

ORIGINAL**The Co-Existence of Technology and Caring in the Theory of Technological Competency as Caring in Nursing**Rozzano C. Locsin^{1,2}¹Professor of Nursing Institute of Biomedical Sciences Tokushima University Graduate School, Tokushima, Japan, ²Professor Emeritus Florida Atlantic University

Abstract : The coexistence of technology and caring is best exemplified in nursing. The theory of Technological Competency as Caring in Nursing illuminates this coexistence as the essence of technology in health care premised on machine technologies as a generic concept of objects or things that are mechanical, organic, and electronic. With its timely development these technologies are continually imbued with artificial general intelligence. As such, the ultimate expression of machine technologies in nursing turns out to be autonomous robots (ARs) with future potentials of functions comparable to human persons. While theory-based nursing practice is essential to nursing care practice, quality human care, particularly with technologies assuming indispensable practice process mechanisms is critical. Some practice-based questions informing ARs and human person engagements in nursing care practice include, “Will ARs which are imbued with artificial intelligence replace nurses in their practice?” “What contributions to quality human health care will autonomous and artificially intelligent robots provide?” While these questions may reflect far-reaching ramifications of technologies in health care, it must also be acknowledged that these technologies are fundamental to the delivery of quality human health care now, and in the future. *J. Med. Invest.* 64 : 160-164, February, 2017

Keywords : technological competency, caring in nursing, technological encounter, autonomous robots, artificial intelligence

INTRODUCTION

In a 2014 article Carlos Feliciano (1) featured Dr. Rosalind Picard, professor of the Massachusetts Institute of Technology in an interview in which she claimed that “robots should be made available to healthcare providers (nurses and physicians) in order to enhance healthcare delivery, and there are not enough nurses to go around. Countries are starting to get radical in their solutions.”

However, when pressured to guarantee that robots will not fully replace nurses as a way for hospitals to save money, in 2013, Picard said, “You know, when people are in charge all kinds of things can happen...right? People will be in charge until robots take over, but I don’t see that happening in the next ten years (2)”. When this interview was made three years ago such projection may not have been alarming, but three years into her 10-year prediction, it seems a bit disconcerting that Picard’s projected time when robots take over the roles and functions of nurses as a way for health care institutions to save money, may be increasingly becoming a reality. It seems that if Picard’s prediction (2) is correct, in seven years, conventional or traditional health care and nurses’ roles and functions in organized health-based institutions will be simply a thing of the past, and the reality of a technologized human health care system will be realized.

Amazingly, in Japan, technology companies have received grants that cover up to 75% of the cost to design and develop nursing care robotic equipment to assist in caring for the increasing elderly population (3). This implies that health care technologies, e.g. robots can, and might replace the health care work of practitioners in medicine, laboratory science, nursing, radiological science and

other health care professions. How will these health care professionals adapt their disciplinary practices in order to meet future situational demands that may or can be replaced by advancing technologies? Stimulating educated discussions that address the influential nature of future technologies on health care professions is a primary consideration. Therefore, this article will clarify the influence and impact of advancing technologies on nursing, and examine prospective health care work that may be influential to the practice of other health care professions.

CLASSIFICATION OF TECHNOLOGY

Technology-dependence as a concept in human health care (4) is a consequence of technological demands within a technological world of health care. Regardless of dependence on technologies, contemporary technological dimensions exist fostering human health care in a contemporary world. These technologies are classified by Locsin (5) as, 1). Technology as completer of human beings, 2), Technology as instruments and gadgets that facilitate the human caring of persons, and 3). Technology that mimics human beings.

Technology as completer of human beings

These are technologies which are developed to provide missing human parts such as prosthetic devices, or replace non-functional ones such as cardiac pacemakers. Oftentimes, technologies are understood as those artificially fabricated or manufactured mechanical devices which are developed to simulate human parts. However, ‘completer technologies’ can also be organic or biological, such as human tissues/organs or xenografts (6) and zoografts (7).

Technology as instruments and gadgets

These technologies facilitate the practice of human caring of persons. These technologies are assistive devices which are

Received for publication November 21, 2016 ; accepted February 13, 2017.

