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REVIEW

Exploring the Contribution of Engineering in Enhancing Workflow and Efficiency in Nursing

Exploración de la contribución de la ingeniería a la mejora del flujo de trabajo y la eficiencia en enfermería

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ABSTRACT

Complex health concerns demand a very competent solution that incorporates groups of experts from several fields. When the biomedical engineering viewpoint is extended to contain nursing's real-world viewpoint, there are opportunities for improved technology-nurse interactions and eventual innovations. The finest arrangement for a competent nurse engineer who may consider cutting-edge and original ideas which can enhance patient care and results is found in dual nursing engineering degree programs. An analysis of the literature gives background information on innovation and engineering in nursing, justifies the construction of two ground-breaking joint degrees, and provides a description of those programs. These ground-breaking initiatives will progress medical technology while maximizing the nursing profession's potential to contribute to the development and use of original ideas. Additionally, by giving students who are enrolled in separate Bachelor of Science in Nursing interdisciplinary training and exposure, they can advance their knowledge and skills. If nurses are not actively involved in the discovery and design of patient care devices, significant chances for patient care enhancement are missing. To take advantage of nurse creativity and produce improvements in patient care, creative nurse and engineer cooperation are required. This article's main goal is to highlight two cutting-edge biomedical engineering and nursing collaborations that aim to train innovative professionals and create novel knowledge.

Keywords: Biomedical Engineering; Nursing Engineering Collaborations; Nursing Training; Innovative Professionals.

RESUMEN

Los problemas sanitarios complejos exigen una solución muy competente que incorpore a grupos de expertos de varios campos. Cuando el punto de vista de la ingeniería biomédica se amplía para incluir el punto de vista del mundo real de la enfermería, surgen oportunidades para mejorar las interacciones entre la tecnología y la enfermería y para eventuales innovaciones. La mejor disposición para un enfermero ingeniero competente que pueda considerar ideas vanguardistas y originales que puedan mejorar los cuidados y los resultados de los pacientes se encuentra en los programas duales de grado en ingeniería de enfermería. Un análisis de la bibliografía ofrece información de fondo sobre la innovación y la ingeniería en enfermería, justifica la construcción de dos titulaciones conjuntas pioneras y ofrece una descripción de dichos programas. Estas iniciativas pioneras harán progresar la tecnología médica al tiempo que maximizarán el potencial de la profesión enfermera para contribuir al desarrollo y uso de ideas originales. Además, al ofrecer a los estudiantes

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que cursan por separado la Licenciatura en Enfermería una formación y exposición interdisciplinarias, pueden avanzar en sus conocimientos y habilidades. Si las enfermeras no participan activamente en el descubrimiento y diseño de dispositivos para el cuidado de los pacientes, se pierden importantes oportunidades de mejorar la atención a los pacientes. Para aprovechar la creatividad de las enfermeras y producir mejoras en la atención al paciente, es necesaria la cooperación creativa de enfermeras e ingenieros. El objetivo principal de este artículo es destacar dos colaboraciones punteras entre ingeniería biomédica y enfermería que pretenden formar a profesionales innovadores y crear conocimientos novedosos.

Palabras clave: Ingeniería Biomédica; Colaboraciones Entre Ingeniería Y Enfermería; Formación De Enfermería; Profesionales Innovadores.

INTRODUCTION

The usage of engineering ideas, and technology, to enhance the procedures, systems, and equipment used in nursing practice is referred to as engineering in boosting workflow and efficiency in nursing. Utilizing engineering skills entails designing and implementing technological solutions, analyzing and optimizing workflows, and incorporating novel strategies to increase the effectiveness and efficiency of nursing activity.[1] Engineers are responsible for incorporating new technology into the nursing workflow, including electronic health records (EHRs), medical equipment, telemedicine platforms, and mobile devices. The effective application of technology to support nursing tasks is ensured by this integration, which also provides seamless interaction and data transfer.[2] Because healthcare processes are so common, investigators and professionals in healthcare systems engineering have access to a wide range of medical care sets to redevelop processes for mutually optimum patient and professional results. In issues including healthcare information technology combination, patient security, and coordinating care, process modeling has aided in identifying targets for workflow modifications.[3] Engineers create and construct robotic and automated systems which can carry out rote and repeated nursing duties like patient monitoring, medication administration, and sample analysis. Automation decreases human error, improves accuracy, and releases nursing time for more difficult and crucial tasks.[4] Engineers contribute to the development of educational platforms, simulation tools, and virtual training programs that enhance nursing education and ongoing professional development. These tools provide nurses with access to interactive learning experiences, virtual patient simulations, and continuous skill assessments.[5]

The overall goal of engineering in enhancing workflow and efficiency in nursing is to optimize processes, improve patient care outcomes, and support nurses in delivering high-quality care while minimizing errors, reducing administrative burden, and maximizing resource utilization.

