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Usability and Acceptability of SinoBed Mobile App for Pressure Ulcer Prevention Among Stroke Patients

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A B S T R A C T

Introduction: The ever-increasing adoption of smartphones globally has led to an increase in the use of apps for a wide array of health issues, resulting in favorable outcomes. Mobile apps can provide an easy and efficient method to track wound progression, such as pressure ulcers, using easy-to-use tools that organize information chronologically and visually. **Objective:** The purpose of this study was to evaluate the perceived utility, acceptability and satisfaction of potential users with a program aimed at reducing the severity of pressure sores in stroke patients. **Methods:** A quantitative approach was used in this study, with a sample size of 30 people. Users evaluate the usability of the application after the application is shared and ready to use. This research was conducted at STIKep PPNI West Java. **Results:** The usability and acceptance test consisted of 30 participating end users; 76.7% of them were female and 23.3% were male. Their average age was 30.9 years (SD=7.71). Completed two post-task questionnaires. With the average usability score of the total score value assuming the range of 0-100, a value of 85.25 (SD=5.92) was obtained, indicating that most of the data gathered relatively close to the mean, indicating that the Sinobed application is already in the acceptable category with a grade scale of A (Excellent) which indicates that the score is relatively good with a minimum value of 75 and a maximum value of 97.5. Thus, the average acceptance score of the total score of the mean (average) value of 94.32 and standard deviation (SD = 4.65), this result indicates that the majority of respondents tend to agree. **Conclusion:** The SinoBed app has great potential in supporting decubitus prevention in stroke patients in the digital era. Features such as automatic mobilization repositioning, repositioning time reminders, and temperature, humidity, and weight monitoring are considered very useful and helpful in facilitating patient care. Integration of the app with hospital SOPs can also expand the scope of decubitus prevention and ensure consistent care st rs are applied across different care units.

ARTICLE INFO

1. INTRODUCTION

Stroke is the most feared disease among the general public because it is a non-communicable disease that can appear suddenly. Disturbances in blood circulation in the brain can cause blood channels to become blocked or ruptured in the brain, causing the supply of oxygen and nutrients received by the brain to be disrupted. Insufficient oxygen supply to the brain can lead to the death of nerve cells in the brain and contribute to stroke symptoms, Cerebrovascular dysfunction is defined as reduced blood flow or circulation to the brain, resulting in neurological and brain disorders and can lead to the death of nerve cells in the brain. This syndrome, which is a combination of systemic and local symptoms, can be fatal if it lasts more than twenty-four hours (Rahayu & Nuraini, 2020). The global incidence of stroke has increased significantly, with 12,224,551 additional cases identified. There are currently 101,474,558 people who have successfully recovered from stroke. In summary, 25% of people aged 25 years have experienced a cerebrovascular event in their lifetime. According to the World Stroke Organization (WSO) survey conducted in 2020, the death rate due to stroke is 6,552,724 deaths, with 143,232,184 people experiencing disability due to stroke (Feigin et al., 2022).

Immobilization after stroke is associated with significant risks, including thrombosis, decubitus ulcers, pressure ulcers, and partial dislocation of the shoulder joint (Juliani, Ritarwan, & Asrizal, 2022). Pressure ulcers that can prolong treatment days for patients, increase medical costs, and can cause various complications that worsen the patient's condition (Hu, Sae-Sia, & Kitrungrote, 2021). And can cause the patient's quality of life to decrease, emotionally, physically and socially and can even pose a higher risk of death (Herly et al., 2021). A decubitus ulcer is an area of pressure ulcers in the area of the skin covering the bone that appears to protrude outward or in contact with medical equipment, pressure ulcers will arise if the skin is continuously rubbed for a long time (Mataputun & Apriani, 2023). Pressure sores, often known as Pressure Ulcer (PU), are a major public health problem, affecting an estimated 2.5 million people each year (Moore & Patton, 2019). Pressure ulcers accompany 22% of stroke cases in Indonesia, with a prevalence of 0.7% among patients who had a stroke and developed a PU. Immediate mobilization is essential to prevent pressure ulcers and improve daily function. It is imperative to engage patients in regular physical activity to address possible hazards associated with immobility, sensory impairment, friction, and blood flow abnormalities (Juliani et al., 2022).

