Impact of Technology on Nursing Practice

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Technology is changing the world at a rapid speed and the impact is very evident in the healthcare setting. Nursing practice is constantly evolving along with the technology being used to enhance and deliver patient care. The currently stored global healthcare data, which includes demographic data, laboratory results, nurse charted data, diagnostic reports, physicians notes, scanned documents, claims data, trials data, and genomic stores, comes to a total estimate of 150 billion gigabytes, which can be compared to a laptop with a hard drive of 4 gigabytes of memory (Howard, 2011). Emerging technologies are being integrated into nursing practice for reasons such as reducing medication errors, improving safety and efficiency, freeing workers from tasks, providing evidence for care plan decisions, making health information accessible to patients, monitoring workforce, empowering patients to be involved in care, and coordinating care across settings. However, there are barriers with these technologies such as ethical dilemmas, healthcare literacy, and moving care outside of the physician’s office or hospital. Several factors may influence the appropriate use of technologies and determine their success or failure such as the complexity of the hospital workplace, limitations in the number of care components that can be automated, and the technologies’ interaction with human factors. Integrating technology into practice is challenging as well as expensive. Nurses play a critical role in implementing new technology and must be trained with skills to understand how to use the devices. The emerging technologies that are impacting practice consist of genomics, less invasive tools for diagnosis and treatment, automated dispensing machines, computerized physician order entry, electronic medication administration records, robotics, 3-D printing, nurse call systems, wearable chips, electrocardiogram necklaces, and smartphones. In addition, a field of nursing informatics has emerged which is a specialty that integrates nursing science, computer science, and information science to manage and communicate data and information. According to Elizabeth Halley, a nurse informaticist, “Health information technology is the greatest tool available to transform and innovate nursing care” (personal communication, October 10, 2015).

According to The American Cancer Society (2011), genetic testing is being used for many reasons. One benefit is the predictive value in identifying gene mutations that put a person at risk of developing a disease such as cancer, cystic fibrosis, sickle-cell anemia, or Tay-Sachs. Genetics and genomics can also be used to determine carrier status of a condition, as a prenatal screening to diagnose conditions in utero, and for newborn screenings to determine inherited conditions (Huston, 2013). Genetic testing can also be used to check cancer cells to determine prognosis or potential benefits of types of treatment. Genetics and genomics can be an effective intervention because the majority of disease risk, health conditions, and therapies used to treat those conditions have a genetic influence by environmental and lifestyle factors. A study done by Conley, Biesecker, Gonsalve, Merkle, Kirk, & Aouizerat (2013), provides evidence that genomic sequencing is a more efficient and relevant diagnostic approach as compared with conventional sequencing when considering diseases that can be caused by multiple genes or have broad presentations, such as heart disease. Gene therapy is expected to make a significant impact in curing cancer and preventing birth defects within the next two decades (American Association for Cancer Research, 2012). An example of how genomics will have clinical use is predicting an individual’s genotype-specific drug responses for commonly used drugs. Another benefit is that genetic advances have potential to eliminate the need for organ transplants since new organs will be able to be grown from a patient’s own tissues. Researchers are beginning to grow individual tissues, tendons, and cartilages from stem cells and several years ago, a kidney-like organ was grown from scratch in the lab and used successfully in animals (Coghlan, 2012). Huston (2013) suggests that stem cells will be used to generate cartilage tissue to repair damaged joints, which will be beneficial for osteoarthritis patients. A challenge with this technology is that many nurses currently lack knowledge about genomics and the competence needed to effectively teach patients. A prepared nursing workforce is essential to effective integration of genomic research to benefit patient care, but the knowledge gap is a global concern (Conley et al., 2013). Nurses need an understanding of scientific concepts to provide genomic education. They need to be able to explain the implications of screening and testing, possible risks, and treatment choices to patients and families. However, there are ethical dilemmas with safeguarding this personal information and emotional consequences of releasing unknown medical data without the guaranteed support of a primary provider, which poses challenges for healthcare professionals.

