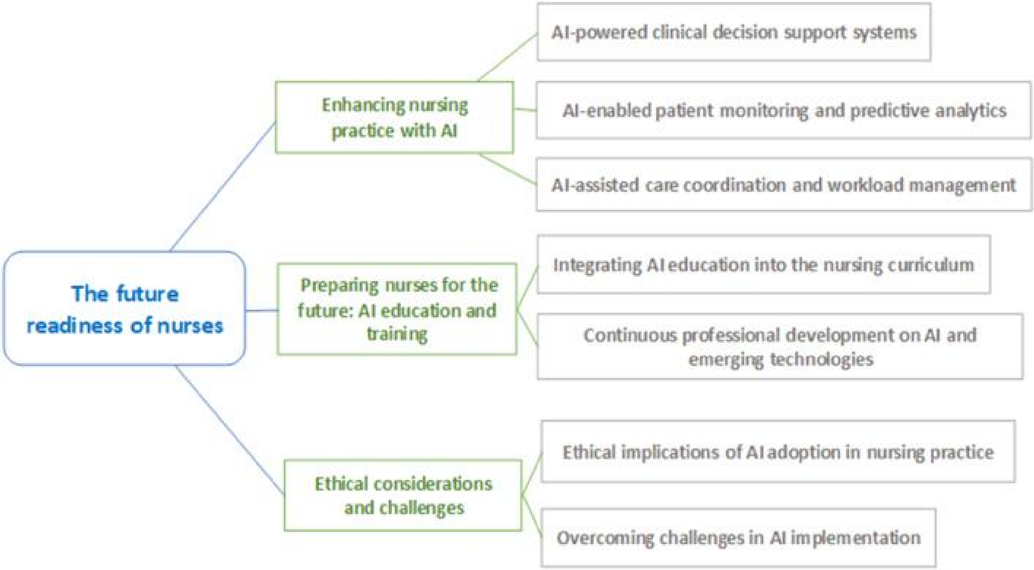

Figure 4: The future readiness of nurses

The primacy of nurse–patient relationship as a defining priority of nursing can contribute greatly to AI applications in robotics and elsewhere. Nurses can provide insight into the value of empathy and human touch, the role these concepts play in therapeutic relationships (Dobson et al., 2002; Kerr et al., 2019), and the dynamics between AI technologies and human relationships that need to be considered throughout the AI development lifecycle.

4.8 AI for Good in Nursing Gap:

There is a limited recognition of the relationship between AI technologies and the nursing profession as related to the contribution towards global (and oftentimes national) health and humanitarian efforts. There are numerous movements focused on the use of 'AI for good' in the academic, non-profit and industry spheres (e.g. Google's AI for Social Good, Google AI, 2018; Microsoft's AI for Good, Microsoft, 2020; AI for Good Foundation, AI for Good Foundation, 2015), AI for Good Global Summit (International Telecommunications Union, 2020), advocating for the use of AI to benefit humanity and address difficult social, economic,

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environmental, health and humanitarian challenges around the globe. Despite the potentially significant impact of AI technologies on nursing work, there remain to be efforts from nursing relating to the notion of using AI4GN, or the use of AI technologies in nursing to achieve a greater good for the profession and for populations.

4.9 Strategies and opportunities in AI Nursing

Artificial intelligence (AI) has many potential benefits in healthcare, including improved diagnosis and treatment ,AI can help medical professionals and staff diagnose medical problems and create treatment plans. Reduced human error,AI can help reduce the risk of human error in surgical procedures. Drug discovery and development, AI can help researchers identify the best drug targets to test for various diseases. Patient services, AI can provide patient services 24/7, such as schedule reminders, tailored health tips, and suggested next steps. Streamlined administrative tasks,AI can help streamline administrative tasks, such as answering phones and analyzing population health trends. Data management ,AI can help healthcare organizations analyze large data sets and share them with different systems or departments. Dosage error reduction, AI can help reduce the risk of medication errors and improper dosage.

