



# Revisiting the nursing metaparadigm: Acknowledging technology as foundational to progressing nursing knowledge

Elizabeth Johnson, Jane M. Carrington

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**Title: REVISITING THE NURSING METAPARADIGM: ACKNOWLEDGING  
TECHNOLOGY AS A DOMAIN TO PROGRESS NURSING KNOWLEDGE**

The nursing metaparadigm, as described by Fawcett in 1984, includes human, health, nursing and environment, all of which support theory development by giving direction to our focus as a scientific body. Nursing scientists make their mark in biotechnological applications, mobile health, informatics, and human factors research. We give voice to the patient through design feedback and incorporating technological advancements in our evolving nursing knowledge; however, we have not formally acknowledged technology in our metaparadigm. In order to continue patient-centered care in this age where machines are enmeshed in daily human life, we propose technology must be a domain of the metaparadigm to continue advancing nursing science and knowledge. In this paper, we propose a separate domain of technology within the metaparadigm to challenge nurses to consider approaches within their research and practice of how technology will impact patient care and their personal development within the profession. A technology-specific domain within the metaparadigm also is a signal to other bodies of science of our willingness and ability to run at-pace with novel, exciting new discoveries while adding our perspective. Nurses may become active agents in novel developments rather than passive adopters, continuing our legacy of patient advocacy through new knowledge generation. Emerging and continuing nurse leadership has set the stage for the next era of nurse-led innovation and technology development, which provides opportunity to embed technology as a core aspect of the nursing metaparadigm.

Technology may be foundationally defined in the context of nursing as a phenomenon comprised of knowledge and skills, associated with machines or tools, which facilitates patient care (Barnard, 1996). Healthcare delivery and technology is a co-evolving, dynamic relationship.

Together, technology is created and implemented to enhance quality care to further elevate the system of healthcare delivery. As healthcare delivery becomes more complex, so too does the technology created to address complex care. Digital assistants guide patients through paperwork completion, such as during mobile or kiosk check-in stations deployed in urgent care clinics. Clinical support systems and electronic alerts help to guide care management. Death itself can be suspended with the aid of extracorporeal machines that, through machine learning and artificial intelligence, continue body system functions. Health records are now accessed via mobile apps, allowing bi-directionality in the exchange of information between patient and provider.

The relationship between machine and provider has become inseparable, prompting an increase in healthcare spending. Costs associated with implementation of artificial intelligence (AI) within the next five years will exceed \$45 billion, with the major drivers of growth stemming from the need for AI-supported diagnostic and imaging platforms (ReportLinker, 2020). These platforms, housing significant amounts of data, are now being design to ‘talk’ to one another in an exchange of ideas and information. This interconnectivity of technologies- platforms, applications, devices- has been called the Fourth Industrial Revolution (Diño & Ong, 2019).

The Fourth Industrial Revolution nomenclature has been applied to both nursing education and practice as focus turns to the utilization of information and computing technologies to address challenges with modern-day delivery of human-centered care (Lee, 2022). Through use of artificial intelligence (AI) and big data, nursing education and practice have been intertwined with the digital realm. Nursing programs have sped towards adopting simulation laboratories that include tools that mirror the human condition, such as lifelike manikins and use of augmented reality/virtual reality. Nurses at the bedside rely on technology for each phase of the nursing

process, using tablets for patient admissions, ‘smart’ pumps for accurate medication delivery, and remote monitoring for continuous patient status evaluation. Common technologies that do not require Internet access, such as Universal Serial Bus (USB), also can be used for information exchange to support quality patient outcomes. In Epic’s Sijilli project, Somali refugees were given a wearable USB necklace to support inter-organizational patient health record communication among healthcare providers without Internet requirements (Saleh et al., 2019).

Beyond the Electronic Health Record (EHR), over 70% of the nurses in the United States utilize a smart mobile device to inform their decision-making while at work (Jelec, Sukalic, & Friganovic, 2016). Williamson and Muckle (2018) found that, within their sample of 375 nursing students, 99.7% owned a smartphone and 95% reported comfort with using various technological modalities. The demonstration of technological self-efficacy is now an assumed aspect of shaping the continuum of nursing education for both faculty and nursing students (Roney et al., 2017). Person-centered care now includes use of mHealth and telehealth, creating a season of adaption within nursing to use technology to access information and collaborate with providers from a spectrum of specialties to shape care (Billings & Halstead, 2020). Technology is also a bridge to foster connection between patient and nurse when collaborating on finding best resources regarding a disease or treatment. Nurses have demonstrated great agility in locating and using Internet-based applications to strengthen patients’ knowledge bases with disease processes or treatments, further demonstrating person-centered care (Saab et al., 2021).