The study[6] developed and refined an early conception including communications and workload as significant drivers of turbulence to better understand it. The contributions of handoffs and pauses to interaction are further examined. To better understand workload, patient turnover, supplies, and equipment, human resources, and the physical environment were incorporated. The study[7] developed and constructed a unique system, the Smart Agent, using step-by-step systems engineering techniques to semi-autonomously administer intravenous insulin by our hospital's policy for nurse-management insulin infusion in the intensive care units. The model process made use of our current electronic health record and a commercial medicine infusion pump. The study[8] addressed the difficulties cited in clinical training, they sought to create guiding and evaluation uses. With this application, nurse learning in clinical training was meant to be more adaptable, high-quality, and effective. It also aimed to boost interactive communication which promotes guiding and ensures systematic assessment of nursing students during clinical training. The research[9] addressed the difficulties cited in clinical training, they sought to create guiding and evaluation uses. With this application, nurse education in medical training was meant to be more adaptable, high-quality, and effective. It also aimed to boost interactive communication which promotes guiding and ensures systematic assessment of nursing students during clinical practice. The research[10] created a consensus document outlining the main themes of a worldwide think-tank on artificial intelligence (AI) and nursing that was invited to participate. The study[11] determined how these alerts and alarms affect nursing practices and patient security, an analytical method is required. To examine a thorough infusion database from an intelligent infusion pump scheme and determined what contributes to infusion programming alerts, operational alarms, and alarm resolution timeframes. The study[12] examined and clarified variances in the workflow, we used a systematic methodological approach. 10 preoperative cases at regional referral centers in Florida and Arizona were recorded using video recording software. Using quantitative research, we contrasted how much time is spent on off-screen tasks versus tasks related to electronic health records. The exploration of suboptimal patterns and the causes of variance using qualitative research. The study[13] determined the areas of multidisciplinary nursing and engineering collaboration in the field of health care, with an emphasis on the contribution of nurses to the partnership. The research[14] examined increasing the outcome

of effort between frontline nurses as the goal of this staff improvement and ability of building initiative. The study[15] looked into how clinical dashboards are used to provide nurse care. Studies published between 1990 and 2020 that explored the function of clinical dashboards in the nursing area met the inclusion criteria. A researcher-made checklist was used to obtain the essential data, which was then evaluated and described descriptively. The study[16] provided a quality improvement (QI) program to improve NPs' job satisfaction by decreasing workflow interruptions and raising their perceptions of patient safety among trauma NPs.

DEVELOPMENT

Analysis of nursing engineer education

Unprecedented changes in the provision of healthcare have included a shift toward more community-based care, population-based care, and the expansion of nurse practitioners-staffed walk-in clinics. The rate of alteration is anticipated to quicken as new service models are created and demand to contain healthcare costs continues to climb. Numerous "futurist" forecasts about the future of health care have been made in response to the requirement to coordinate projected technical advancements, capital investments, patient results, and cost reductions, such as Healthcare and Life Sciences Predictions 2020. Wearable monitoring tools, individualized genetic therapies, the use of machine learning in diagnostic and therapeutic procedures, and robotic medical and social uses are just a few of the predictions that are now available to physicians.

Nursing

The complexity of nursing care is also rising. There are also a plethora of ethical and data security concerns. There have been challenges to the utilization of technology in healthcare and its prospective effects on patients and nursing treatment. Nurses will need to develop into more than merely proficient technology users if nursing care is to continue to advance.