Address correspondence and reprint requests to Dr. Rozzano C. Locsin, Professor of Nursing, Institute of Biomedical Sciences, Tokushima University Graduate School 3-18-15 Kuramoto, Tokushima 770-8509, Japan and Fax : +81-88-633-9035.

designed and developed to enhance the activities for human health care. For example, the DaVinci[®] Surgical System provides precision in surgical interventions, or Penelope[®], a surgical robotic arm that responds to a surgeon's voice regarding operative instruments, e.g. scalpel, sponges, forceps, etc. are examples of facilitative technologies. Computers as technologies, are the passive but central mechanisms of the existence of automated robots.

Technology that mimic human beings

These technologies are categorized as robots which can visually and physically resemble human persons, often with built-in artificial intelligence (AI). Depending on the sophisticated level of AI, these healthcare robots (8) are visually life-like, possess capabilities which are like humans, and performs tasks much like humans can and do as these are programmed to do. As of April 2016, Smashing Robotics (9) have identified thirteen available assortments of humanoid robots which are for sale, and the most advanced and expensive at the cost of \$2,500,000.00 is the Asimo that was developed by Honda Robotics. However, in 2010, the most advanced humanoid robot with physical qualities that are nearly human is of a female android known as Geminoid F (10), also known as Actroid F, developed at Osaka University, Japan with the help of Kokoro Co., Ltd. (Published on Sep 5, 2012). However, Borenstein and Pearson (11) declare that robot reactions to human behavior and emotions may be more important to reconsider than their appearance when caring for people and seeking to gain patient acceptance. Masahiro Mori's theory "The Uncanny Valley" (12) supports this concern and has modeled many robot technological advancements in Japan.

Subscribing to the description of technology as anything that makes things efficient, two additional conceptualizations of technological functionalities within the dimensions of technological competency as caring exist. These are, 4). *Technology as enhancer of human qualities* as exemplified in the potentials of cybernetic organisms, and 5). *Technology that facilitates the advancement of human-like organisms* best illustrated in evolving inter-human species development such as a chimera - a human being composed of two genetically distinct types of cells (13).

From the technological enhancers such as cyborgs or cybernetic organisms, to the facilitative technologies illustrated by the chimera, facilitative technologies has been sustained with organic, physical, psychological, and oftentimes genetic changes. Enhancements sustained over time and maintained by such sciences as biology, and genetic engineering occupy the hoped-for naturalistic future of the human person. The post-human and/or trans-human phenomena come alive in the transformative nature of human beings, be this be nurses themselves, or those persons being nursed.

The techno-physico-physiological composition of human beings begin to function in iterative designs in which the description of a human being will be greatly optimized. The development of human persons are diverse yet focused on the distinction of what it takes to be a human being. Characteristic human qualities remain a primary concern in the over-all assembly of the improvement of human persons in the future.

Technologies are here to stay, and the adaptation of advancing technologies on human caring practices demand human health care institutionalization of technological knowing (5) as undeniably essential. Nonetheless, while this may appear to be a laudable view of nursing practice (2), views can also serve to move the nursing profession's progression to a more integrative, and utilitarian system of technologies of care, becomes critically important to nursing practice as indispensable to the delivery of quality of human health care and the ultimate human health and well-being.

NURSING PRACTICE, AUTONOMOUS ROBOTS, AND HUMAN PERSONS

Furthermore, it is necessary that nursing and its practice is redefined, i.e. from a predictable service in which persons are understood as complete, whole, and can be known through the parts (while guided by a prescribed process of actions), towards a contemporary or futuristic nursing practice of persons understood as whole, complete, and unpredictable. The adaptability of nursing practice underscores the constitutionality of nursing as a discipline of knowledge and a practice profession. In this practice, there is no predetermined plan of care, because doing so will only make human beings appear reducible to parts, and therefore predictable. This perspective only perpetuates the perception that nursing practice is the prescription of nursing actions to complete human beings, affirming the traditional understanding that it is indeed the achievement of health care tasks, and that nurses' skills and techniques define its practice. Task completion follows the prescriptive process of traditional or conventional nursing, emphasizing excellent nursing as how well nurse exercised decision-making, judgment, and skillfulness in their delivery of technological actions.