Less invasive and more accurate tools for diagnostics and treatment will also change nursing practice. One noninvasive technology that has been developed is tattoos that can monitor blood glucose without a finger prick, which is a significant advancement for the large population of Americans with diabetes. The miniature tattoo is made up of nanosensors that contain a yellow-orange dye. The dye lights up when glucose levels are high and becomes dark when the levels drop. I can relate this to my current practice as a nurse extern because I consistently use invasive procedures with the AcuCheck to test blood glucose levels of patients. The benefit of minimally invasive tools is lower patient risk and cost. Another noninvasive technology is magnets. Cleared by the FDA in 2008, small electromagnets are placed on the scalp behind the left forehead as a therapeutic intervention for major depression (Howard, 2011). These magnets deliver an electric current to the part of the brain linked to depression. Based on findings from a large study by Howard (2011), this intervention is proven to be beneficial because these magnets were three times more effective than a placebo and they had no serious side effects. Another noninvasive technology that is common in health care facilities is telemetry. Telemetry is an automated communications process by which measurements are collected, such as blood pressure and heart rate, and transmitted to receiving equipment for monitoring. A study was done at Christiana Care that involved integrating evidence-based guidelines on medication and telemetry use into Christiana’s health information technology systems. The findings conclude more effective care was delivered through the use of cardiac telemetry. The results showed a 47% decrease in the average duration of telemetry monitoring, 43% decrease in the number of telemetry orders, 70% reduction in telemetry use overall without any negative impact to patient safety, and it saved Christiana 4.8 million dollars (“Christiana Care earns national recognition for reducing unnecessary telemetry saving $4.8 million,” 2014). These findings are significant because reducing telemetry use by 70% on a daily basis is equivalent to more than 115 hours of nursing time saved every day and no harm to patients was found. I found this study interesting because it was done on unit 5E, which is the unit where I completed my clinical rotations. A challenge for nurses is competency because of the rate at which these minimally invasive tools are being introduced to practice.

Medication errors and adverse drug events are a common problem in nursing practice that can be prevented in order to increase patient safety. For example, the Quality & Safety Education for Nurses developed a competency for safety that is defined as “minimizes risk of harm to patients and providers through both system effectiveness and individual performance” (QSEN Institute, 2013). The competency describes that pre-licensure knowledge and skills that nurses need to have includes selected safety-enhancing technologies such as barcodes, computer provider order entry, medication pumps, and automatic alarms. Technology interventions have been recommended as a key mechanism for reducing the likelihood of medication errors and adverse drug events. Automated dispensing machines have replaced the traditional unit dose cassette system in many hospitals. This technology allows medications to be conveniently stored and retrieved. Automated dispensing machines increase patient safety because they only dispense to a specific patient based on their medication profile. Other benefits of this technology include increased drug availability, increased efficiency of drug dispensing and billing, and increased time for patient care. Additionally, if automated dispensing machines are linked with bar-coding systems, these machines have been proven to decrease medication errors by ensuring an electronic match between the physician-ordered medication and the corresponding administered medication. According to Oren et al. (2013), five studies observed a decrease in medication errors associated with automated dispensing machines. Bar coding is a common technology used in hospitals and has the potential to improve patient safety by ensuring accurate patient identification, correct medication use, and improved medical record keeping. The technology can ensure that the appropriate drug is being administered and accurately records when the drug is received and administered by the nurse. An example of how this works is by using a wireless device to scan bar codes on a nurse identification badge, a patient’s wristband, and the medication to confirm the correct patient, medication, and administration. A challenge with this technology is the implementation cost is estimated at 119,516 dollars annually (Oren et al., 2013). Computerized medication administration records allow integrating patient information into a comprehensive database. The benefits of this technology include consistency in medication documentation, consistency of directions, and precise dosage information. This idea of a computerized system also improves productivity through printouts of fill lists and labels and allows nurses to focus on patient care. However, there are some consequences of this technology that need to be further researched such as multiple entries for a medication order and different interpretations of orders by pharmacists and nurses.

Computerized physician order entry is a rapidly growing clinical software application designed for providers to write patient orders electronically rather than on paper. It has been estimated that computer physician order entry implementation at all non-rural hospitals in the United States could prevent over 500,000 serious medication errors each year (Oren, Shaffer & Guglielmo, 2013). A benefit of computerized physician order entry is that providers produce clearly typed orders, which reduces medication errors. Another benefit is that it gives providers clinical decision support via access to information tools that help make decisions related to diagnosis, therapy, and care planning of patients in order to improve patient outcomes. According to a study done by Oren et al. (2013), computerized physician order entry is said to provide process improvement, increased accuracy and legibility, support of institution recommendations, integration of clinical decision support into the order-entry process, optimization of physician, nurse, and pharmacist time, drug allergy checks, and identification of drug interactions and incorrect dosages. However, very few controlled studies have evaluated the appropriateness of the use of this technology and the impact on patient outcomes. The slow transition of this technology may be related to cultural barriers and logistical challenges such as training users, installing and upgrading equipment, and cost of implementation. For example, at Brigham and Women’s Hospital, it costs approximately 1.9 million dollars for development and 500,000 dollars for maintenance per year (Oren et al., 2013).