Pressure sores are caused when the skin or tissue is damaged as a result of being placed under sufficient pressure or distortion to inhibit blood supply, various efforts can be made to prevent or reduce the degree of decubitus, one of which is by providing repositioning to reduce prolonged pressure on certain areas of the body, especially on prominent bone surface areas that can cause local tissue ischemia (Najihah et al., 2022). Handling that can be done to prevent the occurrence of decubitus by changing the bed, namely the position given to reduce pressure and friction on the skin. Changing one's position can help reduce the likelihood of pressure ulcers. The two main variables that influence the development of pressure ulcers are the level of pressure and the duration of the pressure load (Kim & Shin, 2021). A change in lying position or mobilization is an appropriate nursing intervention and is carried out every 2 hours at regular intervals. This is due to the movement of layers that reduce the pressure caused by holding the patient in a certain position to reduce pressure and friction on the skinc(Herly et al., 2021).

As a result of rapid technological advances, significant progress has been made in the health sector, especially in the application of artificial intelligence technology and the Internet of Things (IOT), as well as the advancement of science and technology (science and technology) today has developed very rapidly, one of which is the development of smartphones (Antoni & Suharjana, 2019). Various technological breakthroughs, such as Android, have been created to help various aspects of health and fitness (Ardianto Pambudi, Nurchim, & Agustina Srirahayu, 2020). Efficiently designed programs allow medical devices to monitor and m movements, resulting in positive outcomes. The use of artificial intelligence (AI) in the identification, prognosis, and real-time monitoring of the health status of stroke patients, with a particular focus on pressure ulcers, is driving technological advancement, AI makes it possible to monitor these individuals remotely.

A study was conducted to educate participants on the need for frequent position adjustments for pressure ulcer patients who have been bedridden for a long time. According to Karmandika and Candra's report published in 2023. This study, titled "Utilization of risk assessment and repositioning time requests to reduce pressure ulcer risk". Provides a modified iteration of the Braden scale, which is a method for estimating pressure ulcer risk (Henda Karmandika & Andodo B A-B, 2023). This measurement scale includes a large number of categories derived from the measurement results. The duration of repositioning reminders was determined by following the criteria provided by the National Institute for Health and Care Excellence. Thereafter, pre- existing query and assessment data were consolidated according to the established criteria, with specific adjustments made to improve usability. The pressure ulcer risk score was calculated by converting the user's assessment of the client's condition into pressure ulcer risk score categories.

Research has been conducted on elderly patients in beds equipped with systems that must be monitored by the Elderly Care System. The system consists of a real-time monitoring system, an in-bed position prediction system, and a notification system. Pressure signals from weight sensors and vibration signals from piezoelectric sensors are used to detect posture in bed. Neural networks and Bayesian networks are used to classify the user's position based on the t-waves obtained from the sensors (Silva et al., 2021). Then there is a new method with the use of pressure or weight and temperature sensors on the skin to measure areas or bodies that are prone to pressure sores. With sensors applied to the body prone to pressure sores for an extended period of time, the smart device worn by the caregiver will receive an alert, leading to prompt corrective action.

Based on what has been previously announced, the Sinobed application which has the function of monitoring stroke patients with prolonged bed rest, providing family education related to bed rest in stroke patients and the application mechanism can assist nurses in monitoring patient mobilization, by utilizing a mobile phone, which requires the user to register an account using the user's username and email, then the user is asked to enter the home menu where there is monitoring of mobilization repositioning, temperature, humidity and weight. Then the user is asked to take advantage of the repositioning feature automatically by using a timer that has been set to be able to change the mobilization position automatically, or can be used manually without using a timer, then after that the user is asked to take advantage of the graph feature to be able to monitor the results within one day the progress of mobilization in the patient. Then the user is required to fill out an assessment related to the care of stroke pressure sore patients, which uses an integrated assessment of stroke pressure sores. Then the user is directed to the nursing care feature which

provides nursing diagnoses and nursing interventions. After that the user is presented with an intervention view which is required to fill in the treatment action plan and implementation of nursing evaluation, which has been provided according to the guidelines of the standardization book in Indonesia. This study aims to measure the usability of Sinobed as well as its effectiveness according to the perceptions of potential end users.