Will autonomous robots (ARs) in health care answer the demands of contemporary and future patient health care concerns? Will healthcare robot co-dependency answer the question and concern about robots replacing nurses? Robot co-dependency seems to be inevitable, dominating the view of the imminent co-existence of robot and nurses. The demands of contemporary health care are focused on enhancing human caring as the ultimate response to the advancing "technologization" of health care, the prominence brought about by the exigencies of technology and its ability to provide objectified data, or to enhance the quality of data and timeliness of information retrieval. Ultimately encompassing the rationalization of the grand role of technology in health care, how can the glorification of technology best be made visible in health care? Demanding time constraints, predictive efficiency and ease of use altogether command the imminent utilization of technologies for human care.

The imminent coexistence of ARs and human persons

The five dimensions of technology describe the essential and developmental dependence of health care on advancing technologies. From low-fidelity to high-fidelity technologies, human health care continues to depend on technological advancements, the main advancement in health care being the design, development, and utilization of health care robots - robots that embrace natural-language processing, and engineering that prioritizes aesthetics in its mechanics. While these advancements are engaged in enabling the specific growth details of technologies in human care, the science of caring in nursing has been efficiently received into the fray of health care as described by Locsin (14) and as the all-encompassing foundation from which can evolve the congruence among the natural world of technology, caring, and nursing.

The Value of Robot-Nurse Coexistence

Futurists have long predicted the necessity of technologies in health care, and the demand for technological advancements in the service of human health care. Facilitating efficiency has become the clarion call in contemporary health care. No doubt the future holds similar mandates as technologically advanced wares demand critically savvy partners that will be engaged in the over-all determination of efficient human health care. In this scenario, technological enhancements provide the best possible solution. With the five dimensions of technologies which influence nursing as a human health care service, it is obviously natural that co-existence between humans and robots is critical for the common good of the human person. However, in future scenarios of health care, not all

human beings will be completely human persons thereby creating a best nursing practice situation allowing for shared engagements between the nurse and person being nursed.

THE THEORY OF TECHNOLOGICAL COMPETENCY AS CARING IN NURSING

In order to deal with such imminent utilization of technologies for human care, the understanding of technological encounter within the universal technological domain (UTD) is essential for apprising optimal nursing activities within the theory of “*Technological Competency as Caring in Nursing*.”

This theory (15) allows provisions in the procedure of nursing practice in which efficiency in practice within the perspective of human caring is understood and appreciated. Outcomes of health and well-being viewed as a way to exhibit the integral nature of nursing practice is underscored by technological encounters between the person and the nurse. With the practice of nursing grounded in the theory, evidences of living the meaning of one’s own life determines the richness of nursing as practiced from the persons perspective of health and well-being.

Assumptions of the Theory

Five assumptions structure the theory of *Technological Competency as Caring in Nursing*. Assumptions affirm the logical reality of the philosophical and theoretical bases from which the theory is established and develops. These assumptions provide the essential elements of the theory guiding the nurse in the practice of nursing as “knowing persons as caring.” Necessary in the practice is the proficient use of technologies for human care.

- *Persons are caring by virtue of their humanness* (16).

In nursing, caring is understood as the substantive focus of the discipline. It is not simply the act or emotion one may portray toward another person but also the substance of the domain that directs the integral nature of nursing as a discipline of knowledge. In the assumption, “persons are caring” is studied as fundamental to the practice of nursing.

- *The ideal of wholeness is a perspective of unity* (15).

It is derived from the ideal that persons are known as wholes in ways shaped by philosophical truths and realities. The conceptualization of wholeness allows for the recognition of human beings as complete in their being without reference to composition of parts. This ideal allows the nurse to focus on nursing as a shared lived experience between the nurse and the person being nursed (16), rather than focusing on fixing the person or completing the person’s lack or missing “parts.”

- *Knowing persons is a multidimensional process* (15).

The nurse and nursed focus on appreciating, celebrating, supporting, and affirming each other, while allowing for mutual recognition as dynamic participants in human caring.

- *Technologies of health and nursing are elements for caring* (15).

Through these technologies nurses in practice are able to know human persons more fully as active contributors in their care, rather than simply as passive objects of care.