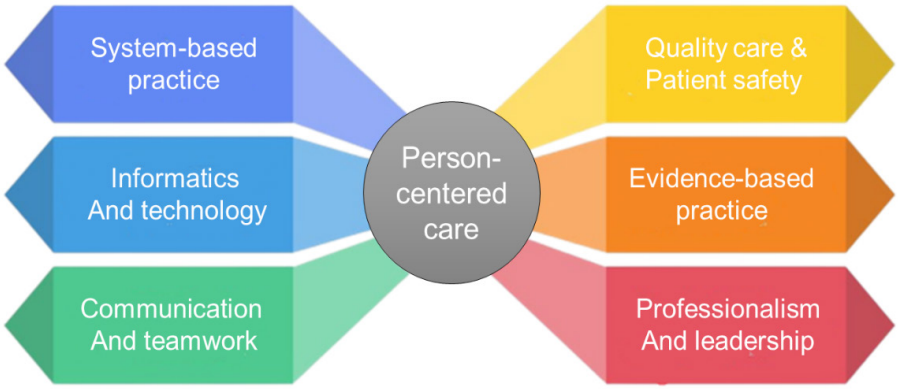

Figure 1. Core competency system for Undergraduate nursing

According to figure 1, the final Core Competency System draft contained 16 competency elements spread across six competency domains. Every competency element explained every necessary efficiency behavior. The evolving clinical nursing environment necessitates that nurses take a more active part in the study, design, and debates over policy and practice which surround cutting-edge medical technologies. Nursing partnerships with low-conventional professional partners, such as engineers, are vital because of the expectation for multidisciplinary education and practice in today's society. Two recent instances of these creative collaborations include an initial-generation telerobotic smart nursing assistant created by Duke University nursing and engineering students. The telerobotic intelligent nursing associate replaces human interaction, reducing threats to medical professionals and being helpful to patients with contagious illnesses. Despite telerobotic smart nursing assistants are still in their infancy, nurses and engineers are working to create a more comfortable interface among humans and robots so that treatment can be provided using fine motor skills. Secondly, engineers from the Massachusetts Institute of Technology worked with Beth Israel Deaconess Medical Center labor and delivery (L&D) nurse supervisors, and obstetrics and gynecologist physicians to allocate difficult nursing staff in a busy L&D ward. To evaluate their decision-making in light of changes in the L&D patient census and staff resource allocations, nurse supervisors took part in computerized simulations. Both in actual life and in computer models, a growing unit census is linked to delays in patient care. An effective and practical way to show how care decisions are affected by changes in patient volume is using computer simulation. To improve clinical resource management, nurses, doctors, and engineers plan to use simulations.

Nurse-engineer: new professional

It has been suggested for about 25 years that nursing and engineering should have official education programs and links with other professionals. Both nurses and engineers employ science and technologies as well as creativity to find solutions to real-world issues, however, nurses place more emphasis on the skill of treatment and training of well-being improvement whereas engineers place that emphasis on the skill of layout & practicing of building. It suggested that nursing is presently combined to a technical degree rather than having a fully combined educational/professional database to consider nurse engineering as a complete field. A few colleges have developed original partnerships or combined grades to enhance patient skills or increase the effectiveness of the medical scheme, but no universities have yet established a whole new specialty, such as nurse engineering. The work of a nurse engineer in the further of medical treatment can require to comprise the following, according to the notions (i) developing & executing original tools, systems, and technology; (ii) developing secure environments for patient care; (iii) ensuring the existence of a data security and ethical care system; and (iv) creating efficient interaction plans and communicating for professionals, patients, and their caregivers. To communicate with future healthcare leaders, policy and public data are also crucial.

Input from nurses will be needed during the theoretical, study, and development phases of any novel item or system. When significant functional improvements might not be conceivable, nursing is all too frequently limited to evaluating or evaluating final products. In circumstances where there are several nursing training designs, administrative frameworks, and practice settings, such as the hospital, community, and home, providing healthcare is more complicated. This highlights the requirement for developing a structured process to evaluate patient and nurse requirements. Ethical and data security concerns will be more crucial as nursing and engineering collaborate more. With our focus on ethics, dignity, and the welfare of humans, it is crucial for technologies and nursing to understand one another in every circumstance. The perspective of innovative technology and training advancements will need to be communicated to healthcare managers, leaders, caregivers, patients, lawmakers, and the common public in novel ways. There are also some instances of classically educated nurses who have enhanced patient care through the development of novel inventions.

