Chapter 16
The Future of Nursing Informatics in a Digitally-Enabled World

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Abstract  The nursing profession has a history of embracing novel technologies that support the delivery of compassionate, person-centred care. The emergence and rapid adoption of ‘intelligent’ technologies that have the ability to act autonomously, but that are often embedded and ‘invisible’ to users, is challenging the nursing profession to reconsider their role in the health system of the future. Using a socio-technical lens the authors examine artificial intelligence and process automation technologies because of their significant potential to become much further embedded into nursing work and disrupt the healthcare system as we know it. Opportunities for nurses to transform their role in the healthcare value chain, will arise from the profession’s proactive reconceptualization of the nursing role in an era where technology is moving from discrete transaction processing and monitoring applications to pervasive computing. But the nurse’s traditional patient and family advocacy role will remain important, as policy, regulatory and ethical challenges arise from the development and use of these emergent digital technologies. The rapidly changing healthcare ecosystem demands nursing involvement in the research, design, adoption and use of emergent digital technologies. The subtle normalization of these technologies into the nursing role will require new nursing knowledge and skills, and different relationships between nurses (i.e., practice, education, research, leadership) and other actors (i.e. patients, physicians, technologies) in the healthcare ecosystem of the future.

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**Learning Objectives for Chapter**
1. Understand emergent digital technology, as related to nursing practice, education, research, and leadership.
2. Explore new social and technical (socio-technical) relationships that are beginning to emerge between humans and technology in all areas of nursing practice.
3. Understand philosophical and conceptual inquiry as it relates to the use of artificial intelligence and robots/robotics within nursing practice and future models of care.
4. Evaluate the ethical, social justice, and nursing care implications of emergent digital technology like artificial intelligence and robotics upon various aspects of the nursing role.

**16.1  Introduction**

The nursing profession has witnessed significant technological and societal change over the last few decades. With the increased adoption of all forms of electronic and communication innovations and increasing diffusion of emergent digital technologies like artificial intelligence across all areas of society, the nursing profession is currently entering a critical point in its history. How will the emergent technological forces of today shape the nursing profession, and the role and function of nursing in the future? How can the profession differentiate itself from other caring professions? How do emergent technologies complement current nursing value(s) and reveal entirely new ones? The profession as we know it, may be facing a subtle existential crisis - what will the nursing role look like and be like, in the future?

In this chapter, we will explore the rapid growth and adoption of emergent digital technologies and the impact, growth and relevance to the nursing profession now and into the future. While nursing has a long track record of using innovation in both proactive and creative fashions, the exponential growth of disruptive emergent digital technologies has resulted in uncertainty around how best to align current-state nursing roles and knowledge with approaches to health(care) in the not-too-distant future. Although it is has been predicted that many of the roles and skills currently fulfilled by nurses will continue to exist in the foreseeable future (Frey and Osborne 2017), remaining static as a profession in this quickly evolving environment will likely be incompatible with a productive or prosperous future (Booth et al. 2019). To help practitioners plan for this future, the chapter will also help identify strategic opportunities and practical suggestions as to areas where nursing can evolve in meaningful and proactive ways that leverage emergent digital technologies to advance the profession and remain relevant to the goal of improved
The chapter will conclude with a range of strategic planning considerations and exemplars to help guide practitioners to reconceptualize aspects of their nursing role in light of emergent digital technology, and reflect on how the profession can differentiate itself and generate new and innovative ways to contribute to the healthcare value chain in a digitized and automated world. While not always comfortable, with this level of discussion and candour we hope to stimulate timely and important reflection of the nursing profession.

16.2 Current State

The current state of the nursing profession in relation to informatics and other digital technologies is both extensive and multi-dimensional. Recent societal and global events (i.e., COVID-19 pandemic, climate change induced diseases and disasters) have reinforced the importance and potential of modern information and communication technology. It would be redundant to enter into a discussion here about what the nursing profession uses now in terms of technology (as of writing in April 2020) or to provide a list of current state technologies that are important within contemporary nursing. For that we encourage readers to consult other chapters of this book and the numerous other resources available on the topic (Booth et al. 2019; Risling 2017; Morse et al. 2019; Frazier et al. 2019; Huston 2013).

Instead we intend to explore nursing’s current-state interpretation of emergent digital technologies. Over the decades, numerous scholars and practitioners have presented their ideas regarding the state and value of all forms of technology used within the nursing profession. Taken as a collective, there appears to be an underlying notion across much of the nursing discourse that the impressive growth and diversity of technology adoption happens around or adjacent to the nursing profession. That is, the nursing profession possesses the ability to remain largely unchanged in the types of traditional roles and activities for which its known, despite an ever-increasing variety and complexity of emergent digital technologies used in and for nursing work. Although there are a variety of reasons the nursing profession commonly elects to discuss informatics and emergent digital technology from a socially-grounded and human-centric perspective, for the remainder of this chapter, we will adopt a more balanced conceptual lens that balances the social aspects of action (e.g., nursing roles, their relationships with patients, etc.) with the complementary technical aspects of reality (e.g., emergent digital technology and the processes they facilitate, etc.). We believe this socio-technical (Berg et al. 2003; Sittig and Singh 2010) approach to conceive and generate recommendations for future practice offers a more balanced theoretical perspective from which to generate implications for future practice. As we progress in this fashion, it will become quickly apparent that the digital healthcare ecosystems of the future will challenge the nursing profession’s conception of the nursing role and necessitate a move to leverage the best elements of what is human and what is technology. It must engage in discussion that privileges both social and technical features as equally powerful, important, and
essential to the generation of realistic recommendations for the future of nursing as it relates to emergent digital technology.