Efforts that recognize the contributions that fall in AI4GN can include leveraging the unique positionality of nurses in healthcare systems towards advocating for the inclusion of equity and social justice considerations in the development and implementation of AI technologies in health systems. Nurses are health professionals who spend the most time with patients and are often referred to as the most trusted profession. Nurses are well situated to identify potential biases in data collection (e.g. decontextualized data that does not consider the impact of systemic structures on individuals) which can lead to the embedding of these biases in the AI tools developed. As well, nurses are ideally situated to identify ethical concerns relating to the implementation and use of AI tools (e.g. highlighting the problematic nature of using facial recognition tools) and instances that can exacerbate existing inequities and cause

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potential harm among particular groups and populations. For example, a recent study highlights the greater likelihood of digital data being collected and shared from children's use of apps when those children come from lower-education backgrounds. In the context of the healthcare system, this translates to an important facet of nursing education that needs to be developed and embedded as a routine component of a holistic nursing assessment and intervention. Namely, this comprises educating patients and families about digital literacy, digital privacy, laws and regulations on data collection and protection of digital health data and how these all relate to the AI tools

4.9.1 Application Scenarios for Artificial Intelligence in Nursing Care

Artificial intelligence (AI) holds the promise of supporting nurses' clinical decision-making in complex care situations or conducting tasks that are remote from direct patient interaction, such as documentation processes. There has been an increase in the research and development of AI applications for nursing care, but there is a persistent lack of an extensive overview covering the evidence base for promising application scenarios. This study synthesizes literature on application scenarios for AI in nursing care settings as well as highlights adjacent aspects in the ethical, legal, and social discourse surrounding the application of AI in nursing care. Following a rapid review design, PubMed, CINAHL, Association for Computing Machinery Digital Library, Institute of Electrical and Electronics Engineers Xplore, Digital Bibliography & Library Project, and Association for Information Systems Library, as well as the libraries of leading AI conferences, were searched in June 2020. Publications of original quantitative and qualitative research, systematic reviews, discussion papers, and essays on the ethical, legal, and social implications published in English were included. Eligible studies were analyzed on the basis of predetermined selection criteria. The titles and abstracts of 7016 publications and 704 full texts were screened, and 292 publications were included. Hospitals were the most prominent study setting, followed by independent living at home; fewer application scenarios were identified for nursing homes or home care. Most studies used machine learning algorithms, whereas expert or hybrid systems were entailed in less than every 10th publication. The application context of focusing on image and signal processing with tracking, monitoring, or the classification of activity and health followed by care coordination and communication, as well as fall detection, was the main purpose of AI applications. Few studies have reported the effects of AI applications on clinical or organizational outcomes, lacking particularly in data gathered outside laboratory conditions. In addition to technological requirements, the reporting and inclusion of certain requirements capture more overarching topics, such as data privacy, safety, and technology acceptance. Ethical, legal, and social implications reflect the discourse on technology use in health care but have mostly not been discussed in meaningful and potentially encompassing detail.

The results highlight the potential for the application of AI systems in different nursing care settings. Considering the lack of findings on the effectiveness and application of AI systems in real-world scenarios, future research should reflect on a more nursing care–specific perspective toward objectives, outcomes, and benefits. We identify that, crucially, an advancement in technological-societal discourse that surrounds the ethical and legal implications of AI applications in nursing care is a necessary next step. Further, we outline the need for greater participation among all of the stakeholders involved.

4.10 Robotics Role in Nursing

Technological advancements have led to the use of robots as prospective partners to complement understaffing and deliver effective care to patients. This article discusses relevant concepts on robots from the perspective of nursing theories and robotics in nursing and examines the distinctions between human beings and healthcare robots as partners and robot development examples and challenges. Robotics in nursing is an interdisciplinary discipline that studies methodologies, technologies, and ethics for developing robots that support and collaborate with physicians, nurses, and other healthcare workers in practice. Robotics in nursing is geared toward learning the knowledge of robots for better nursing care,

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and for this purpose, it is also to propose the necessary robots and develop them in collaboration with engineers. Two points were highlighted regarding the use of robots in health care practice: issues of replacing humans because of human resource understaffing and concerns about robot capabilities to engage in nursing practice grounded in caring science. This article stresses that technology and artificial intelligence are useful and practical for patients. However, further research is required that considers what robotics in nursing means and the use of robotics in nursing.

To explore the concept of futurism and the emergence of robotics in relation to the fundamentals of care, highlighting how nurses need a more anticipatory and contemporary position towards technology to maintain relevance in the future. The future of nursing in Western countries will soon be linked with the emergence of robotics for efficient and cost-effective provision of fundamental care. Their emergence and roles with care of the body and more broadly assisting people with their daily living activities has enormous implications for the profession and health care. Despite this importance, how nursing understands and will respond to technological trends and developments is insufficiently reflected in the professions discourse.