- *Nursing as a discipline and a professional practice* (16).

As a discipline and professional practice, nursing is imbued with knowledge derived from rigorous research providing the essential knowledge for nursing practice.

KNOWING PERSONS AS CARING

A Dynamic Process of Nursing

This dynamic process affirms the practice of nursing as a shared engagement in response to the question, “How do nurses practice

nursing?” The challenges of nursing care are vital to human health and well-being. Meeting these challenges and responding to various critical concerns have never been most sought-after as nursing practice than it is today. Nursing care practice sustains and maintains, supports, and celebrates human health and well-being. As a dynamic process nursing care practice focus on activities that human nurses and ARs engage in, to service humankind.

However, today, activities of health care have taken newer forms, predicated on the ideals of functionalities, predictability, and the naturalness of human beings, thereby facilitating a greater appreciation of machine technologies for human caring. Functionalities direct the actions and interactions between human persons - the nurse and the one nursed, while predictability heightens the way human persons provide opportunities of care for appropriate and accurate human care. While these demands which are vital to human health and well-being evolve from traditional and conservative practices, the technological revolution that has transformed health care towards being a dependent entity trigger the flourishing conditions and situations that forges the very naturalness of the carer and receiver of care. ARs seem to be the endowed with technological capabilities which can serve nursing care practice well.

The practice of nursing grounded in the science of caring is expressed in the technological competency of nurses (15), using technological knowing, mutual designing, and participative engaging (17). This process of knowing persons as nursing embraces the futuristic visioning of nursing as engagements between human persons who may be endowed with technological enhancers thereby facilitating the living of meaningful lives in a highly technological world. The world of advancing technologies is illuminated in the coexistence of technology and caring unfolding in the process of knowing persons as caring (18).

Knowing persons as a practice process of nursing is revealed in the knowledgeable demonstration of intentional, deliberate, and authentic encounters with persons in technologically demanding nursing practice settings, particularly those in environments requiring specialized technological expertise. From the perspective of the theory, three dynamic nursing processes serve to guide nurses in their practice. These processes may occur altogether, and may not necessarily be sequential events as these inform each occurrence as aspects of a whole. These dynamic nursing process events (See Fig. 1) of knowing persons as caring are identified as technological knowing, mutual designing, and participative engaging.



Figure 1. Illustration of the Dynamic Nursing Process Events in Nursing

Technological Knowing (19)

Technological knowing is a way of understanding persons through the use of technologies of health and human care and provides nurses an “other way of knowing persons”. Technological knowing is the shaping of deliberate understanding of persons guided by the revelations of the competent use of technologies. In this process, the understanding of the person is magnified through the realities of the data obtained from the technology. In comprehending these realities, the nurse enters the world of the other, knowing them as participants in their care rather than as impersonal objects of care. Although the person’s status may change from moment to moment, the person is realized by the nurse as a dynamic and unpredictable human being.

Endowed with AI, ARs will actively participate in knowing the fullness of the person using its endowed technological capabilities. In time, these capabilities will progress as artificial general intelligence (AGI) is expected with a 90% chance to exist before the end of this century.

Mutual Designing

Mutual designing is a multidimensional process of knowing persons in which both the nurse and the one nursed co-create a mutually fulfilling nursing care process derived from both the nurse’s design and those of the person being nursed, and together conjointly practiced as nursing.

A significant issue within mutual designing is the capability of the machine to participate actively in designing the mutual nursing care process. The legitimacy of this concern is centered on the AI that robots may be endowed with considering advancing technologies.

The probability of Artificial *Super* Intelligence (ASI) as Barrat (20) claims will occur much sooner than expected. He described the development of the AGI as the “ability to solve problems, learn, and take effective, human-like action, in a variety of environments”. However, Barrat further claims that an autonomous robot with the ASI will be “a thousand times more intelligent than the smartest human, and it is solving problems at speeds that are millions, even billions of times faster than a human. The thinking it is doing in one minute is equal to what our all-time champion human thinker could do in many, many lifetimes.” Given this progression of abilities in the autonomous robot machines, assuming that a gradual development of AI will be dominant, it is highly likely that mutual designing between human persons and ARs with ASI may be synchronous as both participate in designing the nursing process of care.

