Title

Technological machines and artificial intelligence in nursing practice.

Journal

Nursing and Health Sciences, 25(3)

Authors

Vasquez, BrianA
Moreno-Lacalle, Rainier
Soriano, Gil
et al.

Publication Date

2023-09-01

DOI

10.1111/nhs.13029

Peer reviewed

Published in final edited form as:

Nurs Health Sci. 2023 September ; 25(3): 474–481. doi:10.1111/nhs.13029.

Technological machines and artificial intelligence in nursing practice

BrianA. Vasquez, RN PhD[1], **Rainier Moreno-Lacalle, RN, PhD**[2], **Gil P. Soriano, RN, MHPEd**[3], **Phanida Juntasoopeepun, RN, PhD**[4], **Rozzano C. Locsin, RN, PhD, FAAN**[4,5,6], **Lorraine S. Evangelista, RN, PhD, FAAN**[7]

[1]Department of Nursing, College of Applied Medical Sciences, Majmaah University, AL-Majmaah, Saudi Arabia

[2]College of Nursing, St. Louis University, Baguio City, Philippines

[3]Department of Nursing, College of Allied Health, National University Manila, Manila, Philippines

[4]Faculty of Nursing, Chiang Mai University, Chiang Mai, Thailand

[5]Graduate School of Biomedical Sciences, Tokushima University, Tokushima, Japan

[6]Florida Atlantic University, Christine E. Lynn College of Nursing, Boca Raton, Florida, USA

[7]College of Nursing, University of Laws Vegas, Laws Vegas, Nevada, USA

Abstract

This article is a theoretical discourse about technological machines and artificial intelligence, highlighting their effective interactive outcomes in nursing. One significant influence is technological efficiency which positively affects nursing care time, enabling nurses to focus more on their patients as the core of nursing. The article examines the impact of technology and artificial intelligence on nursing practice in this era of rapid technological advancements and technological dependence. Strategic opportunities in nursing are advanced, exemplified by robotics technology and artificial intelligence. A survey of recent literature focused on what is known about the influence of technology, healthcare robotics, and artificial intelligence on nursing in the contexts of industrialization, societal milieu, and human living environments. Efficient, precision-driven machines with artificial intelligence support a technology-centered society in which hospitals and healthcare systems become increasingly technology-dependent, impacting healthcare quality and patient care satisfaction. As a result, higher levels of knowledge, intelligence, and recognition of technologies and artificial intelligence are required for nurses to

Correspondence: Rozzano C. Locsin, Florida Atlantic University, Christine E. Lynn College of Nursing, Boca Raton, FL 33431-0991, USA. locsin@health.fau.edu.

AUTHOR CONTRIBUTIONS

Brian A Vasquez: Investigation; resources; writing – original draft. **Rainier C. Moreno-Lacalle:** Data curation; investigation; writing – review and editing. **Gil P Soriano:** Data curation; investigation; resources; writing – original draft. **Phanida Juntasopeepun:** Data curation; investigation; writing – original draft. **Rozzano C Locsin:** Conceptualization; funding acquisition; methodology; project administration; supervision; writing – review and editing. **Lorraine S. Evangelista:** Data curation; investigation; writing – review and editing.

CONFLICT OF INTEREST STATEMENT

Authors confirm that they have no conflicts of interest, and are in agreement with the final manuscript.

render quality nursing care. Designers of health facilities should be particularly aware of nursing's increasing dependence on technological advancements in their practice.

Keywords

artificial intelligence; computational intelligence; Industry 5.0; Life 3.0; technological machines

1 | INTRODUCTION

With technological efficiency and dependence positively affecting nursing care time, nurses can focus more on their patients as the core of nursing (Chang et al., 2021). Over the last decade, investments in health technology and digital health have increased by more than 180%, while pharmaceutical and biotech investments have increased by more than 230% (Cigniti Technologies, n.d.). Similarly, the robotics industry is rapidly expanding into healthcare, expected to reach a value of 34.79 billion US dollars by 2026 (Emergen Research, 2020), owing to an explosion of development work on personal care robotics led by the Republic of Korea and Japan (Sharts-Hopko, 2014). Simultaneously, it was estimated that global healthcare spending on artificial intelligence (AI) alone will reach 36.1 billion US dollars by 2025 (Robert, 2019). The desire for AI-enabled healthcare solutions is well documented as healthcare robot efficiency, safety, and security features expand.

The ability to act collectively and the essential demands for efficiency among human beings suit today's technological climate, driving transformations toward liberating human ways of life while improving quality of life. This newfound independence in people's lives is valuable to nursing because nurses can benefit from technological advancements with intelligent machines powered by accuracy and innovation, helping them to overcome human cognitive biases in judgment and decision-making. In so doing, Yasuhara et al. (2019) declared that it is vital for nurses to assess the utility of technological dominance and embrace compassionate care. However, what is the impact of machine technologies and AI on nursing in the era of heightened technological advances and dependencies?