16.3 Nursing’s Contemporary Relationship with Technology

The dominance of discourse in nursing about advantage or disadvantage of technology exemplifies a profession struggling to come to terms with the phenomenon. (Barnard, 2016, p. 9)

As described by Barnard (2016), throughout nursing discourse technology (of all types) is often characterized as an object or tool which, through the act of being used by a nurse, can generate outcomes that are potentially beneficial to practice. While a seemingly accurate characterization, the role, presence, and potential value of technology within the profession has been largely reduced to discussions about the explicit advantages and disadvantages brought by the presence or functionality of a specific technology (Barnard 2016). The nursing informatics literature has a long tradition of discussing and examining various technologies used by nurses in practice, leadership, research and education, commonly through a lens that assesses benefits and/or drawbacks. Although this approach to conceptualizing the role and merits of technology is valuable, these high-level assessments fall short when applied to newer forms of emergent digital technologies many of which invisibly shape models of practice and nursing activities.

For instance, there is a long lineage of health and nursing informatics research that describes how traditional health technology (e.g., electronic medical records, bar code medication administration systems, etc.) used by practitioners can sometimes (re)shape actions of people in both intended and unintended fashions (Koppel et al. 2005; Gephart et al. 2015; Novak et al. 2013). As both Sandelowski (1999) and Barnard (2002) describe, nursing discourse has privileged the notion that technology sometimes possesses an overt ability to direct the actions of people, and to be “everywhere we practice, yet we are not always aware of it” (Barnard 2002, p. 19). These seemingly invisible forces acting upon and between the relationship of nurses and technology continues to accurately depict the contemporary reality faced by many nurses, especially as related to emergent technologies that use advanced functionality like artificial intelligence. Recently, concerted efforts have been undertaken within informatics research to synthesize how emergent digital technology using artificial intelligence and other self-learning functionalities can and do influence their human clinician counterparts in both intended and unintended fashions (Shortliffe and Sepúlveda 2018; Lynn 2019; Cresswell et al. 2020). Given the increasing embeddedness of many newer technologies and an individual’s inability to consistently be “aware of it” (Barnard 2002, p. 19), we propose that the rapid evolution of many modern-day technologies has superseded the abilities of many nurses to remain situationally aware of their presence in health(care) practice. In the span of less than a decade, all forms of mobile technology, digital communications infrastructure, robotics, and innovations using artificial intelligence which were
once the narratives of science fiction, have become fixed realities in many western societies and health(care) practices. Although technology has evolved significantly, nursing’s conceptualization and descriptions of technology and the new human-technical relationships it can stimulate are still constrained by a range of traditional semantic and cultural factors. As described by Sandelowski (1999), the nursing profession has historically utilized a “traditional western binary distinction…” (p. 204) between what is conceived to be human and what is technology. Further, Sandelowski (1997) suggests that “English language customs make it difficult to convey the human-technology relation as other than one of us/it and cause and effect” (p. 222). While written over 20 years ago, the desire to discuss the function of humans and technology separately persists today. While it would seem that the semantic division of humans and technology is still commonly preferred in nursing discourse, the rapid integration of emergent digital technology in the profession and across society is making it increasingly difficult to ignore how interdependent the relationships between humans and technology have become. For instance, with a range of wearable Internet of Things (IoT) devices now available (e.g., FitBit, biometric trackers, modern smartphones) that connect humans to devices and to larger networks of devices (e.g., 5G cellular internet, home automation technology, social media platforms), that also possess varieties of potentially human (e.g., real-time chat for product consultations, multi-person webinar and teleconference technology) and non-human interaction points (e.g., internet bots, personalized marketing, artificial intelligence bots for journalism, news articles, and publications, blockchain), we are entering a new paradigm where it is almost impossible to discuss the modern-day activities of humans in the absence of technology. With the blurring boundaries between embedded digital technology and many activities of daily life, it is increasingly difficult, if not impossible, to conceptualize nursing actions in the absence of some form of modern digital technology (and vice versa). Although it is appreciated that nursing is not technology and technology is not nursing, the challenge for practitioners and scholars moving into the future is to embrace and better understand the socio-technical relationships that have become normalized (either consciously or unconsciously) over the last decade.

16.4 Conscious and Unconscious Normalization

As described by Agar (2015), hedonic normalization is the tendency for people to form “goals and experiences … [as] appropriate to the environments experienced as an individual comes to maturity.” Simply put in reference to technology, experience of using technology by an individual is normalized through use of the specific technology. Over time, an individual can add to their baseline of experiences, and subsequently normalize the use, function, and existence of the innovation as being commonplace or necessary for action. If the technology is useful and beneficial to individuals, they continue to draw hedonic gains from its use, which can eventually result in treating the innovation as normal or potentially requisite in everyday life.
As an extension to Agar’s interpretation of hedonic normalization, we suggest that the rate of change and innovation has become so rapid in recent times, that most individuals no longer have adequate time to consciously understand or realize which digital technologies they normalize into everyday life. Thus, we propose that hedonic normalization of technology occurs at a rate faster than individual generations of people now realize, and commonly occurs unconsciously, stimulated by the nature and subtle embeddedness of many modern-day digital technologies in daily life. Insomuch as we have entered a new time period in nursing history where the life cycles of technology occur so quickly, we suggest that conscious awareness of the role, function, and even presence of many innovations is never fully realized by users of the technology. For instance, there are over 100 million artificially-intelligent, cloud-computer connected, natural language conversational Amazon Alexa smart devices that have been sold to date (Bohn 2019). A decade ago, a device like the modern-day Alexa would have been described as a primordial prototype of a future voice-enabled smart device; two decades ago, a device like Alexa would have been viewed more of an artifact arising from science-fiction, than an easily obtainable piece of digital technology that is currently sold globally. From a nursing perspective, we have entered a new domain where the profession is having to evolve in response to many types of emergent digital technology, and awareness of this evolution and intended [or unintended] consequences may not be present or appreciated. To our original point, we have stumbled into a reality where the socio-technical blurring of human and technological roles, knowledge, and action occurs on a daily basis in nursing, commonly without conscious awareness. In the coming sections, we provide explicit examples where blurring is happening between the nursing role and emergent digital technology, and explore the new roles, actions, and knowledge possible from this reconceptualized human-technical relationship. Furthermore, we expand upon how nursing must position itself to impact healthcare and patient outcomes in the technology-normalized future.

