



Scoping Review of the Literature on Smart Healthcare for Older Adults

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Smart healthcare systems are being designed to provide medical services to and improve the daily lives of older adults. However, most research has been focused on technical issues, despite a need to conduct in-depth studies on related ethical issues. Therefore, this study aimed to examine ethical issues in smart healthcare for older adults. We reviewed published literature using PubMed. In total, 292 documents were analyzed by applying the scoping review method. Finally, 29 articles were selected from the 292 articles. Ethical issues in smart healthcare for older adults were analyzed in terms of the themes of responsibility/autonomy (n=10), privacy (n=9), and digital divide (n=10). Technical help provided by smart healthcare may infringe on the autonomy of tacit choice for older adults. This pose a potential ethical issue as the subject of responsibility here is unclear. Privacy is a concern as smart technology may intrude the personal life of the user. The digital divide is a challenge because of low responsiveness from older adults to technological changes. The future development and application of smart healthcare systems must take these ethical aspects into account to enable their efficient and effective use in supplementing healthcare for older adults. Critical discussions to identify ethical issues and customize ethical requirements for specific user needs are necessary among smart healthcare providers.

Key Words: Aged, delivery of health care, ethics

INTRODUCTION

The United Nations defines an “aging society” as one in which the proportion of people over 65 years of age accounts for more than 7% of the total population.¹ According to some reports, the rate of aging is progressing rapidly in societies worldwide.^{2,3} A key issue to be addressed in this context is the resultant increases in medical expenses and the number of chronic disease patients.⁴ The aging population and increases in medical expenses

have emerged as social problems, and efforts are being made to efficiently respond to these issues. One potential solution to combat these challenges is smart healthcare.¹

Smart healthcare provides healthcare services based on information and communication technologies (ICT), and recently, various health-related services have been provided for older adults. Smart healthcare has been developing sensor technologies that analyze health data for older adults and monitor their daily lives.^{5,6} Therefore, smart healthcare has significant advantages over traditional healthcare services in that it can provide medical services by monitoring the overall health of older adults and securing their safety in daily life.⁷

Recently, the growing smart healthcare field has been providing psychological and emotional support for frequently occurring problems in older adult populations, such as anxiety, insomnia, and depression.⁸ It has proven to be a promising and future-oriented field for both psychological support and physical health management for older adults.^{9,10} However, current improvements in smart healthcare are focused primarily on technological advancements, despite concerns for possible data

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leakage from data sharing, unauthorized access, and disclosure of health information through smart healthcare practice, which can cause physical and ethical damage to users.¹¹⁻¹³ Therefore, it is necessary to consider the ethical issues associated with smart healthcare in the context of older adult patients.

Although older adults can improve their quality of life through new science and technologies, they often experience difficulties accepting new technologies when unfamiliar with the use of ICT.^{14,15} Older people are often indifferent to, or have difficulty getting used to, new technologies. Therefore, in order to effectively introduce smart healthcare to older adults, it is necessary to understand these advancements from their point of view, and this first step should be from an ethical perspective. However, there is a lack of discussion about ethical issues associated with smart healthcare that older adults may experience as users.¹⁶⁻¹⁹

LITERATURE SEARCH STRATEGY

This study was conducted by applying the scoping review methodology with a specific subject scope.²⁰ The procedure for the literature review in this study is shown in Fig. 1. In the process of confirming the research topic, research papers related to ethics

in smart health research for older adults were selected to secure papers related to the research topic. A total of 292 articles were identified and collected from PubMed, a database of medical papers, by inputting the keywords ('Smart health') [AND] ['Ethic' (OR) 'Ethics'] as of March 16, 2021. Two experts in the field of medical informatics, focusing on the titles of the identified articles, reviewed their suitability to the research topic.

The eligibility criteria for this study were that the research article had to include research on older adults. There were 210 articles that were excluded, particularly articles that did not primarily deal with ethical issues (n=119), articles that did not target older adults (n=25), and articles that focused solely on the technological development of smart healthcare (n=66). Among the remaining 82 articles, after reading their abstracts, the contents were analyzed based on the same criteria as above, and the papers that did not primarily deal with ethical issues (n=20), papers that focused on the technological development of smart healthcare (n=13), or papers that did not target older adults (n=6) were excluded. After application of these eligibility criteria, 43 articles were selected for analysis in this scoping review. Subsequently, a full-text scoping review was conducted, and as a result of this process, a total of 29 articles were finally selected, excluding 14 papers that were considered inconsistent with the research purpose in their ethical text content. The