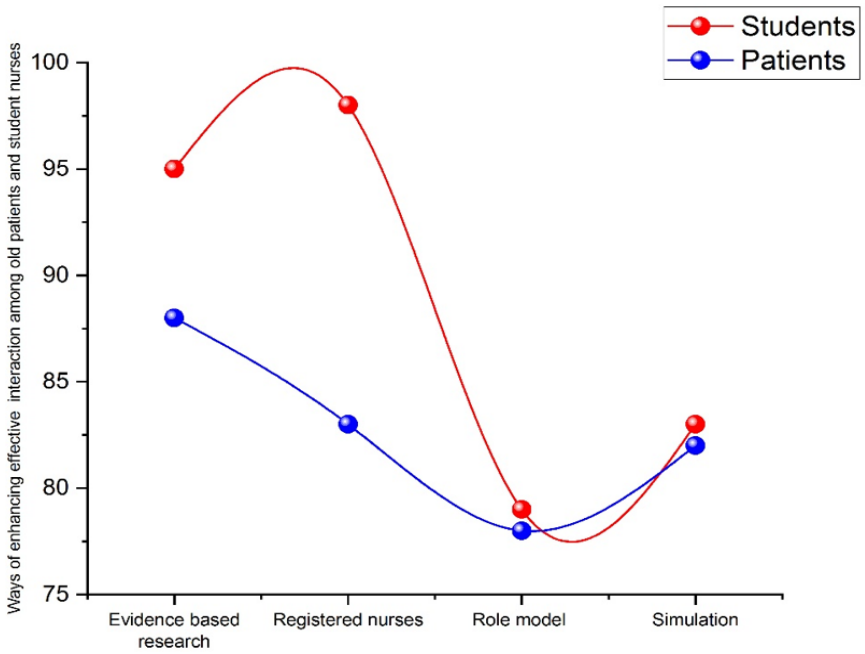

Figure 2. Enhancing efficient interaction among old patients and nurse students

Table 1. Computation value of old patients and nurse students

Ways of enhancing effective interaction among old patients and student nurses		
	Students	Patients
Evidence based research	95	88
Registered nurses	98	83
Role model	79	78
Simulation	83	82

Figure 2 depicts the enhancement of efficient interaction among old patients and nurse students and table 1 denotes the computation value of old patients and nurse students. Utilization of evidence-based research was cited as a method for promoting efficient interaction by 95 (88 %) patients and 98 (83 %) students, while connection to registered nurses was suggested as a solution by 79 (78 %) students and 83 (82 %) patients. Eighty-eight (78 %) of students and 69 (79 %) of patients felt that using role models will help them communicate better. 83 percent of patients and students agreed that using simulations as a teaching strategy will enhance their ability to communicate. Patients and students both felt that pairing students with qualified professionals was a good method to increase student nurses' confidence, which in turn enhanced communication. When students contact closely with registered nurses who serve as role models for leadership in the care of older patients, positive attitudes toward caring for the elderly are frequently created. Because of their position in the healthcare system, nurses are in an ideal situation to observe the experiences and results of their patients and to provide recommendations for improvement. Since nurses are the primary caregivers for patients in healthcare settings, it stands to reason that considerable opportunities for improving patient care are missed when nurses are not engaged in innovative technology. Therefore, we argue which nurses constitute an essential yet underappreciated component of either the nurse-patient or patient-technology interfaces. Particularly, it is challenging for someone who has only received education in one of the two disciplines to continue their studies to become a nurse engineer due to the sequential nature of nursing and engineering schooling. To understand and create ground-breaking medical imaging technology, for example, an engineer needs first to take two years of university-level math, accompanied by 2 to 4 additional degrees in signal and image processing. The difficulty of a professionally educated engineer using clinical methods and protocols made possible by the nursing school and subsequently nursing practice highlights the issue even more clearly. The program's goal is to equip nurses for careers in the science and development of medical technology, between other things. To support nursing contributions in this field, several universities have already created courses or innovation spaces. For instance, the engineering and nursing colleges at the University of Detroit Mercy collaborate to give supportive gadgets to people with disabilities while instructing students in creativity, technologies, and teamwork. Nursing students are given background information and insights into certain disabilities to update engineering about predicted system requirements. A few instances of interdisciplinary equipment are a baby carrier which can be attached to an electric wheelchair, a crib which can be opened on one side to fit a mother in a wheelchair, and an innovative technological walker to assist in lifting patients in the occurrence of a fall. There are instances of initiatives made particularly to unite these 2 fields of expertise to address health-related issues.

