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Nurse-Engineer Opportunities and Education in The Post-Pandemic Nursing Care

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ABSTRACT
Nurses are one of the frontline professions in dealing with patients affected by Covid-19. Nurses are dealing directly with problems that occur in covid-19 health services. This challenge is an opportunity for the emergence of the competence development of the nursing profession by implementing technological competency. If a nurse has technological competence, they are expected to produce appropriate technological innovations. This paper discusses the opportunities of nurses to implement engineering competency in order to improve innovation opportunities in post-pandemic nursing care. Technological, economic, regulatory, and sociological forces that influence the transformation of the nursing profession into nurse-engineers will be explained below with a new collaborative nurse-engineer educational competencies are also proposed.

Keywords: Covid-19, New Profession, Nurse-Engineer, Post-Pandemic, Primary Force

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BACKGROUND

The development of health science, especially in the field of nursing, has experienced significant changes in degradation, along with the development of science in the field of technology. Nurses are required to be able to understand and implement changes in technological developments. One of the simplest examples is the examination of patient blood pressure using the concept of digitization, supported by documents and operations that require nurses to be able to apply it. The application of nursing professional values is the latest challenge in the current industrial revolution era. Nurses are able to provide health services by caring for patients, caring is the center of dynamic nursing practice. International competency standards required nurses to be able to capture developmental signals, especially after current covid-19, the use of medical devices in improving the quality of services to patients in a holistic and general manner.

Covid-19 requires accelerating innovation, especially technological development in the health sector. The acceleration of health technology development has made it possible to transform the role of the health profession after this pandemic end in anticipation if the same or worse events occur again. Nurses as the frontline in dealing with Covid-19 patients and health professionals who die the second most after doctors become a sign that nurses might be coming to a need to transform in competence so that they can contribute more to innovation and health technology (ICN, 2020). These transformations include the role of hospital management, health IT, and telehealth capabilities (Chiang-Hanisko, 2020).

One of the possible role transformations of nurses in post-pandemic nursing care is the nurse-engineer profession. Nurse-engineers combine the competencies of medical care in nursing with the advanced use of technology to enhance the innovation of solutions. This has also become a prospective solution to the unsuccessful problem of a truly integrated educational/professional program (Eisenhauer, 2015). Some studies have been conducted to identify collaborative competency in nursing and engineering disciplines such as (Oerther et al., 2020) who disclosed many opportunity evidence of nurse-engineer competencies that have been implemented in some educational programs. Moreover, nurse-engineers also will be involved in digital advancement technologies such as databases and artificial intelligence (Booth et al., 2021).

The objective of this study is to disclose the opportunities of nurses to implement engineering competency in order to improve innovation in post-pandemic nursing care. Some literature on primary forces affecting the nursing profession, strategic inflection point theory, and current educational programs that are close to nurse-engineer competencies are reviewed. In the end, the opportunities and resistances in developing nurse-engineer are discussed.

PRIMARY FORCES AFFECTING NURSING PROFESSION IN THE POST-PANDEMIC NURSING CARE USING PEST ANALYSIS (SAMMUT-BONNICI AND GALEA, 2015)

a. Political Forces

Politics or regulation plays a big role in affecting the future of nursing care technology. Regulatory may simplify a complicated administration. This may reduce cost by adopting Electronic Data Interchange (EDI) and improve the use of electronic medical records which is also supported by the improvement of data security (Khalid, 2020; Park et al., 2019). Data security must be improved because of keeping the data integrity, availability, and confidentiality.

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The regulation also takes a role in performing quality and safety reports to make the data used to be evaluated and improve the quality of future medical technology. All information about the equipment including the availability, the suitable models, the cost to purchase and to operate, the required facility and environment, the compatible user and the user training, the service requirement and frequency, and the expired date. To obtain this data, they need to conduct an assessment, conduct an environmental assessment, translate nurse requirements into technical specifications, research, evaluate functional and technical, give recommendations, purchase the equipment, conduct inspection, submit to the equipment control program, conduct installation, and train the user. All procedures need to be regulated in a simple and innovative way for the future of medical technology.

