Perceptions About Nursing Practice Based on the Internet of Things: A Survey of Nursing Managers

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Abstract. The purpose of this study was to investigate the perceptions of nursing managers about adopting nursing practices based on the Internet of Things and to examine related ethical issues. Questionnaires were sent to 538 nursing managers in Japan, with 131 responses. Of these, 87% and 33% agreed that a system using radio frequency identifiers would be useful for locating patients and nurses, respectively, 58%–81% recognized the value for patient safety of various camera systems for nursing observation, such as cameras linked to biometric alarms, 73% agreed the usefulness of automatically prioritizing alarms, but only around 39% were in favor of using facial recognition to help nursing observation. Many nursing managers expressed concerns about privacy. Data storage for at least 6 months was supported by 53% for location data and 41% for ceiling camera videos. Thus, nursing practice based on the Internet of Things is widely accepted in Japan.

Keywords. Internet of Things, nursing managers, nursing practices

1. Introduction

In Japan, there is a serious shortage of nurses due to the aging population. Addressing this requires making the most effective use of the limited number of nurses available. It is therefore important to explore nursing practices based on the Internet of Things (IoT). In response to these issues, the Inpatient Device Working Group (IDWG) of the Japan Association for Medical Informatics' Nursing Informatics Committee (JAMI-NI) has been discussing appropriate IoT-based nursing practices. These discussions have shown that nursing practices based on IoT are gradually being allowed by nursing managers, but that there are important ethical issues to consider.

IoT was first defined around 2011, and it was noted at that time that this technology could be used to provide a warning function for health professionals [1]. Around 2016, IoT cases in education and practice in the field of nursing information began to be

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reported [2]. In 2017, a review by Mieronkoski et al. [3] identified four types of nursing IoT: comprehensive assessment, periodic clinical reassessment, activities of daily living, and care management. Papers on the evaluation of nursing information systems using IoT began to emerge in 2018 [4], and a survey in 2019 by a nursing student reported positive intentions to implement nursing practices based on IoT [5].

Thus, there are increasing reports on the use of IoT and high expectations for future implementation. However, there have been few studies on whether nurses themselves accept these changes in nursing practice. IoT has the potential to change the flow of patient observation by nurses, such as in assessing patients' physical and mental changes and intervening to provide care. Although there has been a survey of nurses' perception such changes at a single hospital [6], no nationwide surveys have been reported.

The need to evaluate the impact of new technologies and address ethical issues has repeatedly been noted when such technologies are adopted, and this has been the subject of ethics education [7,8]. IoT has the potential to change nursing practice considerably, so it is important to evaluate its scope of influence and to reflect this in ethics education. The purpose of this study, therefore, was to investigate the perceptions of nursing managers about adopting nursing practices based on IoT and to examine associated ethical issues.

2. Methods

2.1. *Identifying the Scope of Impact*

It is not yet fully understood which nursing practices can be based on IoT and how this will affect overall nursing practice, and there is a limit to discussing ethical issues without a common understanding of these issues. For this reason, the IDWG organized by JAMI-NI prepared an overview of nursing practice based on IoT. The first goal was to show this to nursing managers.

The discussions at the IDWG required a mutual exchange of ideas between clinical considerations based on nursing science and technical considerations based on the available technology. The IDWG therefore conducts joint discussions with the Ubiquitous Information Media and Healthcare Systems Study Group (UHG) organized by the Japanese Society for Medical and Biological Engineering (JSMBE). This arrangement has been approved by JAMI-NI.

Japan has the world's longest life expectancy and therefore the population with the most advanced aging. This has resulted in a serious shortage of nurses. Because of this, we concluded that the most likely function of IoT would be to supplement nurses' observations and to automate the recording of observations. We therefore decided to prepare illustrations that explain to nursing managers how observation and recording using IoT can be implemented with current technology, and to use these to investigate the nursing managers' perceptions of nursing practice.

2.2. *Data Collection and Analysis*

From about 2,300 hospitals in Japan with comprehensive community-based care wards, about a quarter (538 hospitals), were selected because nurse managers were in charge of safety management at these hospitals. These nurse managers were sent a survey questionnaire that described theoretical scenarios of nursing practice based on IoT that

had been developed through discussions at IDWG and JSMBE-UHG. The nurse managers were asked whether they thought each of these practices was useful for patient safety and whether there were any privacy issues. In addition, they were asked for their opinions about the storage period for the data collected as part of the IoT practices. The questionnaire was designed so that the individual respondents could not be identified; only the hospital type was included on the response. The survey was approved by Tokyo Healthcare University's Institutional Review Board.

The survey results were tabulated descriptively and compared between public and private hospitals. Based on the results, IDWG and JSMBE-UHG clarified the scope of nursing practice based on IoT so that it was acceptable to nursing managers.

