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RESEARCH ARTICLE

Dissonance Between Human Nurses And Technology: Understanding Nurses' Experience Using Technology Beds With Monitoring Functions Within Clinical Nursing Practice

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Abstract:

Aims:

Are nurses adapting to the mechanized nursing practice environment? Is it possible for nurses to collaborate with technology to provide care to patients? The aim of the study is to investigate what nurses feel about using technology in nursing practice.

Background:

Preventing patients from falling is one of the nursing tasks that can be helped by using technology, such as sensors. However, little is known about how nurses experience and feel the use of technological beds for monitoring functionality within clinical nursing practice. Especially it is indicated that alarm fatigue makes nurses and patients fatigued and induces a dissonance between nurses and technology.

Objective:

To clarify the experiences of nurses in clinical practice following the introduction of a bed with monitoring and fall prevention technology (technology bed).

Methods:

We interviewed 12 nurses working at a hospital about their nursing practice experiences with the technology bed.

Results:

The content of the interview was classified into three categories: 'providing a safe environment', 'limitation of entry into machine care scenes', and 'nurses' dilemmas'; with eight themes describing nursing practice: (1) strategies of fall prevention, (2) decrease in nurses' burden, (3) not good at using technology (all tools must be easy to use), (4) inefficiency such as over-engineering, (5) patients feel annoyed by frequent visits from nurses, (6) limitations of utilization from a nursing perspective, (7) nurse resistance to equipment introduction and (8) ethical issues.

Conclusion:

Although technology beds could effectively prevent falls, many nurses face an ethical dilemma in using these beds. It would be important for nurses to recognize the role of technology, embrace it, and raise awareness of collaborating with technology to eliminate a dissonance between technology and nurses.

Keywords: Dissonance, Ethics, Monitoring technology, Clinical nursing practice, Multiple tasks, Fall prevention.

Article History

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1. BACKGROUND

The nursing practice environment is becoming more

mechanized, and it is difficult to establish nursing work without technology, such as monitoring the electrocardiogram for early detection of abnormalities. Robert [1] indicated that

technology, such as AI robots, is viewed as assistants that can help nurses at the bedside or in the community. With increasing mechanization, it becomes important for nurses to collaborate with technology to care for patients.

One of the mechanized nursing tasks is the technology for fall prevention. Technology for fall prevention has advanced in recent years, and various sensors and multifunctional beds are currently being developed [2 - 5].

Falls can be a stressful experience for patients and nurses, representing moments of fragility, fear, suffering, and the unpleasant feeling of insecurity before the onset of disease [6]. Moreover, the WHO [7] states that falls and related injuries are a global public health issue expected to worsen as the population ages.

In Japan, a mat equipped with a load sensor is often used, which has a mechanism judging the patient's movement based on the difference in load and notifying the nurse that the patient has left the bed by a nurse call. This nurse call lets a nurse come to help the patient get off the bed and prevents falls that might occur due to the patient's movements. However, this system informs nurses by a nurse call only when a patient gets off the bed and steps onto the mat. Since the risk of a fall increases when patients get out of bed, it would be desirable to notify nurses of it earlier.

A technology bed equipped with a sensor informs the nurse call of the risk of the patient falling due to the pressure load difference. Some Japanese hospitals use it instead of a mat to prevent falls. Unfortunately, previous studies show that such sensor technology does not reduce falls [8 - 10] or injury associated with falls [11, 12]. One of the factors was false alarms, which caused nurses and patients fatigue [12, 13].

It might have induced a dissonance between the nurse and the technology.

However, the development of a fall prevention system is an urgent issue for nursing wards with many older patients. Additionally, the task of nurse is not limited to fall prevention; it consists of treating and caring for multiple patients. It is important for nurses to use technology beds and take care of patients in a confined working environment so that patients can remain comfortable in the hospital without falling. Determining whether the use of technology beds influences nursing work could have implications for the development and application of mechanization in the nursing practice environment in the future. To date, no studies have evaluated nurses' experiences of using such technology beds in the prevention of falls in nursing clinical practice within the hospital. Therefore, the purpose of this study is to qualitatively clarify, through an interview survey, how the introduction of a technology bed equipped with a fall prevention function affects nurses' experiences within the nursing practice of multiple-task work. Moreover, we clarify whether there might be a dissonance between the nurse and the technology in terms of the factor of alarm fatigue.