With this innovative regulation, industrial players may easily collaborate with researchers to produce the best and innovative medical technology. A nurse engineer also will be able to be involved in developing a new technology by conduct needs assessment, research, develop design and specification, build prototype, conduct testing and evaluation, construction, testing, and documentation of final assembly, submit for regulatory approvals, user training, conduct nurse trials, modification, documentation, and reporting, and submit to the equipment control program.

b. Economic Forces

In the global nursing care economic sector, there are various changes that cover many things which are competition in many insurance companies and insurance options for patients, demand in insurance customer satisfaction improvement, and approach in the contractual connection between various government levels, suppliers, and customers (Marć et al., 2019). This will guarantee that the nurses will require a new technology to be used for the patients.

Post pandemic is the biggest momentum to develop the nursing care economic sector. Therefore, between this current pandemic situation, many countries are capable of supplying their own medical device needs. This thing is certainly based on the faith in economic potential and industrial capability to fulfill the high demand. After the coronavirus pandemic, many countries believe that their economy will return to grow rapidly provided that they could prioritize the suitable sector, especially in the industrial nursing care sector. The growth of the economy will also move the raw material so medical technology gets their supply which is supported by many good researches.

c. Sociological Forces

Every society must be run into changes. Sociological changes in society affect their social systems, including value, character, behavior between community groups, therefore these changes then affect other community structures. For example, the appearance of the coronavirus pandemic makes this world restless. The number of positive victims in the world now reached 48,539,872 cases and caused 1,232,791 deaths in 215 countries (Khan et al., 2021). Therefore, a prevention action against this contagious disease is compulsory as soon as possible. Many countries take lockdown and conduct physical distancing to cut off the spread of coronavirus. This of course will affect many things especially the nursing care sector.

By sociological forces, nurse engineers together with clinical engineers are projected to conduct technology assessment, strategic technology planning, and integrate nurse and information technologies. Following the rise of industrial revolution 4.0, future medical technology will be driven by computing power, communication speed and telemedicine,

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data storage capacity, internet of things sensor, 3D printer, artificial intelligence, neurotechnology, and nanotechnology. It required nurse engineering to adapt their function and capability to the latest technology with more complex problems.

d. Technological Forces

In technological research, the involvement of nurses is still lacking. According to Davis (2017), although from 1865 to 2003, 42 nurses produced 94 inventions, out of a total of 5,639 medical device patents published from 1976 to 2015, the involvement of nurses was only less than 5%. Even though there are so many technology innovation developments for nursing care improvement. For example, equipment that is able to send brain signals to control a hand robot. This device is designed to help stroke disease patients who are unable to move their body tissue and for communication facilities for paralyzed patients and rehabilitation needs (Jeong et al., 2020; Lonsdale et al., 2020). Surakusumah et al. (2014) develop a linear robot ultrasound to help nurses to operate ultrasound machines in more accurate ways, decrease human error, and improve the resolution. A novel flexible bronchoscope also was developed using the advantages of soft actuator technology to ensure the safety of lung inspection that was performed by nurse or bronchoscopist (M. Faudzi et al., 2015). There is also some technology development to enhance the nursing care system such as e-health. E-health is an innovative solution in the nursing care field because many parties are collaborating, starting from general societies, hospitals, clinics, universities, to drug manufacturers, and pharmacy industries (Hussey, 2021; Saranto and Kinnunen, 2021). Moreover, there is also the Digital Medical Records (DMR) process which is a basic part of e-health, because DMR gives data exchange facility between health institutions stated above. E-health may help to reduce any data interpretation error, variation data presentation, accelerate decision making, and help to analyze data. E-health application produces an amazing leap in the health sector such as epidemiology, telemedicine, surveillance, prescribing, and Health Geographic Information System (GIS) (Donzia and Kim, 2021; Hierink et al., 2021).

In the end, there are so many aspects that need to be handled in the development of health, especially the improvement of society's health level through the effort of promotive, preventive, rehabilitative, and curative. Technological force and innovation become one of the spearheads for these developments, therefore, the contribution of nurse-engineer is expected to be able to be involved in producing many products that can give benefits for the aspect of drug development, medical technology, health technology, and health service management system.

