REVIEW

Current State of Healthcare Robots for Older Adults in Care Facilities in Japan and the Related Ethical Issues for Nurses

Yuko Yasuhara

Department of Nursing Art and Science, Institute of Health Biosciences, The University of Tokushima Graduate School, Tokushima, Japan

Abstract : This review discusses the introduction of healthcare robots, such as those that provide transfer, toileting, bathing, and communication assistance, in Japanese facilities for older adults and considers these issues from the perspective of nursing ethics. Although healthcare robots can support older adults and their caregivers, they may cause ethical dilemmas when introduced in assisted living facilities. Nurses should make ethical decisions by considering different types of information to determine the best care for older adults ; they can resolve ethical dilemmas by referring to the 6 principles of nursing ethics. As healthcare robots are increasingly used in the care of older adults, nurses should protect patients' rights and ensure patient safety. Further, engineers and medical professionals must discuss and share issues related to the use of healthcare robots to build improved robotic technology for older adults. J. Med. Invest. 72 : 8-13, February, 2025

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BACKGROUND

The total population of Japan was 126.15 million in 2020 ; however, it is expected to decrease to 87 million by 2070, with 45.35 million individuals aged between 15 and 64 years and 38.7% of the population aged over 65 years (1). According to the World Health Organization, between 2015 and 2050, the percentage of the world's population aged 60 years and older will nearly double from 12% to 22% (2). In particular, the proportion of working-age people may become severely low in North Africa, Latin America, and West, Central, South, East, and Southeast Asia (3).

Most older adults need care or suffer from a disease, and nurses play a central role in providing care to them (4). However, the number of nurses and caregivers per patient is insufficient owing to the increasing demand for nursing personnel (5, 6). The novel coronavirus disease (COVID-19) has become a major threat to global public health (7). The emergence of COVID-19 has significantly impacted the psychological and mental well-being of frontline health workers, including nurses, who are quitting their organizations and the profession (8, 9). When a new infectious disease appears, task support and systems are crucial to reduce infection risk for healthcare providers. Thus, robots are attracting attention as a countermeasure for such serious situations in older adult care.

In Japan, the development of healthcare robots (HCRs) to support the lives of older adults is expected to increase in the future, is being promoted under the Japanese government's "Japan Robot Strategy" (10), which aims to develop robots for use in long-term care facilities. Based on the classification of HCRs in Japan (transferring, mobility, nursing activity support, monitoring and communication, toilet, bathing, others) (10), a survey was conducted in 29 countries in 4 regions, and the total number of HCRs was 340 (11). Although only a few products are currently available, more than 50% of them were at the verge of being introduced into long-term facilities and home care for "transferring," "toileting," "bathing," and "monitoring/communication" (number of products, percentages : 29, 56% ; 7, 64% ; 11, 79% ; and 63, 59%, respectively) (11). The use of HCRs varies by country, depending on factors such as the number of working-age individuals, attitudes toward the provision of care by HCRs, and cultural backgrounds ; overall, HCRs are not widely used (11, 12). Nonetheless, HCRs can replace some aspects of nursing care and may be rapidly introduced in healthcare settings in the near future. Although they can support older adults and their caregivers and nurses, they may cause ethical issues when used in assisted long-term facilities and nursing homes.

Nurses provide care to patients in a variety of clinical settings, including acute care hospitals, long-term care facilities, and nursing homes. They are responsible for modifying the environment to ensure the autonomy and safety of elders and patients as well as acting as advocates when needed (13). According to the International Code of Nursing Ethics (14) and the Japanese Nursing Association (13), nurses are required to provide care while respecting human life, dignity, and rights according to the law. This means that nurses need to consider the introduction and use of HCRs in clinical fields from the perspective of not only convenience but also the nursing ethical code. Thus, this paper describes the current situation in Japan regarding the use of HCRs (for transfer, toileting, bathing, and communication assistance) in nursing care facilities and examines related issues from the perspective of nursing ethics, which advocates for older adults and patients.