2. METHODS

2.1. Definitions

This study defines a technology bed as a system for fall prevention that notifies the nurses of the patients' danger with respect to this. We also define dissonance as impaired harmony of nurse and technology in clinical nursing practice. In brief, a dissonance refers to the way that a nurse is not able to collaborate with technology.

2.2. Design

This study was conducted between April 2021 and May 2021. We applied a descriptive qualitative design because little is known about the topic of nurses' practice in relation to a technology bed. The method of data collection and analysis in a descriptive qualitative study allows researchers to stay close to the data by presenting a comprehensive summary of nursing practice using simple language to increase agreement among researchers. The bed used to prevent falls is a technology bed (KA-N1410J, NU-1610, PARAMOUNT, Japan).

2.3. Participants and Recruitment

Participants were recruited from one rehabilitation hospital with a total of 352 beds separated into seven wards (including 120 beds in a long-term care ward, 192 beds in a medical treatment ward, and 40 beds in a convalescent rehabilitation ward) in the west of Japan (*A Hospital*). When the beds were full, the number of patients in the ward ranged from 40 to 60, and the number of nursing staff on a day shift was about 12 to 15 (nurse-to-patient ratio of 1 to 13 or 1 to 20, depending on the ward).

The technology beds have been used at *A hospital* since 2018. There were about 10 technology beds used per ward, though it depended on the patients' conditions. The technology beds were used for patients whom nurses assessed were of high risk of falling. The technology bed was a low-floor type with a width of 83 cm and a height of 22 cm, and had a nurse call with a length of 3 m. It also alerted nurses of the patient's movement. If the patient left their bed, the bed-leaving sensor caught the movement, linked it to a nursing call and notified the nurse.

We explained the purpose of the research to the nursing director at *A Hospital* whom we asked to select an appropriate ward for the survey field.

Inclusion criteria were participants who had experience working at *A Hospital* for a few years and who worked for patients who used technology beds. Exclusion criteria were associate nurses and those who had never used the technology bed. We requested research cooperation from nurses who worked in the selected wards and met the selection criteria through the nursing director at *A Hospital*. There were 12 nurses who offered to participate in the study from among the applicable nurses. We interviewed 12 nurses who provided their consent.

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Committee of Teikyo University, Faculty of Fukuoka Medical Technology

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(Teifukurin 20-10). All participants provided written consent.

2.4. Procedure

One researcher conducted face-to-face interviews using a semi structured-interview guide. The face-to-face interviews occurred at a convenient and in a quiet place.

Data were collected using a three-part, semi-structured interview guide (Table 1). The first part of the interview was intended to evaluate the effectiveness and change of the working environment for nurses, such as if working was easier than before when using the technology bed. The second part of the interview was intended to determine the technology's usefulness and/or inconvenience. The third part of the interview was intended to discover how nurses think about the mechanization of nursing work. Open-ended questions were determined by the flow of each interview. All interviews were conducted in the participants' native language (Japanese).

On average, the interviews lasted slightly over 30 minutes. As agreed by the participants, the interviews were audio-recorded. A survey was also completed with participants which collected data on demographic characteristics.

2.5. Data Analysis

Individual recorded interviews were transcribed verbatim. Two authors (A and B), working with another author (C), translated Japanese to English and then back-translation

occurred for equivalence of meaning.

Thematic analyses were undertaken following the six steps of Braun and Clarke [14], which involved being immersed in the data, having preliminary codes identified, allowing themes to evolve from exploring the codes, then having the themes reexamined and defined and finally the narrative completed.

The magnitude of the effectiveness or ineffectiveness of nursing practice using the technology bed and nurses' consciousness including a dissonance of nurses toward to technology were characterized in a descriptive interview, the researchers (A, B, and C) checking across multiple information sources within the interviews to establish themes. Interviews were then compared to establish cross-interview patterns. In addition to deep engagement with the transcripts, three researchers (A, B, and C) met biweekly *via* teleconferencing software to discuss findings or challenges, and as a process of informing each other on the ongoing analysis and increasing the credibility of the results. Finally, six researchers (A, B, C, D, E, and F) revisited each site to observe or discuss the technology *via* interviews to confirm understanding.