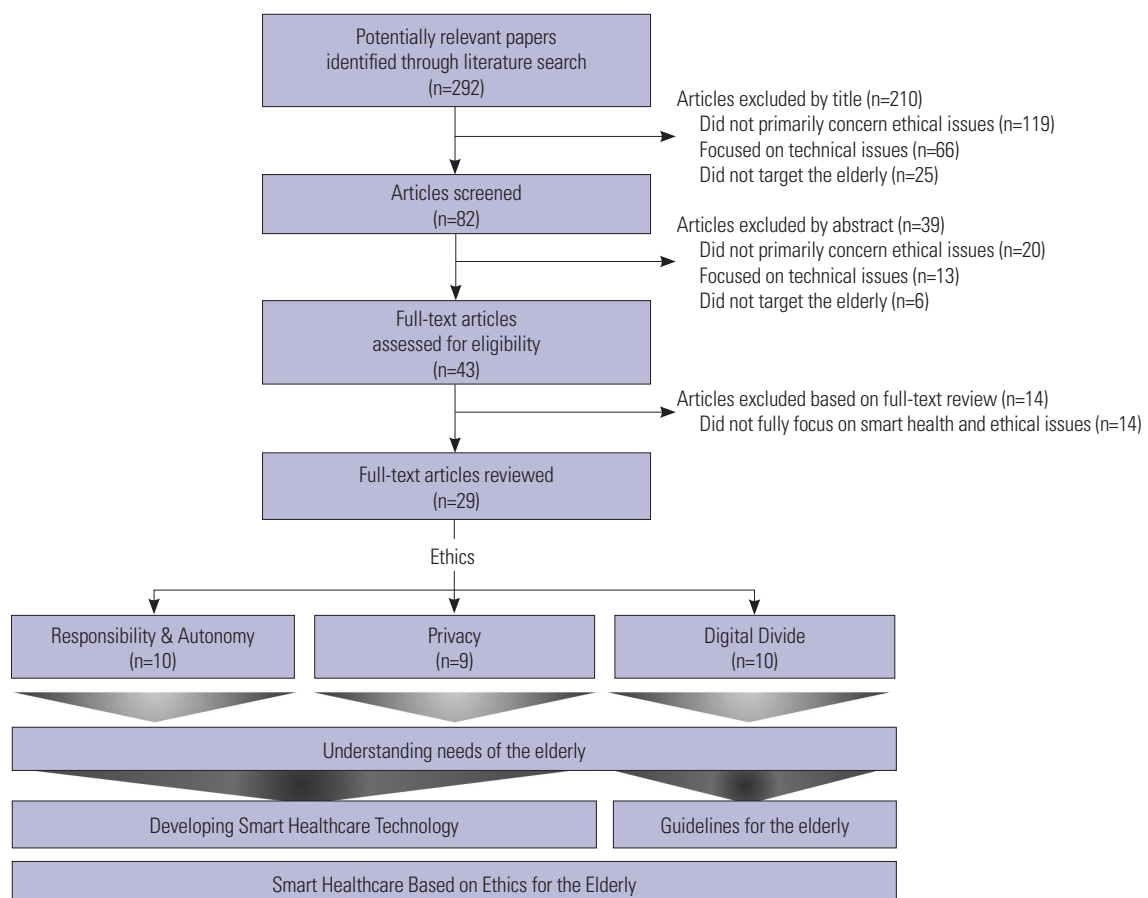


Fig. 1. Flow diagram of the scoping review in this study.

main contents of the study were organized into the charting of data to analyze topics covered by each area, and the validity of the contents was confirmed through cross-analysis conducted by two medical informatics experts.

CURRENT CLINICAL TRENDS

Among the 29 papers that comprised the scoping review, 10 studies were related to themes of responsibility and autonomy (Table 1),²¹⁻³⁰ 9 studies were related to privacy (Table 2),^{21,23,31-37} and 10 studies were related to the digital divide (Table 3).^{15,36,38-45} The first issue identified as an ethical dilemma caused by smart healthcare is responsibility and autonomy. In the case of older adults who need absolute support from healthcare, the auton-

omy of their tacit choices may be violated due to technical assistance associated with smart healthcare, and therefore, it is necessary to identify where to place responsibility when such an ethical issue arises. Because smart healthcare uses sensor-based monitoring technology, privacy issues have also been raised insofar as they infringe on an individual's personal life. Lastly, for aged populations, a problem can arise due to the "digital divide," because their responsiveness to progressive technological change is typically low.