HCRs IN OLDER ADULT CARE

The history of HCRs

In Japan, the Basic Plan for Science, Technology, and Innovation Policy was formulated as a 5-year plan in 2021. Accordingly, the Sixth Basic Plan (15) expressed the vision for "Society 5.0," which Japan should strive for to become "a society that is sustainable, resilient, and ensures security." The Japanese government aims to become the first country to realize a human-centered society (i.e., Society 5.0) (16). Society 5.0 envisions the creation of new values in healthcare through the AI-driven

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Address correspondence and reprint requests to Yuko Yasuhara, Institute of Health Biosciences, University of Tokushima Graduate School, Kuramoto-cho, Tokushima 770-8509, Japan.

analysis of big data that includes various types of information, including personal real-time physiological data, healthcare site information, and treatment and infection information (16). These values can help reduce the social costs associated with healthcare and care and solve the problem of labor shortages at healthcare sites. There is a growing need for robots in the healthcare industry to address labor shortages, particularly in nursing, welfare, and rehabilitation (5).

Since the 1980s, the use of robots has increased rapidly throughout Japan, especially in the manufacturing sector (10). In particular, the automobile, electrical, and electronics industries have experienced significant growth against the backdrop of greater labor productivity. Previously, the only standards available for robots were ISO 10218 (17), which relates to industrial robots and robot-related equipment, and safety standards for HCRs had not yet been established. The ISO 13485 (Medical Devices -Quality Management Systems) (18), which is the standard for medical devices used in the diagnosis and treatment of diseases and injuries, was established in 1996 ; it is now referred to as ISO 13485 : 2016.

Furthermore, in the face of severe population aging and a declining birthrate in Japan, the Ministry of Health, Labour and Welfare and the Ministry of Economy, Trade and Industry formulated the "Important development field" (10), which refers to important fields of care where robotic technologies can be used to solve issues in nursing such as watching over people with dementia and transfer, excretion, and bathing support. The "Important development field" was revised in 2014 and 2017, and the revised list includes 13 items across 6 fields. The Japan Agency for Medical Research and Development (AMED) and the Ministry of Economy, Trade and Industry have conducted a project on long-term care technology to promote the development of HCRs (19).

In February 2014, ISO 13482 (20), an international standard for HCR safety excluding medical use, came into effect. Its creation was led by Japan, which is a pioneer in the development of HCRs. Subsequently, in 2014, the Japanese government announced the Japan Robot Strategy, which included the development of robots for use in the nursing and medical fields (10). The Ministry of Health, Labour and Welfare defines a robot as a machine system that has been made intelligent by a sensor, intelligent control, and drive system. The term HCR is used to describe care equipment that uses the aforementioned technology, can help support user independence, and reduces caregiver burden (21).

In June 2024, to further promote the development and dissemination of innovative devices in care, the "Important development field" was renamed as "Priority fields for the use of care technology," which includes the use of information and communication technology and care robots. The list will be expanded to include support for functional training, diet and nutrition management, dementia, and care, resulting in a total of 9 fields and 16 items by April 2025 (22).

A survey of 29 countries in 4 regions related to HCRs showed that the total number of HCRs was 430 and the highest numbers were in Australia, New Zealand, the United States, Sweden, and Denmark, respectively ; furthermore, the survey revealed that development and sales are progressing in countries with gradually aging populations (11). In Germany, negative opinions abound about HCRs taking care of people ; therefore, the demand for HCRs is low (12). Countries such as China, South Korea, the United States (23), and those in Europe (24) that expect to face an aging population by 2030 are also displaying interest in HCRs, which might be increasing demand.

THE USE OF HCRs IN ASSISTED LIVING SETTINGS

The AMED (19) provides comprehensive information on the introduction of long-term care technology in nursing facilities and the development of these devices, sourced from the Japanese government, professional organizations, and companies. This review covers the typical HCRs that have been developed with the support of AMED (19) or reported in the Survey of the Current Situation of Technology in Long-Term Care by Ministry of Health, Labor and Welfare (25) and are still in use in Japanese facilities.