A theoretical discourse is employed in the article to broadly examine the impact of technologies and AI on nursing practice environments within the context of technological advances and AI. The literature supports existing evidence impacting nursing practice concentrating more on the dominance of technology and AI in environments of industrialization explicated within the realm of Industry 5.0. (Demir et al., 2019), while societal situations influencing human living are represented well within the Japanese view of Society 5.0 (Ferreira & Serpa, 2018) and environments of human living in the Life 3.0 domain (Tegmark, 2017; the conceptual label "Life 3.0" is derived from the book title, *Life 3.0*).

2 | DESCRIPTIONS OF INDUSTRY 5.0, SOCIETY 5.0, AND LIFE 3.0

Industry 5.0 is the environmental condition in which machines and humans work together to improve the quality of life (Demir et al., 2019). Industry 5.0 applications consider the need to solve problems essential to human living, such as those being facilitated in Society 5.0

(Ferreira & Serpa, 2018). Jumpstarting the progress of life as known—from biological (Life 1.0) to cultural (Life 2.0) and ultimately to technological—is fashioned well within Life 3.0 (Tegmark, 2017). In analyzing technology-driven changes, this inquiry focuses on how machine technology and AI have become essential to nursing and its practice, especially as breakthroughs in technology-based systems affect people's life processes and promote their health and well-being.

The fundamental principles of AI and robotics, as applied to Industry 5.0, Society 5.0, and Life 3.0, consider the potential and limitations of technological advancements in human healthcare systems. Therefore, a much-needed discourse about designing the future of healthcare while urging health-related professions to conceive their disciplinal position within the context of rapid technological advancements is fundamentally relevant and necessary for successful patient-centered care. Therefore, the current article adopts the definition formulated by Eklund et al. (2019) of patient-centered care as creating a relationship between the nurse and the recipients of care that manifests unique human emotions like empathy, respect, and engagement, and with a holistic and individualized focus. When a patient-centered approachy is instituted, the quality of care received by the patient improves.

In the "Age of Augmentation" (Longo et al., 2020), the criteria necessary for achieving prominence in an industry where technological breakthroughs have a significant impact include assurances of the quality of life. The concepts of Industry 5.0 promote the view that the role and contribution of industry to society are critical in addition to its efficacy and industrial output. As a result, the healthcare practitioner is projected to achieve success beyond expectations by advancing new technology. In the case of Europe, this perspective complements its industrial dominance strategy by prioritizing improvements through a human-centric and resilient approach in Industry 5.0 (European Commission, n.d.).

2.1 | Description of Industry 5.0

The Fourth Industrial Revolution introduced digitalization (Doyle-Kent & Kopacek, 2020), establishing an intelligent and real-time digital network of humans and machines for industrial management (Dombrowski et al., 2017). As a result, the gradual transition to digital commerce throughout the supply chain was enabled, resulting in the conversion to real-time data (Pereira et al., 2020). However, forecasting was impossible due to the market's instability because of rivalry, (the limitations of? the nature of?) contemporary industrial design, and cost. This instability resulted in enormous quantities of varied and strange goods (Dombrowski et al., 2017).

Industry 5.0 prompted organizations to adopt real-time management, resulting in considerable improvements to the current job context, procedures, and surroundings, as well as new skill set requirements and innovative working frameworks. Areas of collaboration have been defined across the organization's accessible positions, both within and between processes and systems. This development was encouraged and supported to manage relationships between customers (consumers of information technology-assisted services) and providers (information technology creators). Additionally, the requirement for cybersecurity advancement has grown exponentially, affecting required capital. As a result,

the required organization capital exponentially increased to create cybersecurity systems and adopt a system befitting Industry 5.0 (Kopacek, 2018).

2.2 | Description of Society 5.0

Society 5.0 is the attempt to establish a cyber-physical culture where a growing relationship with AI may benefit people's daily lives. While the notion may seem to dehumanize humans and stress the supremacy of technology, it also seeks to establish a more human-centered community coexisting with autonomous social robots and embodying AI. The Society 5.0 model's advancements and preferences are both a philosophical exercise and a practical undertaking to influence the future (Hofmann et al., 2020). Society 5.0 is predicated on spreading technological unity, enabling human-machine partnerships, and co-creation (Ferreira & Serpa). It reflects the fusion of humans, technology, and virtual space, with real and virtual ecospheres combining at multiple temporal and spatial scales to produce intelligent systems and human-technology collaborations (Medina-Borja, 2017; Pu & Yano, 2020).

Society 5.0 aspires to transform humanity to improve people's quality of life through technological revolutions and inventions derived from Industry 5.0 (Costa, 2018); by 2050, the utility of technology, such as AI, the internet of things, robotic process automation, and big data science will be integrated into a variety of technologies, particularly those involving healthcare robots (Ferreira & Serpa, 2018).