Responsibility and autonomy

Understanding the problems encountered by older adults and identifying adequate means to provide them with the technical support they require are directly linked to ethical issues.²⁹ This is because healthcare for older adult patients regularly

Table 1. Scoping Review of Articles Pertaining to Responsibility and Autonomy

	Results	Limitation	Notice
Responsibility & Autonomy			
Birchley, et al., 2017 ²¹	Provision of user choice for unauthorized sharing of personal information	Undeveloped system considering the personal information protection of technicians	Provision of options for information sharing and user responsibility of smart healthcare users
Rajesh, et al., 2020 ²²	Emphasis on social and economic factors rather than technological factors as determining factors for the success of telemedicine	It is difficult for IT technology to provide optimal clinical application results according to the effectiveness/efficiency of the medical system	Emphasizes the logic of physician-patient joint decision-making and patient selection on the use of technology
Berridge, 2016 ²³	Lack of control over users' personal information	It is difficult to solve the problem of basic consent procedures for control and follow-up measures for information access	Opportunity to give users voluntary prior consent and the right to decide the use of personal information
Entwistle, et al., 2014 ²⁴	Provides management support for patient self-monitoring, open connection and opportunity, and opportunity for joint decision-making	Lack of careful attention and attention to patient participation	Providing opportunities for voluntary management and participation of medical service users
Responsibility			
Institute of Medicine, 2012 ²⁵	Contents affecting the safety of EHR	The impact of patient safety is a long-term issue	Responsibilities of both patients and providers for system design and use are required
Berlinger, 2005 ²⁶	Consideration of rationality and morality in medical errors	Problems of service provider attitudes in solving moral problems in medical practice	Recognition of the healthcare system as an actor who raises ethical issues in the process of providing medical services
Autonomy			
Wang, et al., 2019 ²⁷	The user, older adults, is interested in co-design for the use of technology on their own and aspirations for data control	Low technical literacy, restrictions on the ability to use technology, etc.	The need to reflect the will of older adults to participate in technology design and to control data in a joint partnership
Klugman, et al., 2018 ²⁸	Right to exercise autonomy due to patient voluntary consent and to be responsible for data management	Adopting a transparency policy and the issue of patient roles in user agreements	Maximize patient autonomy for consent and withdrawal of use of digital devices
Collste, et al., 2012 ²⁹	Moral decisions are made autonomously	Lack of attempts to establish a common moral basis among experts	Strengthening respect for autonomy by confronting moral issues caused by advances in healthcare technology
Floridi and Sanders, 2001 ³⁰	Allowing the moral status of artificial agents	Computer technology as a new feature makes it difficult to draw on traditional moral concepts and norms	The realm of cyberspace is the result of autonomous execution of artificial agents, application of technological ethics

EHR, electronic health record.

Table 2. Scoping Review of Articles Pertaining to Privacy

	Results	Limitation	Notice
User privacy protection			
Gutierrez, et al., 2018 ³¹	Stability of collaborative smart health applications and the importance of data protection	The need for an ethical approach to medical safety	The need to respect patient rights in the ethical sector related to smart health
Birchley, et al., 2017 ²¹	Providing user choice as a solution to unauthorized sharing of personal information	Privacy concerns may reduce the attitude of users to adopt the technology	Importance of technical and ethical guarantees that respect users' privacy
Berridge, 2016 ²³	Privacy issues for older people who rely on monitoring should provide opportunities to make their own decisions	The problem of privacy cannot be solved only by disclosing information	The need to use "opportunity for boundary management" as a design and practice principle for privacy
Jacelon and Hanson, 2013 ³²	Older people demand a role as decision makers in their smart health settings	No feedback on actual use after collecting information from older adults in the monitoring system	Education and support are needed so that older adults can control and use information with their own technological control
User consent			
Townsend, et al., 2011 ³³	Privacy must be traded to make older people embrace monitoring technology	Loss of average level of privacy for older people receiving healthcare	An older adult who uses smart home monitoring should provide voluntary consent in the process of receiving medical services
User privacy protection and user consent			
Demiris, et al., 2008 ³⁴	Smart home technology provides innovative health monitoring functions, but the safety of residents must be paramount	User's consent to personal safety and privacy is important due to physical and functional priorities	Smart home monitoring should be based on user consent that does not interfere with the privacy of the occupants
Essén, 2008 ³⁵	Feeling of being cared for by electronic medical care and worrying about invasion of personal information	Conflicts arise for older people's caring functions and violations of their freedom of privacy	The need to develop technology to solve the problem of involuntary consent and protect personal information
User driven design			
Demiris, et al., 2004 ³⁶	ICT technology monitors older adult residents, and although there are positive attitudes of management, several concerns are expressed	Older adult expectations and perceptions are not communicated to healthcare service providers	User-led design of technology is required
Cook and Song, 2009 ³⁷	Establishing a system through participation of governments, providers, and patients by conducting monitoring surveys	Patient safety issues are complex and time consuming	Maintaining close relationships with regulatory agencies, users and suppliers for patient safety and sharing of responsibilities