Electronic health records have developed as a result of technology and this documentation is essential in the nursing profession. The electronic health record is a digital record of a patient’s health history that may be made up of records from many locations or sources, such as hospitals, providers, or clinics. A benefit of this technology is that the record is available for healthcare providers to have access to 24 hours a day, 7 days a week, which allows for better coordinated care between professionals. Electronic health records also have built-in safeguards to assure confidentiality and security of patient health information. Challenges with this technology consist of understanding and demonstrating meaningful use, capturing the relevant data, and not having the appropriate certified technology. For example, in a recent survey, only 48% of healthcare leaders feel confident in their organization’s readiness to meet Stage One meaningful use requirements (Millard, 2012). Other barriers include implementation costs and debates about who “owns” the data in the record. One of the key risks with electronic health record implementation is when it is the responsibility of the information technology department to design a system for clinical users without their input into what is required for them to successfully complete their work (McGonigle, Hunter, Sipes, & Hebda, 2014).

Nurse call systems are an essential part of nursing care and are warning systems that allow an alarm to be raised when a patient requires assistance from a staff. Call systems enable nurses to achieve better quality of care if used correctly. The call systems have changed over time from a simple alarm system where a button is pressed and triggers an alarm to a more dynamic system with greater functionality. Call systems can be wireless, which frees the system from the constraints of additional wiring and can incorporate the addition of mobile phones or tablets and a range of additional sensors. Call systems have improved communication because staff can communicate with each other as well as directly with patients. One of the main responsibilities of my job as a nurse extern is to respond to call systems and I believe that the most important benefit is being able to meet the patients’ needs immediately.

Robotics is another emerging technology that will have a significant impact on future nursing practice. The increase in the use of robotics is expected due to workforce shortages, a growing elder population, and demand for higher quality care. This technology will have an impact on nurses because staffing is currently a significant dilemma in this profession. Robots will increasingly be used to provide direct patient care. Mental service robots are already used as therapeutic adjuncts in mental health care. For example, Paro is a mental service robot used in Japanese nursing homes to provide comfort and reduce stress and also to care for autistic and handicapped children (Huston, 2013). These robots help with tasks such as washing or carrying elderly patients, although they are still not developed enough for commercialization. In July 2012, iRobot Corporation developed a 5-foot, 4-inch mobile robot, which allowed doctors to examine diagnostic data and interact with patients anywhere in the world (Seiffert, 2012). The robot has a flat-screen that turns like a human neck, showing the physician's face and allowing them to look around the room and talk to patients, family, and other healthcare professionals. The robot includes sensors for navigation and carries a stethoscope. A challenge with these robots is that healthcare providers have expressed concern about the lack of emotion, suggesting that this will never replace human caregivers. However, new technology in Japan has developed robot intelligence known as “kansei,” which means “emotion or feeling” (Huston, 2013). Kansei robots monitor human expressions, gestures, and body language and listen to people. The robot hears a word, searches through its database of more than 500,000 words, and then displays one of 36 expressions it thinks matches the word (Huston, 2013). They also sense human emotion through sensors that monitor pulse rate and perspiration. Robots will also be used to find and deliver medications, supplies, and equipment so that nurses do not have to leave the patient care area when there is a staffing issue. Another reason for the increase in the use of robots is for surgical procedures, since they are more accurate and steadier than human caregivers (Huston, 2013). Biomechatronics is another robotic intervention that involves creating machines, which replicate or mimic how the body works. According to Huston (2013), by the year 2020 it is predicted that there will be pancreas pacemakers for diabetics, mentally controlled electronic muscle stimulators for stroke and accident survivors, and miniature cameras and microphones that can be wired into the brain, allowing blind people to see and deaf people to hear. An example of how this works is the bionic eye where a camera is mounted on a person’s glasses and sends signals to an implant on the retina, which sends impulses to the brain, which are perceived as images. About 30 individuals have received artificial retinas and the technology continues to improve in order to change lives for patients with macular degeneration (Howard, 2011). Further research is needed on comparing the effectiveness of robotics and human care providers, but the ideas behind this technology can have a benefit for the patient and nurse.