Society 5.0 is a place where humans and intelligent autonomous devices coexist. Science and technology lead the way in resolving issues, not by technological dominance but through their reliable utility. For example, with Japan's rapidly aging population, 40% will be over 65 by 2050. With a projected reduction in human resources of 13 million over the next two decades, autonomous driving vehicles, including automatic toilets, nursing robots, and remote healthcare services, are expected to address these challenges efficiently (Gu, 2021). Similarly, countries like China, Ghana, India, Mexico, Russia, and South Africa are also projected to face an aging population (Kowal et al., 2012). However, the problem lies in rural areas with weak technological infrastructures. The adoption of Society 5.0 in rural areas is particularly challenging because they lack the necessary infrastructure to sustain technological machines and AI. However, they can still combine algorithms to facilitate decision-making. For instance, decision trees on referring patients from primary care to tertiary facilities can be augmented by layering symptoms based on the urgency of care needed. These complex societal challenges are addressed with Society 5.0 by effusively absorbing digital technology into the physical ecosphere.

Additionally, within Society 5.0, technologies, AI, and autonomous intelligent machines showcase the viability of humanness while assuring a high standard of living through technical breakthroughs derived from Industry 5.0 concepts. Numerous critical infrastructures, monetary technologies, and healthcare procedures are derived from the Fourth Industrial Revolution, defined by human dependence on technology. Society 5.0 integrates technology and AI advances into every part of society, as seen in Japan, by creating a "super-smart" society that will serve as a model for global parity. With the

expectations of Society 5.0, the continued effort to create a new social contract and economic model incorporating technological breakthroughs is critical.

2.3 | Description of Life 3.0

The modern human being's quality of life is where technical improvements significantly impact. However, surprisingly, the definitions and explanations for observed quality of life have imposed constraints on conceptualizations of "life." These constraints, however, are insufficient because they are currently time-bound. Rather, existence should be construed broadly as a value capable of sustaining its complexity and reproducing itself (Krewit, 2020).

Three stages of "life" (Tegmark, 2017) were described based on the dynamics of life. Life 1.0 represented the simplicity of life as biological organisms evolved and informed the hardware (body) and software (mind)—life evolving rather than being designed. A common example is bacteria that undergo structural changes due to deoxyribonucleic acid mutations occurring over many generations via trial-and-error processes.

Life 2.0 is "life" with evolved hardware and software (Krewit, 2020), emphasizing cultural evolution. This viewpoint includes Life 1.0, and humans are used to illustrating the level. Humans gain versatility through the process of development and learning. This allowed rapid adaptability to environmental changes, allowing humans to dominate earthly life.

With humanity facing uncertainty, *Life 3.0*, defined as the stage of technological growth, developed. The World Economic Forum reports that in Life 3.0, predictive analytics will become the dominant model in healthcare, hospitals will be hyperconnected, and patient and provider satisfaction will skyrocket. As a result, it is becoming increasingly easy to rethink the technology and software that run our lives. The intertwining of Life 3.0 in healthcare can now be seen in the use of big data science in precision medicine. The machines can be programmed to empirically utilize accurate models on new individual patients (Bzdok, 2021). In this scenario, technological innovation will simplify access to multiple data sources to illuminate illness epidemiology, facilitate treatment, and improve healthcare. Reaching beyond the biological restrictions of Life 2.0, Life 3.0 demonstrates the evolutionary aspects of life (Krewit, 2020).

3 | DISCUSSION

In healthcare institutions, applying technological machines and AI may extend to routine activities resulting in more efficient and effective nursing care practices. For example, healthcare robots, intelligent robotic systems incorporated with machine learning, can secure medication delivery carts to patients using high-fidelity sensory technologies. In Radiology, machine learning interpretation of complex imaging data is made possible with the efficiency and clarity of film images that may need to be more commonly addressed by radiology machine operators. As robots develop and become equipped with technological decision-making capabilities, their functionality increases, resulting in spectacular, dependable, precise, and efficient productivity (Pepito & Locsin, 2018a). Robotic machines can also prevent the transmission of harmful microorganisms normally

transmitted via human touch. The complexity of intelligent machines needs a high level of attention toward unanticipated events as human-robot interactions continue to evolve and alter human life and living.

Current research shows that healthcare robots can help with preventive, therapeutic, and supportive activities and provide efficient, timely, assistive, and rehabilitative services (Shao et al., 2019). These assistive activities include interventions to keep patients' mental health in check while adapting to new medical information systems and performing medical procedures (Jones, 2018; Shao et al., 2019).

4 | NURSING PRACTICE AND TECHNOLOGIES

Progress in technology, particularly with smart technologies, is frequently reflected in how successful nurses perform. However, nurses may perceive challenges to efficiency and competencies when working with or relying on intelligent machine technologies in the clinical setting. Nurses' anxiety can be drawn from their lack of control over machines that are becoming more intelligent (than humans). As reflected in a qualitative study on the use of machines, nurses experience stress and anxiety, particularly when facing unfamiliar situations (Lamb & Norton, 2018). Nurse reluctance is demonstrated through unsettling images and research on the effect of nursing practice when partnered with healthcare robots (Liang et al., 2019).