3. RESULTS

3.1. Sample Characteristics

Twelve participants ranging in age from 26 to 62 years were purposively recruited. Table 2 Shows the participants' characteristics.

Table 1. Interview guide.

| | Purpose of the Question | Questions Example |
|----------------------------------|---|---|
| The first part of the interview | To evaluate the effectiveness change of the working environment for nurses. | 1) How has your nursing practice changed before and after using the technology bed? 2) What do you think is good for the patient to use the technology bed? 3) Did the technology bed improve the efficiency of nursing work? |
| The second part of the interview | To determine the usefulness and/or inconveniences of the technology. | 1) What are the features of the technology bed that you find unnecessary? 2) What are the features of the technology bed that you find effective? 3) What was good or bad for the patient with the function of the technology bed? |
| The third part of the interview | To discover how nurses think about the mechanization of nursing work. | 1) What was good or bad for the patient with the function of the technology bed? 2) Please let us know if you have any reason to actively utilize the technology bed. 3) What do you think about mechanization like the technology bed? |

Table 2. Sociodemographic details of participants.

| - | - | Age Range | Gender | Years of Experiences as Nurse | Years of Employment | Position | Ward in Charge |
|---|---|-----------|--------|-------------------------------|---------------------|----------|----------------------------------|
| 1 | A | 50-59 | Female | 30 | 15 | - | Medical treatment ward |
| 2 | B | 30-39 | Female | 7 | 5 | - | Medical treatment ward |
| 3 | C | 40-49 | Female | 21 | 25 | Chief | Long-term care ward |
| 4 | D | 20-29 | Female | 8 | 8 | - | Long-term care ward |
| 5 | E | 30-39 | Female | 15 | 15 | - | Medical treatment ward |
| 6 | F | 30-39 | Female | 14 | 10 | Chief | Convalescent rehabilitation ward |

(Table 2) contd....

| | | | | | | | |
|----|---|-------|--------|----|----|-------|----------------------------------|
| 7 | G | 30-39 | Female | 15 | 15 | Chief | Medical treatment ward |
| 8 | H | 20-29 | Female | 9 | 9 | - | Medical treatment ward |
| 9 | J | 60-69 | Female | 30 | 12 | - | Convalescent rehabilitation ward |
| 10 | K | 50-59 | Female | 16 | 12 | - | Long-term care ward |
| 11 | L | 40-49 | Male | 6 | 16 | Chief | Medical treatment ward |
| 12 | M | 20-29 | Female | 4 | 1 | - | Medical treatment ward |

3.2. Thematic Categories

Three thematic categories were identified with the synthesis of the analysed data (Table 3): 1. providing a safe environment, 2. limitation of entry into machine care scenes, and 3. nurse’s dilemma. From the data analysis, eight themes highlighted each category: category 1. providing a safe environment, which includes 1) Strategies of fall prevention and 2) decrease nurses’ burden; category 2. limitation of entry into machine care scenes, which includes 3) not good at using technology (all tools must be easy to use), 4) inefficiency such as overengineering, 5) patients feel annoyed by frequent visits by nurses, and 6) limitations of utilization from a nursing perspective; and category 3., nurse’s dilemma, which includes 7) nurse resistance to equipment introduction and 8) ethical issues.

3.2.1. Providing a Safe Environment

3.2.1.1. Theme 1): Fall prevention

The perception of providing fall prevention was based on the effectiveness of the technology bed using the sensor to detect the patient’s movement. Many participants thought it was effective as a preventive measure to prevent falls. The technology bed is one strategy to prevent a fall. For example, one of the participants commented that ‘there are many patients with dementia, so um ... I was impressed that it would be good to prevent of fall from bed’ (A). Another participant also expressed the strategy to preventing a fall: ‘I could be aware of it before they fell because of the bed’s call. ..., it would be more important for the staff who work at night to get a notice from bed for patients’ situation. Because there are few staff who work there, and it would be much more difficult for them to prevent the patients’ fall if the patients move quickly’ (M).

