Discussion

Can nurses remain relevant in a technologically advanced future?

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ABSTRACT

Technological breakthroughs occur at an ever-increasing rate thereby revolutionizing human health and wellness care. Technological advancements have drastically changed the structure and organization of the healthcare industry. McKinsey Global Institute estimates that 800 million workers worldwide could be replaced by robots by the year 2030. There is already a robotic revolution happening in healthcare wherein robots have made tasks and procedures more efficient and safer. Locsin and Ito has addressed the threat to nursing practice with human nurses being replaced by humanoid robots. Routine nursing care dictated solely by prescribed procedures and accomplishment of nursing tasks would be best performed by machines. With the future practice of nursing in a technologically advanced future transcending the implementation of nursing actions to achieve predictable outcomes, how can human nurses remain relevant as practitioners of nursing? Nurses should be involved in deciding which aspects of their practice can be delegated to technology. Nurses should oversee the introduction of automated technology and artificial intelligence ensuring their practice to be more about the universal aspects of human care continuing under a novel system. Nursing education and nursing research will change to encompass a differentiated demand for professional nursing practice with, and not for, robots in healthcare.

1. Introduction

With technological breakthroughs occurring at an ever increasing rate, and more and more tasks of nurses are being delegated to machines and artificial intelligence (AI), the main question of this discussion paper is, "how can nurses remain relevant in a technologically advanced future?"

2. Technology in nursing

What is affecting every aspect of modern society today is technology. From low fidelity machineries to high fidelity technologies with artificial super intelligence (ASI) [1], technological advancements have changed the practice of nursing. Technological breakthroughs occur at an ever-increasing rate thereby revolutionizing human health and wellness care. Technological advancements have drastically changed the structure and organization of the nursing industry: From the adoption of electronic health records, to advances in biomedical and engineering technologies that enable the development of ever more sophisticated technologies in health care, robotics technology, and artificial intelligence, these modal changes in modern healthcare and its methods of delivery have transformed the nursing industry.

Advances in technology have been made available to aid nurses perform their jobs and care for patients more efficiently and safely. Nursing today is not the same as it was 30 years ago. From technological advancements such as robotic-assisted surgery which may one day replace surgeons and nurses in the operating rooms [2], humanoid nurse robots which have the possibility of replacing human nurses in hospital wards [3], companion robots that are designed to provide useful and socially acceptable assistance to people who need special attention like the elderly, children who have autism, or the disabled [4], automated dispensing robots which would take away the responsibilities of nurses in medication administration [5] coupled with major progresses seen in the development of ever more sophisticated artificial intelligence that would enable machines to make critical decisions in health care

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and the coordination of patient care [6–11], nurses are facing challenges in the integration of these new technologies particularly in their practice. However, what if these technological advancements are making human nurses and their practice irrelevant in healthcare? What can human nurses do to remain relevant in healthcare, in a technologically different and advanced future?

3. Contemporary and future nursing practice

The practice of nursing today is often consigned to following a routine process that is commonly referred to as "The Nursing Process" that involves assessment, diagnosis, planning and outcomes, implementation, and evaluation. This process guides nurses in performing nursing care. Towards predictable outcomes from planned and implemented nursing interventions or actions, the nursing process is envisioned to deliver nursing care predictably from a cause and effect process [12]. However, as Locsin and Ito [13] expressed, nursing that is guided by this routine is dictated solely by prescribed procedures and by the accomplishment of nursing tasks.

The future practice of nursing in a technologically advanced future would transcend the implementation of nursing interventions or actions to achieve a predictable outcome. Routine nursing care dictated solely by prescribed procedures and the accomplishment of nursing tasks would be best performed by machines. This would result in the essential question "what would the tasks of human nurses be in the future when these predictable tasks are so ably performed by programmed robots with ASI?"

4. Future nursing practice with artificially intelligent machines

The ultimate question remains, can nurses remain relevant in a technologically advanced future? Healthcare professionals should learn more about emerging technologies in healthcare: what these technological advancements are capable of, how to work with these technologies, particularly those intelligent machines, and search ways that can move these technologies to complement the tasks which they perform daily. Otherwise, the human healthcare professional might get replaced [13] or grow frustrated if they experience that artificial intelligent machines are able to do their jobs more effectively and efficiently. What can human persons do to attain, maintain, and sustain human health and well-being with robots as partners?