2. METHODS
Research Design

This study used a quantitative research methodology. This study evaluates the usability and user experience of the Sinobed application by conducting thorough testing of the application. This research was conducted on nurses working at Hasan Sadikin Hospital located in Bandung.

Application Development

The proposed device, Sinobed, integrates artificial intelligence and Internet of Things (IoT) technology. The main aim of the device is to reduce the prevalence of pressure sores by utilizing a system made up of essential elements that monitor weight, temperature, and humidity. Sinobed comes with a number of features designed to combat pressure sores in stroke victims. The aforementioned features include a variety of treatment options tailored to pressure ulcers, automatic repositioning with alarm reminders, diagrams depicting daily movements, direct messages for immediate assistance, and wound management educational materials, nursing care that includes nursing assessment, nursing diagnoses, nursing interventions as well as nursing implementation and evaluation that support in the preventive care of pressure ulcers stroke survivors who are on bed rest after a stroke require proper pressure ulcer care and prevention methods. This is made possible through the integration of artificial intelligence and Internet Of Things (IoT) technology.

Figure 1. SinoBed Mobile App

Population and Sample

Respondents who were nurses by profession were included in this study. Data for this research project was obtained using convenience sampling, which involved selecting individuals who were willing to participate. A sample size of 30 participants was used to determine the frequency of user achievement, defined as the proportion of tasks completed correctly. The inclusion criteria for this study were nurses working in hospitals who had treated stroke patients, were Android phone users, and owned a personal mobile device. Nurses who did not have expertise in caring for stroke patients were excluded.

Instrument

A survey instrument will be used to obtain respondents' demographic data such as age, gender, and occupation. The usability assessment method is specifically designed to assess the main components of usability which include effectiveness (the ability of users to complete tasks using the system, and the quality of outputs and tasks), efficiency (the level of resources consumed in performing tasks) and satisfaction (the subjective reaction of users in using the system). Measurement of effectiveness, efficiency and satisfaction is done through the administration of a post task questionnaire, namely the System Usability Scale (SUS) questionnaire, a simple scale with ten items that provides a subjective assessment of usability (Cheah, Mat Jusoh, Aung, Ab Ghani, & Mohd Amin Rebuan, 2023). The technique used to select items for Likert scales is to identify examples of things that lead to the expression of the attitude to be captured. Likert scale with numbers ranging from 1 to 5. This scale incorporates a scoring mechanism that allows users to easily indicate the level of satisfaction with the system. To determine the level of satisfaction of respondents, the following six levels of rating scale are used: (1) strongly disagree, (2) disagree, (3) disagree, (4) agree, (5) strongly agree. The inclusion of scenarios is essential to provide clear guidance for respondents in using the application.
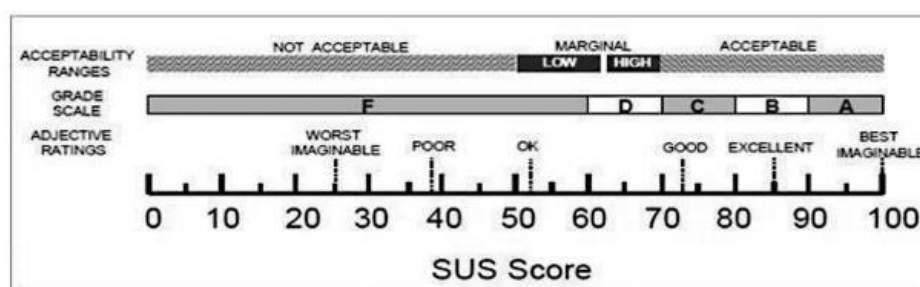

Figure 2. Ranking of SUS Questionnaire Scores

The acceptance assessment method is specifically designed to assess user acceptance and evaluate the system before it is launched using a questionnaire called the Technology Acceptance Model (TAM). The main components of acceptance include perceived usefulness (PU) which is defined as the extent to which prospective users expect the target system to facilitate, and Perceived ease of use (PEU) which is defined as the extent to which prospective users use the system determined by behavioral intention to use (Cheah et al., 2023). Acceptance measurement is done through giving a post task questionnaire, a simple scale with perceived usefulness (PU) seven

items and Perceived ease of use (PEU). The simple scale used is the Likert Scale with numbers ranging from 1 to 5. This scale incorporates a scoring mechanism that allows users to easily indicate their level of satisfaction with the system. To determine the level of respondent satisfaction, the following six levels of rating scale were used: (1) strongly disagree, (2) disagree, (3) disagree, (4) agree, (5) strongly agree.