The debate over the use of advanced technology in healthcare remains unresolved, and nurses are frequently drawn to it due to their polarized views on robotics efficiencies. For example, many arguments against technology are founded on humanism, and nurses frequently view robotics as morally objectifying, depersonalizing, and dehumanizing, which contrasts sharply with the humanist values they are trained to possess (Durkin et al., 2021). When considering the care of pediatric patients, Liang et al. (2019) explained the predicament nurses face because robots could reduce repetitive tasks, become an emotional cushion for children, and influence human care in general. However, the major downside is that robots could reduce nurses' employment opportunities.

Considering this discourse, Dening (2019) identified challenges from a humanist perspective that help make nursing work involving intelligent machines and robotic technologies as partners more human, namely: having an evolving practice culture with machines enhanced with technologies and AI; centralizing humanness as a critical concern in designing automaton plans; ensuring equal access to AI and automation across the workforce; transparency about the use of automation and its potentials; and cultural responsiveness to change and preparation for widespread automation deployment.

Furthermore, Fagerström et al. (2017) emphasized that a new human-informatics fusion will achieve greater knowledge, power, intellect, and autonomy. The ultimate liberating method is technology and intelligent machines in an information-based culture. The definitive question is whether nurses as clinical practitioners will remain relevant in a highly technological world. What is clear is that this enhanced future is driven by advances in human-technology-interface care systems (Pepito & Locsin, 2018b).

Nursing practice in healthcare is evolving to integrate advanced technologies in human care, freeing nurses to facilitate nursing care. For example, in child care, intelligent machines could engage in therapeutic play with children while waiting for their surgery. Similarly, electronic charting is facilitated by speech-to-text technology. In these few situations, nurses and other healthcare practitioners better understand emerging technologies in healthcare. Influential and effective work involving technologies supplements the task completion required for quality patient care (Bahari et al., 2021; Chang et al., 2021). However, what if that is not the case? In that situation, nurses may be dissatisfied with their practices or can fear being replaced when machine technologies with AI duplicate their job performance effectively, precisely, and efficiently. As a result, many nurses resist the implementation of AI in nursing practice. This could be attributed to the dearth of support systems and limited support in its implementation, especially in places where the infrastructure remains weak and unstable.

Still, another plausible explanation for this resistance to technology is that adopting electronic charting could engender issues like cybersecurity problems and resources to purchase and sustain expensive electronic charting software. As a result, it is crucial to healthcare that nurses increase their knowledge of emerging technologies, notably intelligent machines such as healthcare robots. This suggestion places value on the potentials offered by industrialization through Industry 5.0, awareness regarding environmental influences within the situation of Society 5.0, encompassing human living perspectives informed by tenets of Life 3.0.

The rising impact of technological advancements in nursing and healthcare highlights events and conditions that limit nursing practice relevancy in a technological world (Pepito & Locsin, 2018a). When nursing practice is defined as the performance of simply technology-driven activities, healthcare robots imbued with AI can perform these tasks with a higher degree of dependability and consistency than is possible with mere human effort. In remote areas, patient monitoring and telemedicine allow patients who require help to connect with healthcare professionals and receive health services without the need to travel long distances. The process of robotic automation using software-controlled intelligent anthropomorphic machines can replicate human input in a computer program. Hoffman et al. (2020) expressed the objective of automating operations in industries that are very repetitive and rule-based. In this context, robots are intended to work alongside humans to boost productivity rather than supplant humans in the workforce (Nahavandi, 2019).

5 | REPLACING HUMAN WORKFORCE

The dependency on technologies and AI is increasing in certain countries experiencing rural depopulation and growing older person populations, creating significant issues for sustaining the livability of current environments (Shichijo & Akaike, 2019). These issues pertain to activities nurses can institute as they carry out their professional responsibilities to produce healthy ways of living in partnership with technologies and AI. Furthermore, the need to intensify research on human-robot interaction implies a greater emphasis on monitoring intelligent machines and examination of the psychological barriers that need to be overcome to achieve greater tolerance and acceptance of robots as intelligent machines. Therefore, this

raises the question of whether robotics in nursing should be deemed critical to nursing care practice.