A report by McKinsey Global Institute [14] estimates that 800 million workers worldwide could be replaced by robots by the year 2030. There is already a robotic revolution happening in nursing and these robots have made tasks and procedures more efficient and safer (see Tables 1 and 2).

Technological advancements have been happening in nursing during the recent years but none of them can compare to the impact that artificial intelligence has made in the industry. Artificial Intelligence in nursing could be capable of improved organization of patient routes or treatment plans and would also provide all relevant information needed for physicians and nurses to make correct decisions [27]. Artificial Intelligence is already operating in several areas in nursing, from the crafting of plans for treatment to the facilitation of repetitive jobs and in managing medications or the creation of drugs. And this is only the beginning which is why many nurses fear that the growing adoption of artificial intelligence may force them out of their jobs.

Artificial intelligence in healthcare is only made possible because of the increasing availability of healthcare data and rapid development of analytic methods in big data. Powerful artificial intelligence techniques can determine clinically significant information underneath a massive amount of data and this can aid in

Table 1
Examples of Robots Used in Nursing and Health care [15–26].

Name of Robot and Robotic Technology	Capabilities
Da Vinci Surgical Robot	Improves precision and accuracy of surgeons
	Decreases responsibilities of nurses in the operating room
Companion Robots such as Jibo, Pepper, Paro, and Buddy	Helps people with special needs such as the elderly, autistic children, or the disabled. Provides comfort and emotional support
"Robear" and "RIBA"	Lifts and transports patients as well as those who need assistance in standing up
Georgia Tech's "Cody"	Gives bed baths to patients
"Veebot"	Has an 83% accuracy in selecting the best vein
Robotic Prescription Dispensing Systems	Made the dispensing of pharmaceuticals more accurate and safer decreases the responsibilities of nurses in medication administration.
TUG robots	Perform transportation and delivery tasks in the hospital
Lynx Autonomous Intelligent Vehicles	Capable of moving goods in a large facility and can self-navigate in dynamic environments
Swisslog RoboCourier	Used for transport of specimens, medications, and supplies in hospitals, clinical laboratories and pharmacies

Table 2
Some of the most sophisticated artificial intelligence machines today [6–11].

Name of Artificial Intelligence system	Capabilities
Google DeepMind Health	Identifies all tasks that need to be performed in order to prevent individuals who have been admitted to a hospital from deteriorating, allocates patients to the necessary staff, and tracks what has and has not been done, and notify staff about necessary tasks
IBM's WatsonPaths	Applies data analysis to patient records and translate it into useful advice to medical staff. Offers evidence of how it came to its conclusion which can help healthcare providers consider new angles on how to treat their patients.
CareSkore	Combines clinical, socio-economic, demographic, and behavioral data to create a holistic picture of patients that doctors and nurses can use to provide better preventative care
Zephyr Health Inc.	Integrates thousands of data sources to create precise and predictive insights
Sentrian	Uses machine learning to eliminate all preventable hospitalization by leveraging the revolution in biosensors and clinician-directed machine learning to remotely detect patient deterioration earlier and with higher accuracy
CloudMedx	Uses healthcare specific nlp and machine learning for the generation of real-time clinical insights from all care points that is used to improve patient outcomes
Enlitic	Uses medical deep learning that leverages proprietary algorithms to quickly and accurately improve healthcare diagnosis

clinical decision making for nurses [28–30]. Artificial Intelligence utilizes sophisticated algorithms to uncover clinically relevant information from a large volume of healthcare data, and utilize the gained insights to aid in the clinical practice of nurses. It is also capable of learning and equipped with self-correcting abilities to improve accuracy based on feedback. Artificial intelligence systems can also reduce therapeutic and diagnostic errors that are inevitable in human clinical practice [28,31–33].

These tasks are currently being performed by nurses but with artificial intelligence, these tasks can be delegated to machines.

It is highly likely that robotic technology coupled with artificial intelligence will be implemented in clinical settings [34]. The nursing profession may be at risk if there's a robot that can mimic human movements, is ideal for human tasks, and is programmed with artificial intelligence that is capable of making clinical decisions. Human-like robots are already working in hospitals as supplemental healthcare workers. The Da Vinci Surgical Robot is already in use in more than 3600 hospitals around the world [35]. Robear is currently being utilized in Japan [36]. More and more hospitals are adopting robotic prescription dispensing systems [37] and TUG robots are now being used in several hospitals [38].