Literature from nursing fundamentals of care/fundamental care, information science, technology, humanities and philosophy informed the arguments in this article. This article examines the intersection of futurism and the fundamentals of care, and how adopting an anticipatory and posthuman perspective towards technological-care integration is necessary amidst a robot revolution in the techno-era. Nurses are currently challenged to understand, prioritise and deliver fundamental care. Health systems are challenged by a lack of care predicated by shortfalls in skilled staff and deficiencies in staff mobilisation. Both challenges can be compounded or alleviated by further integration of technology, but to maximise benefit requires forethought and understanding. This article can help open needed dialogue around planning for the future and is a call to action for the nursing profession to conceptualise its position on exponential technological growth and fundamental care provision.

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4.10.1 Meet Nurse Robots and Healthcare AI Tools

In Japan, human-like robots have been utilized for years as supplemental healthcare workers in elderly homes across the country. More recently, hospitals and healthcare facilities have started to introduce nurse robots and other healthcare AI tools. Larger robotic machines can be used to carry out laborious physical tasks like moving patients, and smaller interactive robots are being used to combat loneliness and inactivity in the elderly population. Austin, Texas-based Diligent Healthcare was established in 2017 and has been working on Moxi ever since. Moxi is an advanced robot designed to assist healthcare teams . The robotic assistant is outfitted with modern sensors, cameras, and artificial intelligence algorithms that allow it to autonomously roam healthcare facilities, engage with people, and complete non-patient-facing tasks such as delivering lab specimens and supplies or collecting soiled linens. Moxi also greets patients in hallways and poses for selfies. The robot's social intelligence enables it to learn and adapt to its surroundings . Japanese robotics engineers at Riken and Sumitomo Riko Labs have created a robotic bear capable of helping care for elderly patients. This bear can lift a patient from a standing position or from the floor, transfer a patient to a wheelchair, carry a patient from point A to B, and turn patients in bed. An increasing elderly population paired with an insufficient amount of healthcare workers able to care for it makes revolutionary inventions like nurse robots incredibly helpful. Without sufficient staffing for elderly care, more Japanese citizens are forced to leave their jobs to take care of aging family members. And those who do work in nursing and healthcare, suffer from high stress and fatigue. So Japan is looking towards robotics for help.

In Johansson-Pajala et al. (2020),we found a definition of care robots that matches our understanding, the authors say: "we refer to care robots as machines that operate partly or fully autonomously with the aim of supporting potential users, older adults and relatives, as well as professional caregivers, in providing physical, cognitive, or emotional support." Krick et al. (2019) showed that the use of robots in care can be acceptable. However, even though there is a desire to increase the use of these new technologies and the presence of robots, it is important to

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ensure that the human is still at the center of the collaboration. Human–robot interaction (HRI) is about people, and the use of robotics in care does not aim at replacing the nursing staff, but at supporting and helping them. In order to have a successful HRI, it is necessary to fulfill certain requirements. First, the interaction has to be physically close and safe, so it is necessary to consider the physical contact between the robot and the user when designing a solution, in order to mitigate possible injures. Secondly, there is a dependable physical interaction in a shared workspace, and for this reason, the human's intention and preferences have to be taken into account, so there is an interaction behavior and a realization of human-friendly motions (Gliesche et al., 2020). In addition to these aspects of the use of robots in care, thbetween (professional or informal) caregivers, the person in need of care, and a supportive robotic system. Depending on the functional (sensory, cognitive, motor) limitations of the patient and the activities to be supported, the strength of the interaction between both the patient and their caregivers varies. Figures 1–3 show three different scenarios where this triangular relationship is presented, at the same time, Figure 4 schematizes it. Kachouie et al. (2014) described how robots can benefit both the caregivers and patients. For the caregivers, the robots can help relieve them from tasks that are very time consuming and thus allow them to perform other tasks that are more useful and rewarding. For patients, the benefits are very extensive. Most of all, there is an increase of positive emotions, improving good feelings, general mood, and decreasing the stress and depression levels. They also promote engagement, increasing the commitment to physical activities and in also helping patients to externalize internal emotions. At the same time, there is an improvement in relationships, as they help with increasing social interactions and communication with other persons. An important building block fort his analysisis an overview of robotics projects in care, and a categorization of these according to a technical and a use case classification. Priority has been given to a broad coverage of projects worldwide. This provides an overview of the fields in care robotics where current investment in research and product development is concentrated and therefore could be considered as more relevant and to have bigger target groups. At the