Table 3. Summary of themes and subthemes.

| Categories | Themes | Subthemes | Codes | Example of related sentences/phrases |
|---------------------------------|--|---|--|---|
| 1. Providing a safe environment | 1) Strategies of fall prevention | give a notice of patients' move | I can get to know it quickly. | Speaking of impressions, I can get to know it quickly. I frankly thought that I could know when the patient moved ... (B) |
| | | preventing patients with dementia of fall from bed | many patients with dementia, ... the bed could prevent them from falling. | There are many patients with dementia, so um ... I was impressed that the bed could prevent them from falling..(A) |
| | | strategies of fall for patients who have a history of fall | such a sensor attached rather than falling | If the patient who uses such a bed has a history of falls, I wonder if it would be better for the family to have such a sensor attached rather than falling. (C) |
| | | Can be set to some extent according to the patient's situation | you can distinguish the settings | It means that you can distinguish the settings, such as how many seconds you get up, how it sounds when you stand up, and you can make detailed settings. (K) |
| | | Prevent falls by predicting patient movement | it would be more important for the staff who work at night to get a notice from bed for patients' situation. Because there are few staff who work there and it would be much more difficult for them to prevent the patients' fall if the patients move quickly. | After all, the reaction of the technology bed is quick, so for patients who move quickly, I could be aware of it before they fall because of the bed's call. However, it would be more important for the staff who work at night to get a notice from bed for patients' situation. Because there are few staff who work there, and it would be much more difficult for them to prevent the patients' fall if the patients move quickly. (M) |
| | strategies of fall before they move | it would be better for patients to say 'what's wrong' when they get up | I think it would be better for patients to say 'what's wrong' when they get up, rather than being told that they shouldn't do it before or after they move. I think that is a benefit for patients. (M) | |
| 2) decrease nurses' burden | decrease nurses' burden of fall risk of patients | if you think about the danger of getting up from the bed, it will make decreased our burdensome to have such a bed. | but if you think it is danger of patients' getting up from the bed, it will make decrease our burdensome to have such a bed. In fact, I don't feel such a burden less than before. (C) | |

(Table 3) contd....

| | | | | |
|---|---|--|---|--|
| 2. Limitation of entry into machine care scenes | 3) Not good at using technology (all tools must be easy to use) | Nurses are too busy to read all manuals. | I want an easy-to-understand manual. | Ah—I want an easy-to-understand manual. Even if the characters are written all over the place, I want an easy-to-understand manual that can be used instantly, when I'm busy, or immediately. (B) |
| | | | | It's difficult or troublesome, but it takes a little time. (K) |
| | 4) Inefficiency such as over-engineering | not always necessary using such a technology bed. | I have to look at it with a tingling sensation, so from that point of view, I wonder if it's not good to increase it too much. It's kind of convenient, but it's not surprising that it's being swayed by it. | However, if only the number of beds like now increases, the sensor is linked to the nurse call, so it is quite possible that the nurse call will be frequent. I think I must look at it with an annoying sensation. If it is working like that, I wonder if it's not good to increase it too much. It's kind of convenient, but it's not surprising that we are being swayed by it. (C) |
| | | | I think there are many useless visits to the patients' room. But even if I get a notification just before they fall, I can't make it in time. | It's better to let us know that it's dangerous when the patients are about to fall though I think there are many useless visits to the patients' room. But even if I get a notification just before they fall, I can't make it in time. (A) |
| | 5) Patients feel annoyed by frequent visits by nurses | Patients want to keep their private space. | You should watch me! | The patient just laid down like this, he just had a little physical movement. Then I heard a nurse call like this, so when I went 'What's wrong?', then he said, 'why did you come?'. Every time he moved like that, I heard a nurse call like this, then I come to him many times. Finally, he shouted at me, 'Leave me alone!', then he said, 'Do not watch me! You monitored me, which was horrible!!' Well, it can't be helped. The sensor is not attached to the entrance, but it's attached to the bed, so I go to see it to make sure if he is ok. (D) |
| | | disturbing nurses' tasks | It can be disturbing to look at it again. I was wondering 'Why do you peep!', But if I fell down, I would go if it rang. | If there is something like a monitor that can be monitored from a distance, such as someone who move tremendously or behaves dangerously ... that's strange, but I think it would be nice if there was a little. There are times when things are very difficult. Such a technology bed sometimes is good for the patients who have some risk of fall, such as their physical condition and physical ability. However, sometimes I get in trouble because of my visiting several times. Some patients get disturbed and become disquiet because of our frequent visits. When I come to them as the nurse call tell us their movement, then they shouted, 'Why do you peep!'. Therefore, I try to look as quietly as possible, but when I come to the front of the room and meet the patient, I get yelled at, 'You are here again!! What brings you here?!' (K) |
| | 6) Limitations of utilization from a nursing perspective | technology bed is not doing as nurses do | people who are suitable for the bed, people who are not suitable for it | Now, there are scenes where people who are suitable for the bed, people who are not suitable for it, people who are difficult, this is suitable, but this is not good. (B) |
| | | technology bed does not think the way nurses do, such as responding to each patients | With various devices, it would be nice if the sound was a little individual. | You can hear the same sound on the monitor like this. We talked, 'If it's a little switched sound to distinguish which patients' notice, it would be nice'. I think with various devices, it would be nice if the sound was a little individual. (B) |

