



Fall Prediction and Prevention System using a Technology: A Literature Review

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Abstract. The Incidence of falling at the hospital becomes a severe problem among patients due to indicators of patient safety. The technology used is an effective strategy to prevent falling during patients' hospitalization. A literature review was conducted in this study. Several databases were used to select relevant articles through ProQuest, Science Direct, EBSCO, and Pubmed. The results of the study showed technology had proved an effective strategy to prevent patients' falls, including remote visual monitoring (RVM), sensor-based fall prevention, smartphone usage, and alarms safety. This technology needs to implement at the hospital to prevent the falling incidence. However, nurses' knowledge and skill need to strengthen to reduce human error and improve the effectiveness of those tools during implementation

Keyword: Fall prevention, the technology used



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INTRODUCTION

Falling is an important issue for all health facilities since it becomes the leading cause of injury-related deaths among patients. Nurses play an essential role in maintaining patient safety. Data from the United States showed that 2.6 to 17.1 per 1000 patients per day hospitalized patients have fall experience during moving from their bed (1). The death rate due to falling increased by 3.0% per year during 2007-2016 (2).

The Minister of the Health Republic of Indonesia launched a regulation No. 11, which concern on patient safety. This regulation reduces the risk of patient injury because of fall incidence. To cut off physical and economic burdens for patients, for example, injury and death rates and increased quality of life among patients during hospitalized, it should be implemented in all hospitals. Following this regulation, it could create a program to improve patients' safety at a hospital in terms of fall prevention, which focuses on promoting a culture of patient safety from managing level until unit level (3).

Falls are defined as the inadvertent settling down of a body on the ground, floor, or other lower level (4). Falling events at the hospital have commonly occurred when patients need to move to other places (1). This accident impacts physical injury, such as fractures, which affect individual independent and psychological aspects (4). Therefore, challenging for nurses to identify the risk of falls and find out strategies to prevent falls event challenging to do (5).

The practical strategies to prevent falls among patients can be applied by using technology. The integration between the internet system and the nursing workflow system needed to inhibit falls at the hospital (1). Falls can be prevented through systematic evaluation by health care providers (6). Fall prevention using interactive treatment technology is an effort to empower and involve patients in avoiding falls in patients during hospitalized (7). Currently, prevention efforts fall on patients is still limited in Indonesia, and prevention efforts only use the equipment around the patient's environment. New interventions to prevent falls must be explored, one of which is by using a video monitoring system that has been proven to reduce fall rates in brain injury units (8). The technology used by hospitals can later be adapted to the patient's condition and the ability of the health facility.

OBJECTIVE

The study aimed at exploring the technology used to predict and prevent falls among patients hospitalized.

METHOD

A literature review was applied in this study. Several databases through ProQuest, Science Direct, EBSCO, and Pubmed were used to search the relevant articles. We asked keywords during articles exploring, including "fall prevention," fall prediction," technology used to prevent falls," and.

We limit the year between 2014 to 2019 to update information regarding the technology used to predict and prevent falls. The inclusion criteria of selecting articles as follows: 1) articles discussed on the technology used to avoid falls, 2) original articles which focused on adults and elderly population, 3) the study was conducted at nursing home and community, and 4) published in the English language. The study focused on child population were excluded in this study. After data screened, we appraised all articles to ensure the quality of the article. Finally, twelve articles were identified and analyzed in this literature review.

RESULTS

We described the findings of this review by using mean themes. Details explanations were narratively described as follows:

Fall prevention technology system

The fall prevention systems aimed to deal with falls and the risk of falls among patients hospitalized. Four central systems prevention were reviewed in this study, including 1) pre-fall prevention system, 2) post-fall prevention system, 3) fall injury prevention systems, and 4) cross prevention intervention systems. In this review, the researchers focused on the pre-fall prevention intervention system.

A technology application was indicated to support and to prevent patients from the risk of falling (9). An application development approach comprised of supporting physical

activities, exercises, and educational programs to increase awareness of the risk of falls and to develop strategies for fall prevention.

Application of technology

Various hardware devices applications were used to prevent including 1) interactive, static, 2) game, and 3) virtual reality (VR) applications. Interactive applications, it allows users to connect with applications in several ways. A static app aims to collect data and remind them when it falls. Game applications, aiming at educating and increasing awareness of risk falling or involving users in exercises and physical activities designed to increase mobility and hence reduce the risk of falls. A virtual reality (VR) application was presented in a 3-D interactive display that required users to move.