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same time, this approach identifies fields that have not been addressed intensively yet and might provide potential for further study. A secondary aim of this review is also to provide these results in a way that can help caregivers and patients to identify which robotic technologies can be used for their specific use cases. Due to the advances in the field of robotics and its possible use in nursing care, the aim of this review is to determine the directions in which the investigations in care robotics are going worldwide and to identify promising research and commercialization gaps. This article provides an overview of robots for care and projects that are prototyping them. It does not include projects that are developing or investigating applications of robots in care. After the identification of 133 projects worldwide, we performed an analysis of them, present in the following contributions:

- A novel four-category classification, deduced from the consideration of the triangle robot, patient, and nurse in the technical classification from Haddadin and Croft (2016).
- An engineering-driven and actionable use case classification, defined by the authors, the first to our knowledge with this degree of specification in nursing care.
- A technical classification, directly obtained from Haddadin and Croft (2016).
- An analysis unifying the classification schemes above in a multidimensional view.

4.11 Results

We identified a total of 133 relevant projects worldwide, including research and commercial products. We extracted 25 of these projects from internal documentation: 10 of them are the robotic projects that we supervise inside the Be Be Robot project (project within which this article is developed), and we got 15 from an internal project's document. In both cases we only got the names of the projects from these lists and, we searched later for the documentation and information attached to them and shown in this article. As we explained, we focused our search on projects and products and not on systematic literature search, i.e., once we identified a project or product, we searched for further information that

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allowed us to classify and analyze them. project is at least published and described on a website, while for most of them, there are also popular and scientific articles that provide information about the project. The number of articles per project varies, but we selected a total of 161 articles. Supplementary Table S1 presents all the projects, along with the associated country and the specific references.

Figure 6 shows the number of projects found for each country. There is certainly a bias in the distribution of projects over countries because we could include German sources (in addition to English), which increases the number of German projects found, but we were unable to use similar sources in other languages.

The number of projects found in each country matched well with the distribution of articles across the countries included by Krick et al. (2019) in their scoping review on robotics in care . Only the number of projects found in Germany is significantly higher, since there were better search options (including the project database of the German Federal Ministry of Education and Research).

Among the international projects, it is possible to see that the two countries with a higher number of projects are the United Kingdom and Japan, both of which are large economic powers with significant capacity and need to invest in research and development of such new technologies and remain the largest markets for robotics after China (Bieller, 2019).

Robotic technologies are available on the market or in research. A first scheme is extended from Haddadin and Croft (2016) (Figure 7) applied to the identified projects. Both parameters defined by them, proximity and autonomy, were assigned and used for classification. For proximity, we considered how close the interaction with the patient or caregiver is as two different dimensions. For autonomy, we considered to which degree the robot could act independently, or conversely, to which degree it was (remote) controlled. Low autonomy means that the robot needs to be controlled directly or receives significant input/ supervision from the user. Medium denotes that at some point the robot requires some action from the user in order to proceed, or it requires that the user checks regularly if everything is working properly. High autonomy

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means that the robot does not have to be controlled by a user to operate at all. Autonomy and decision-making are a very important aspect of assistive robots. According to ISO 8373 (ISO, 2021), a robot always has a certain degree of autonomy to perform its movements and tasks. However, the autonomy of some robots can go far beyond this. Kostavelis et al. (2017) showed a possible decision-making model in realistic situations, like those where service robots are designed to be used. Service robots can learn when to perform which task and when they need to take care of themselves (e.g., loading). This can lead to conflicts, especially in the medical and care sector. For example, unexpected situations can lead to a service robot actually having to charge its batteries at a time when it should be preparing critical medication. In this case, the robot must decide whether to perform the task that is important for the patient and then remain inactive or whether to charge first and deliver the medication to the patient too late, which may be time-critical, but still allow the robot to continue working. Alternatively, it would also be possible for the robot to outsource this decision to a human (nurse or patient). The German Ethics Council advocates "shared decision-making" here (Deutscher Ethikrat, 2020).