Participative Engaging

Participative engaging promotes the opportunity for simultaneous practice of shared activities which are crucial to knowing persons. In this engagement, the alternating rhythm of implementation and evaluation occurs during which the nurse enters the world of the other and the engagement results in continuous knowing.

As ARs attain AGI, sophisticated activities become the normative expectation. Participative engaging between human persons and ARs continuously advance as AI progress to a level that complements the emergence of super intelligent machines and human persons.

UNIVERSAL TECHNOLOGICAL DOMAIN (UTD)*The technological encounter within the UTD (17)*

The dynamic nursing process of care occurs as the momentary occasion in which knowing persons as caring is encountered through technological knowing, mutual designing, and participative engaging. In a technological encounter, the occasion is an opportunistic

association in which ARs as ‘nurse’ and the human person as being nursed participate conjointly and know each other more fully as caring persons. Together they communicate in a reciprocal manner as intentional and sharing beings who experience themselves as caring persons. This experience will be dependent upon the existing AR intelligence level at the time of the encounter.

Anywhere the technological encounter occurs, the UTD is its environment. The UTD is the all-encompassing unity of ‘space and technology’ in which the dynamic engagement of the process of nursing is known. This domain is where all technological skills and techniques of engagement occur between ARs and human persons, wherein explications and utilizations of knowing persons as caring is illuminated as the technological encounter.

CONCLUDING STATEMENTS

Further considerations of the coexistence between technology and caring in nursing are strengthened by three features that uphold the imminent and harmonious coexistence and co-dependency of ARs and human persons.

- Integration of technological competency in the practice of nursing through the nurses’ proficient use of advanced technologies.

In situations such as this the imminent coexistence is premised on the affirmation of an informed practice engagement. Such engagement is focused on technologies of care with technological competency being integral to the realization of nursing practice as critical to human care.

- Participation in research and development of technologies in which nursing is increasingly considered vital to human care.

The development of nursing knowledge is predicated on the science of nursing in which the scientific evidence in support of nursing activities and futuristic endeavors influencing human caring are derived.

- Engagement in efficient nursing practices involving predictive interventions in human caring, in which human thinking becomes the dynamic through which human persons and intelligent machine can interface.

While the predictability of interventions remain an ideal in contemporary nursing practice, the futuristic endeavors of nursing care practice is engagement within the realities of contemporary human care demands. As such, there is no room for prediction and prescription, for human persons and technologies of care change with the times and the nurse must be cognizant, critical, and practical in the practice of nursing of knowing persons as caring grounded in the theory of *Technological Competency as Caring in Nursing*.

“Will ARs which are imbued with AI replace nurses in their practice?” Implications derived from Picard’s (2) response to a similar question dictates that the direct realization of what nursing is and ought to be is that “People will be in charge until robots take over.” It is not a guarantee that ARs will not take over the practice of nursing, but that, when nursing practice is infused with the predictability of completing tasks involving nursing skillfulness, then ARs with all its AGI and ASI may perform proficiently and with more efficiency. It be appropriate for contemporary practicing nurses who are engaged in nursing care processes to be wary of predictability and task completion as defining characteristics of human care

The coexistence of technology and caring in nursing is exemplified in the characteristics of ARs and human persons. ARs represent extant and advancing technologies endowed with AI, while human persons are caring persons characterized by humanness. For the continuance of human existence quality human health care is viewed as dependent upon the fundamental provision of technological competency and caring in nursing. Theory-based nursing

practice is essential if nursing care practice is to distinctively acknowledge the contributing feature of human caring particularly with technologies assuming the indispensable practice process within the science of caring in nursing.

CONFLICT OF INTEREST

There is no actual or potential conflict of interest that exist in this manuscript.

ACKNOWLEDGEMENT

The author is indebted to Dr. Tetsuya Tanioka, Professor of Nursing Outcomes Management of the Department of Nursing, Faculty of Health Sciences, Tokushima University for his astute, magnanimous, collegial and collaborative annotations and recommendations in the development of this paper.