16.5 Conceptualizing the Future of Nursing

Across society, many types of emergent digital technologies have been used to stimulate new patterns of human behavior, models of economy, and approaches to knowledge sharing and dissemination. With the generation of new approaches to human action, new relationships between humans and technology are formed, refined, and evolved as necessary. While nursing and healthcare have begun to leverage many of these emergent digital approaches in support of nursing work and knowledge generation, further discussion of how nursing can leverage the best parts of human presence, knowledge, and abilities augmented by the power of emergent digital technology must be conducted. To do this, deeper exploration and reconceptualization of nursing roles and knowledge in health(care) activities of the future is required. Through theorization of the future roles and knowledge requirements, this
chapter aims to provide practitioners with a blueprint from which to begin reconceptualizing all aspects of nursing practice, education, research, and leadership.

16.5.1 Future Roles and Knowledge Required by Nurses

In light of the advances in novel technologies, there is a substantive amount of scholarly literature exploring the future trajectory of the profession (Tanioka et al. 2019; Buchanan et al. 2020; Nagle et al. 2017; Topaz et al. 2016; Strudwick et al. 2020; Remus and Kennedy 2012a; Remus and Donelle 2019; Fridsma 2018). Within the nursing informatics domain, experts have speculated on various competencies and trends that will be important over the coming decade. For instance Nagle et al. (2017) suggest that a future nursing informatics specialist will function within virtual models of care, complemented by a range of knowledge related to data analytics, and leverage new care delivery approaches enabled by IoT and other technologies. Topaz et al. (2016) completed a large cross-sectional survey of 272 international nursing informatics researchers and practitioners and uncovered a desire within the discipline to expand the roles of nurses related to digital technologies by: (1) increasing leadership opportunities for nurses (i.e., chief nursing informatics officer); (2) integrating informatics more deeply into nursing education; and, (3) demonstrating clear linkages between the use of nursing data and related health outcomes, including its impact on clinical decision-making, interprofessional collaboration, and increasing research opportunities for practitioners. They note that as consumers have progressively more access to their own health records, the role of nurses will expand to include that of digital knowledge broker and system navigator. More recently, Strudwick et al. (2020) propose that the nursing role within future digital healthcare ecosystems supported by artificial intelligence and process automation technologies, will require the profession to reconsider how compassionate, person-centred care is conceptualized and enacted. Through an extensive review of literature and expert panel consultations, the authors conclude that difficult decisions will need to be made including: (1) reconsidering traditional roles and tasks conducted by nurses that may not contribute value or be valued in future healthcare ecysystems; and, (2) how the profession can better position itself to direct future health(care) processes in relation to critical issues such as ethics, social justice, and humanistic practice, in light of technological advances.

As introduced by Strudwick et al. (2020), the ability of nurses to provide compassionate, person-centred care in the future will be contingent on a deep understanding of not only the mechanical skills needed to use the technology, but an evolved appreciation of the ethics and social justice issues associated with its use. Nagle et al. (2017) and Topaz et al. (2016) both describe nursing in the future as requiring receptivity toward various virtual and digital care models that may look significantly different than approaches used in the past. Taken together, these scholars have suggested that future nursing roles will require an evolved understanding of various processes (and their related implications) stimulated by new
opportunities generated by digital technology. Two such emergent digital technologies that have been projected to significantly influence the nursing profession include artificial intelligence and process automation (Booth et al. 2019; Buchanan et al. 2020; Strudwick et al. 2020; Pepito and Locsin 2019; Archibald and Barnard 2018; Erikson 2016; Frith 2018; Booth 2016). While there are other innovations that will likely have material influence on the role and knowledge used by nurses, artificial intelligence and process automation technologies have been targeted for deeper exploration due to their significant potential to become much further embedded into nursing work. In the following section we conduct a detailed discussion and analysis related to the use of artificial intelligence and process automation technologies in nursing and within the nursing role.