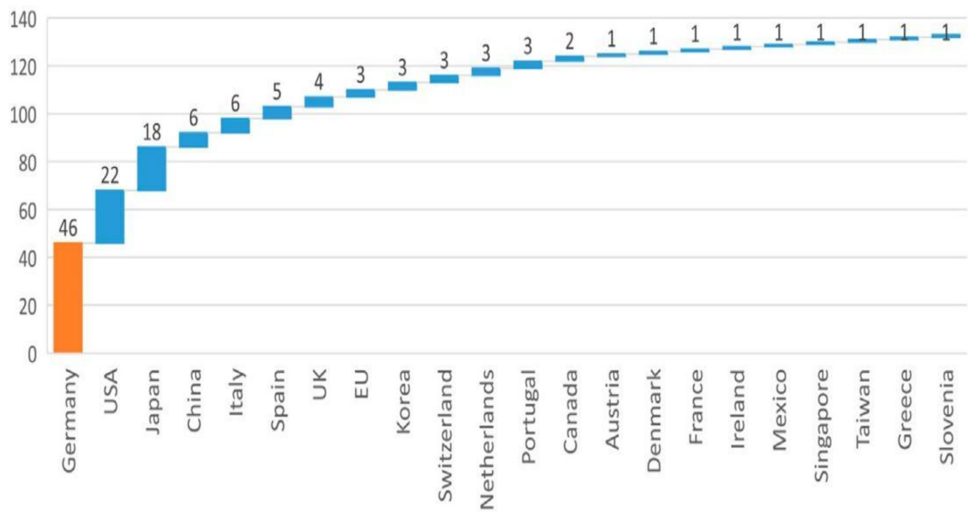

Figure .5 Number of projects found to be country

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In this way, the greatest good can be achieved for everyone involved. The adaptation of the service robots' tasks and the degree of privacy can also be optimally adapted to the patient in this way. In the following, the categories are described (see the Supplementary Material for details) by highlighting up to three examples of projects for each category. An exhaustive list of projects and their assigned categories are available in the Supplementary Material. In the category Supportive (where robots assist in the performance of the task, providing tools or information), we find robots like TUG (Mutlu and Forlizzi, 2008; Niechwiadowicz and Khan, 2008; Zhang et al., 2008; AETHON, 2020), a robot to perform logistics activities in hospitals; BUDDY (Buddy Robotics, 2020), which has multiple functionalities at home (entertainment, monitoring old people, and reminding tasks and events); and AuRoRoll (German Federal Ministry of Education and Research, 2017; Wimmer et al., 2017) (when in automatic mode) a wheelchair capable of navigating autonomously. The parameters "Proximity" and "Autonomy" for these robots are identified as follows

- TUG: As it is a product designed to help nurses, patients have no contact with it, so we do not analyze the proximity aspect from their point of view. From the caregiver's perspective, it is possible to define it as "out of reach", even though there are moments when it comes closer (when delivering products), but most of the time, it moves autonomously, at a distance from the medical personnel.
- BUDDY: In this case, the situation is the other way around.

Caregivers have barely any contact with the robot, at the most, only when checking on the elderly via the telepresence system, so we can define the proximity as "out of reach". This is also the case from the user perspective, although in situations like playing it can also be considered "at arm length", because of the closer interaction.