And the robotics industry is still growing. $91.5 billion was spent worldwide on robotics and related services during 2017 and would more likely double by 2020 at a staggering $188 billion according to International Data Corporation (2017) [39]. With companies such as iRobot, Google, Accuray, Epson Robots, Autonomous Solutions, GreyOrange, Honda Robotics, IBM, Intel, Boston Dynamics, Uber, and Nvidia driving innovation in robotic technology [40], technological advances in robotics will be made at an accelerating pace.

5. Quo vadis? (Where are we going?)

It is very difficult to determine the trajectory of the development of artificial intelligence because there are many possibilities. Serious technological and computational progress has occurred in the last few decades and this has led many experts to acknowledge a seemingly inevitable conclusion: that artificial intelligence could progress from machine intelligence to an unbounded intelligence unlike anything we could ever understand. The development of Human Level Machine Intelligence roughly defined as intelligence that outperforms humans in all intellectual tasks has been considered by experts. It is a crucial tipping point for society because once you have a machine that outperforms humans in intellectual tasks, humans can be rendered irrelevant [41].

Automation would put most of the jobs at risk. Automation includes robots that have some resemblance to humans, robotic devices, and algorithms. Silicon Valley Investor Vinod Khosla stated that 80% of healthcare professionals will be replaced by machines due to machines being driven by big data and more improved computational power but also due to being relatively cheaper but more precise and more objective than the average human [42]. McKinsey Global Institute cautions that as many as 375 million workers may lose their jobs due to automation [14].

Nursing shortage is a problem throughout the world [43]. Research has also shown that an elevated patient-to-nurse ratio would result to an escalation in patient mortality and an escalation in burnout experienced by nurses [6]. Reduction of the patient-to-nurse ratio would conclude in lower cases of missed patient care. The call for assisting robots that assist nurses in the completion of their daily tasks would likely complete their daily tasks will likely escalate in the coming years. And perhaps these assisting robots would overtake human nurses and replace human nurses altogether [44].

Some robots have already shown ability that it can perform the functions of a nurse and sophisticated artificial intelligence has also show that it has some ability to think like a nurse. In a highly technological future, how can nurses remain relevant? If nurses do not exert effort in understanding technology and discovering a function in its evolution and execution, the profession of nurses and the patient's best interests would suffer [45]. Planning for one's own obsolescence to some extent should be done by nurses because nursing work and activities that are very predictable and are not overly complex will be automated.

6. Summary

It is of priority that there should be involvement of nurses in deciding which aspects of their role can be delegated to technology and which roles cannot. Nurses should oversee the introduction of automated technology and artificial intelligence so that nurses can ensure that their roles in providing a more holistic aspect of care continue under the novel systems [46]. There is a need to give roles in technology to nurses to ensure that healthcare would fit the needs of the patients.

Nurses should be more involved in technological development [45]. In a technologically advanced world, nurses would become delegators. Nurses would oversee care given to patients and the coordination with other healthcare workers and technologies to ensure the appropriate delivery of patient care [46]. With technology taking care of routine tasks, more time can be devoted to patient interaction. More time can be spent in getting to know more about the patient's condition, preferences, establishing an emotional connection with patients and responding appropriately to their needs [47]. The "caring" aspect of nursing will be made real.

In getting more nurses involved in technological development, there is a need in reframing nursing education that incorporates technology and machine learning in its curriculum. The challenges and opportunities of leveraging technology as a tool in health care should be addressed in nursing education. Teaching with the use and in relation to emerging technology will be the future of nursing education because nursing care provided in a highly technological work environment is the trajectory of the practice of nursing [48].

Aside from changes in nursing education, more focus on research on emerging technologies in nursing is recommended. The growing number of new technologies that are becoming available to nursing can improve the quality of care, enhance working conditions, and reduce costs. More research is needed to determine the effect of this new technology in the nursing field and how to hasten its adoption in nursing practice [49].