(Table 3) contd....

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|--------------------|--|--|--|---|
| 3. Nurses' dilemma | 7) Nurse resistance to equipment introduction, | Nurses don't want to rely on machine. | I don't think we can rely on machines. | It's also a part that humans must look at properly, so I don't think we can rely on machines. (M) |
| | | Nurses are confident with communicating with patients. | I think I can put in emotions ... but then I might lose. I hear that machines are still much smarter, but I don't want to lose. | Observation. I think that numerical observation can be done on a machine, but ... Ah, if you put in the data ... It's different for each person, isn't it? Even with the same data as the symptoms, you can connect with the patient. I wonder ... with machines ... Reliability, I might be able to answer questions like this, but with machines, relationship with patients is not as the same as with humans. I think human can put in emotions ... but then machine can become to put the emotion, I might lose. I hear that machines are still much smarter, but I don't want to lose. The time to win ... I think I'm winning now, but I don't think I should lose until then. (A) |
| | 8) Ethical issues | The sensor is kind of a restraint. | the sensor mat is a restraint for the time being, so of course patients' family has permission, but since the patient himself has dementia, we have to be careful about that from the ethical point of view. | We don't have the consent of the person to use such a bed, such as being watched over. In the part of consent, the sensor mat is a restraint for the time being, so of course patients' family has permission, but since we use such a bed to the patient with dementia, we must be careful about that from the ethical point of view. I think it's true. However, as I said earlier, this type of bed is as same as a sensor mat and we must inform and get their consent. For example, 'We are sorry for the safety aspect, but we'd like to use this type of bed', we must tell them. (C) |
| | | don't know if the technology bed is not restraint or not | Weird restraint is strange, but it's strange to say that it also directly binds the trunk restraint, but that isn't it forced | Weird restraint is strange, but it's strange to say that it also directly binds the trunk restraint, but that isn't it forced, I can move to some extent, but after all, from there there are things like not being able to get out. So I think though it can be minimized, it can be restraint. (K) |

3.2.1.2. Theme 2): Decrease Nurses' Burden

Many participants believed that the technology bed could provide them a sense of security that patients were being monitored. For example, one of the participants commented, 'but if you think it is danger of patients' getting up from the bed, it will make decrease burdensome to have such a bed. In fact, I don't feel such a burden less than before' (C).

3.2.2. Limitation of Entry into Machine Care Scenes

3.2.2.1. Theme 3): Not good at using technology (all tools must be easy to use)

Many participants stated that they were not good at operating machines and felt that it would be nice to be able to use them easily once the machines were introduced. When a new bed was introduced, participants found that learning how to use it was difficult. It took a long time to learn how to use and master the bed, which increased participants' stress. In addition, because the bed has various functions, even if participants did learn how to use it, the learning process took time as did asking for help when participants did not understand. For example, one of the participants commented that 'ah—I want an easy-to-understand manual. Even if the characters are written all over the place, I want an easy-to-understand manual that can be used instantly, when I'm busy, or immediately' (B).