16.5.2 Artificial Intelligence

As with much technology discourse in the past, artificial intelligence has become a monolithic term within the nursing discourse and refers to many different forms of machines or digital systems that mimic the cognitive functions of a human, including actions like problem-solving, decision-making, and learning (Stuart and Peter 2016). While the domain of artificial intelligence is wide and diverse, for the purposes of simplicity, this chapter will use the term to describe technology that has the ability to perform actions or tasks (e.g., decision-making) which would normally require some degree of human intelligence (Buchanan et al. 2020). As described previously, over the last decade the use of artificial intelligence in society has become both ubiquitous, but also commonly invisible. Applications using artificial intelligence underpin numerous processes and activities that support contemporary life and economies (West and Allen 2018). Virtually every device connected to the Internet now uses some form of artificial intelligence, either through its embedded decision-support functionalities, or its connectivity with larger intelligent systems that can generate personalized or predictive information for a user. While it is beyond the scope of this chapter to provide a fulsome discussion of the pervasiveness of artificial intelligence within contemporary society, it is sufficient to say that many aspects of modern life have been transformed through the use of these forms of technology. One common feature of artificial intelligence in a system is its use of complex algorithms to execute actions. Unlike traditional computerized systems that are unable to evolve the algorithms pre-programmed into the system, technology using artificial intelligence generally possesses the ability to improve upon pre-existing algorithms through self-learning and exploration of new or existing data. Machine learning is a subset of techniques in artificial intelligence, that helps systems receive, process and analyze data then change their embedded algorithms as they learn more about the data they’re processing; in essence they improve their predictive capabilities and accuracy in semi- or autonomous fashions without human intervention (Kwon et al. 2019).
The increased penetration of artificial intelligence into computerized and digital systems used by humans, has generated concerns amongst privacy and ethics proponents regarding the use of systems that can self-learn with limited human oversight. According to Vayena et al. (2018) one of the primary concerns about the use of machine learning systems in healthcare is that “algorithmic bias” (p. 3) in the machine learning process may reinforce inequity, stigma, and imbalanced representations of people or populations. AI’s blackbox problem, caused by our inability to always fully understand how algorithms work the way they do, means that many machine learning processes particularly those that teach themselves to make predictions on datasets, are unable to be reverse engineered leaving clinicians with outcomes they are unable to interpret or justify.

While artificially intelligent systems using machine learning can interrogate massive data sources and generate important recommendations and predictions to optimize outcomes, they may be susceptible to algorithmic biases, with unintended consequences. Automating inequalities is the term used to describe the outcomes of algorithmic decision-making approaches that are applied uncritically and amplified through the use of digital technology (Bullock 2019; Eubanks 2018). There are reports in both the media and scholarly literature that suggest the uncritical use of digital technology underpinned by self-evolving algorithms can sometimes reinforce inequities found in society due to over or under representation of various population traits in data sets used to train the machine learning systems (Vayena et al. 2018; Gianfrancesco et al. 2018). From a nursing practitioner’s perspective, the potential amplification and reinforcement of inequities should be of significant concern. With a long history of social justice advocacy in the profession (Woods 2012), we envision an equally important role for nurses in future digital health(care) ecosystems (Sensmeier 2020). It is predicted that investments in artificial intelligence and machine learning technologies related to healthcare will eclipse $36 billion by 2025 (Brenswick 2018), further reinforcing that nurses must continue to play a role in advocacy and oversight to ensure algorithmic biases within these systems are both detected and addressed. As outlined by a number of nursing scholars (Nagle et al. 2017; Strudwick et al. 2020; Frith 2018; Booth 2016; Kwon et al. 2019; Brennan and Bakken 2015; Remus 2016), the profession needs to become more embedded in data sciences in order to act as a steward for patients and their families who might suffer inequities due to the inappropriateness of automated algorithms or its underlying data. Further, the nursing profession must become more adept at understanding the purpose or value of applying artificial intelligence to various care processes; the various latent biases that may exist within the algorithms or data sets; and, the clinical appropriateness of applying predictions generated by these systems to real-life practice and clinical workflows (Frith 2018; Kwon et al. 2019).

To date, the existing nursing discourse addressing algorithmic bias and the automation of inequities has focused on healthcare-centric models of care, or data sources used or generated by nurses (Remus 2016; Hansen et al. 2014; Bakken and Reame 2016; Brennan and Bakken 2015). Although this is a logical starting point, we suggest that a more pervasive view of algorithmic bias across all areas of society
and its interface with health(care) would be beneficial (e.g., digital economy; information manipulation; online personalization-marketing; education; civil and societal governance). As champions of social justice, nurses must acquire not only the skills and knowledge to participate in the development of predictive analytics, but also advocate on behalf of marginalized populations who stand to suffer the most from the automation of inequalities. Therefore, along with developing professional skills and expertise in data analytics, nurses must conceptualize equity-based and social justice nursing theories, and develop complementary and mutually synergetic skills sets. It will not be enough in the future for nurses to learn data science and artificial intelligence methods; rather, nurses will also need to contemporaneously generate evolved understandings and theoretical interpretations of ethics and social justice in a world underpinned by artificially intelligent entities. As previously described, in the healthcare ecosystems of the future, the blurring of human and technological entities will become increasingly difficult to tease apart – equally, so will the intertwined ethical and social justice implications generated from this emergent human-technical relationship. Therefore, we recommend that the use of advanced data analytics such as artificial intelligence and machine learning in health care, include the contributions and refined understanding of the nurse as advocate for the values of compassion and social justice. Clearly, without reconceptualizing nursing’s role as advocates for ethics and social justice in light of technological advances (Risling 2017), the profession will not possess the robust moral and philosophical heuristics from which to accurately assess, advise, or help develop artificial intelligence systems to support practice and patient care into the future.