NURSE-ENGINEER EDUCATIONAL PROGRAM

The profession of nurse engineer cannot be separated from the development of educational programs that teach the competencies needed by the industry. The nurse engineer education program has actually been implemented in several educational institutions in the world. One of the new nurse engineer programs has been developed by Duquesne University since 2012 by combining the competencies of nurse and biomedical engineer (RWJF, 2014). This program is in the form of a dual degree program for 5 years consisting of 2 years of biomedical engineering program and 3 years of nursing program (Duquesne University, 2014). Some of the outputs of this program are shown in Table 1.

Table 1 Dual Degree Nurse-Engineer Program Competencies in Duquesne University

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Biomedical Engineering Competencies	Nursing Competencies
1. Identify, formulate, and solve complex engineering problems by applying the principles of engineering, science, and mathematics. 2. Carrying out the application of engineering designs to produce solutions that meet specific needs with consideration of the health, safety, and welfare of the community, as well as global, cultural, social, environmental, and economic factors, communicating effectively with various audiences. 3. Recognizing ethical and professional responsibilities in engineering situations and making informed judgments, which must consider the impact of engineering solutions in a global, economic, environmental, and social context, 4. function effectively in a team whose members provide leadership together, 5. Creating a collaborative and inclusive environment, setting goals, planning tasks, and meeting goals, 6. Developing and conducting appropriate experiments, analyzing, and interpreting data, and using judgment techniques to draw conclusions, 7. Acquire and apply new knowledge as needed, using appropriate learning strategies.	1. Integrate clinical assessment skills when applying care to individuals, families, groups, and communities. 2. The role model of ethical, legal, and professional standards into one's professional nursing practice when acting as a moral agent. 3. Show a caring attitude in all aspects of one's practice. 4. Institutionalize collaborative efforts to improve care for individuals/families and communities. 5. Demonstrated ability to utilize integrated systems analysis for personal and professional navigation of a health care delivery system. 6. Integrate culturally congruent care in caring for individuals/families from diverse populations. 7. Engage in evidence-based practice. 8. Incorporating teaching and learning processes into all aspects of one's practice. 9. Participate in continuing education activities that promote professional growth and enhance health care. 10. Make use of evolving information technology to improve professional nursing practice. 11. Communicate effectively both orally and in writing to all individuals and groups. 12. Use leadership abilities to influence professional nursing practice. 13. Evaluating the relationship between nurse competence and patient characteristics with patient outcomes

At the School of Nursing University at Buffalo, there is a data science course attended by students from nurses and engineers (M. Pasek, 2019). From this course, it is hoped that there will be collaboration and exchange of perspectives from the virgin side and the engineer side so that it will generate new ideas in health services.

A registered nurse continues his education by taking a software engineering program at Holberton School (Feldman, 2020). Her background as a nurse and manager in the

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Intensive Care Unit at the hospital made her understand about the organization and planning of the hospital. This experience helped him understand his new field as a software engineer. Six sigma competencies that are usually found in industrial engineering programs have also been applied in nursing education facilities (Johnson, 2021). This engineering competency is very useful for nurses in measuring and improving the quality of services in the hospital.

DISCUSSION

The nursing profession has actually implemented engineering concepts since 1959. According to Ayllon and Michael (1959), nurses have acted as behavioral engineers to serve patients who have mental health problems in the hospital. Nurses use engineering concepts to formulate problems, design solutions effectively and efficiently, and implement and evaluate the system being carried out. The nurse can also act as a safety engineer in the hospital (Ahern, 1969).

Basically, the needs of the nurse-engineer profession have been previously met through collaboration between nurses and engineers. This has been done by the University of Maine in designing special care units by involving doctors, nurses, and engineers (Lucia et al., 1977).

Furthermore, the discussion of the scientific basis of nursing competencies through engineering concepts has also been discussed by Josefson (1988). A nurse must have the competencies in mastering technology to be able to adapt to the development of patient care. This is expected to increase the efficiency and effectiveness of health services. This is also implemented by Kernohan (1999), where developing recommendations for procurement budget planning of medical devices in hospitals effectively and efficiently must be carried out by a team consisting of nurses and engineers. Josefson (2008) also continued that the implementation of the engineering concept on the competence of nurses has become the main focus in developing the expert system. This is done to support the development of advanced technology in the future.