Healthcare as a system has become a new frontier in the exploration of how machines and humans intersect to elevate health. Where, then, does nursing position itself in this revolutionary New Age as the line between machines and humans become further blended? The profession champions our collective ability to advocate for dignity and humanness in patient

care, making the voice of nursing critical in the development of new knowledge and theory generation. Nurse researchers are plotting the course for the future of nursing by seeing what we have accomplished in the literature to garner direction for the era ahead (Buchanan et al., 2020).

However, we present a complementary perspective in this paper to braid together the technological revolution and nursing's acknowledgement of technology as an inseparable condition of patient care through integration within the nursing metaparadigm. The addition of technology will encourage nurse researchers to acknowledge the blended reality of human and machine experienced by patients, supporting our colleagues at the bedside through prescribed practice guidance.

The purpose of this paper is to first review the nursing metaparadigm as described by Fawcett (1984) and then propose the addition of technology as a separate pillar of the metaparadigm. The nursing metaparadigm and growing adoption of technology will be presented as it is used in nursing education, practice, and research.

In base description, the nursing metaparadigm was developed as a means of unifying nursing focus in knowledge generation at the most abstract level of thought. Transitioning from the disorganization among nursing perspectives, Jacqueline Fawcett sought to organize the commonalities into domains (Bender, 2018). The catalyst to organizing nursing perspectives was due in part to the transition of nursing from an apprenticeship model to the structured education of university-based curricula, requiring defined structure to the creation of a body of knowledge. The nursing metaparadigm consists of the domains: person, health, environment, and nursing (Fawcett, 1984). Between domains, relationships were also created: person-health, person-health-environment, and person-health-nursing (Fawcett, 1984). These relationships reflected

the areas of interest for nursing research at the time of Fawcett's development of the metaparadigm.

The unique contributions of nursing are not easily interpretable from the domains themselves. Bender (2018) questioned the ability of nursing to remain agile and dynamic in our body of science should the metaparadigm remain fixed to these domains alone. These concerns were noted by Morse (2016) regarding potential for stunted development of new nursing insights.

One component of healthcare where nursing innovation is lagging behind other disciplines is the novel development and adaptation of technologies to propel nursing knowledge. Innovation and entrepreneurship in technology development diverts from the traditional identity and culture surrounding the role of the nurse as described by the original Fawcett paradigm. At the time of Fawcett's writing, the role of the nurse was action-based focused on treatment of a patient's health-related issues rather than novel creations or inventions (1984). Even in present day, approximately less than 1% of all nurses globally self-identify as an entrepreneur (Jakobsen et al., 2021). The friction with traditional and modern profession values surrounding technology and the nurse's role in its development propagates discomfort, creating a stalemate for nursing adoption of technology.

Nursing theories define the domains of the metaparadigm and their relationships with the intent of guiding decision-making in care, scholarship, and research. A question then remains: does accepting technology as fundamental to nursing knowledge generation and practice lessen the emphasis on person-centered care? Furthermore, is this the source of discomfort that inhibits nursing's progress in technology innovation as a facet of research and scholarship? Archibald and Barnard (2017) instead offer the stance that a *lack* of recognition and adoption of machine

influence in nursing care will jeopardize compassionate care and nursing's future in the technera. Technology can expand the concept of what it means to be human, such as a person receiving life-saving medication through a skin patch or relying on an embedded insulin pump to enjoy a higher quality of life. As these machines and technologies influence the health and life of the patient, they also influence the care delivery approach of the nursing. Through the nurse's recognition of the technology, whole-person care is possible. The inclusion of a technology domain lessens the rigid boundaries resulting from the current metaparadigm that hamper nursing's influence on the perception of compassionate, whole-person care in the digital age.

Fawcett's depiction of the nursing metaparadigm has prompted much discourse among the profession when expansion of domains past the traditional realms of person, health, environment, and nursing are proposed (Thorne et al., 2002). Technology as an adjacent factor in each domain risks allowing it to recede to the background of nursing consideration. Expanding to nursing research, the inclusion of technology as a separate domain of the metaparadigm places a positive pressure on nurse researchers to 'bridge the relevance gap' of nursing middle-range theories to be testable and shared with other bodies of science (Lim-Saco, 2019, p. 10). Policies shaping nursing scope are also impacted by technology, such as delegation of nursing duties to humanoid robots (Locsin & Ito, 2018). Nursing voice in policy development and research are increasingly critical to evaluate the ethical, legal, and professional implications of technology on nursing practice (Tulyakul & Meepring, 2021).

Nurses find common ground in the concept of person, as the central focus of the profession (including person as a patient as well as the nurse). Person may include the thoughts, feelings, perceptions, and physical nature of self (Barnard, 1996). These aspects of '*humanitude*' have drastically changed with the increased use of medical devices to therapeutically disrupt

natural body systems (Teixeira de Almeida Viera Monteiro, 2015, p. 23). Described as cyborg ontology, the recognition of the dualism between human and machine denotes nursing's lived experience of managing patient care where the natural course of the human lifespan remains ill-defined (Haraway, 1991; Teixeira de Almeida Viera Monteiro, 2015).