ICT, Information and Communication Technology

relates to issues of responsibility regarding side effects or risks. The ethical principles of ICT can be applied to this problem.³⁰ This framework presents standards that consider smart health as a moral actor, and it emphasizes that the smart health industry should be recognized as an actor that has the potential to cause moral and ethical problems.^{14,26} Thus, if current or future industry actors fail to adhere to prescribed ethical standards, there will be an established baseline against which they can be held accountable, and an argument could be put forth about whether to exclude such non-compliant players from broader healthcare services.

However, previous results from a qualitative study on 20 experimenters²¹ have identified that users' choices in smart healthcare services are often limited due to technical reasons. As a result, there are limitations for the process of interacting with older adults who use smart healthcare.²² In particular, older

adults are often reluctant when engaging in novel healthcare systems, not only in the areas of prescription and diagnosis by clinicians, but also in the utilization of their own information.²⁸

Researchers have identified that subjects who use smart health services are viewed as mere consumers, rather than as healthcare patients, which can infringe on their autonomy and exacerbate power imbalances in the healthcare system.^{24,25} Therefore, if the ethical dilemma of autonomy is reduced through an increase in available choices, the result may be situations wherein responsibility may not be taken, as the smart health patients are viewed only as customers.²¹ This also suggests that tasks pertaining to patient selection are considerably more important than focusing solely the technical aspects of smart health systems.⁴⁶ In fact, one study suggested that older adults are also interested in, and willing to participate in, the co-design and data control for smart health technologies.^{23,27} Over-

Table 3. Scoping Review of Articles Pertaining to Digital Divide

	Results	Limitation	Notice
Digital Literacy			
Venkatesh, et al., 2012 ¹⁵	Survey on the acceptance and use of technology by various subjects	Difficulties in accepting and using technology for older adults	Older people have difficulty using new technology, i.e., technologically innovative applications
Demiris, et al., 2004 ³⁶	Functional limitations of older adults are a digital divide problem	Difficulties in reading, recognizing, and using information provided by digital devices for older adults	One barrier to the development of smart health is the absence of ethical frameworks
Miller and West, 2007 ³⁸	Based on the frequency of surveys accessing health information, the participation rate of older adults aged 65 or older is extremely low	The problem of digital divide appears according to the user characteristic	Effort should be made to bridge the information gap between users
Markmann and Goodman, 2006 ³⁹	Disclosure of personal medical information may affect users with digital divide	User's information might be obtained by various people and manufacturers without their approval	Each individual, government, and policy-maker should attempt to implement ethical frameworks with IoT smart medical services
Abascal, 2004 ⁴⁰	For users with digital divide, smart healthcare is acceptable	Older adults become dependent on function	User's functional dependence creates ethical problems
Van Berlo, 2002 ⁴¹	Need to develop smart home technology tailored to the needs of older adult users	It takes more time for older adults to accept technology	Smart technology should be developed based on feedback from older adults
Cabrita, et al., 2019 ⁴²	The older adult's opinions and wishes are not considered in the design of new technologies	There are many issues regarding the cognitive function of older adults' use of technology	Technology needs to be developed focusing on ethical concerns of older adults
Equality in the digital age			
Townsend, et al., 2015 ⁴³	Older people are forced to use digital medical resources	Ethical issues caused by managers being exposed to the health information of older adults	Compared to the development of common people into mutual relationships, older adults face difficulties
Buchman and Ho, 2014 ⁴⁴	Older adult patients face technical discomfort	Uncritical acceptance of the device	Patient's safety can be threatened
Holt-Lunstad, et al., 2015 ⁴⁵	Social isolation due to the digital divide among older adults	Failure to participate in managing one's own healthcare information	Need to improve clinical and ethical problems by solving the information gap problem

all, the issue of providing autonomy to older adults throughout this process is critically important.