Transfer support robots

In assisted living settings and long-term facilities, assistance for based human needs such as toileting and bathing is the most common type of care provided by caregivers. The early turnover rate of nurses in nursing homes is approximately 15% in Japan (26) and 19.0%–55.0% in the United States (27). The turnover factors in this context include pay, work environment, human relations, and physical strain, and facility managers need to address these issues (26). Transfer support robots can reduce physical strain such as back pain by reducing the load caregivers have to lift.

First, an example of a wearable robot for transfer support for caregivers is the non-medical HAL (Hybrid Assistive Limb, Ibaraki, Japan) (28), which aims to support motion assistance, promote independence among patients, and reduce stress on caregivers' lower back during care. Similarly, the Muscle Suit Exo-Power (INNOPHYS, Tokyo, Japan) (29) has a maximum assistive force of 27 kg and can reduce the lower back burden of caregivers working in facilities. Other HCRs for transfer support include the J-PAS Fleairy (JTEKT, Aichi, Japan) (30) and Assist Lumb (Koganei, Tokyo, Japan) (31), which are assistive robots specifically designed to reduce strain on the lower back during nursing and caregiving activities.

Second, an example of a non-wearable robot for transfer support for caregivers is the Resyone Plus (Panasonic AGE-FREE, Osaka, Japan) (32), which is a combination of an electric bed and a wheelchair ; the wheelchair half of the bed can be detached at the touch of a button. Kato *et al*. (33) reported that over an 11-month period after the introduction of the Resyone Plus, the instances of assistance by 2 caregivers decreased gradually, and all transfers were eventually performed by a single caregiver. The ROBEAR (RIKEN and Sumitomo Riko, Saitama, Japan) (34) can perform tasks such as lifting a patient from a bed to a wheelchair or assisting a patient who can stand but needs assistance. Unfortunately, although the Resyone Plus and ROBEAR continue to be used in nursing care settings, their production has been discontinued. Relatedly, Yoshimi *et al*. (35) suggested that a robotic lifting device, "Hug" (Fuji Innovation Spirit, Japan) (36), which inserts a soft robotic arm under each armpit of a care recipient, could assist in transfer tasks and reduce the physical burden on caregivers. This robot is used when older adults have the strength and are physically able to stand and walk on their own with its assistance.

A survey of 18,000 Japanese nursing care facilities and businesses showed that the percentage of Japanese facilities that use robots to help transfer older adults daily is low (between 1.2% and 1.4%) and the use of robots tends to increase as the size of the workplace increases to 50 people or more (26). Often, HCRs are developed but not implemented because of their costs. In Asia, mobility support accounts for 26% of total HCR development and sales, but there is no data on the rate of adoption in facilities (11). In China and Singapore, where the number of older adults is expected to increase in the future, the need for (wearable) mobility support such as the HAL for Medical Use - Lower

Limb Type, which has received CE Marking (CE 0197) (Hybrid Assistive Limb, Ibaraki, Japan) (37), is expected to increase (12) ; however, their use is not prevalent at present.

Excretion and bathing support robots

Per day, an average adult is estimated to urinate 5 to 6 times and defecate 1 to 2 times. If an older adult is unable to use a toilet (e.g., if they are bedridden), it is essential for their caregivers to provide assistance with toileting. Older adults often feel resistant and reluctant to call caregivers for such assistance because of feelings of shame.

Wearable devices such as the DFree (DFree, Tokyo, Japan) (38) and Lilliam IP200 (Lilium Otsuka Co, Kanagawa, Japan) (39) use an ultrasonic sensor to measure the amount of urine in the bladder in real time and alert the user when it is time to urinate. Reducing both diaper costs and caregiver burden is possible by encouraging urination at appropriate times. In contrast, the Bedside Flushable Toilet (TOTO, Fukuoka, Japan) is a retrofitting and movable flush toilet (40). By moving the toilet to the bedside, older adults can easily move from their bed to the toilet.