Data Analysis

Evaluation of the mean and deviation of st r is done by utilizing the user success rate, which measures the average acquisition of scales completed by users. Where Xi represents the respondent's Likert scale score {0,1,2,3,4,5}, while the n value is the total amount of data with the Xi value as the average score. The concept of application usability can be measured as the average value obtained.

3. RESULT
Demographic Data

Based on table 1 shows that the characteristics of 30 nurse respondents with ages less than 25 years as many as (36.7%), nurses aged 26-30 years as many as (16.7%), nurses aged 31-35 years as many as (10%), nurses aged 36-40 years as many as (26.7%), nurses aged >41 years as many as (10%).

Table 1. Demographic Data with a Sample Size of 30 Participants

	Karakteristik	Total Populasi (N=30)	%
Age in Years	(Mean±SD) : 30.9±7.71		
	Min-Max : 22-50		
Nurse Age	<25 years	11	36.7
	26-30 years	5	16.7
	31-35 years	3	10
	36-40 years	8	26.7
	>41 years	3	10
Jenis Kelamin	Female	23	76.7
	Male	7	23.3

Satisfaction

Table 1. Observation Sheet and Results Obtained from Usability Testing with a Sample Size of 30 Participants

| Komponen Kepuasan	Mean ± SD	Min-Max
1. I think I would like to use this system frequently	4.10±0.92	
2. I think this system is too difficult	2.36±0.61	
3. I find the system easy to use	4.26±0.52	
4. I think I need technical support to be able to use this system.	3.26±0.94	
5. I found the various functions in this system well integrated	4.13±0.34	
6. I think there are too many inconsistencies in this system	2.83±0.79	
7. I imagine most people will learn to use this system very quickly	4.00±0.454	
8. I find this system very complicated to use	2.06±0.78	
9. I feel very confident using this system	4.06±0.365	
10. I need to learn a lot before I can start using this system	3.00±0.870	
Total Skor	85.25 ±5.92	75-97.5
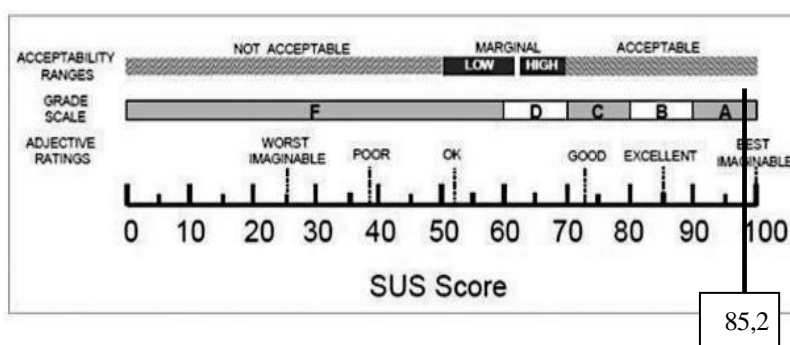
Figure 3. Average SUS Score Results

Table 1 shows that respondents generally tend to agree with the statement. The mean which is close to the highest value on the scale indicates that the majority of respondents tend to like or want to use this system regularly, a value of 4 indicates that most respondents are in the direction of agreeing, and the average value of the total score assuming the range 0-100 obtained a value of 85.25 (SD = 5.92) at the level of satisfaction with the use of the application shows that most of the data gathered relatively close to the mean, indicating consistency in positive responses to the use of this system. The results of the above research show that the "Sinobed" application is included in the Acceptable category, meaning that users have accepted this application and the "Sinobed" application enters into grade scale A (Excellent) which indicates that the score is classified as good with a minimum value of 75 and a maximum value of 97.5.