Potential effects of nurse engineering education

Graduates from schools which teach the foundations and applications of biomedical engineering, as well as the fundamental skills and clinical training of nursing, are capable to work at the interface between technologies and patient treatment. The creation and evaluation of innovative healthcare systems in tiny, start-up businesses is one situation which is pertinent in the present fast-paced technology commercialization environment. After a successful financing campaign, founders must inevitably bring on fresh people to carry out engineering improvement and organize and manage the clinical analysis. A nurse engineer can serve as both a clinical assessor and a technology developer for smaller projects, cutting prices and streamlining the product improvement process. Certainly, nurse engineers maintain a close relationship between engineering development and clinical analysis and, more crucially, clinical usefulness in later-stage initiatives, which gives rise to this edge. These issues are eliminated during the procedure of teaching nurse engineers in a shared program, which also offers the chance for educational synergies. Though the divergent nature of the degrees in nursing and engineering might not make it immediately apparent, this kind of synergy has been demonstrated in several dual-degree courses, including law and business. While there might not be a direct correlation among engineering plan and nursing treatment, in general, the senior engineering capstone offers an opportunity to integrate the ideas from all previous classes. Two colleges moved to create integrated nursing and engineering programs in strength to enhance the multifaceted demands of patients and the medical system as a whole. The following describes both methods. The dual degree program at Duquesne University has already started; this study explains its syllabus, programmatic components, and ideas for academic result evaluations.

Table 2. Computation value of clinical settings

Types of clinical settings	Percentage (%)
Hospital	88
Outpatient clinic	9
Community / mental health sites	17
Elementary/middle/high school settings	5

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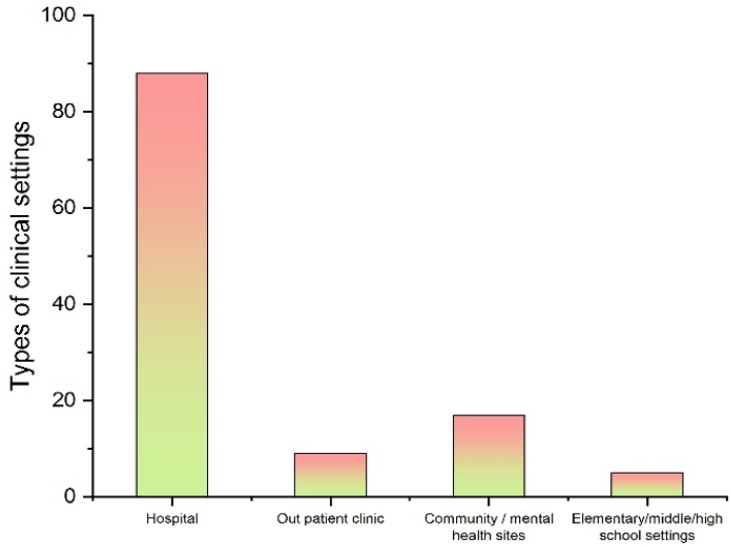

Figure 3. Clinical settings

Figure 3 depicts the clinical settings and table 2 depicts its computation value. Students at the sophomore (43 %), junior (38 %), and senior (19 %) level represented nursing students. There were many clinical teaching site setups present. Hospitals, outpatient clinics, community, and mental health facilities, as well as elementary, middle, and high schools, are a few examples of places where students have completed clinical experiences. With 88 % representation, the hospital setting was the most prevalent (figure 3). 88 percent of the students said that the nursing school's safety tools were explained to them. This beginning to the safety resources and procedures at the nursing school was conducted in a variety of locations, including the clinical, theoretical course, online student school site, email, and conversations with peers. According to this analysis study, 69 % of students said that clinical and 59 % of students said that theory classes were their preferred settings.

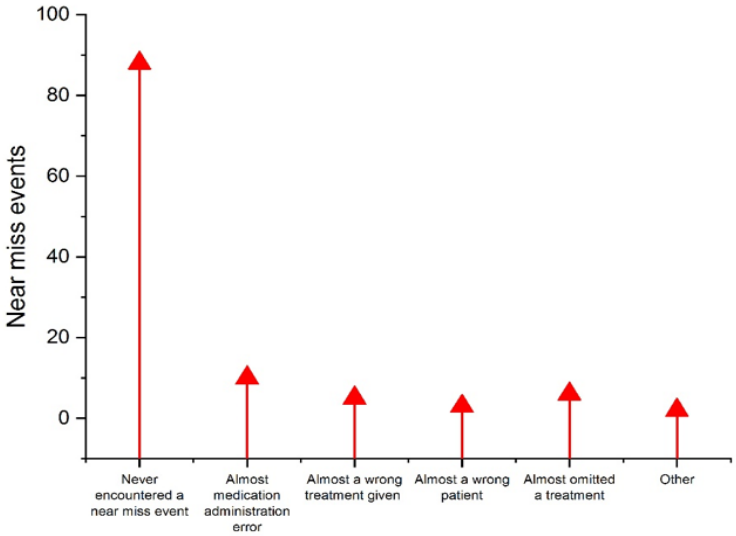

Figure 4. Never miss events

Table 3. Computation value of never miss event situation

Near miss events	Percentage (%)
Never encountered a near miss event	88
Almost medication administration error	10
Almost a wrong treatment given	5
Almost a wrong patient	3
Almost omitted a treatment	6
Other	2