16.5.3 Robotic Process Automation

Humans have been using various forms of automation technology for thousands of years in an effort to reduce human labour needed to complete various procedures, processes, or tasks. In contemporary terms, the use of automation technology has been observed in many industries, including manufacturing, food production, and other domains where activities that require the completion of repetitious, predictable tasks or necessitate certain levels of production consistency that humans have difficulty replicating (Peruffo et al. 2017). Although there are many types of automation technologies used currently, for the purpose of this chapter we focus on process automation technologies that seek to re-engineer large scale business operations (Khodambashi 2013; Martinho et al. 2015). Currently, there are many kinds of process automation technologies that are embedded and largely invisible within nursing activities and workflow. While many healthcare practitioners would not generally conceive technologies like electronic medical records, Lean process optimization activities, and other inventory and/or supply chain devices (e.g., medication dispensing cabinets) as a form of explicit process automation, these innovations have all been designed to standardize the replication of various procedures and tasks and capture process efficiencies if and where possible. Since the domain of process
automation has not been well studied within the nursing literature (Lu et al. 2018), the profession currently only possesses limited conceptual and philosophical understanding regarding the use, function, and potential implications of this form of technology upon the nursing role.

As a profession that has historically prided itself on the delivery of therapeutic care through a range of well-developed knowledge and skills, the development of robotic-enabled process automation technologies has stimulated scholars to question how, where, and why these sorts of devices might be used to support care. While robotic process automation is essentially a new topic to the profession (Kangasniemi et al. 2019; Syed et al. 2020), a long lineage of theorization related to the use of robots in care, cyborg ontology, and other hybridized human-machine approaches to supporting the nursing role have been published over the last few decades (Sandelowski 1999; Maalouf et al. 2018; de Almeida Vieira Monteiro APT 2016; Lapum et al. 2012). Much of this preliminary theorization related to robotics in the profession demonstrates invaluable historical thought-leadership and visioning by nursing scholars and has generated situational awareness to the topic and potential for robotics within nursing practice. That said, most of this work was completed when nursing-centric robotics and their corresponding functionalities were still largely primordial or prototypical. Until recently, many of the robotic process automation technologies used within healthcare did not influence the nursing role in a direct fashion; rather, these technologies served in largely invisible ways, supporting providers to complete their respective clinical tasks and activities, including lab specimen processing, medication dispensing, and other ancillary supply chain logistics. With the improved functionality of robotics and advancements in artificial intelligence, robotic process automation that directly influences aspects of the nursing role have become reality. To date, there is increasing use of robotics to support or augment tasks once completed almost exclusively by humans in health(care) settings (Schwab 2019; Whitesell 2017). For instance, collaborative robotics (cobots) are a growing type of robotic process automation technology that are specifically designed to work in close proximity with humans to complete shared tasks (Bendel 2020). Unlike previous automation technology that was largely mechanistic and potentially dangerous to be those nearby, cobots are a type of service robot that can be used in a range of settings (e.g., healthcare, domestic) to assist in the co-completion of various tasks, activities, and procedures (Bendel 2020; Marr 2018). Healthcare has begun experimenting and testing the use of cobots in a range of clinical and service applications. For instance, the use of humanoid supportive robots in the care or recovery of patients; drone robotics to assist or support supply and transportation logistics within a facility; and, an ever-increasing variety of semi-autonomous robotics that assist nurses in stocking shelves and other non-patient facing tasks (Schwab 2019; Whitesell 2017; Bendel 2020).

The growing presence and availability of robotics like cobots to support and augment aspects of the nursing role has engendered deep philosophical discussions within the profession (Strudwick et al. 2020; Maalouf et al. 2018; de Almeida Vieira Monteiro 2016). To date, most contemporary nursing discourse has cautiously viewed the rise of cobots and other robotic process automation as being potentially
beneficial to the profession, in the way that these innovations can support the nursing role and generate nursing efficiencies that can be applied back to important human-centred roles (e.g., more time with patients; free nursing time to complete more important therapeutic and knowledge activities; etc.). While there is significant interest in the use of robotics within the nursing profession, there also remains a great deal of hesitation and qualification by nursing scholars regarding the presence and function of these non-human entities. Speculation about the potential replacement of nurses by robots and other computerized devices remains a perennial topic of discussion by the profession over the years (Pepito and Locsin 2019; Rinard 1996; Almerud et al. 2008; Wollowick a 1970), however the general consensus by scholars is that the direct displacement of nurses by robotics and other process automation is not foreseeable. Instead, wider scale augmentation of nurses and their roles by artificially intelligent, robot process automating technologies like cobots is more likely to occur as these forms of innovation become increasingly available within healthcare environments (Booth et al. 2019; Pepito and Locsin 2019; Erikson 2016).

Although the profession appears cautiously optimistic regarding the role and value of robotic process automation technologies (Pepito and Locsin 2019; Archibald and Barnard 2018), the augmentation and evolution of traditional nursing roles by these forms of collaborative robotics requires immediate thought-leadership and scholarship. Much like the unintended consequences generated by artificial intelligence, we propose that the increasing desire within healthcare settings to enable and scale the use of robotic process automation technologies should also be met with both theoretical development and empirical research to guide practice. To date, work on theoretical and empirical assessment of robotics used in/for nursing roles has generally revolved around two central themes: (1) examining the proposed or actual impacts of robotics upon some aspect of the nursing role and specific tasks (e.g., Frazier et al. 2019; Tuisku et al. 2019); and/or, (2) conceptual or synthesis discussions regarding the implications of using robots as related to traditional values structures of the nursing profession, including caring, patient-centred care, and therapeutic relationships (e.g., Archibald and Barnard 2018; Maalouf et al. 2018; Carter-Templeton et al. 2018). Although the evidence in this domain is still nascent, there appears to be general, theoretical and empirical consensus in nursing discourse that aspects of robotic process automation have a high likelihood of significantly disrupting certain traditional roles and workflows conducted by nurses.