Disruptions, technological innovations, and change result in innovation and necessary transformation. Unfortunately, the healthcare industry has faced numerous obstacles in the way of an innovation mindset, including its possible social, political, financial, and cultural applications (Draghici et al., 2015). As a result, nurses in clinical practice and other healthcare professional practitioners face disruptions as they confront challenges that require quick and consistent decisions. For instance, healthcare providers profit from robotics when implemented appropriately, such as during the COVID-19 pandemic, when it became necessary to minimize human-to-human and maximize human-technology interaction scenarios (2b Solutions, 2016). A specific example illustrating this positive side is that of the Weka Smart Fridge. Faced with a scarcity of available vaccines globally and with the logistical challenges of reaching billions of people, Weka Smart Fridge technology provided cold chain management, reducing vaccine wastage. Smart Fridge digitizes vaccination access and inventory any-where connected to the cloud. The cloud database archives each communication in real time, allowing the analytical procedure to verify the vaccinations' efficacy. In addition, bloc storage on the cloud enables quick analysis and detection of irregularities (2b Solutions, 2016).

This narrative demonstrates how disruptions can result in societal transformations. If risk-based analysis had been applied earlier, the current crisis of widespread pollution and rising worldwide human mortality could have been efficiently addressed. Nevertheless, the value of technical usefulness has been recognized, and with risk-based thinking, the value of intelligent healthcare robots has also been recognized (Betriana et al., 2021; Locsin & Dalanon, 2020).

On the other hand, if Society 5.0 and Industry 5.0 are widely applied, a majority of the population will be displaced as AI replaces human intellectual labor (Nahavandi, 2019). While it is true that this anticipated displacement may occur due to technological developments, it does not necessarily imply economic employment losses. When AI-powered machines supplant humans, they can improve their opportunities for self-realization and pursue personal interests provided guaranteed universal income becomes a reality. This kind of progress does benefit nursing practice and human healthcare by diverting nurses and other human labor away from low-intelligence tasks such as creating, preparing, innovating, and instituting quality control, thereby increasing human output. Overall, the opportunity cost of underutilizing AI to improve human lives surpasses the hazards of losing human autonomy and self-determination and devaluing obsolete human talents. In such situations, people become "unchained" from manual labor, from constraining limits such as repetitive motion injury or boredom, and hours of repetitive tasks.

Healthcare robots can serve as a buffer during handover activities in nursing practice to make the essential activities more efficient and timelier. The assistance of these healthcare technologies with AI ultimately improves precision, endurance, and safety. For example, older patients at high risk of falling and with motion instability can be kept safe from such accidents by using technological monitoring sensors or 3D human-like trajectories that

work in a manner that is similar to that of human limbs. In addition, preventing injury and eliminating waste and flaws improves performance, enabling equipment to operate reliably and accurately (Pepito & Locsin, 2018a; Robert, 2019), and nursing can be the better for it.

6 | POSITIONING NURSING PRACTICE IN THE FUTURE

Nursing and the healthcare industry keep on evolving. Folded into those changes is the use of AI-powered tools and processes to create highly integrated systems. After their adoption in nursing and the healthcare industry, society necessitates sustainability, the predicted next stage of life. Patient-centered and personalized medicine, autonomous systems, and data-driven decision-making have been characteristically operating in Life 4.0 (Staunton, 2020). Connecting through data streams, combining efforts through various care partners, and powered by sharing buttons (as platforms of care) will drive healthcare workers toward a more sustainable industry. In the future (Society 6.0), the automatic robotic industry may be controlled by quantum radar with dynamic inter- and intra-connectivity across organizations. In Industry 6.0, an intelligent healthcare industry with advanced cognitive computing systems using nanotechnology to create new manufacturing processes (Duggal et al., 2022) will ensure an easier data exchange resulting in personalized, evidence-based, and time-sensitive decision-making. If industries, including nursing and healthcare, are integrated seamlessly with other industries, it can create a sustainable and anti-fragile system geared toward survival in the 22nd century (Chourasia et al., 2022). This is Industry 6.0, where the nursing and healthcare industries are synchronized with the environment and nature. Nursing must evolve and adapt to these changes to ensure relevance in the future.

7 | CONCLUSION

With the application of Society 5.0 and Industry 5.0, AI can displace human intellectual labor (Nahavandi, 2019). Despite implying economic employment losses, AI-powered robots can improve human opportunities for self-realization and the pursuit of personal interests. Technological advancements benefit nursing and human healthcare by diverting human labor from low-intelligence activities such as routines requiring manual delivery and redirecting it toward developing, innovating, and instituting value controls to increase human productivity. The opportunity cost of not fully utilizing AI to advance human lives outweighs the concerns associated with the loss of human autonomy, self-determination, and devaluation of human endowments.

Nursing and healthcare practice demands the acknowledgment of the technological requirements of current healthcare practice. Technology-driven healthcare practice aims to improve the quality of care by leveraging the precision of Industry 5.0, considering influences within Society 5.0, and providing more wholesome living within the milieu of Life 3.0 encompassed in a high-tech human-centered environment.

Accepting technology-enhanced nursing and healthcare practice while adhering to extended safety designs and interventions increases legitimate, safe, and secure practices in this technologically challenging yet tech-dependent world of healthcare. Investigating phenomena connected to quality improvement and its methods and applications will

be necessary to detect problems affecting human care delivery's quality and safety via technologies, effect changes, and carry out corrective actions. For instance, reduced variability and errors can result in increased precision (Horii & Sakurai, 2020), ultimately transforming existing healthcare practices into more technologically savvy and intelligent ones.