7. Recommendations: How nurses can be irreplaceable by technologies

A redefinition of the roles of nurses in healthcare would result in a technologically advanced world of nursing. Nurses should be more involved in technological development, ensuring that the technology is catered to the needs of patients, instead of patients made to fit the technology. As an overseer of care, the nurse can delegate routine tasks to machines like vital signs taking, medication administration, and performance of personalized nursing interventions like bedbaths while the nurses would attend to the finer parts of caring for the patient.

Nursing is the expression of caring [50]. Person-Centered Care in Nursing concentrates on a person's individual needs, wants, desires, and goals so that these would become central to nursing care. This means that a person's needs as defined shall be put first. These needs will be placed above those identified by healthcare professionals. Person-centered care indicates a strong interest in the experience of patients on health, illness, injury, freedom, need et al. [51]. Person-centered care focuses on the person being nursed

rather than focusing on fixing the person or the completion of a person's missing parts [52]. Person-centered care has been shown to improve satisfaction with care [53]. Technology in healthcare would serve as elements for caring [54]. Through the use of technology, the nurse can become more familiar with people under their care more fully and as active contributors in their care, rather than only as objects of care.

Nurses should learn how to adapt to advancing technology and how to supplement and enhance their skills, there are ways nurses can stay relevant in a technologically advanced future. It is important for nurses to constantly upgrade their practice processes in order to remain attractive for employers as machines begin to fulfil more tasks and responsibilities assigned to them.

One of the primary reasons why artificially intelligent machines seem to threaten the nursing profession is the possibility that it would outperform human thinking. However, these machines cannot truly outperform human thinking because performance includes the subjective, constantly changing, and particularly individual nature of most scenarios. Today, an area where artificial intelligence fails to compete is in the learning process wherein individuals are continually taking in new information and expanding their personal databases. This is because artificial intelligence cannot independently form new context and learn like human beings, rather they are inherently "human-dependent" [55]. Because of this, what would likely happen is the combination of optimal human power and artificial intelligence. Combining advanced analytics of artificial intelligence with the experience, knowledge, and critical thinking skills of nurses would result in making better clinical reasoning and clinical decision-making which improves patient care at lower costs [32].

Using predictive models that are capable of making real-time inferences from an enormous patient population to generate alerts or predict the length of stay of patients can be done by artificial intelligence. Artificial intelligence can also be used to automatically detect threats and problems related to patient safety [56] What nurses need to do is to focus on capabilities and skills that artificial intelligence has difficulty in replicating like critical thinking which is made of creative thinking, analysis, problem solving, interpretation, reasoning, and evaluation [57]. Critical thinking is an important factor in clinical reasoning and clinical decision-making which are important in rendering patient care [58].

Compassion and empathy are very difficult to model in machines [59]. Unlike machines, human nurses can react to the unpredictable aspects of humanness, particularly including the emotional contexts of the situations. Receiving medical care is a very emotional experience, and a machine may not be able to truly understand these aspects of others. Hojat [60] declares that human nurses can provide better care to patients because of their ability to understand the nuances of humanness and their emotions.

8. Conclusion

To be relevant in the future technological world, by growing as caring professionals, nurses can leave the more basic tasks to machines such as taking the vital signs, performing nursing procedures, and medication dispensing, while the human nurses attend to more complex issues. This would not only unload the nurses of their routine tasks to a machine, it would also give them enough freedom to plan with the aid of artificial intelligence in the care of patients as they participate in their care. Because machines are unable to understand the unpredictable aspects and contexts of nursing situations, human nurses will be able to provide better care to patients because of their ability to engage in participative encounters involving, among other things the unpredictable human

emotions and use of critical thinking skills in making clinical decisions. Person-centered care would be implemented at a participative level. Focus would be on the person being nursed rather than on fixing the person or the completion of a person's missing parts.

Getting more nurses involved in the development of technology would ensure that the human caring perspective is infused and affirmation of persons as whole and complete regardless of parts is facilitated. There is a need to reframe nursing education that incorporates technology and machine learning in the curriculum and increased focus in nursing research that investigates the effects of technology in the nursing profession and ways on adopting technology in nursing practice. Essentially, as machine technologies will not be able to replace nursing practice, there is no need for nurses to worry about the security of their employment. When challenged by the rise of technology, as long as nurses are willing to grow professionally and become even better versions of the remarkable healthcare providers that they are today, human nursing practice will prevail.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijnss.2018.09.013.

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