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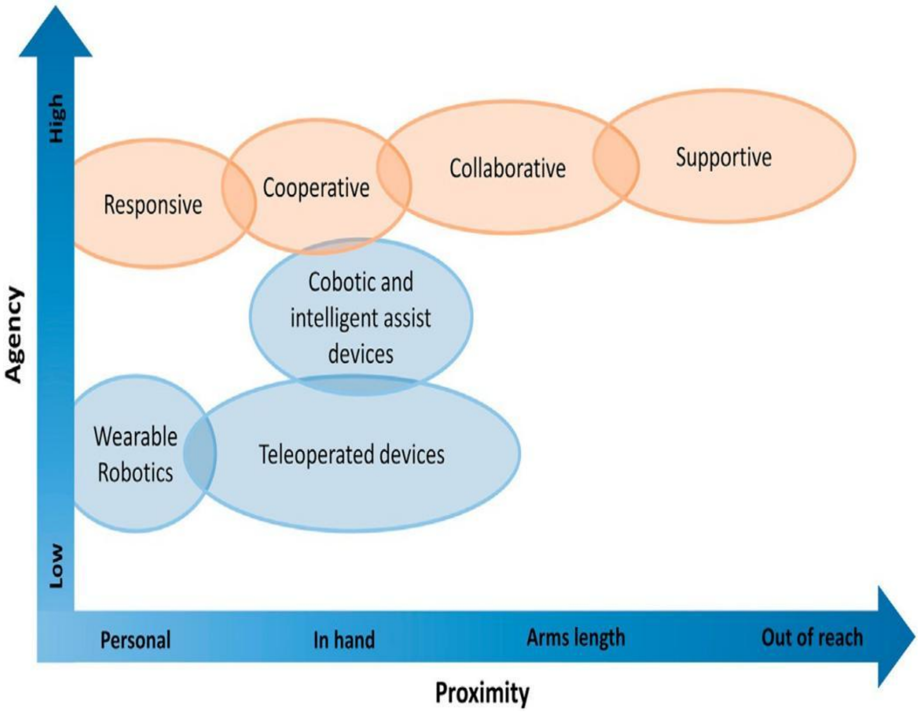

Figure 6: Classification scheme for HRI, by proximity of interaction and autonomy of the robot.

Baxter-based dressing assistant ,in the case of this robot, the nurse is out of the loop, so we do not analyze the proximity with them. From the patient's point of view, the proximity can be classified as "in hand" or "arms length" because the robot has to be close enough to help them get dressed. Pillo, when considering the proximity with the patient, ican be defined as "in hand" because the user has to collect the medicines dispensed by it and read the notifications on its screen. As caregivers can remotely control the robot to receive notifications or manage some actions via the app, the proximity is considered "out of reach". AuRoRoll , again in this case, the caregiver has no role in the interaction, and from the patient's point of view, it can be considered as "personal" because the user sits on the chair and as "in hand" because the user uses the joystick to direct the chair.

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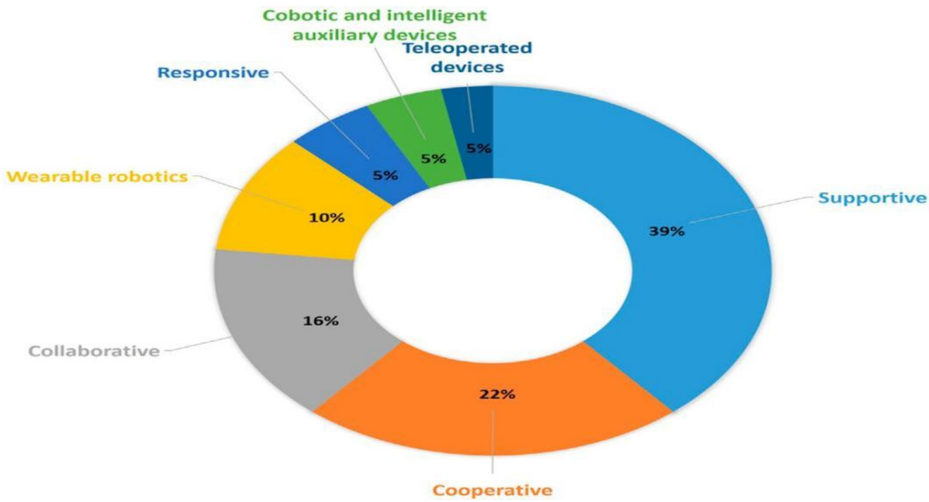

Figure 7: Percentage of project per each category of technical classification

Technical vs. Use Case

In the previous sections, we have analyzed both the technical characteristics and use case scenarios. However, the relationship between these two classifications is also of interest. Table 1 shows how many projects from each technical category support which use case category. The empty cells indicate that there are no projects categorized in that intersection.Before analyzing the relationship between these two categories, it is important to clarify that a project could have more than one use case scenario, as the robot capabilities could be used to perform different tasks that are not always covered by only one of them. However, the majority of systems have only one technical category, as the technical characteristics of the robot generally do not change. Although, in some cases, where the robot's degree of autonomy can change, it is possible to find more than one technical category. For this reason, it is possible to find in the analysis examples of robots that can be assigned to more than one class of the use case classification. This explains why the sum of all cells in Table 1, 263, is significantly higher than the number of projects reported in Section 3, 133.