Bathrooms tend to be slippery, and therefore, caregivers need to ensure safety when helping older adults bathe. Bathing support robots help people move from the bathroom into a bathtub and complete a series of steps until they enter the bathtub. For example, the burden of bathing assistance can be reduced using a Bath Lift (TOTO, Fukuoka, Japan) (41), an electric seat that can raise and lower itself. Similarly, the Viami series of products (AIR WATER INC, Saitama, Japan) includes devices that allow patients to bathe while sitting on a stretcher or special wheelchair (42).

Communication/monitoring robots

Engaging in conversation with others helps maintain sociability and cognitive function, especially in older adults, and many communication robots (CRs) have been developed for this purpose. For example, the PALRO (FUJISOFT, Tokyo, Japan) is an autonomous humanoid robot that learns the faces of older adults to have spontaneous conversations with them (43). It has 4 learning capabilities : conversation, walking, network connections, and AI. Similarly, the NAO (Aldebaran.com, Paris, France) has direct microphones for interacting with humans and speakers as well as 2 cameras to recognize people (44). Pepper (SoftBank Robotics, Tokyo, Japan) is another humanoid robot that supports users' everyday lives by providing recreation and conversation (45). It has infrared sensors, an inertial unit, 2D and 3D cameras, and a sonar for omnidirectional and autonomous navigation. The abovementioned CRs can act as perception modules that recognize and interact with the person speaking to them and support users' everyday lives by offering recreation to and engaging in conversation with older adults (43-45). Furthermore, CRs can improve cognitive function and reduce the behavioral and psychological symptoms of dementia in patients through rehabilitation and recreation (46).

Pet-type robots are also a type of CR. For example, Paro (Daiwa Lease, Osaka, Japan) (47) is a baby-seal-like therapeutic robot with 5 types of sensors (tactile, visual, auditory, thermal, and posture). Similarly, the AIBO (Sony, Tokyo, Japan) (48) is a dog-shaped robot with eyes that can perform gestures. Sony Japan provided an AIBO free of charge to 100 institutions for 3 years, with the aim of reducing stress and promoting healing among patients in hospitals during the COVID-19 pandemic. Three years after its introduction, the participation of patients with dementia in rehabilitation and conversation improved (48). The LOVOT 3 (GROOVE X, Tokyo, Japan) (49) is another pet-type robot that has a human-like warmth, can recognize the faces of more than 100 individuals, and has a monitoring function. Similar to real animals, although pet-type robots cannot speak with older adults, they can cheer them up and reduce stress through their interactions. These robots pose no risk of animal allergies or infections and are comfortable to use.

Other monitoring HCRs such as the Watch Over Sensor (King Tsushin Kogyo, Tokyo, Japan) (50) and A. I. Viewlife (A. I. Viewlife, Tokyo, Japan) (51) can monitor the movement of older adults and patients with dementia out of bed and can prevent falls for those in care. These are especially useful at times when there are few medical personnel, such as at night.

In other countries, "monitoring and communication" accounts for 60% of all HCRs in North America and 38% of in Asia (11). The development of HCRs may be the most advanced in the United States, where some aspects of "monitoring and communication" with wearable products and communication devices are becoming more widespread in not only facilities but also home care (12).

Many CRs are commercially available in Japan, but the greater their communication functionality, the more expensive they are, costing approximately $2,600 to $3,900 (43-45). Thus, only 0.3% of the facilities in Japan use CRs daily (26).

ISSUES WITH HCRs FROM A NURSING ETHICS PERSPECTIVE

Nursing and ethics

Innovations in healthcare, including technology and robotics, can provide clinicians and healthcare providers with the tools they need to focus on their patients' needs and help people live better lives (15). Therefore, technology can help nurses better understand their patients (52). With the rapid development of robots and AI in recent years, academic societies have issued ethical codes and guidelines, particularly in the field of engineering (53-55). However, the laws and ethical standards for care robots remain unclear.