The dualism of patient and technology pre-dates the era of the fourth revolution. Medicine has a long and expansive history of using technology for acute patient care as well as long-term quality of life support outside of the hospital. For example, mechanical ventilation, glucometers, and pacemakers are all accepted means of modifying human physical nature via technology to provide what is seen as compassionate and quality care when recommended by the provider. The nurse then must discern where the body ends and machine begins to provide informed holistic care (Lapum et al., 2012; Teixeira de Almeida Viera Monteiro, 2015).

While nursing may integrate technology within the domain of person, this suggests *accommodation* of technology when mandated for care. Rather, technology is an ever-evolving aspect of patient care that requires continuing nursing education (Tulyakul & Meepring, 2021). The rate of technological innovation and the rate of technological decay (outdatedness) threatens to out-pace nursing education's ability to include specific technological models or programs in nursing curricula. While nurses in clinical and bedside roles will decidedly integrate technology into care, technology must also be treated separately such that there is a guiding cognitive process for how to identify, action, and predict next steps related to patient care. Particularly if the technology is new to the nurse, a nurse must have a means of using environmental cues and pre-established cognitive frameworks to support expeditious discovery and incorporation into care delivery.



Health is the state of well-being as defined by the patient and can be influenced by setting as well as the experiences of a patient (Wayne, 2021). Patients are partners in the use of technology to drive health outcomes with the use of patient portals and mobile apps that provide reminders for medication administration, documentation of symptoms, and provider messaging. Patients have been granted newfound mobility in disease management with remote tools such as applications (Ritenbaugh et al., 2010). Health has been contextualized by how the body may be disassembled and reassembled through adaptive device design, boundary constraints within monitoring machines, and system logic build within our record-keeping platforms (Haraway, 1991).

Utilization of the Electronic Health Record (EHR) is now an integral investment in 96% of US hospitals, with over 700 vendor platforms developed (Schulte & Fry, 2009). Data collected by health technology have revealed patterns in health status, such as clinical laboratory values or vital signs that lead to events such as sepsis. These data patterns have informed models that can predict elements of health and outcomes. Predictive models and clinical support system applications guide providers through care pathways, with the EHR becoming a critical juncture and touchpoint to direct patient care outcomes.

Technology has influenced patient health through its partnership with a nurse, particularly advanced practitioners, during clinical decision points led by data aggregation. A nurse, for example, may review blood glucose levels in real-time from a remote patient upload that then may determine clinical guidance on insulin dosages. However, technology integration without a means of separating technology from health may lead to errors of omission or commission if there is a heavy reliance on system recommendations over nurse training and experience. Technology as a separate domain from health permits the nursing research to

examine technology's influence as it relates to a health-based phenomenon rather than as an accommodation within the phenomenon itself. Establishing a relational perspective with technology and health rather than technology within health also affords nurse innovators and entrepreneurs to consider traditional human factors elements of technological fit to the phenomenon, the form of the technology, and the functionality of the technology to address a health care gap.

The environment consists of the context of the patient that will influence their status of well-being (Wayne, 2021). The environment is context to the patient's health, the cumulation of clues that guide the nurse in care management. Nurses ask patients where they live to learn the town or city to then know health resources. Does the patient live in a house, apartment, alone with assistance, long-term care, or on the street? The patient's residence shares insight about their function, mobility, and abilities towards activities of daily living. The environment further includes the patient's interactions with the healthcare system. How do the encounters with nurses, physicians, and other members of the healthcare team affect daily living and vice versa?

Technology is now commonly being used as an informative presence within a patient's environment to provide healthcare providers feedback as it relates to a patient's health. Technology in this space includes sensors at home, wearable sensors, and sensors with medication administration technology as well as data collection with sleep technology. This data are also useful towards predictive modeling for patients staying in their home or early detection of issues to prevent admission. Technology also extends the healthcare system to the patient in their home via telehealth, mHealth, and patient portals.

Nursing's integration of technology is far beyond the bedside and pervades the inner functioning of a healthcare system. Turing's (1937) Computational Complexity Theory

highlights the consideration to resources within the complex adaptive system in order to understand its constraints. Nursing as a resource consumes data and inputs data related to patient care, such as within the EHR, which is then in turn utilized by other care team members for similar purposes. Decision-making and theory generation are impacted by the dynamics within design, data, and designation of teams within the embedded networks of care management (Bossaerts & Murawski, 2017). As such, how a healthcare system and its shared communication system are constructed impacts the ability of nurses to perform daily tasks at optimum efficiency. Dynamic co-evolution between nurse and technology is then encouraged should the profession take the opportunity to recognize successful adaptations to nursing practice (Litaker et al., 2006).