Our analyses demonstrate that, when it comes to the ethical issues of responsibility and autonomy, opportunities must be provided for older adult users to receive information and make autonomous choices about the use of the smart healthcare system and the provision, management, and utilization of collected data. Additionally, aged users must be allowed to take responsibility for problems that occur in the smart healthcare process, so that they can be offered selective autonomy.

Privacy

In the case of smart healthcare, a network connection for monitoring residents is essential.^{37,47} Here, as a measure to increase user independence, various applications are utilized, including the monitoring and support of a patient's physiological status, safety monitoring and support, security monitoring, and social interaction.³⁴ The privacy of clinical health data transmitted and exchanged between applications, devices, and providers

has clear ethical implications, and the challenge of privacy protection has been identified as a significant potential barrier to the acceptance of information technology by older adults.^{31,36}

In general, smart healthcare users accept privacy infringements in favor of the benefits provided by the smart health services and devices. Indeed, in some cases, it is argued that this is a user's privacy fair trade.^{32,33,35} However, because monitoring a patient's personal information infringes on their personal information and rights,⁴⁸ smart healthcare is not free from the invasion of personal privacy.

For this reason, considerable efforts are being made to improve the safety of smart healthcare through improved cyber security and personal information protection. In one study, rather than establishing an operating principle from the perspective of the provider of health services, users who were highly dependent on technological use were able to establish an operating principle from the subjective standpoint of the design principle.²³ That study suggested that medical service providers who manage or care for data in terms of personal information

must also provide feedback after using said data, providing an opportunity for users to become aware of when and how their data are being used; rather than approaching privacy from the perspective of physically minimizing data exposure, it is more important for users to provide their consent and exercise some degree of technical control and for the subsequent management of their data to proceed according to the user's consent and requests. Considering these points, in the field of smart healthcare, privacy can be described as a pertinent issue that must be addressed in a practical manner to encourage usage without putting user privacy at risk.

Digital divide

The digital divide refers to the gap that exists between an individual who is knowledgeable and one who is relatively uninformed with respect to digital information and technology.⁴⁹ This digital divide is linked to issues of equity in medical care for aged persons, which is additionally associated with problems of digital literacy.³⁸ Studies on the usability of digital healthcare targeting older adult users have demonstrated that older users often experience greater difficulties when using novel or technologically innovative applications.¹⁵ The basis of smart healthcare is the process of assisting patients through the storage, processing, and transmission of patient information based on ICT, which has resulted in significant ethical debate.³⁹ In addition, the adoption of smart healthcare strategies can cause moral problems by creating users' functional dependency on the smart health systems.⁴⁰ In the case of older adults who lack experience with technology, problems have emerged in that they often require more time and effort to learn and effectively utilize smart health technologies, which can result in poor or inaccurate measurements.^{36,41} Aged individuals have a desire to play an active role not only as users who interface with the technology, but also as users involved in sharing data. However, due to problems related to digital health literacy, difficulties arise for the role of older adult populations in digital healthcare.^{42,50}

Broader sections of the public who are familiar with digital environments typically have higher medical literacy levels, which helps facilitate mutual, therapeutic relationships with physicians.⁴³ Smart healthcare itself is considered to have improved access to medical care, and in this sense, the equity of the digital age is now a major factor in improving the quality of services. In the case of older adult patients, most feel uncomfortable with these technologies, yet often depend on their devices, and, as a result patient safety, may be compromised due to distrust in the expert advice or treatment because of this dependent attitude.⁴⁴ With rapid social change and as digital technology develops, social isolation caused by this digital divide appears at the outset to be inevitable for older adults. The digital divide should be addressed as a separate clinical and ethical issue so that individuals can actively participate in smart healthcare for their own health as an active participant in leading healthcare.⁴⁵ This should be recognized as a key issue to be

resolved to improve healthcare opportunities and outcomes for older adult patients. Reducing the digital divide can fundamentally contribute to reducing social inequalities in health and removing barriers to access to healthcare. Therefore, for smart healthcare to succeed, it is necessary to adopt a multi-faceted approach to medical access and equity. To date, the issue of accessibility has been raised, however, discussions on equity or digital divide are lacking. There should be no unfair differentiation between population groups, and users should be free from the potential disadvantages of their own healthcare provision and provided with fair opportunities within the same system. This concept has recently been established as an important area for research in smart healthcare requiring further development in the future.

FUTURE PROSPECTS FOR SMART HEALTHCARE ETHICS IN OLDER ADULT POPULATIONS

This study aimed to identify ethical issues affecting how older adult individuals receiving healthcare support via ICT. In the case of aged individuals with lower adaptability to new technologies and less digital literacy than younger populations, we identified several ethical issues to be considered from the perspective of smart healthcare providers and the developers of such smart healthcare technologies.