Nurse-engineer profession is still echoed by Glasgow et al. (2018) which explains the collaboration between biomedical engineering and nursing in carrying out professional regeneration and increasing innovation in the field of health service technology. The innovations that can be developed in this collaboration consist of patient care devices, robots, and computer simulations.

Glorivic (2020) explained that basically nurse-engineer has been done by a nurse because the activity carried out is process engineering. This engineering process consists of planning, problem formulation, solution design, implementation, and evaluation. However, by developing it into a nurse-engineer profession, of course this will increase the ability of nurses to implement technology in the process engineering that is carried out. (Davis and Glasgow, 2020)

Furthermore, the rapid development and use of information technology systems at this time in the service sector in health facilities should be a concern for a nurse. This information technology system is needed to streamline health services, such as reducing patient waiting times for treatment, reducing nurse duties, and efficient hospital services, minimizing errors and also improving the quality of healthcare facilities. All activities that were traditionally carried out using paper, pens, stored in hardcopy, and distributed physically, have shifted to using electronic data using barcode identification systems, computers and smartphones, electronic processing, and cloud storage (Sayam and Sukihananto, 2018). Although nurses have been exposed to the use of IT systems in health facilities, the adaptations that have been made cannot be effectively implemented by nurses,

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especially when it comes to developing innovations. Therefore, nurse-engineers are also required to have competence in mastering information technology systems so that new innovations in the field of IT systems emerge in solving problems that exist in clinical services. (Hendrickson, 1993).

The effect of the development of computer technology is also an important discussion that must be applied in nurse-engineer education (Rambo, 1994). Harerimana and Mtshali (2019) explained that in order to improve the competence of nursing students, the information technology application that was widely used was the Microsoft word application at 86.7%, Microsoft PowerPoint by 70.7%, Moodle by 81.3%, and the ability to search data online by 74.7%. This ability was also found to be related to student ownership of digital equipment such as smartphones, laptops, and tablets. Information technology mastery competence has also been applied by Warshawski (2020) in conducting nurse education.

Furthermore, the current 4.0 industrial revolution has brought us to Artificial Intelligence technology where diagnosis is carried out using automatic computer algorithms. This is of course a very big challenge for nurses when one day their jobs can be replaced by robots (Frith, 2019). Of course, to deal with this, nurse-engineer is an alternative where nurses will get used to interacting and even developing artificial intelligence technology in health services and increasing the accuracy of this technology.

CONCLUSION

Nurses are health professionals who deal directly with patients affected by Covid-19. This condition allows nurses to understand various problems related to patient healthcare. This is an opportunity for nurses to develop their profession by implementing technology and information competencies that are currently being discussed in the form of the nurse-engineer profession. Nurse-engineers answer the problem of the communication gap between nurses and engineers that have occurred in healthcare and innovation development. The rapid development of technology encourages the acceleration of innovation to solve problems in healthcare. The condition of nurses who lack competence in the mastery of technology makes the adaptation to the implementation of existing technology become slow. The lack of direct involvement of engineers in health services makes the technology also inappropriate. Nurse-engineers are expected to produce appropriate innovations that can solve healthcare problems. From the political and policy aspects, the need for policy development to increase the effectiveness and efficiency of health services is getting higher, especially during pandemic conditions where the number of patients continues to increase. Nurse-engineers through their technological competencies will certainly play a major role in making policies that are effective and can be understood and applied in health services. From an economic aspect, Nurse-engineers open up new job opportunities and new resource needs that can drive the economy. From the sociological aspect, Nurse-engineers can play a role in bridging communication between services and technology development so that there is harmony in the handling of patients in the future. To make this profession a reality, educational programs that integrate nursing competence and technology must be developed. This program can refer to several educational concepts that have been implemented in several universities. The competencies adapted include the concepts of engineering, mathematics, robotics, technology and information, and artificial intelligence. It is hoped that the nurse-engineer profession will bring up technological product innovations and can be an alternative in solving health service problems in the future.

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