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The highest concentration of projects is found in the last three columns, that is, spread across the *Cooperative*, *Collaborative*, and *Supportive* categories of the technical classification. This means that in each of these categories, it is possible to find a robot for the majority of use cases. A plausible explanation of the high presence of projects in these categories is the fact that the settings where they are developed are directly related with the activities of daily living (ADL), scenarios where service robots have been already introduced in order to help with these activities. The advancement of the technology allows their evolution to more care-related scenarios.

We can conclude that for the use cases of logistics, companion robots, and mobility support, there is a greater offer of projects or products within the *supportive* category. For the first two use cases, we can assume it is because they present situations where the robot and the human do not have to share a task. In fact, the robot performs a task for the user, e.g., bringing objects from another place (logistics), reducing the feeling of loneliness by playing entertaining multimedia for the user, reminding them to

Conclusion

AI technologies will change the profession of nursing. AI technologies can serve as important tools to support the contribution of nurses towards higher level aims of evolving the nursing profession and improving population and global health. If nursing takes a proactive role in addressing these above-mentioned priorities, AI has the potential to enhance and extend nursing capabilities. In return, nursing has much to contribute to the development of AI systems that leverage nurses' strengths and expertise in relational practice and patient advocacy, towards the development of AI that considers patients with a more holistic view. It is important to note that all priority areas discussed in this paper are necessarily linked. They do not each sit on their own but inform a broad purposeful approach to empowering nurses in their active involvement in all aspects of AI in health care. We argue that nurses have a responsibility to know about the AI technology they use, as has been stated from an industry perspective (McGrow, 2019). Moreover, there is a

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great opportunity for AI tools to support nurses' problem-solving abilities and identify solutions for optimizing care provision (Cato et al., 2020). There is nevertheless a need for support from health systems stakeholders and high-level decision-makers to facilitate the ability of the nursing profession to address these identified priorities. The priorities presented in the paper are summarized in Table 1, alongside a list of specific recommendations based on the strategies and opportunities outlined in this paper.

The following represent a summary of the discussion points identified in the NAIL Collaborative think-tank discussions, framed as pressing priorities for the nursing profession. Each priority point is introduced with the identification of a current gap in understanding or use of AI in relation to nursing practice. For each identified gap, we propose strategies and opportunities––with implications for nursing practice, education, research and leadership—that can be pursued to ensure the appropriate and safe use of AI in nursing and enable the nursing profession to use AI tools to optimize health outcomes. Unlike humanoid robots, TUG is a robotic cart designed to transport materials around a facility safely. It is capable of transporting medication, lab samples, and surgical supplies. It can also be used to facilitate EVS services by moving waste. Aethon holds a Veteran's Affairs contract, and TUG is currently used in over nationwide. As robotics become more prevalent in healthcare, nurses and other healthcare personnel can embrace new technology without fear of being replaced. Pepper is another notable robot found in healthcare facilities worldwide. Created by SoftBank Robotics of Japan, this robot assists with activities such as guiding patients, giving directions, answering basic questions, and providing emotional support. Its expressive and warm manners are designed to welcome and engage patients. This humanoid robot made headlines during the pandemic as hospitals leveraged technology to protect healthcare workers. Hospitals in Japan used Pepper to greet visitors and provide valuable information at facility entrances. French doctors used Pepper to enable COVID-19 patients to video chat with family and friends. In Sweden, the robots provided a fun distraction for

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pediatric cancer patients. And in Germany, Pepper provided socialization for Alzheimer's patients . Technology and AI are useful and practical for patients. Robotics in nursing is an interdisciplinary discipline that studies methodologies, technologies, and ethics for developing robots that support and collaborate with physicians, nurses, and other healthcare workers in practice. Robotics in nursing is geared toward learning the knowledge of robots for better nursing care, and for this purpose, it is also to propose the necessary robots and develop them in collaboration with engineers. However, further research is required that considers what robotics in nursing means and the use of robotics in nursing. There is still a lack of study on whether they are capable of replacing humans due to human nurses' ability to manifest caring relates to their humanness or their unpredictable nature. One of the most important, in our opinion, would be to work on the Nursing Situation and Response Databases. The empathic capacities that robotics and AI can demonstrate for humans can exist through programmed activities. The knowledge generated will bring information to engage in relationships between empathy and AI and contribute to understanding its usefulness and impacting nursing/caring theories.

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