As new robots are developed for healthcare, the profession of nursing must become more present and active in this domain. To date, there are promising glimpses of nursing professionals becoming involved in the development, design, and evaluation of robotics that can be used within practice settings (Frazier et al. 2019; Glasgow et al. 2018); regardless, we believe more can and must be done. Similar to preceding discussion regarding the intended and unintended consequences of artificial intelligence, the use and adoption of robotic process automation in the profession must be met with increased theoretical and empirical interrogation by nursing scholars and practitioners. As with emergent digital technologies, the nuanced socio-technical relationships that process automating
innovations can engender with humans is an area of inquiry nearly absent in nursing literature. Drawing from work in other disciplines that have experienced significant investments in robotic process automation, there are currently many important ethical and labour policy implications from the adoption of these forms of innovations that have yet to be explored by nursing. For instance, Theodore et al. (2019) conducted a large scale workplace policy analysis examining the use of automation and optimization technologies within warehouse and storage facilities. They concluded that while newer process automation technologies like robotics “promise to alleviate the need for the most arduous activities… [their use] will be coupled with attempts to increase the pace of work and productivity in other tasks, with new methods of motivating and monitoring workers.” (Theodore et al. 2019, p. 52).

Although there are material differences between warehouse and health(care) work environments and related roles, tasks, and knowledge needed to operate in each respective domain, Theodore et al.’s (2019) conclusions are striking and worthy of deeper consideration. From a nursing perspective, much of the discourse related to robotic process automation has avoided explicit discussion of the potential policy implications that might arise from adoption and use of these technologies. While many of these process automating technologies may be designed or branded as possessing the ability to increase productivity by alleviating or assisting humans with mundane tasks, rarely is there deeper discussion of where or how this realized efficiency will be reapplied to the nursing role or patient care. Commonly, the underlying assumption of robotic process automation is that when productivity gains are generated, these derived benefits will be altruistically reinvested in aspects of the nursing role, including the reduction of workload; will afford clinicians the opportunity to seek higher level cognitive or value activities; or to provide nurses more time with the patient (Kachouie et al. 2014; Katsuya and Kelemen 2011; Vänni and Salin 2019). Drawing from conclusions proposed by Theodore et al. (2019), we suggest benefits realized from automation may not be equitably reapplied to proactively amplify nursing activities, without nursing profession’s advocacy and stewardship of policy development to protect these emergent gains. The use of robotic automation technology which can augment or displace traditional human activities is a perfect storm of social versus technological friction. The nursing profession must proactively explore its adoption in relation to labour policy and contractual agreements. Further, entirely new domains of nursing inquiry exploring the human-robotic relationships developed by the increasing presence of robotic process automation innovation is needed to afford the profession guidance into the future. It is proposed that new areas of inquiry should be undertaken, including deeper theoretical and empirical analysis related to: (1) nursing activities and tasks through which humans and robotics can co-collaborate to achieve higher and more robust outcomes; (2) exploration of specific nursing roles and tasks related to robotic process automation that can be successfully and safely amplified in semi- or autonomous fashions; (3) re-examination of traditional nursing informatics topics like technology usability and user-centred design, in light of robotic technology that potentially possesses self-intelligence and the ability to learn and meaningfully respond to human interaction; and, (4) other future-forward policy, practice guidance, and legal
frameworks related to the delegation of complex and regulated tasks to artificially-intelligent robotics. Although the profession is still likely years away from seeing robotic process automation en masse within work environments, without this sort of theoretical and empirical grounding, nursing may miss a significant opportunity in its history to expand and evolve the nursing profession in ways previously unimaginable.

16.6 Implications for Nurse Educators

Globally, nurse educators represent an important group in shaping the nursing profession as they prepare tomorrows nurses for the realities of the practice world and beyond. However the current challenge is that nurse educators at the entry-to-practice level are not well equipped to tackle future-focused topics such as artificial intelligence, robotics, and implications of innovative technologies on the nursing profession (Risling 2017; Nagle et al. 2014). In fact, this group is at times not well prepared or comfortable teaching some of the basic nursing informatics topics present today (Nagle and Furlong 2019). Since the future of nursing informatics is constantly evolving, nurse educators will need to understand and be comfortable teaching concepts that supersede individual technologies, and that can be applied to a variety of novel technologies that nursing students may interact with in their clinical practicum environments. Nurse educators must do so while still recognizing the implications of specific technologies (e.g. automation, sensors, voice activated technologies) on practice, and at times incorporate these innovative technologies into their usual teaching methods like simulations, skill development, lectures and beyond. One crucial opportunity that nurse educators must be equipped for and embrace is to engage students in important discussions about the privacy, regulatory and legal implications when new technologies are developed for healthcare contexts. Numerous countries have developed entry-to-practice competencies for nursing informatics (CASN/Infoway 2012; O’Connor et al. 2017); while these initiatives are an important start, they should be assessed for relevancy in the context of future-forward topics and technologies.