Acceptability

Table 2. Usability Testing of the Acceptance Evaluation with a Sample Size of 30 Participants

TAM Model Evaluate the Acceptability	Mean ± SD	Min-max
Perceived of Usefullness (PU)		
1. The use of the Sinobed application can help me simplify the treatment of pressure sores in stroke patients.	4.46±0.50	
2. think it will be easy to perform the task (pressure sore care for stroke patients) by using the application	4.43±0.56	
3. The use of the Sinobed app can improve stroke pressure sore care for my patients	4.30±0.59	
4. The use of the Sinobed application is in accordance with my work habits	4.20±0.61	
5. The use of the Sinobed app can encourage good clinical practice	4.26±0.52	
6. The use of the Sinobed app can improve my performance in the treatment of pressure sores of stroke patients	4.33±0.47	
7. The use of the Sinobed app can facilitate the treatment of stroke pressure sores in my patients	4.26±0.63	
Preceived Easy To Use (PEU)		
1. I think the Sinobed app will be easy to use	4.20±0.48	
2. I think the Sinobed app is a flexible technology for stroke pressure sore treatment	4.30±0.46	
3. I think I can easily learn how to use the sinobed app	4.10±0.48	
4. Using the sinobed app can help me maximize my time in caring for stroke pressure sore patients	4.30±0.59	
Total Score	94.32±4.65	39-55

Based on table 2 with a total mean (average) value of 94.32 and a standard deviation (SD) of 4.65, this result indicates that the majority of respondents tend to agree with the statement "The use of the Sinobed application can help me in facilitating the treatment of pressure sores of stroke patients". On a rating scale of 1 to 5, where 1 indicates full disagreement and 5 indicates full agreement, a mean value close to 4.46 indicates that most respondents are willing or agree that the use of the Sinobed application can provide benefits in facilitating the treatment of pressure sores of stroke patients. The relatively low standard deviation (0.50) indicates that respondents' responses tend to be uniform or consistent with the statement. This means that the majority of respondents have similar views regarding the benefits of the Sinobed application in the context of pressure sore care in stroke patients. This result can be interpreted as a positive indication of the potential acceptance of the app in supporting pressure sore care in stroke patients.

4. DISCUSSION

Advances in this field have seen that apps can assist healthcare professionals in the prevention and treatment of decubitus ulcers and facilitate the involvement of family members and patients in their own care, thereby improving wound management and outcomes (Koepp et al., 2020). The "SinoBed" mobile app promises to play an important role in pressure ulcer prevention efforts among stroke patients. The results showed that in general, the app received positive responses from users, indicating great potential in improving the quality of patient care (Ross, Arrohmah, Hasanah, Yusran, & Wijareni, 2021). A mean close to the highest value on the scale indicates that the majority of respondents have a tendency to agree with the usability and benefits offered by the "SinoBed" app. The features provided by the app, such as monitoring body pressure contained in the app such as temperature, weight and humidity monitoring sensors and providing alerts to avoid positions that could potentially cause pressure ulcers, are considered useful by users (Silva et al., 2021).

The assessment that the "SinoBed" app has reached the "Acceptable" category indicates that users have accepted the app as an important part of the treatment regime. This acceptance factor is important as it indicates that the app has successfully established trust among users, which is a key factor in successful long-term use. The classification of the "SinoBed" app as grade scale A (Excellent) shows that its quality has been recognized as the best. This confirms that the app not only meets users' expectations, but exceeds the standards required for an app of its kind. The "SinoBed" app can be considered an effective and useful solution in the effort to prevent pressure ulcers among stroke patients.

Ensuring that an app has features that suit the needs of the user and its purpose, such as an app to prevent pressure sores in stroke patients, features such as reminders to automatically change sleeping positions are crucial to aid optimal care with an app interface that is easy to use for all users, both caregivers and patients (Henda Karmandika & Andodo B A-B, 2023). Users feel comfortable and minimize barriers in using the app. The app should be relevant to the patient's needs, for example by providing effective education on pressure sore prevention or providing information on required sleep position changes, it is important to ensure that the app adheres to health standards and keeps patient data secure properly, responses and feedback from users and healthcare professionals are essential to assess the app's acceptance and success in meeting needs

and expectations(Taryudi, 2022). Some nurses provided feedback on the evaluation of the "SinoBed" app suggesting improvements in some aspects of the app such as connecting via WiFi which allows users to use the app at a great distance, as well as requesting educational content in written form, such as leaflets or posters, so that users who better understand written information can more easily absorb the education on pressure sores provided in this app.