To determine the best course of action for patients when faced with ethical dilemmas, nurses can refer to ethical guidelines such as the American Nurses Association Code of Ethics (56), International Council of Nurses Code of Ethics (14), and Japan Nursing Association Code of Ethics (13). As highlighted in Table 1, nurses should consider the 6 principles of nursing ethics (beneficence, non-maleficence, autonomy, veracity, justice, and fidelity) when facilitating robotic innovation (57, 58). The following section discusses the issues related to HCRs based on the 6 principles of nursing ethics.

Table 1. The six principles of nursing ethics (57, 58)

Beneficence : Actions that consider the welfare of others and include attributes like kindness and charity.
Nonmaleficence : Actions that prevent or inflict minimal harm to others.
Autonomy : Recognizing the individual's right to self-determination and decision-making.
Veracity : Interacting with others in a truthful, trustworthy, and accurate manner.
Justice : Treating others with fairness and with equal degree of respect and concern.
Fidelity : Being loyal and faithful to patients who trust the nurse.

Issues in the use of HCRs based on the 6 principles of nursing ethics

While HCRs can help older adults and healthcare providers, including nurses, it is important to avoid overburdening healthcare providers who use HCRs (59). This is related to the ethical principle of justice (i.e., providing proper and fair nursing care for all patients) because the extra time needed for familiarization with HCRs may be used to directly provide care for older adults. Such problems are likely to occur immediately after HCRs are introduced into a facility ; however, it is necessary to provide equitable care for patients who do not use HCRs.

Moreover, patients have the right to know about themselves (i.e., autonomy). The principle of autonomy refers to an individual's right to self-determination and decision-making. In other words, older adults have the right to choose whether to be cared for by HCRs (i.e., autonomy) ; additionally, it is important that the staff at facilities that use HCRs explain their use to older adults and respect care recipients' wishes.

The principle of veracity specifies that nurses must provide sufficient explanation, tell the truth, and not lie. When providing patient care, nurses must explain the details of the care and provide it with the patient's consent. In particular, nurses are expected to act as advocates for older adults with diminished decision-making capacities, such as those with dementia. Hence, nurses are involved in deciding whether to use HCRs in nursing care from the perspective of patient advocacy (non-maleficence and veracity). This is particularly important for activities such as toileting and bathing, which are associated with feelings of shame. When offered toileting assistance, many older adults feel reluctant to even inquire if their human caregiver will help clean up or dispose of excreta. Some HCRs have urination aids that are placed on the bladder and alarm the individual when a certain amount of urine has been collected ; such aids have the potential to promote independent urination among older adults (38, 39). In mobile toilets, excreta can be automatically flushed (54).

Nurses observe the entire body of patients, including their vital signs, and accordingly assess and provide care. However, there is a possibility of misunderstanding the patient's state when using HCRs ; it is important for nurses to observe patients' urine and feces, and this opportunity should not be missed (non-maleficence and beneficence). In addition, the use of HCRs may lead to the development of allergies to the sensor surfaces (non-maleficence and beneficence). Therefore, nurses must consider whether using HCRs is beneficial and safe for patients at any time.

Nursing professionals in countries that do not have a declining birthrate or an aging population (60) have a strong negative image of robots. However, they also believe that robots should be used for some types of assistance, such as toileting assistance. Bathing in bathtubs is characteristic of Japanese culture ; therefore, there may be little need to use HCRs in other countries. However, bathing is an important form of nursing care that helps older adults maintain cleanliness and feel satisfied. There is a high risk of falling in bathrooms, and the safety of HCRs alone cannot be guaranteed (non-maleficence). While wearable transfer support can reduce physical strain, such as back pain, in caregivers, it may cause issues because of the additional time taken to wear it and the need to adjust the size (non-maleficence and beneficence). Non-wearable robots for transfer support can assist older adults and reduce caregiver burden. However, the range of motion and joints varies for older adults because of joint contractures or paralysis. Human caregivers assess the patient's condition and accordingly provide assistance, and currently, HCRs are positioned as assistants for human caregivers. When HCRs are used in a healthcare setting for older adults, assisting and supervising human caregivers and nurses is necessary to ensure safety (non-maleficence and beneficence). To that end, certain issues must be resolved, including those related to the use of medical malpractice insurance for HCRs.