16.7 Implications for Nurse Leaders

Similar to nurse educators, nurse leaders in influential roles today can have a significant impact on shaping the nursing profession of the future. These nurse leaders are often in the position to support procurement, selection, budgeting, implementation, optimization, evaluation and other critical processes common to the lifecycle of technology in healthcare organizations, regions or authorities, or even countries. Nurse leaders should work towards the inclusion of nursing input at all levels of the technology adoption lifecycle, influencing decision-making to ensure that
technologies support nursing professional practice, and in turn, positively impact the recipients of their care. In doing so, if done consistently, there are tremendous opportunities for improvements to the profession and more importantly for patients. However, several challenges exist. In many cases nurses in senior leadership positions have not had informatics-related topics discussed or taught during their entry-to-practice education, and therefore the knowledge may be unfamiliar to them (Collins et al. 2017; Remus and Kennedy 2012b). In addition, informatics competencies that are unique to the nurse leader level may not be well developed (Strudwick et al. 2019).

Nurse leader informatics competencies have been uniquely identified in several countries (Strudwick et al. 2019; Westra and Delaney 2008). The uptake of these competencies at the present time is low but growing, as more opportunities for professional development and advanced degrees in nursing informatics is offered. The shortage of nurse leaders skilled in informatics frustrates the professions’ ability to generate positive benefits from technology implementation and use in nursing practice.

16.8 Implications for Nurse Researchers

Nursing informatics applications of the future offer a significant opportunity for nurse researchers. The breadth and volume of health-related data available to nurse researchers to ask and answer important profession-related questions are unprecedented. Data sources include electronic health record systems, wearables from both patients and nurses themselves, voice-activated and voice-recognition technologies, sensors, active and passive data collection from mobile phones, biometrics, and other remote patient-monitoring systems in the home. Advanced statistical methods such as text mining using natural language processing and social media analytics, and predictive analytics using data mining techniques such as decision tress and artificial neural networks are increasingly used by nurse researchers. These new tools allow them to ask new and different questions that have been impossible in past clinical and health services research (Strudwick et al. 2020; Kwon et al. 2019; Brennan and Bakken 2015). Nurse researchers also play an important role in conceptualizing the changing role of nurses in our tech-enabled future. The opportunities for nurses studying and researching in this domain is limitless.

16.9 Differentiating Nursing Now and into the Future

As described in the previous sections, nursing is at a significant inflection point in its history and evolution as a profession. Advanced technologies that were once the topics of science fiction mere decades ago are now real-life considerations that influence and shape nursing practice. In order to fully leverage this new and
emerging reality the nursing profession must act quickly and decisively to communicate its vision for the future. While collective action is sometimes difficult, given the exponential gains made by emergent digital technology over the last few years and the creeping skill-mix augmentation of the nursing role with lower-skill healthcare providers (Aiken et al. 2017), difficult questions will need to be addressed to help differentiate the profession now, and into the future. In short, the nursing profession will need to clearly delineate its competitive advantage moving into the next few decades, that will likely be underpinned in fundamental ways by artificial intelligence and other robotic process automation that will continue to challenge modern day nursing activities and value-structures. As outlined in previous sections, the socio-technical blurring of roles, action, and behavior related to the presence of emergent technology like artificial intelligence and robotics are variables that need to be considered in all future conceptualizations of the profession. Partaking in deeper discussions related to how nursing and emergent digital technologies can work together in new ways to deliver care that is both human-centric but also receptive to nursing role, knowledge, and activity evolution, is of utmost importance. The nursing profession needs to view the growing presence and importance of these technologies not as a barrier; instead, as an antecedent force that will allow the profession to amplify its future value proposition to health(care), by allowing the nursing role to evolve in meaningful ways to interact in and within virtual and digital models of care that are currently primordial or uncontested by other healthcare professionals (Booth 2016). In order to move forward into this future as a unified and valued profession, nursing needs to explore how it will synergize with various emergent technologies, and amplify the new roles, behaviours, and knowledges these newfound relationships can enable. Without approaching future visioning for the profession using this socio-technical mindset, the profession will miss a significant opportunity to differentiate itself from the roles of other healthcare providers and capabilities of emergent health technology – both of which, purposefully or not, will begin to augment the traditional nursing role in ways that may not be compatible with aspects of professional longevity or autonomy.

16.10 Conclusion

Throughout this chapter, we explore the future of the nursing profession in an era where technology is moving from discrete transaction processing and monitoring applications to pervasive computing where “intelligent” systems are used for problem analysis, prediction, decision support, and the autonomous performance of tasks in the healthcare setting. While this chapter provides, at times, a critical interpretation of the technologies currently or foreseeably used within the nursing role, we advocate for the nursing profession to adopt a more proactive stance. The rapidly changing clinical environment demands nursing involvement in the research and design of these tools, as well as in developing the necessary policies and regulations that will govern their adoption and use. The subtle normalization of these
technologies into the nursing role engenders new and different relationships between nurses (i.e., practice, education, research, leadership) and other actors in the clinical theatre. Without critical reflection and proactive future visioning, the profession will miss the opportunity to establish consistent professional structures, messaging and guidelines that appropriately differentiate nursing value(s) that are strengthened by emergent technologies, from those of other human care providers. The nursing profession has long understood the value of data, tools, and technology in regards to patient and client care; it is now time to fully actualize these attendant skillsets towards revisioning the future of the nurse-technology relationship and strengthening the role of nursing into the future.

**Review Questions**

1. Compare and contrast the approach that the nursing profession has historically taken to examine the impact of new technology on its role in healthcare with the socio-technical approach used here to explore the role of emerging digital technology.

2. Define artificial intelligence, and its sub-domain machine learning. Artificial intelligence is being used in the detection of disease, management of chronic conditions, delivery of health services and drug discovery. Describe one example of a nursing tool, that you think could improve patient outcomes if it included different data and the capacity for advanced analytics such artificial intelligence.