3. Results

3.1. Survey Response

The questionnaire was sent to nursing managers in charge of medical safety at 538 hospitals, and 131 valid responses were received (response rate 24.3%). Of the hospitals that responded, 38 were public hospitals and 93 were private hospitals.

3.2. System to Detect the Locations of Nurses and Patients

The first scenario related to the implementation of a system that uses radio frequency identifiers to identify a patient's or nurse's location. Of the 131 respondents 87% considered such a system useful when used for patients and 33% considered it useful when used for nurses. In both cases, many nursing managers expressed concerns about privacy (Table 1).

Table 1. Perspectives on a radio frequency identifier system to detect the locations of nurses and patients.

	Public (n = 38)	Private (n = 93)	Total (n = 131)
Agreement that location detection is useful for patient safety			
For patients	36 (94.7)	78 (83.9)	114 (87.2)
For nurses	13 (34.2)	30 (30.2)	43 (32.8)
Concerns that location detection can adversely affect privacy			
For patients	25 (65.8)	59 (63.4)	84 (64.1)
For nurses	34 (89.5)	73 (78.5)	107 (81.7)

Data are presented as number (%).

3.3. Patient Observation Using Cameras and Face Recognition

The second set of scenarios related to the observation of patients using a ceiling camera (A–D in Table 2) and face recognition (E and F), and the use of technology to automatically prioritize alarms (G). Table 2 summarizes the level of agreement that these approaches would help patient safety. However, the majority of respondents said they had privacy concerns about scenarios (A), (B), (E), and (F). For scenario (D), the majority of nursing managers in public hospitals responded that they had privacy concerns, but there were significantly fewer such concerns in private hospitals ($p < 0.05$).

Table 2. Perceptions about nursing observation using cameras and face recognition.

	Public (n = 38)	Private (n = 93)	Total (n = 131)
Agreement that the technology will help patient safety			
(A) Ceiling camera: Patient does not know when the camera operating	24 (63.2)	63 (67.4)	87 (66.4)
(B) Ceiling camera: A red light shows the patient when the camera is operating	25 (65.8)	56 (60.2)	81 (61.8)
(C) Ceiling camera: Operates only in response to a nurse call	22 (57.9)	54 (58.1)	76 (58.0)
(D) Ceiling camera: Activated by an ECG alarm or when the patient gets out of bed	32 (84.2)	74 (79.6)	106 (80.9)
(E) Quantitative observation with a face recognition camera: used by nurses	15 (39.5)	35 (37.6)	50 (38.1)
(F) Quantitative observation with a face recognition camera: used by nonmedical staff	12 (31.6)	40 (43.0)	52 (39.6)
(G) Automatic prioritization of medical device alarms and nurse calls using technology	32 (84.2)	64 (68.8)	96 (73.2)

Data are presented as number (%).

3.4. Data Analysis and Storage

Overall, 118 (90%) of the respondents (92% of those in public hospitals and 89% of those in private hospitals) agreed with analyzing data obtained from medical devices and IoT devices and using these for medical safety. Although the majority of respondents said there was no problem with patient privacy, concerns about this were expressed by 41 (31%) of the respondents (40% of those in public hospitals and 28% of those in private hospitals).

The storage period considered appropriate for the location detection data was as follows: <1 month, 28 respondents (21%); 1–6 months, 42 respondents (32%); and >6 months, 57 respondents (44%). The storage period considered appropriate for the video data from the ceiling cameras was as follows: <1 month, 30 respondents (23%); 1–6 months, 45 respondents (34%); and >6 months, 53 respondents (40%).

4. Discussion

4.1. Expectations for Nursing Practices Based on IoT

The majority of nursing managers who responded to the survey expected that IoT would be used to detect the location of patients and to keep them under observation. Although some respondents saw the need for face recognition technology, this was not a majority opinion.

The use of face recognition technology in hospitals has not yet been studied extensively, and almost 40% of the nursing managers felt the need is considered a positive result. Many of the respondents were positive about the use of cameras, despite concerns about the impact on privacy. In the United States, although there are concerns about privacy, many consider cameras to be useful for preventing abuse [9]. In Japan, observation cameras are considered an acceptable technology. The view about patient location systems is similar.

4.2. *Appropriate Management of IoT Data*

Many of the nursing managers responding to this survey considered it safe to analyze location detection logs and surveillance camera videos, although there were concerns about privacy. If these systems are implemented, hospitals would need to store the associated data for an appropriate period. According to the Japanese Personal Information Protection Law, data stored for >6 months may be required to be disclosed. In this survey, there were various views regarding the length of storage, but >80% of nursing managers responded that the data should be stored for at least one month.

Based on this finding, the JAMI-NI IDGW recommends that data from nursing practice based on IoT should not be deleted within a short period such as one month. This would avoid any misunderstanding that the data were discarded to hide something.

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