With advancements in robotics and AI, nursing and healthcare practice are prompted to identify procedural techniques that contribute to practice processes instituting human liberation within the industry, to social relevance, and to human existence. Technological advancements and their contemporary applications serve as futurist designs depicting human life as heavily dependent on technology. AI utilization for healthcare encourages outcomes on the assumption that by freeing healthcare practice from the monotony of routine, skill-based competencies compel the fulfillment of thinking beings' human characteristics. Nonetheless, the nursing practice requires a higher level of intellectual ability, including consciousness, self-awareness, and sensitivity to the consequences of human behavior. Therefore, it is incumbent upon clinical nurses and healthcare designers and providers to be mindful of the growing reliance on technology in the era of Life 3.0, living in a Society 5.0 world dominated by an Industry 5.0 environment.

8 | RELEVANCE TO NURSING CARE PRACTICE

The realization of human autonomy is derived from Industry 5.0 derivatives, stressing freedom and eradicating human "enslavement" by relying on technologies, robots, and AI connectivity (Sawa, 2020). A Nobel Laureate, Amartya Sen (2000), calls for abolishing "unfreedoms" that impede inclusive and sustainable social development, including poverty and limited economic prospects, social/educational deprivation, and hidden oppressions. The elimination of unfreedoms makes sense, particularly within the Society 5.0 standpoint, as processed by Industry 5.0, as evolving toward environments of human living that are characteristic of Life 3.0.

When nursing is characterized by task completion, it is reasonable to question the relevance of human nurses being replaced by automated nurse robots (Locsin & Ito, 2018). For example, in managing patient-centered nursing care, task completions such as administering medications, delivering medications, and interpreting healthcare instrument data (e.g., EKGs) are essential interventions that influence nurse-staffing patterns to ensure quality care. With healthcare robots, nurses can be freed from these tasks using machine learning and robotics technology. These monotonous tasks can be consigned to automatons. Fundamental expectations can be subscribed to as well-suited practice processes for intelligent machines loaded with programs capable of producing accurate and efficient outcomes. Professional nursing practice as patient-centered care can then be focused more on professional disciplinal practices that require creativity, inventiveness, and imagination.

With machine technology and AI becoming indispensable to nursing and healthcare, nurses as professional practitioners can focus more intently on quality patient-centered care, enhancing patient satisfaction as central to ensuring human health and well-being.

ACKNOWLEDGMENTS

The authors thank Dr. Savina Schoenhofer RN, PhD, nursing consultant and nurse theorist for her invaluable support toward the development of this manuscript. Ms. Feni Betriana's assistance in facilitating literature updates and formatting the manuscript are greatly appreciated.

FUNDING INFORMATION

Funding was received from the Visiting Professorial Grant, Faculty of Nursing, Chiang Mai University, Chiang Mai, Thailand.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

REFERENCES

Bahari K, Talosig AT, & Pizarro JB (2021). Nursing technologies creativity as an expression of caring: A grounded theory study. Global Qualitative Nursing Research, 8, 1–20. 10.1177/2333393621997397

Betriana F, Osaka K, Matsumoto K, Tanioka T, & Locsin RC (2021). Relating Mori's Uncanny Valley in generating conversations with artificial effective communication and natural language processing. Nursing Philosophy, 22(29), e12322. [PubMed: 32803785]

Bzdok D, Varoquaux G, & Steyerberg EW (2021). Prediction, not association, paves the road to precision medicine. JAMA Psychiatry, 78(2), 127–128. 10.1001/jamapsychiatry.2020.2549 [PubMed: 32804995]

Chang H, Huang TL, Wong MK, Ho L, Wu CN, & Teng CI (2021). How robots help nurses focus on professional task. Journal of Nursing Scholarship, 53(2), 237–245. 10.1111/jnu.12629 [PubMed: 33567145]

Chourasia S, Tyagi A, Pandey SM, Walia RS, & Murtaza Q (2022). Sustainability of Industry 6.0 in global perspective: Benefits and challenges. Mapan, 37(2), 443–452. 10.1007/s12647-022-00541-w

Cigniti Technologies. (n.d.). Technology is changing Healthcare from top to bottom. Cigniti https://www.cigniti.com/blog/technology-transforming-healthcare/

Costa JM (2018). Society 5.0, the future, for the present. Dinheiro Vivo, Publicação Diária Digital (opinião) http://www.dinheirovivo.pt/opiniao/sociedade-5-0-o-futuro-pelo-presente/

Demir KS, Doven G, & Sezen B (2019). Industry 5.0 and human-robot co-working. Procedia Computer Science, 158, 688–695.