Although smart healthcare is recognized as an essential component of modern healthcare systems, older adults often experience infringements on their autonomy of choice, and implicit consent must be given to delegate all rights to service providers of the healthcare. Autonomy is the ability for older adult individuals to be given the authority to decide what happens to themselves in the healthcare system. Because the principle of respect for autonomy is important in biomedical ethics, respect for autonomy has similar importance in smart health technologies. The older adult should be empowered not only to make choices independently, but also to share responsibility for various problems that may occur as a result of using a smart healthcare system.

Despite the conveniences provided by digital healthcare, the issue of privacy cannot be neglected, and must be considered with respect to actual operation management rather than through countermeasures to the technical or physical environment. In the process of data collection and use, technical support is necessary to ensure that collected data are used within the scope allowed and in a manner that has been consented to by older adults themselves.

As a result of lack of technological information, experience, and knowledge in some older adult individuals because of the digital divide, inequalities in the quality of service may also emerge. Naturally, technical support for bridging the digital divide must be provided. It is necessary to clearly understand

the requirements of users and develop technology considering its utility and the ability of its end users to guarantee that it will not exacerbate existing inequalities. To increase ease of access, it is necessary to increase technological confidence and digital knowledge in older adult populations by improving their exposure to smart healthcare-related technologies and educational programs.

CONCLUSIONS

Smart healthcare has an important role to play for older adult and chronic patients. For various smart healthcare service providers, however, considering ethical issues will be key to supporting the effective integration of older adult populations into their systems while simultaneously supporting their needs, without compromising their specific rights and requirements. In the future, as an indispensable element of life in an aging society, the ethical considerations of smart healthcare must be identified, and measures must be taken to ensure the effective application of solutions to alleviate them.

Because this research applied the scoping review method, some limitations exist in terms of providing specific guidelines. This review method does not formally evaluate the quality of evidence and often gathers information from a wide range of study designs and methods, thereby putting it at risk of introducing biases from different sources. Furthermore, additional research on the topic is required before specific guidelines on ethical considerations in this context can be fully developed.

Unlike previous studies related to smart healthcare, which focused largely on clinical or technological points, this study focused on the ethical issues associated with smart healthcare research targeting older adults. It was necessary to review the ethical issues that must be recognized from the position of engineers who develop these technologies to be used in smart healthcare, as well as medical staff who provide medical services.

We must accept the challenges associated with infringing on individual autonomy that results from older adults using smart healthcare. It is necessary to strengthen the autonomy of older adults in terms of their own choices such that they can maintain a shared responsibility for the future use of technologies that may emerge as important for healthcare provision. Additionally, it is necessary to provide older adults with opportunities to gain access to education on technology utilization to help bridge the digital divide that has occurred based on education and age. Accordingly, it may be necessary to develop a participatory system that increases medical accessibility in general. Considering these ethical issues in the development and application of smart healthcare systems in the future will enable the efficient and effective use of smart healthcare technology as an auxiliary tool for positive healthcare promotion among older adults.

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AUTHOR CONTRIBUTIONS

Conceptualization: Young-A Ji and Hun-Sung Kim. **Data curation:** Young-A Ji and Hun-Sung Kim. **Formal analysis:** Young-A Ji and Hun-Sung Kim. **Investigation:** Young-A Ji. **Methodology:** Young-A Ji and Hun-Sung Kim. **Project administration:** Hun-Sung Kim. **Resources:** Young-A Ji and Hun-Sung Kim. **Software:** Young-A Ji and Hun-Sung Kim. **Supervision:** Hun-Sung Kim. **Validation:** Young-A Ji and Hun-Sung Kim. **Visualization:** Young-A Ji. **Writing—original draft:** Young-A Ji and Hun-Sung Kim. **Writing—review & editing:** Young-A Ji and Hun-Sung Kim. **Approval of final manuscript:** Young-A Ji and Hun-Sung Kim.