Three-dimensional printing is “a method of building objects layer by microscopic layer, fusing each cross section of molecules until a complete object is formed" (Pellet, 2013). Bioprinters use a bio-ink made of living cell mixtures to build a 3D structure of cells to form human tissue and organs for replacement. A benefit of this technology is it makes the body into a system of interchangeable parts. Artificial limbs, dentures, hearing aids, and human organs can be made with 3-D printing. The parts are made from the organ recipient's genetic matter, and precisely match the tissue or organ they replace. For example, in February 2013, doctors and engineers in the Netherlands used 3-D printing to create a prosthetic lower jaw, which was implanted into an 83-year-old woman with chronic bone infection (Huston, 2013). The printer produced the prosthetic jaw from 33 layers of titanium powder that were heated, fused together, and then coated with bioceramic artificial bone. Currently, 3-D printers are able to print simpler tissues like skin, heart muscle, and blood vessels; in addition, the printing of solid organs like hearts and livers is expected within a generation (Huston, 2013). A challenge with this technology is that there are limits to the materials which can be used for printing.

Telenursing is the use of telecommunications technology to provide nursing care while using information and data remotely. This specialty has the potential to transform nursing practice and improve patient safety. Williams, Hubbard, Daye and Barden (2012) examined the usefulness of the Tele-ICU in improving outcomes for critically ill patients and the results showed reductions in intensive care unit mortality, shorter stays in the hospital, increased compliance with evidence-based best practices such as screening for sepsis, improved outcomes in cardiopulmonary arrest patients, and decreased costs for patient care. The Tele-ICU has the ability to assess and monitor hundreds of patients through any electronic technique in use at the patient’s bedside. Standard monitoring such as electrocardiography and hemodynamic values are maintained continually, and access to medical records, diagnostic images, and laboratory results is available at the click of a mouse. A telehealth nurse makes rounds and assesses patients via video or audio camera technology but assessments still require the same observation skills as a bedside nurse. Alarms alert the nurse to physiological trends so that changes in patients’ condition can be noted earlier by nurses who view the telemetry monitor to provide early intervention and prevent deteriorating conditions. Telehealth also supports the collaboration between staff because a telehealth nurse acts as a resource for the bedside nurse. The telehealth nurse can quickly retrieve vital data for the bedside nurse in order to save them valuable time, provide accurate current information, and improve patient care and safety (Williams et al., 2012). By watching over a bedside nurse’s second patient while the bedside nurse transports a patient off the unit to a diagnostic test or a procedure, this technology supports the safety of patients and decreases the workload of caregivers. An example of how this technology can improve patient safety is by preventing a fall from thirty miles away (Williams et al., 2012). The nurse can check the camera view in a patient’s room after noticing a change on the main telemetry monitor and see a patient out of bed who appears unsteady. The telehealth nurse can speak to the patient and realize they are disoriented. The nurse can call the bedside staff to alert them of the patient’s situation and the bedside staff can rapidly arrive at the patient’s side, reorient them, and return them to bed. Despite the advantages described, using telemetry can be challenging. A level of trust must be developed between the telehealth nurse and the bedside staff because of the absence of face-to-face communication. Also, overcoming equipment malfunctions or a network crashing can cause problems in the setting.

Nurses need to develop leadership skills to respond to emerging technologies in order for these interventions to be effective in practice. According to the *Future of Nursing* report by the Institute of Medicine (2010), nurses are expected to use a variety of technological tools and information management systems that require skills in analysis and synthesis to improve the quality of care. One leadership skill that is critical for nurses is the ability to use technology that facilitates mobility as well as relationships, interactions, and operational processes (Huston, 2013). Healthy People 2020 suggests that communication and health information technology that supports shared decision-making between patients and providers can result in social support networks (Healthy People 2020, 2012). Health information technology can deliver accurate and accessible health information, promote exchange of health information among healthcare professionals, enable quick action to health risks and emergencies, increase health literacy skills, provide new opportunities to connect with culturally diverse populations, and design interventions that result in healthier behaviors. Another skill set that nurses need is having expertise in knowledge information, acquisition, and distribution. Nursing is a profession where knowledge doubles every six years, therefore nurses can no longer be the keeper of knowledge (Huston, 2013). Instead, they must master collecting and sharing knowledge with others. Computers will play a significant role in knowledge acquisition and distribution since they have potential to extend memory and cognitive capacity. Nurses cannot make appropriate decisions when caring for patients without having the right information. Nursing is an information-based profession and technology helps bring knowledge into care.

Nursing informatics is a specialty that integrates nursing science, computer science, and information science to manage and communicate data and information in nursing practice (McGonigle et al., 2014). This specialty involves the use of computer technology to support all aspects of nursing practice, including direct delivery of care, administration, education, and research. In clinical practice, nursing informatics can be used to track patient outcomes, find data trends, and assess workload and interventions. It also can develop technologies to help health care providers virtually monitor and stay in touch with patients. Nurse informatics supports nurses by allowing quick access to information to facilitate the delivery of safe patient care, support administrative decisions, and enhance the education of nursing students, health care consumers, and the public through the use of technology. Nursing informatics can help managers with cost containment, improved workflows, decision support, budgeting tools, and trending costs and savings. Nursing informatics also supports nursing research by evaluating patient outcomes and evidence-based practice.