3.2.2.2. Themes 4): Inefficiency Such as Overengineering

Many participants felt that the sensor caught too much information, such as the patient moving only a little, which increased unnecessary visits and was swayed by a nurse call. For example, one of the participants commented, 'However, if

only the number of beds like now increases, the sensor is linked to the nurse call, so the nurse call may be frequent. I think I must look at it with an annoying sensation. If it is working like that, I wonder if it's not good to increase it too much. It's kind of convenient, but it's not surprising that we are being swayed by it' (C).

3.2.2.3. Themes 5): Patients Feel Annoyed by Frequent Visits by Nurses

Participants could not determine if the nurse call was a result of the patient's movement from the technology bed alarm or if the patient had pressed the nurse call button. Therefore, many nurses felt that the patients were in a bad mood because the nurses had to visit the room every time the nurse call was made. For example, one of the participants commented, 'If there is something like a monitor that can be monitored from a distance, such as someone who moves tremendously or behaves dangerously ... that's strange, but I think it would be nice if there was a little. There are times when things are very difficult. Such a technology bed sometimes is good for the patients who have some risk of fall, such as their physical condition and physical ability. However, sometimes I get in trouble because of my visiting several times. Some patients get disturbed and become disquiet because of our frequent visits. When I come to them as the nurse called tell us their movement, then they shouted, 'Why do you peep!' Therefore, I try to look as quietly as possible, but when I come to the front of the room and meet the patient, I get yelled at, "You are here again! What brings you here ?!" (K).

Patients sometimes got angry with nurses if nurses were always monitoring them. For example, another participant commented, 'The patient just laid down like this, he just had a

little physical movement. Then I heard a nurse call like this, so when I went "What's wrong?", then he said, "Why did you come?". Every time he moved like that, I heard a nurse call like this, then I come to him many times. Finally, he shouted at me, "Leave me alone!", then he said, "Do not watch me! You monitored me, which was horrible!!" Well, it can't be helped. The sensor is not attached to the entrance, but it's attached to the bed, so I go to see it to make sure if he is ok' (D).

3.2.2.4. Theme 6): Limitations of Utilization from a Nursing Perspective

The technology bed did not capture the individuality of the patient. These devices provide an alert of patients' movements via a nurse call. When participants received a nurse call informed by the technology bed, they did not know what was happening to each patient until they went to the patient's bedside. Once at the bedside, the nurses observed the various conditions and situations of the patients, made their judgements, and not only prevented a fall but also provided care. The technology bed only informed participants if patients had moved and did not provide a clinical nursing judgement. For example, one participant commented that "now, there are scenes where people who are suitable for the bed, people who are not suitable for it, people who are difficult, this is suitable, but this is not good" (B).

3.2.3. Nurse's Dilemma

3.2.3.1. Themes 7): Nurse Resistance to Equipment Introduction

Many participants thought that they should be able to accomplish their nursing tasks on their own and not relay on the technology bed. For example, one of the participants commented, 'It's also a part that humans must look at properly, so I don't think we can rely on machines' (M), 'Observation. I think that numerical observation can be done on a machine, but ... Ah, if you put in the data ... It's different for each person, isn't it? Even with the same data as the symptoms, you can connect with the patient. I wonder ... with machines ... Reliability, I might be able to answer questions like this, but with machines, the relationship with patients is not as the same as with humans. I think human can put in emotions ... But then the machine can become to put the emotion, I might lose. I hear machines are still much smarter, but I don't want to lose. The time to win ... I think I'm winning now, but I don't think I should lose until then' (A).

3.2.3.2. Themes 8): Ethical Issues

Many participants considered that the use of the technology bed to inform the nurse of the patient's movements to be one type of physical restraint. For example, one of the participants commented that 'we don't have the consent of the person to use such a bed, such as being watched over. In the part of consent, the sensor mat is a restraint for the time being, so of course, patients' family has permission, but since we use such a bed for the patient with dementia, we must be careful about that from the ethical point of view. I think it's true. However, as I said earlier, this type of bed is as same as a sensor mat and we must inform and get their consent. For

example, one of the nurses commented that 'We are sorry for the safety aspect, but we'd like to use this type of bed', we must tell them' (C).