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REFERENCES

- Sidorenko A. World policies on aging and the United Nations. In: Robinson M, Novelli W, Pearson C, Norris L, editors. *Global health and global aging*. 1st ed. San Francisco: Jossey-Bass; 2007. p.3-14.
- Kim JH. [Population policy outlook 2018]. *Health Welf Policy Forum* 2018;255:61-74.
- Al-Mahmud O, Khan K, Roy R, Alamgir FM. Internet of things (IoT) based smart health care medical box for elderly people. *Proceedings of the 2020 International Conference for Emerging Technology (INCET)*; 2020 Jun 5-7; Belgaum, India: IEEE; 2020. p.1-6.
- Lehnert T, Heider D, Leicht H, Heinrich S, Corrieri S, Lupp M, et al. Review: health care utilization and costs of elderly persons with multiple chronic conditions. *Med Care Res Rev* 2011;68:387-420.
- Payne TH. Electronic health records and patient safety: should we be discouraged? *BMJ Qual Saf* 2015;24:239-40.
- Hori T, Nishida Y, Aizawa H, Murakami SI, Mizoguchi H. Sensor network for supporting elderly care home. *Proceedings of the IEEE Sensors* 2004; 2004 Oct 24-27; Vienna, Austria: IEEE; 2004. p.575-8.
- Vandemeulebroucke T, Dierckx de Casterlé B, Gastmans C. The use of care robots in aged care: a systematic review of argument-based ethics literature. *Arch Gerontol Geriatr* 2018;74:15-25.
- Broekens J, Heerink M, Rosendal H. Assistive social robots in elderly care: a review. *Gerontechnology* 2009;8:94-103.
- Fausset CB, Kelly AJ, Rogers WA, Fisk AD. Challenges to aging in place: understanding home maintenance difficulties. *J Hous Elderly* 2011;25:125-41.
- Eckert JK, Morgan LA, Swamy N. Preferences for receipt of care among community-dwelling adults. *J Aging Soc Policy* 2004;16:49-65.
- Denecke K, Bamidis P, Bond C, Gabarron E, Househ M, Lau AY, et al. Ethical issues of social media usage in healthcare. *Yearb Med Inform* 2015;10:137-47.
- Chang V, Cao Y, Li T, Shi Y, Baudier P. Smart healthcare and ethical issues. *Proceedings of the 1st International Conference on Finance, Economics, Management and IT Business (FEMIB 2019)*; 2019