Nurses commonly used technology as a strategy to prevent falling during patients hospitalized, such as Video monitoring, Sensor-based fall prevention, Smartphone use, and alarm safety. A detailed explanation was described as follows:

1. Video monitoring

It was indicated to prevent the risk of falls by remote visual tracking (3). This remote video monitoring (RVM) used a wireless system by providing video streaming of patients' activity and tracking by a tale sitter (5). The monitoring system involves a camera installed in the patient's room, equipped with an infrared lighting system to help visualize when the situation is dark or at night. The tale sitter monitors the video and warns the nursing staff (turn on the alarm). Thus, the nurse can predict the risk of falls among patients immediately. Another term used has *cared to view video monitor (CVVM)* and video monitor technician (VMT). For the nurses using the CVVM system, time is a factor that can impact the effectiveness of the process, and another factor is the nurses' skill in accurately assessing patients to determine who should be monitored via the CVVM (13). This visual monitoring technology is useful for preventing falls and cost efficiency (especially for financing patient caregivers) in hospitals. Therefore, it was determined that the nurse manager's clinical judgment in collaboration with the primary nurse would be used to determine if a patient was appropriate for video monitoring (8).

2. Smartphone-based fall prevention

Smartphone-based fall prevention used accelerometers and gyroscopes to predict the risk of falling among patients. This tool has been embedded with smartphone devices to provide specific parameters (10).

3. Alarm safety

The alarm system was a useful device since this tool was designed to reduce falls by reminding staff (nurses) when patients need to move to other places. This tool also completed by methods to ask for help among hospitalized patients at the hospital. Several alarms were used to remind nurses, including pressure mats, infrared movement detectors, wired-activated alarms, and worn devices (11). Signals could increase the sense of security in residents who suffer from cognitive impairments or who are at higher risk of falling (12).

4. Sensor-based fall prevention

The most common example is the use of "Wii-Motes," used with Wii Nintendo. A hand-held sensor device with an infrared sensor and a built-in accelerometer with a size like a television remote control. Depending on the pressure and motion sensors. Used to monitor and assess patient balance (9). The use of shoe insoles that provide vibration

stimulation which improves somatosensory function to prevent falls and improve gait and stability (10,14). Another example of the use of sensor-based falling patient technology is the pressure sensing system (15), pressure images of the subject help identify the posture that determines the risk of the subject experiencing pressure and the possibility of experiencing the risk of falling out of bed. Sensor technology was used to apprise risk of falls among adult population. Measuring displacement during structured movements (walking, stepping, sitting to standing, etc.) is considered feasible to assess the risk of falling and overall provides an objective, accurate, inexpensive, and easily managed fall risk assessment (19).

The benefits of fall prevention technology in hospital

Technology is an innovative strategy to improve patient safety (3). The effectiveness of technology-based fall prevention interventions is influenced by what type of technology was used. Technologies such as remote video monitoring will prevent hazards and maintain patient safety by enabling audio-visual tracking (3). Technology-based interventions used in diagnosing and managing falling risks are crucial to reducing costs and reducing the burden on the health care system (9). Costs incurred could reduce when using fall prevention technology, compared to costs that must be incurred when a patient experiences a fall event.

Studies show that the majority of falling patients are not witnessed; nurses are absent when patients do activities related to getting in and out of bed (7). The technology is beneficial, especially in the acute unit. In this unit, nurses faced problem to monitor patients' conditions regularly. Therefore, using a technology system, the patient's concern about falling can be managed (16). Technology is not only decreasing the incidence of falls but also increases the level of service provided by nurses (18). By using technology-based fall prevention interventions, nurses can focus more on caring for patients. The time spent by nurses to make continuous observations on patients at risk of falling can be streamlined.

The use of falling prevention technology requires nurses to be able to increase their knowledge. A good understanding of the use of technology will enhance nurses' compliance in the use of technology in patients at risk of falling. Staff is an important aspect to prevent patients from falling (17). Staff skills and care are needed in the use of fall prevention technology. Precautions for falling patients are more productive and have a significant impact on improving the quality of life of patients.