4. DISCUSSION

This study explores the efficacy of and nurses' experiences in nursing practice of using a device (a technology bed) to prevent patients from falling from the bed. Our findings contribute to the literature in three major ways. First, the study reveals two main categories that contribute to fall prevention interventions and decrease nurses' burden, including that such a technology bed could be used in clinical nursing practice as one strategy for fall prevention. Second, the entry of technology beds into care scenarios could be limited, as they cannot make clinical nursing decisions in the same manner as nurses can. Third, the findings highlight the feelings of nurses toward the mechanization of nursing work, such as the 'nurses' dilemma'. These findings could suggest how nurses work with machines to prevent falls.

4.1. Safety Environment

Early detection is important for preventing falls. In this study, many participants were convinced that such a technology bed was effective for preventing falls because the bed let them know before patients stood up. A technology bed that functions to watch and support the patient's behaviour is desirable. In addition, one of the participants mentioned that it would be better for caregivers to let them know about the movement of patients, such as those with dementia, for preventing falls. Sometimes, patients with dementia act beyond the expectations of nurses, which can be a danger for falls. A previous study showed that patients with dementia had a higher risk of falls as compared with other elderly patients [15]. Although it is a general assessment for nurses to focus more attention on preventing falls in patients with dementia, it can be difficult for nurses to continuously watch these patients because of the multiple tasks they have to perform. The technology bed could support nurses in monitoring patients with dementia to prevent falls.

4.2. Free from Nurses' Anxiety

Previous studies reported that carers were concerned that their care recipients would fall again, and one study found that some carers were equally concerned even if the older persons had not fallen [16, 17]. Nurses are also concerned that patients who had previously experienced falls might fall again, and they monitored such patients constantly. However, nurses have multiple tasks to carry out, and they always must care for patients during their shift. While they care for one patient, they cannot monitor what their other patients are doing. They are always concerned if the other patients move on their own and face a risk of fall, which could be one burden for nurses. If many patients must be cared for and the number of staff is small, tasks beyond the capacity of one nurse will be imposed, which could be a factor in the use of physical restraints. A previous study showed a strong negative correlation between nursing skills and physical restraint use [18]. If patients who are at risk of falling are watched by technology beds, nurses can concentrate on caring for other patients. One of the nurses

mentioned that the technology beds monitored the patients with high risk of fall, which gave her a sense of security. Thus, a technology bed could decrease the nurses' burden of patient fall.

4.3. Nurse's Dilemma

This study showed that the technology bed provides patients with a safe environment in that it informs the nurse of patients' movements and allows the nurse to check for dangerous behaviour, reducing the nurse's anxiety about the patient's fall risk. Nevertheless, it became clear that nurses could not solve the ethical dilemma, and they still had negative concerns that they were not completing their task completely. This study showed that one of the reasons for the nurses' dilemma was their worry that their frequent visits were a source of annoyance to patients. In addition, although many participants had the intention to provide care by hand, due to the lack of manpower, they faced the dilemma of having to rely on machines. The reason nurses struggle with taking care of many patients on their own without technology support might derive from the nurses' dilemma. Nurses can feel how patients are cared for by nurses, and if patients feel uncomfortable with nursing care, the nurses might blame themselves for providing insufficient care. In this study, some participants mentioned a negative feeling arising from entering a patients' room after receiving a notice from the technology bed and found that the patient was annoyed with their visit. Participants were concerned whether their nursing care was not only sufficient for patients but also would not annoy the patients. Contrary to that intention, when the participant's visit to the patient's room due to the technology bed warning was unwanted and frustrating for the patient, this could cause the participant's dilemma of using the technology bed. Additionally, such a dilemma would make nurse fatigue by sensor alarm (alarm fatigue). There would occur dissonance between human nurses and technology here.