Dening, [initial?]. (2019). Make work human: Taking the robot out of human workers by automating at scale. https://www.itproportal.com/features/make-work-human-taking-the-robot-out-of-human-workers-by-automating-at-scale/ [this URL redirects to another article]

Dombrowski U, Richter T, & Krenkel P (2017). Interdependencies of industries 4.0 & lean production systems: A use cases analysis. In Pellicciari M & Peruzzini M (Eds.), 27th international conference on flexible automation and intelligent manufacturing (pp. 1061–1068). FAIM 2017.

Doyle-Kent M, & Kopacek P (2020). Industry 5.0: Is the manufacturing industry on the cusp of a new revolution? In Durakbasa N & Gençyılmaz M (Eds.), Proceedings of the international symposium for production research, lecture notes in mechanical engineering (pp. 432–441). Springer.

Draghici A, Baban CF, Gogan ML, & Ivascu LV (2015). A knowledge management approach for the university–industry collaboration in open innovation. Procedia Economic Finances, 23(1), 23–32.

Duggal AS, Malik PK, Gehlot A, Singh R, Gaba GS, Masud M, & Al-Amri JF (2022). A sequential roadmap to Industry 6.0: Exploring future manufacturing trends. IET Communications, 16(5), 521–531. 10.1049/cmu2.12284

Durkin J, Jackson D, & Usher K (2021). The expression and receipt of compassion through touch in a health setting: A qualitative study. Journal of Advanced Nursing, 77(4), 1980–1991. 10.1111/jan.14766 [PubMed: 33559877]

Eklund JH, Holmström IK, Kumlin T, Kaminsky E, Skoglund K, Höglander J, Sundler AJ, Condén E, & Meranius MS (2019). "Same same or different?" A review of reviews of person-centered and patient-centered care. Patient Education and Counseling, 102(1), 3–11. 10.1016/j.pec.2018.08.029 [PubMed: 30201221]

Emergen Research. (2020). Healthcare robotics market by type; By application (neurosurgery, orthopedic surgery, cardiology, laparoscopy, pharmacy applications, others); By portability (mobile, fixed); By enduse industry (rehabilitation, hospitals, and others); By region forecasts to 2027. https://www.emergenresearch.com/industry-report/healthcare-robotics-market

European Commission. (n.d.). Industry 5.0: What this approach is focused on, how it will be achieved and how it is already being implemented. https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation/industry-50_en

Fagerström C, Tuvesson H, Axelsson L, & Nilsson L (2017). The role of ICT in nursing practice: An integrative literature review of the Swedish context. Scandinavian Journal of Caring Science, 31(3), 434–448.

Ferreira C, & Serpa S (2018). Society 5.0 and social development: Contributions to a discussion. Management Organizational Studies, 5(4), 26–31.

Gu V (2021). Society 5.0: Japan's vision to live with robots, 2021. Govinsider.Asia. https://govinsider.asia/connected-gov/society-5-0-inside-japans-vision-to-live-with-robots/

Hofmann P, Samp C, & Urbach N (2020). Robotic process automation. Electron Mark, 30(1), 99–106.

Horii M, & Sakurai Y (2020). The future of work in Japan: Accelerating automation after COVID-19. Gartner, COVID-19 Resource Center https://www.mckinsey.com/~/media/mckinsey/locations/asia/japan/our%20insights/future%20of%20work%20in%20japan/the-future-of-work-in-japan_v4_en.pdf

Jones M (2018). HealthCare: How technology impacts the healthcare industry. https://healthcareinamerica.us/healthcare-how-technology-impacts-the-healthcare-industry-b2ba6271c4b4

Kopacek P (2018). Development trends in cost-oriented production automation. IFACPapersOnLine, 51(30), 39–43. 10.1016/j.ifacol.2018.11.242

Kowal P, Chatterji S, Naidoo N, Biritwum R, Fan W, Lopez Ridaura R, Maximova T, Arokiasamy P, Phaswana-Mafuya N, Williams S, Snodgrass JJ, Minicuci N, D'Este C, Peltzer K, Boerma JT, the SAGE Collaborators, Yawson A, Mensah G, Yong J, … Newell ML (2012). Data resource profile: The World Health Organization study on global AGEing and adult health (SAGE). International Journal of Epidemiology, 41(6), 1639–1649. 10.1093/ije/dys210 [PubMed: 23283715]

Krewit C (2020). Here are three ways AI will change healthcare by 2030. https://www.weforum.org/agenda/2020/01/future-of-artificial-intelligence-healthcare-delivery/

Lamb PC, & Norton C (2018). Nurses' experiences of using clinical competencies: A qualitative study. Nurse Education in Practice, 31, 177–181. 10.1016/j.nepr.2018.06.006 [PubMed: 29929090]

Liang HF, Wu KM, Weng CH, & Hsieh HW (2019). Nurses' views on the potential use of robots in the pediatric unit. Journal of Pediatric Nursing, 47, e58–e64. 10.1016/j.pedn.2019.04.027 [PubMed: 31076190]

Locsin RC, & Dalanon J (2020). Healthcare robots as exigency for COVID-19 pandemic? Philippine Journal of Nursing, 90(1), 76–78.