The physical burden on caregivers reduces when HCRs are used for older adults. However, whether this reduces the time required to provide care is unclear because human caregivers are needed to monitor and operate HCRs. According to the principle of avoiding danger to older adults, it is also necessary to decide in advance not to use HCRs based on patient characteristics. Nurses must anticipate the potential risks associated with the use of HCRs and implement safety measures and risk management (non-maleficence).

Through conversations, nurses can understand patients' changing physical conditions and feelings. Therefore, they must take the time to listen to patients to provide appropriate, high-quality care that suits older adults and those with dementia. However, in assisted living facilities where there are few nurses on duty (5, 26), nurses may not be able to spend enough time talking to patients.

Therefore, older adult care is expected to focus on home care in Japan and other countries (11, 12). Current CRs can guide older adults in recreation and rehabilitation at facilities and facilitate simple conversations. However, they have not reached a stage where their use allows conversations to continue in a manner appropriate for older adults. To establish a dialogue between CRs and older adults, medical staff should remotely input the dialogue content using a PC or tablet or should mediate between the CR and the patient (beneficence and non-maleficence).

Nurses must protect and not disclose patient information (Article 42-2 of the Public Health Nurses, Midwives and Nurses Act). However, security breaches can occur because of malfunctions in cloud servers where conversations between HCRs and older adults as well as patient monitoring videos are stored (principle of inappropriateness and prohibition of disadvantage) (61). That is, the information stored in CRs may be able to identify individuals based on their name, date of birth, medical condition, and treatment information (59, 61).

When CRs with more advanced AI are introduced in care settings, nurses must carefully consider the possibility of leaks of personal data and the breach of privacy rights. To improve patient care, the collected patient information should be shared or reviewed by humans, and nurses and facility managers must discuss the following questions with engineers : "Who manages this information and how?" and "Who has access and use rights?" (61) (beneficence, non-maleficence, and fidelity). These are important points that have not been sufficiently discussed despite the ability of HCRs to resolve several problems and provide patients with greater autonomy.

The cost of HCRs remains high ; however, HCRs can be rented with a subsidy from the Care Robot Support Project. In the Japanese nursing care sector, the larger the company, the greater the percentage of robots (26). However, even in facilities that have introduced robots, the number is limited ; therefore, all users and caregivers cannot use them (justice). To ensure that all older adults in need of care, including those in small facilities, receive equitable care through HCRs, developing systems and laws and providing support to facilities is crucial.

As robotic technology continues to be used in older adult care, nurses must take the lead in determining the roles and functions that robots will perform (62). During these transformative times, the professional moral duty of nurses requires engaging with this technology to ensure that robotic care complements nursing care but does not replace it.

CONCLUSION

This review discusses the use of HCRs in assisted living facilities in Japan for mobility, toileting, bathing, and communication assistance, and considers the related issues from the perspective of nursing ethics. Although HCRs can assist in older adult care, appropriate care and patient interaction remain complex issues for both traditional nurses and robots.

Nurses are responsible for providing the best possible care based on the 6 principles of nursing ethics when faced with ethical dilemmas as well as for protecting the rights and safety of older adults. They must become familiar with ethical and legal principles to make ethical decisions when using robots in clinical settings. Moreover, engineers and medical professionals must discuss and share issues related to the use of HCRs to develop better HCRs for older adults.

CONFLICTS OF INTEREST

The author has no conflicts of interest to declare.

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