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Figure 4 represents a never miss event and table 3 represents its computation value. A near-miss incident is one that almost touches the patient but doesn't. As an illustration, consider the situation in which you almost administered the patient the incorrect dose of medication before discovering the error. Almost a mistake, but the healthcare professional fixes it before it affects the patient. According to this analysis of nursing students, 86 percent of them say that they had never experienced a near-miss situation. The majority of those that did were near misses or almost pharmaceutical errors (figure 4). Near misses included giving the wrong care, to the wrong person, and at the incorrect times.

Numerous significant healthcare concerns have been investigated via collaborative nursing and engineering efforts. One of them is the development and execution of an electronic system for reportage falls for the post-acute treatment method at a sizable elder treatment facility. This tool is still being used in this hospital to monitor falls. One Fellow improved a computer-based optimizations and simulations method for systems engineering to enhance inpatient bed ability allocations at a significant healthcare center which typically admits over 28 666 inpatients annually and has about 700 beds. Postdoctoral research has been completed by the Fellows in these investigations.

RESULTS

This distinct paradigm requires a new evaluation instrument that can provide reliable metrics and assessment, even if nursing and engineering have their discipline-exact endorsement techniques and organizations. Due to the basic contrasts between the two disciplines and the low number of graduates in recent years, the assessment is made more challenging. Assessment at Duquesne will unavoidably include determining educational results and gauging early career development. A system for tracking ongoing advancements in academic relevance will also be implemented by the program, and it will take into account student feedback, achievement, employer satisfaction, job placement, remuneration, and career progression. An internal assessment committee can be in charge of keeping tabs on the program's development to lessen the organizational load caused by the two formal accreditation organizations for engineering and nursing. This analyse group will be made up of academics from the nursing, engineering, and health professions disciplines. Every year, this committee will evaluate student results. These results can be defined in addition to those now used for engineering and nursing accreditation. The analysis committee's initial iteration will determine the specific results for the nurse engineer idea.

Due to the program's ongoing development, there is currently no formal summative result information to report. At the time of writing, two of the twelve officially registered students have started their fourth year, which is when the intensive nursing classes start. Next fall, those students will finish their final capstone projects, which will result in graduation. Recruitment and initial retention rates for students have been good. Anecdotally, advisers and program directors have observed that students are less engaged in the nursing program, instructors, or peers since they spend their first three years.

CONCLUSIONS

The nurse-maker movement and new biomedical and nursing degree alliances have the prospective to significantly alter the nurse-expertise interaction setting. Because of these innovative initiatives, nurse engineers and collaborations can change the way we think, develop technology, and address pressing clinical issues. Through more involvement in and acknowledgment of significant and valuable patient care equipment developments, this model change also presents a chance for specially educated nurses to enhance patient care and ensuing results, whether formally or informally. These programs obviously attracted and educated a novel demographic of nursing students, however, they also opened the door for further academic nursing degrees to follow, which eventually increased the number of nurse-engineers. The complex and ever-varying issues in medical delivery facilities, diagnosis, and therapies are receiving calls for innovative and diverse solutions from stakeholders devoted to enhancing health and patient safety.

Nurses and front-line medical professionals will need to have technical and medical credentials to work in the rapidly changing, technology-centered world of health care. For the objective of the workforce and economic development, healthcare technological innovation, nursing, and engineering professions will therefore need to cooperate. Such inquiries can serve as a springboard for innovative research advancements and discoveries, with the anticipated outcome being an increase in the number of novel and pertinent patient treatment tools, robotic solutions, and workflow effectiveness which enhance healthiness. Given their frequent encounters with patients, nurses are most equipped to evaluate patients' functional health statuses and technological requirements. To utilize nurse creativity and have a good effect on patient care, additional cutting-edge nurse-engineer collaborations are required in many ways.

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CONFLICTS OF INTEREST

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