Nurses will face leadership challenges with integrating new technology. A significant challenge is finding a balance between maximizing the benefits of using the technology, while not devaluing the human element, so that the caring aspect is not lost in the process. The relationship between the patient and nurse is the art of nursing; therefore nurses need to be sure not to eliminate the human connection. Another challenge nurses must address is cost. The United States health care system is already the most expensive healthcare system in the world and technology is one of the leading reasons (Huston, 2013). These technologies are saving lives and improving the quality of life for millions, but in some cases technology development comes first and then a need is created because the technology exists. In addition, many patients face healthcare disparities and cannot afford to pay for technology. Another challenge with implementing new technologies is finding leaders who will train the nurses. All nurses need to take time to demonstrate competencies to maintain practices and nurse informaticists need to be available to lead this training. According to the HIMMS position statement (2011), in order to increase the effectiveness of utilizing new technologies in practice, there needs to be an increase in education on informatics in academic nursing programs and job expectations for all nurses. A final challenge is the ethical aspect of using these technologies. Nurses need to ask why the technology should be implemented and there needs to be specific parameters developed to determine the use of technologies. Nurse leaders must think about how new technologies will change nursing practice and create educational programs to assure that nurses will have the competencies they need to address the new technology. If a technology is not used as intended, increased inefficiency and medical errors may result.

There are many future interventions being researched for technology in healthcare. According to Eric Topol, a leading cardiologist who has embraced the study of genomics, humans will soon use smart phones to monitor vital signs or chronic conditions and nurses are not going to be carrying stethoscopes ("The wireless future of medicine,” 2010). Topol highlights wireless devices in health care’s future, which can reduce the number of patients in hospital beds. Electrocardiogram monitors and fetal monitoring devices are a future intervention that measure cardiac rhythm, heart rate, fluid status, temperature, respiration, oxygen, and position activity. An electrocardiogram necklace or a fetal monitoring device sends data on critical health measures to physicians who can monitor cardiac patients or women with high-risk pregnancies, and start diagnoses before patients reach a hospital. Heart failure is the leading reason for hospital admissions and readmissions in the United States. The cost of heart failure is 37 billion dollars a year, which is 80% related to hospitalization ("The wireless future of medicine,” 2010). Furthermore, 700,000 people die a year in the United States from sudden cardiac death. By using an electrocardiogram or iPatch to continuously monitor vital signs, atrial fibrillation and sudden cardiac death can be prevented. Another future technology is a wireless phone that will be able to display every minute of sleep by continuously monitoring brainwaves. The color orange will display to represent that the individual is awake; the rapid eye movement and dream state sleep are light green; light sleep is gray; and deep sleep is dark green. This is a useful intervention for patients because one third of our life is supposed to be spent in sleep and this can track that pattern. Another technologic intervention for the future is measuring caloric intake as well as expenditure through a Band-Aid. The Holter Monitor is a tiny patch that records for twenty-four hours and can be kept on for two weeks and sent in the mail. The sensors on the patch send a signal and create a body area network to a gateway, such as a smart phone. That signal goes to the web and then it can be processed and sent anywhere: to a caregiver, to a physician, or back to the patient. Another future intervention that is being developed is a chip in a pill that sends data from inside a patient’s body to a web portal where physicians track treatment progress to see if patients are compliant. Current technology allows the healthcare team to connect with patients without the barriers of time or physical proximity. Healthcare environments are incorporating virtual office visits, online appointment scheduling, mobile laboratories, electronic medication prescribing, and patient portals connected with electronic medical records. These technologies provide both opportunities and barriers to moving care outside of the clinician’s office or hospital room. This is a benefit for internet-savvy patients because they can access details about their health problems, treatment options and increase their autonomy. According to statistics from the HIMSS position statement (2011), 59% of adults use technology to access healthcare information. Nurses play a critical role by helping patients set up their personal health records and explaining how to use a patient portal. A challenge with this new technology is the initial work can be intimidating, especially for patients with healthcare literacy barriers. In addition, moving care outside of the hospital can take away from the patient and caregiver relationship.

In conclusion, technology will continue to be a significant enabler of future care delivery and nursing informatics leaders will be essential to transforming nursing practice through technology. The *Future of Nursing* report clearly states that “Health information technology will fundamentally change the ways in which registered nurses plan, deliver, document, and review clinical care” (Institute of Medicine, 2010).

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