The body of nursing science has acknowledged technology integration within nursing practice through the use of middle-range theory and patterns of knowing, or how ways the profession arrives to knowledge. Locsin (2005) translated the Haraway's (1991) concept of *humanitude* through a nursing lens, describing the multidimensional essence of a patient, which includes the technology that supports their care. Purnell and Locsin (2015) further describe the nurse's engagement with technology as a mechanism to not only provide meaningful care to the patient but also as a means of acknowledging the whole person rather than simply parts of a patient's body or being. To expand and improve upon Carper's (1978) patterns of knowing, Purnell and Locsin (2015) include technological competency as caring in nursing, which dissuades impersonalization of the patient and instead promotes technology as a supportive tool to aid the patient in their wellness journey.

Technological competency is significant in the domain of Nursing and has been acknowledged by its itemization in the American Academy of Colleges of Nursing (AACN) Essentials, which are the core competencies for nursing education. Technology has been

integrated within both entry and advanced-level nursing education components including patient safety, medium for care delivery, and tool for interpersonal communication (AACN, 2021).

Integrating technology within nursing education requirements is necessary given the expanded use of AI and robotics to replace nurses or modify nursing's role in patient care. For example, humanoid nurse robots have been utilized as a means of providing basic nursing care, however expose nurses and patients to a variety of ethical, legal, and quality care issues (Locsin & Ito, 2018). Through technological competency, described via middle-range nursing theories and models, highlight the intermediary role of the nurse when engaging with robots or AI to facilitate a caring environment for the patient (Osaka, 2020).

Separating technology as a new domain of the nursing metaparadigm provides opportunity to revisit and advance nursing as a science and art. Nursing's art in caring and emphasis on patient advocacy and ethics cannot be taught to machines or seen in a single data point within the Electronic Health Record. This is consistent with Moravec's paradox: what is easy for humans is difficult for technology and what is difficult for humans is easy for technology (Moravec, 1988). Here we suggest that ethics and patient advocacy would be considered easy for humans as these are essentially straightforward decision-making processes. The techniques of presence, of therapeutic silence, give comfort where the cold metallic surface of a robot cannot. Our ability to recognize and act upon the innate human desire for connection is the true beauty in nursing practice. That connection extends to include the technologies supporting the patient's wellbeing and body function, facilitating their quality of life.

Should technology solely remain as an integration into the domains of the metaparadigms and not as a separate domain itself, nursing loses the ability to measure, research, and observe technology as its own component of care. In the domain of environment, technology can cause

delays in clinical workflow if there are latent design or implementation errors that inhibit successful adoption. Within the domain of health, a distinction is required between a patient's health status and the supportive technology. An individual's health may be influenced by technological wellness support but not defined by the technology. Similarly, within the domain of person, technology is will be utilized as a tool to complete a role-related task (Turing 1937). However, use of technology as a guiding resource is separate tool which complements the experience, schemas, and perceptions that will also influence task completion.

By establishing technology formally as a separate part of the nursing metaparadigm, we demonstrate to bodies of science our recognition of others' technological advancements while solidifying our continued intent and focus as a profession to build upon our knowledge to generate our own innovations. As a domain of the nursing metaparadigm, technology becomes an element of nursing scholarship and research with results informing patient care and outcomes. Specialties of nursing, such as informatics and healthcare systems design, grow increasingly important to support the profession's navigation of big data, machine learning, and other influential technologies that affect the nursing delivery of patient care.

Separating technology as a standalone domain permits nursing researchers, educators, and practitioners to examine technology from a conceptual and theoretical perspective. This examination in turn will support new theories and frameworks to then be tested by nurse innovators in the middle-range space. This cycle of new knowledge generation supplants the current metaparadigm by allowing relationships between technology and person, environment, health, and nursing itself. These connections instead of integrations with technology foster changes in the paradigm of what a nurse 'is' in relation to innovation and entrepreneurship (Tulyakul & Meepring, 2021).

Technology is firmly embedded in healthcare. Technology collected health data, assists in decision-making, sustains and prolongs life. Here we propose a change in the nursing metaparadigm. There are two possible approaches to addressing this gap. First, theory development that conceptualizes the domains of the metaparadigm as facets of technology or second, add technology as the fifth domain of the nursing metaparadigm. Here we argue, that establishing technology as a fifth domain secures technology as a critical and immovable component of nursing care, present and future. Patient care and subsequently nursing practice and science have been forever altered given the blurred delineation of technology and human biology. In order to continue caring for patients, nursing as a profession must embrace technology as a core part of its metaparadigm. Nurses at the bedside must now analyze sensors, patches, and be nimble in the ability to rapidly interpret machine-derived data to save lives, spot trends, and anticipate challenges. To synchronize nursing practice with technology as part of what it means to be a modern-day human is to modernize nursing.

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