REFERENCES

1. Feliciano C : "Robot replacing nurses : Is it really far-fetched?". Nursetogether. Feb 14 2014. <http://www.nursetogether.com/robot-replacing-nurses-is-it-really-that-f>, (Nov 20, 2016)
2. Picard R : "Interview on British Broadcasting Corporation". Nursetogether. Feb 14 2014. <http://www.nursetogether.com/robot-replacing-nurses-is-it-really-that-f>, (Nov 20, 2016)
3. "Japanese Government to Urge Nursing Care Robot Development". ACCESSIBLEJAPAN. <https://www.accessible-japan.com/japanese-government-to-urge-nursing-care-robot-development/>, (Nov 25, 2016)
4. Sandelowski M : Toward a theory of technology dependency. *Nursing Outlook* 41(1) : 36-42, 1993
5. Locsin R : Rozzano Locsin's Technological Competency as Caring in Nursing : Knowing as process and technological knowing as practice. In Smith, M., & Parker, M. (eds)/ *Nursing Theories and Nursing Practice* (4th ed), New York, F.A. Davis, Co 451-462, 2015
6. Institute of Medicine (US) Committee on Xenograft Transplantation : *Ethical Issues and Public Policy : Xenotransplantation : Science, Ethics, and Public Policy*. National Academies Press (US), Washington (DC), 1996
7. Rogers B, Converse JM : Bovine embryo skin zoografts as temporary biologic dressings for burns and other skin defects. *Plastic Reconstructive Surgery Transplant Bulletin* 22(5) : 471-85, 1958
8. Tanioka T : The Development of the Transactive Relationship Theory of Nursing (TRETON) : A Nursing Engagement Model for Persons and Humanoid Nursing Robots. *International Journal of Nursing and Clinical Practices* 4 : 223, 2017
9. "Thirteen Advanced Humanoid Robots for Sale Today". *Smashing Robotics*. Apr 16 2016. <https://www.smashingrobotics.com/thirteen-advanced-humanoid-robots-for-sale-today/>, (Nov 25, 2016)
10. Geminoid F, "Android F" : *plasticpals*. <http://www.plasticpals.com/?p=22355>, (Nov 25, 2016)
11. Borenstein J, Pearson Y : Robot caregivers : Ethical issues across the human lifespan. In : Lin P, Abney K, Bekey GA, eds. *Robot Ethics : The ethical and social implications of robots*. MIT Press, Massachusetts : 251-265, 2014
12. Mori M : *The Uncanny Valley*. (The uncanny valley (K. F. MacDorman & Norri Kageki, Trans.) *IEEE Robotics and Automation* 2(19) : 98-100, 1970/2012
13. Chimera : <http://www.medicinenet.com/script/main/art.asp?articlekey=8905>. (Retrieved, November 10, 2016)
14. Locsin R : The Theory of Technological Competency as Caring in Nursing : Guiding Nursing and Health Care. *Shikoku Acta Medica*. 72 : 5,6, (Accepted for Publication on October 27, 2016. Anticipated publication date : December 25, 2016)
15. Locsin R : Technological Competency as Caring in Nursing : A Model for Practice. Sigma Theta Tau International Honor Society of Nursing Press, Indianapolis, IN, 2005
16. Boykin A., & Schoenhofer S. : *Nursing as caring : A model for transforming practice*. Sudbury, MA : Jones & Bartlett, 2001
17. Locsin R. & Purnell M. : Advancing the Theory of Technological Competency as Caring in Nursing : The Universal Technological Domain. *International Journal for Human Caring* 19 (2) : 50-54, 2015
18. Locsin R : Technological Competency as Caring in Nursing : Co-creating Moments in Nursing Occurring Within the Universal Technological Domain. *The Journal of Theory Construction and Testing* 20(1) : 5-11, 2016
19. Locsin R : 'Painting a Clear Picture' : Technological knowing as contemporary process of nursing. In Locsin, R & Purnell. *A Contemporary Process of Nursing : The (Un) Bearable Weight of Knowing Persons in Nursing*. Springer Publishing, 2009
20. Barrat J : *Our Final Invention*. Thomas Dunne Books, St. Martin's Griffin Press, New York : 9-31, 2013