Locsin RC, & Ito H (2018). Can humanoid nurse robots replace human nurses? Journal of Nursing, 5, 1. 10.7243/2056-9157-5-1

Longo F, Padovano A, & Umbrello S (2020). Value-oriented and ethical technology engineering in Industry 5.0: A human-centric perspective for the design of the factory of the future. Applied Science, 10(12), 4182. 10.3390/app10124182

Medina-Borja A (2017). Smart human-centered service systems of the future. In Iwano K, Kimura Y, Takashima Y, Bannai S, & Yamada N (Eds.), Center for Research and Development Strategy, Japan Science and Technology Agency, future services & societal systems in Society 5.0 (pp. 235–239). https://www.jst.go.jp/crds/pdf/en/CRDS-FY2016-WR-13.pdf

Nahavandi S (2019). Industry 5.0: A human-centric solution. Sustain, 11(16), 4371.

Pepito JA, & Locsin R (2018a). Can nurses remain relevant in a technologically advanced future? International Journal of Nursing Science, 6(1), 106–110. 10.1016/j.ijnss.2018.09.013.eCollection

Pepito JA, & Locsin RC (2018b). Can nursing drive technological advances in healthcare in the Asia-Pacific? Asian Pacific Island Nursing Journal, 3(4), 190–198. 10.31372/20180304.1022 [PubMed: 31037267]

Pereira AG, Lima TM, & Santos FC (2020). Industry 4.0 and Society 5.0: Opportunities and threats. International Journal of Recent Technology and Engineering, 8(5), 3305–3308.

Pu S, & Yano M (2020). Market quality approach to IoT data on block-chain big data. Blockchain and Crypto Currency, 21–40. 10.1007/978-981-15-3376-1_2

Robert N (2019). How artificial intelligence is changing nursing. Nursing Management, 50(9), 30–39. 10.1097/01.NUMA.0000578988.56622.21

Sawa T (2020). Achieving human liberation through AI. The Japan Times https://www.japantimes.co.jp/opinion/2019/12/13/commentary/japan-commentary/achieving-human-liberation-ai/

Sen A (2000). Development as Freedom. Development in Practice-Oxford, 10(2), 258.

Shao SC, Chan YY, Kao Yang YH, Lin SJ, Hung MJ, Chien RN, Lai CC, & Lai ECC (2019). The Chang Gung Research Database—A multi-institutional electronic medical records database for real-world epidemiological studies in Taiwan. Pharmacoepidemiology and Drug Safety, 28(5), 593–600. 10.1002/pds.4713 [PubMed: 30648314]

Sharts-Hopko N (2014). The coming revolution in personal care robotics. What does it mean for nurses? Nursing Administration Quarterly, 38, 5–12. [PubMed: 24317027]

Shichijo N, & Akaike S (2019). Foresight driven policymaking: Society 5.0. In Betz V (Ed.), Society 5.0 (pp. 149–152). Springer.

Staunton D (2020). Life sciences 4.0, revolutionizing manufacturing through connected systems & data. Zenith Technologies https://www.zenithtechnologies.com/zen-blog/life-sciences-4-0/s

Tegmark M (2017). Life 3.0: Being human in the age of artificial intelligence. Penguin Random House LLC.

2b Solutions. (2016). Weka Smart Fridge tracks vaccine inventory using Microsoft Dynamics CRM and Azure IoT. https://www.2bsolutions.com/solutions/wims-365/weka-smart-fridge/

Yasuhara Y, Ito H, Tanioka T, Kondo K, & Locsin R (2019). Report on the second international seminar and workshop on technological competency as caring in the health sciences 2018. Journal of Medical Investigation, 66(1.2), 54–57.

Key points

- As technology and artificial intelligence advance at breakneck speed, so must nursing if it is to remain integral and relevant in healthcare practice.
- Technologies impact nursing by creating opportunities for nurses to focus more on their patients, but also raise issues of humanness in influencing human caring.
- The niche of nursing in practice is innovation, creativity, and imagination from which is nurtured its meaningful furtherance critical to human healthcare.

Impact Statement:

Accepting technology-enhanced nursing and healthcare practices while adhering to extended safety designs and interventions may greatlypromote legitimate, safe, and secure practices in today's technologically complicated but tech-dependent healthcare system. As a result, detecting concerns that jeopardize the quality and safety of technologically enabled human care delivery, making modifications, and taking corrective actions will demand study of quality improvement phenomena, techniques, and applications. In addition, clinical nurses, healthcare designers, and providers must be cognizant of the rising reliance on technology in an Age of Life 3.0 world dominated by an Industry 5.0 environment.