3. Why might nurses’ role in ethical oversight, and as patient and social justice advocates be more important with the introduction of advanced analytic techniques and embedded artificial intelligence in healthcare technologies?

**Answers**

1. The historic notion is that technology should be viewed primarily from a socially grounded and human-centric perspective. The nursing discourse suggests that the impressive growth and diversity of technology adoption happens around or adjacent to the nursing profession. That is, the nursing profession has the ability to remain largely unchanged in the types of traditional roles and activities for which it is known, despite an ever-increasing variety and complexity of emergent digital technologies used in/for nursing work. The socio-technical approach is presented as a more balanced conceptual lens that balances the social aspects of action (e.g., nursing roles, their relationships with patients, etc.) with the complementary technical aspects of reality (e.g., emergent digital technology and the processes they facilitate, etc.). It is suggested that the socio-technical approach provides a more balanced theoretical perspective from which to generate implications for future practice, will help leverage the best elements of what is human and what is technology, and privileges both social and technical features as equally powerful, important, and essential to the generation of realistic recommendations for the future of nursing.

2. Artificial intelligence describes technology that has the ability to perform actions or tasks (e.g., decision-making) which would normally require some degree of human intelligence. One common feature of artificial intelligence in a system is its use of complex algorithms to execute actions. Machine learning is a subset of
techniques in artificial intelligence, that helps systems receive, process and ana-
lyze data then change their embedded algorithms as they learn more about the
datum they are processing; in essence they improve their predictive capabilities
and accuracy in semi- or autonomous fashions without human intervention.

Students responses will vary to the question of nursing practice tools that
might be improved through the inclusion of more data and advanced AI function-
ality. Instructors might prompt students with an example:

Think about the type of information that might usually be collected in a suspected corona-
virus (e.g., COVID-19) intake form at public health. While an EMR will automatically
collate information such as name, date of birth, gender, address, and co-morbidities, an AI
enabled application that could access a database with historic geolocation data from
the person’s phone, and was connected to an exposed population database of similar informa-
tion, could quickly cross-check possible exposure to infected individuals, and based on
morbidity data predict the statistical risk of the person contracting the virus. While this
would not possibly change the nursing intake, when tests are in short supply, nurses could
use the system to prioritize those who received the actual test, and could advise the patient
on quarantine protocols appropriate to their risk.

3. Students responses will vary. However, they should mention the unintended con-
sequences of algorithmic bias when AI is used uncritically in decision-making.
The potential for amplification of social inequities related to race, income, gen-
der and disability when using AI have been widely reported in the media and
scholarly literature. In one seminal case in the U.S. an algorithm was used by
health care providers to screen patients to receive high-risk care management
intervention (Obermeyer et al. 2019). Patients who had especially complex med-
ical needs based on their treatment history are automatically flagged by the algo-
rum to receive additional care resources. However, due to unequal access to
treatment and affordability, black patients were much less likely to have a history
of interventions, and so were much less likely to receive the additional care.

**Glossary**

**Artificial intelligence** Technology that has the ability to perform actions or tasks
(e.g., decision-making) which would normally require some degree of human
intelligence

**Big Data** A term used to describe the extensive volume of both structured and
unstructured data generated in the healthcare system

**Collaborative robotics (cobots)** Robotics process automation that work in close
cooperation with humans to complete shared tasks

**Dialectical learning** An approach to learning through examination and discussion

**Disruptive technologies** Technologies that provoke change and innovation, result-
ing in new or unanticipated opportunities

**Emergent digital technologies** Technologies that are developing and evolving
to become useful or impactful in a variety of settings across society, including
healthcare
**External modality**  Factors impacting change and adaptation that the organization can try to influence but not control

**Inertial conflict**  Resistance to change

**Internal modality**  Factors impacting change and adaptation that are within the scope of influence or control of the organization

**Intrapreneur**  An individual that provokes or supports transformative change within an organization

**Lifecycle**  The phases of a specific process from beginning to conclusion, commonly reflecting software development or project management

**Marginal analysis**  An approach to options analysis by calculating the incremental impacts of change on cost and revenues

**Mind mapping**  Graphical representation of the connection between concepts and ideas

**Nanorobotics**  An emerging field of research focused on microscopic robots used to target specific diseases such as cancer

**Non-repudiation**  A security authentication with a high degree of confidence

**Normalization**  The process of becoming accustomed to a specific concept or process, such as the use of technology to perform a specific task, so that it is perceived to be part of a normal routine.

**NRO**  Non-repudiation of Origin, which documents evidence of origin of the message, and prevents denial of the message by the originating party

**OODA loop**  An approach to decision making that involves Observing information, Orienting or interpreting information, Deciding on a course of action, and Action

**Operational management**  The day to day management of the healthcare system, which includes a variety of departments or services such as human resources, administrative, finance, and inventory

**Organizational ambidexterity**  Two approaches to change reflecting both adaptability and alignment

**Performance indicators**  Specific criteria that are measured at specific points in time to evaluate performance and/or change

**Process automation technologies**  Automation that reengineers processes to minimize human effort and increase both efficiency and productivity

**Rose diagram**  Nightingale’s visualization depicting mortality causes

**Service management plan**  Plan to provide oversight or resolution to an issue related to a specific service or product provision

**Socio-technical**  Refers to the relationship between technology and the social aspect of actions that are influenced by the inclusion of technology in activities

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