Many nursing theories have mentioned that nursing comes from the interaction between the nurse and the patient. However, in clinical practice, there are too many nursing tasks that prevent the nurse from providing rich care for each patient [19]. If the promotion of patient healing derives from the interaction between the nurse and the patient, the nurse needs to further improve the essence of care. According to a previous study, a nurse spends about 5 minutes with a patient in a single care act [20]. Although the interaction between the nurse and the patient may not depend on the length of time spent, 5 minutes might not be enough for patients to tell nurses what they think and feel about their situation or condition. Previous study has suggested that in the Netherlands, integrated technology supports the delegation and coordination of care and is generally well accepted by nurses. The Netherlands nursing staff described the technology as enabling them to perform their work in caring for residents in a calm and peaceful way [21]. Thus, it might be the time to reconsider the most important for nurses to carry out for their patients. It might be necessary to change the mindset of nurses to improve the quality of nursing while relying on technology without carrying out too much work by hand. A previous study also suggests that health care providers and sensor manufacturers

must work together more closely to develop dependable, accurate, and user-friendly sensor systems [22]. Technology can alert nurses to an increased risk of falls, but only patients and nurses can take actions that do not cause falls. Therefore, nurses' acceptance of technology and patient understanding of technology might be important in leveraging technology to success in using technology in clinical nursing practice.

4.4. On Collaboration between human Nurses and Technology

Some participants suggested that the technology supported their tasks so that they could concentrate on patient care. There might be conditions in which technology can support the work of nurses. Some participants mentioned that technology could not do the same work as nurses do. For instance, nurses pay attention to the prevention of falls of the patient and, at the same time, observe for other anxious conditions of the patient. Moreover, if necessary, when nurses visit the room to prevent a fall, they also provide care to the patients from various aspects. Another participant mentioned that the technology bed can provide nurses with only one piece of information about the patient's movement, which is not enough for nurses. Nurses observe patients in a wide variety of ways. If technology supports nursing, it would be meaningless to not incorporate such a wide range of nursing perspectives. One participant pointed out that 'if the technology is used to give advice to nurses to improve the patient's contracture, the patient's self-care ability may be further improved. It is better to have a function that enhances the potential of the patient. Such technologies will work effectively in nursing practice, as improving the patient's self-care abilities will reduce the risk of falls.

Because of the overlap in individual factors, falling is difficult to predict. It is thus difficult to create a manual for fall prevention. Therefore, it may be necessary to create a system that can respond individually to technical assistance.

Clarifying the roles of nurses and technology would make nurses being overcome a dissonance for technology.

5. LIMITATIONS

This study has several limitations. First, the nursing perspectives might not be the general view of all nurses, as the interviews were conducted among nurses at a single institution. In addition, the study was conducted with a small sample of nurses in one hospital in Japan and is not representative of the larger population of nurses, such as those living in other areas of the country. Nevertheless, it is likely that the findings reported here would be common among other nurses who care for older patients in the hospital setting.

CONCLUSION

This study reveals that the perspective of change in effective nursing practice in the hospital regarding fall prevention may be attributed to four themes. The technology bed could provide a benefit for fall prevention of older patients in the hospital, as it could determinate the anxious nurses, have their patients falling, and let them know when patients begin to move from the bed. However, patients could become annoyed

by nurses' frequent visits, which could in turn induce the nurses' ethical dilemma. The functionality of the technology bed could be improved to be used by nurses without any resistance, which could provide some benefit not only to nurses' strategies for fall prevention but also to the patients' safety environment in the hospital.

IMPLICATIONS FOR NURSING PRACTICE STRATEGIES

The mechanization of clinical nursing can also create many ethical dilemmas for nurses. Many of the clinical decisions of nurses are difficult to mechanize. However, to improve the quality of nursing, it would be inevitable to mechanize nursing work, such as fall prevention for improve of the working environment. This study suggests that it would be important for nurses to recognize the role of technology, embrace it, and raise awareness of collaborate with technology, so as to eliminate a dissonance between technology and nurses.

AUTHORS' CONTRIBUTIONS

KK designed the study and acquired and analysed the data. KK, EE, KK, NS, AY, and NJ interpreted the data and wrote the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study acquired ethical approval from the Ethics Committee of Teikyo University, Faculty of Fukuoka Medical Technology (Teifukurin 20-10).

HUMAN AND ANIMAL RIGHTS

No animals were used for studies that are the basis of this research. All the human experiment were performed, in accordance with the Helsinki Declaration of 1975.

CONSENT FOR PUBLICATION

All participants signed the informed consent form.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

Not applicable.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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