- May 3-5; Heraklion, Greece: Scitepress; 2019. p.53-9.
13. Haddad AM. Ethical problems in home healthcare. *J Nurs Adm* 1992;22:46-51.
 14. Peek ST, Wouters EJ, van Hoof J, Luijckx KG, Boeije HR, Vrijhoef HJ. Factors influencing acceptance of technology for aging in place: a systematic review. *Int J Med Inform* 2014;83:235-48.
 15. Venkatesh V, Thong JY, Xu X. Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly* 2012;36:157-78.
 16. Shankar K, Connelly KH. Ethics and pervasive technologies: a collaborative approach to teaching. *Teach Ethics* 2010;11:73-84.
 17. Frisardi V, Imbimbo BP. Gerontechnology for demented patients: smart homes for smart aging. *J Alzheimers Dis* 2011;23:143-6.
 18. Ho A, Quick O. Leaving patients to their own devices? Smart technology, safety and therapeutic relationships. *BMC Med Ethics* 2018; 19:18.
 19. Ho A. Deep ethical learning: taking the interplay of human and artificial intelligence seriously. *Hastings Cent Rep* 2019;49:36-9.
 20. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol* 2005;8:19-32.
 21. Birchley G, Huxtable R, Murtagh M, Ter Meulen R, Flach P, Goberman-Hill R. Smart homes, private homes? An empirical study of technology researchers' perceptions of ethical issues in developing smart-home health technologies. *BMC Med Ethics* 2017;18:23.
 22. Rajesh E, Sharma N, Kousik NV. Different dimensions on health-care using internet of things (IoT): health monitoring. *J Crit Rev* 2020;7:343-6.
 23. Berridge C. Breathing room in monitored space: the impact of passive monitoring technology on privacy in independent living. *Gerontologist* 2016;56:807-16.
 24. Entwistle VA, Brown RC, Morgan HM, Skea ZC. Involving patients in their care. *Curr Breast Cancer Rep* 2014;6:211-8.
 25. Institute of Medicine. Health IT and patient safety: building safer systems for better care. Washington, DC: National Academies Press; 2012.
 26. Berlinger N. After harm: medical error and the ethics of forgiveness. 1st ed. Baltimore: Johns Hopkins University Press; 2005.
 27. Wang S, Bolling K, Mao W, Reichstadt J, Jeste D, Kim HC, et al. Technology to support aging in place: older adults' perspectives. *Healthcare (Basel)* 2019;7:60.
 28. Klugman CM, Dunn LB, Schwartz J, Cohen IG. The ethics of smart pills and self-acting devices: autonomy, truth-telling, and trust at the dawn of digital medicine. *Am J Bioeth* 2018;18:38-47.
 29. Collste G. Applied and professional ethics. *Kemanusiaan* 2012;19: 17-33.
 30. Floridi L, Sanders JW. Artificial evil and the foundation of computer ethics. *Ethics Inf Technol* 2001;3:55-66.
 31. Gutierrez M, Matta C, Miret L, Couvreur C, Carrié S. [Smart health, care relationship and ethics]. *Rev Infirm* 2018;67:29.
 32. Jacelon CS, Hanson A. Older adults' participation in the development of smart environments: an integrated review of the literature. *Geriatr Nurs* 2013;34:116-21.
 33. Tronsend D, Knoefel F, Goubran R. Privacy versus autonomy: a tradeoff model for smart home monitoring technologies. Proceedings of the 2011 Annual International Conference of the IEEE Engineering in Medicine and Biology Society; 2011 Aug 30-Sep 3; Boston, MA, USA: IEEE; 2011. p.4749-52.
 34. Demiris G, Hensel BK. Technologies for an aging society: a systematic review of "smart home" applications. *Yearb Med Inform* 2008; 17:33-40.
 35. Essén A. The two facets of electronic care surveillance: an exploration of the views of older people who live with monitoring devices. *Soc Sci Med* 2008;67:128-36.
 36. Demiris G, Rantz M, Aud M, Marek K, Tyrer H, Skubic M, et al. Older adults' attitudes towards and perceptions of "smart home" technologies: a pilot study. *Med Inform Internet Med* 2004;29:87-94.
 37. Cook DJ, Song W. Ambient intelligence and wearable computing: sensors on the body, in the home, and beyond. *J Ambient Intell Smart Environ* 2009;1:83-6.
 38. Miller EA, West DM. Characteristics associated with use of public and private web sites as sources of health care information: results from a national survey. *Med Care* 2007;45:245-51.
 39. Marckmann G, Goodman KW. Introduction: ethics of information technology in health care. *Int Rev Inf Ethics* 2006;5:2-5.
 40. Abascal J. Ambient intelligence for people with disabilities and elderly people. Proceedings of ACM's Special Interest Group on Computer-Human Interaction (SIGCHI), Ambient Intelligence for Scientific Discovery (AISD) Workshop; 2004 Apr 25; Vienna, Austria: ACM; 2004. p.1-3.
 41. Van Berlo A. Smart home technology: have older people paved the way? *Gerontechnology* 2002;2:77-87.
 42. Cabrita M, Tabak M, Vollenbroek-Hutten MM. Older adults' attitudes toward ambulatory technology to support monitoring and coaching of healthy behaviors: qualitative study. *JMIR Aging* 2019; 2:e10476.
 43. Townsend A, Leese J, Adam P, McDonald M, Li LC, Kerr S, et al. eHealth, participatory medicine, and ethical care: a focus group study of patients' and health care providers' use of health-related internet information. *J Med Internet Res* 2015;17:e155.
 44. Buchman DZ, Ho A. What's trust got to do with it? Revisiting opioid contracts. *J Med Ethics* 2014;40:673-7.
 45. Holt-Lunstad J, Smith TB, Baker M, Harris T, Stephenson D. Loneliness and social isolation as risk factors for mortality: a meta-analytic review. *Perspect Psychol Sci* 2015;10:227-37.
 46. Mol A. The logic of care: health and the problem of patient choice. 1st ed. London: Routledge; 2008.
 47. Astaras A, Lewy H, James C, Katasonov A, Ruschin D, Bamidis PD. Unobtrusive smart environments for independent living and the role of mixed methods in elderly healthcare delivery: the USEFIL approach. In: Bamidis PD, Tarnanas I, Hadjileontiadis L, Tsolaki M, editors. Handbook of research on innovations in the diagnosis and treatment of dementia. 1st ed. Hershey: IGI Global; 2015. p.290-305.
 48. Moreham NA. Beyond information: physical privacy in english law. *Camb Law J* 2014;73:350-77.
 49. Fleming J. Health information on the internet. *J R Soc Promot Health* 2003;123:10-1.
 50. Cabrita M, Lamers SMA, Trompeter HR, Tabak M, Vollenbroek-Hutten MMR. Exploring the relation between positive emotions and the functional status of older adults living independently: a systematic review. *Aging Ment Health* 2017;21:1121-8.