DISCUSSION

Falling is a complex problem and associated with functional ability and environmental factors (9). Fall could impact injury -related deaths among people aged below 65 years, and the death rate due to falling events was significantly increased to be 31% from 2007-2016 (61.6 per 100,000) population (2). Nurses as caregivers and being beside the patient for 24 hours should be able to prevent falling. The risk of fall screening was limited to apply and not to integrate into daily living (19). It was due to fall risk assessment on subjective and unreliable. The detection technology for falls that are accurate, inexpensive, and easily applied by nurses. One strategy deemed successful for fall prevention and reduction in the use of standardized assessment tools to identify risk factors for falls and injuries (20). Prevention of falling patients begins with nurses identifying patients who are at risk of falling, utilizing technology (21). Fall prevention becomes the main focus of nurses regarding indicators of patient safety targets, including reducing the risk of injury caused by fall events. The technology used can reduce the number of patients falling and improve the quality of health

services (18). The technology, such as remote visual monitoring (RVM) nurses becoming more focused on patients because they do not need to run from one room to another, monitoring the risk of falling patients can be quickly done remotely.

Remote visual monitoring technology showed positive effects on cost efficiency, especially costs related to labor in hospitals. External validity was not only to prevent from falling but also to reduce the costs of healthcare services. In 12 months, sitter costs were reduced from 47 \$ 960 to \$ 240 for four patients. Moreover, it was indicated to decrease falling events, about 28.5% (17). The number of patients falling from 2014-2030 is expected to increase from 29 billion falls to 49 billion falls, or seven deaths due to falling every hour (6). In America each year, the costs incurred due to non-fatal fall injuries are around \$ 50 billion, and \$ 754 million is spent on fatal fall injuries (6). Falling patients require additional treatment, and sometimes the length of stay extends, falling with injuries adds 6.3 days to a hospital stay with an average cost to fall with injuries of around \$ 14,000 (20). So it is essential to prevent falls even better.

Innovation in technology is an essential key to reduce costs and reduce the burden on the healthcare system as well as to improve the quality and effectiveness of healthcare services (9). The development of a smartphone-based fall prevention technology could help to prevent falling among patients. Smartphone-based fall prevention (SP) is currently being developed since SP is considered practical and feasible used in daily life. The use of assistive devices for the detection and prevention of falls will help reduce future burdens by preventing adverse falls (4).

Another device to prevent falls is to sensors. The sensor is one example is the use of Zephyr TM BioPatch TM sensors in hospital patients, especially in the acute unit. The device is capable of recording several biological parameters, including ECG (250 Hz), respiratory rate (25 Hz), body temperature (1 Hz), and three-dimensional acceleration (100 Hz). The sensor always takes place in the patients' chest. Monitoring of patients in the acute unit, primarily related to the risk of falling is very important, monitoring of patients becomes difficult when the situation in the critical unit becomes busy and out of control

Another method to prevent falling is through a safety alarm. This instrument was used to record the distribution of subject matter over several sensing devices, conduct a subject risk analysis; to examine analysis results of risk indication parameters, and to record the risk falling event (15).

Fall prevention requires commitment from the leadership with a systematic approach. The role of the nurse is vital for twenty-four hours beside the patient in providing health services. Technology is only an intermediary for preventive measures to fall on patients, but caring (caring) nurses are needed to respond immediately to alarms or signals given by falling risk prevention tools. Without a quick response from technology, nurses like anything will not be able to produce optimal effects.

CONCLUSION

This review described some devices to prevent falling among patients during hospitalized. A technology used to avoid falling among patients has been carried out and proved to be a positive impact on delivering service, improving the quality of services, and reducing costs among hospitalized patients at hospitals. However, the development of health information technology in Indonesia has not been emphasized in optimal. Whereas, prevention of falling can be utilized in nursing care. Healthcare services or hospitals need to innovate to develop fall prevention technology to be safe and efficient for patients.

STRENGTH AND LIMITATION

This study adds up valuable information regarding an innovation to prevent falls among patients at the hospital. Moreover, this study also confirmed the positive effect of technologies on cost efficiency, improving nurse performance, and improving patient quality of life. However, some limitations were encountered since we only described narratively rather than analyzing the data since this study was a literature review. In addition, this study also has limited information since fewer articles found in the English language.

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