In the researcher's opinion the overall information can provide valuable insight into the important role of technology such as mobile applications in improving the quality of patient care. The practical implication of this study is that the use of the "SinoBed" application can assist medical personnel in monitoring and preventing the progression of pressure sores, which in turn can improve the overall well-being and quality of life of stroke patientsc(Henda Karmandika & Andodo B A-B, 2023). Therefore, further research and application of this app in a wider clinical setting is needed to better understand its potential and impact in daily medical practice (Nugraha, 2024).

The Role of Technology in Improving Knowledge of Decubitus Prevention in the Digital Age

Nurses' responses showed that technology, such as the "SinoBed" app, has an important role in improving knowledge about decubitus prevention in the digital era. Nurses find this technology useful in easing the burden on nurses, bringing information closer to patients, and expanding the scope of decubitus prevention through integration with hospital SOPs. Technology such as the "SinoBed" app has a significant role in improving knowledge about decubitus prevention in the digital era. Respondents' responses highlighted that the app is able to ease the burden on nurses by providing features that support the care process, this technology allows information on decubitus prevention to be more easily accessible to patients, thus helping in increasing awareness and understanding of one's own health condition. The app's integration with hospital SOPs also expands the scope of decubitus prevention, ensuring that consistent standards of care are applied across different care units.

App Content and Needs for Decubitus Prevention

Nurses stated that the content of this application is sufficient to meet the needs for decubitus prevention, especially with the automatic mobilization repositioning feature and reminder timer, nurses requested to add educational content in the form of writing, such as leaflets or posters, to facilitate understanding for users. The content of the "SinoBed" application is considered sufficient to meet the needs for decubitus prevention, especially with the features of automatic mobilization repositioning and repositioning timer reminders (Juliani et al., 2022). These features help to ensure that patient care is carried out in a consistent and timely manner. However, the suggestion to add written educational content, such as leaflets or posters, suggests that there is a need to provide additional information that is more easily understood by users.

Ease of Understanding and Use of the Application

In general, nurses found the interface and programming language of the application easy to understand and comprehend, with suggestions to further improve understanding by providing additional language or WiFi connection that facilitates remote monitoring. Positive responses to

the app's interface and programming language indicate that the "SinoBed" app has successfully created an interface that is easy for users to understand and use. However, the suggestion to improve comprehensibility by providing additional languages or WiFi connection suggests that there is still room for improvement in this aspect, especially to support the use of the app in situations that require remote monitoring.

Successful Intervention and Monitoring

Features such as automatic mobilization repositioning every two hours and monitoring of temperature, humidity, and weight were found to be very useful for bed rest care of stroke patients. Feedback from nurses requested additional monitoring of vital signs or laboratory/ nutrition results. Features such as automatic mobilization repositioning and temperature, humidity, and weight monitoring were rated as very useful for stroke patient care. The positive response to these features indicates that the "SinoBed" app has successfully provided an effective solution in facilitating patient care. However, suggestions for additional monitoring of vital signs or laboratory/nutrition results suggest that there is potential for the development of additional features that could improve the quality of care provided.

Visual and Usage Satisfaction

Nurses gave positive responses to the appearance of the application, there were suggestions to add color variations so as not to be monotonous. Similarly, the font style and size, which is considered satisfactory, is suggested to provide font size setting options according to user needs. The positive response to the app's appearance, albeit with suggestions for additional color variations and font size setting options, shows that the "SinoBed" app has succeeded in creating an attractive and satisfying interface for users. The use of more attractive colors and layouts can improve the user's visual experience, while the font size setting option can improve the user's accessibility and comfort in using the app.

A weakness of this study is that the individuals who took part in the study were self-selected volunteers, who may have a higher level of proficiency in using mobile apps compared to individuals who did not volunteer. Consequently, this may have affected the results related to performance.

5. CONCLUSIONS

The SinoBed app has great potential in supporting decubitus prevention in stroke patients in the digital era. Positive responses from respondents indicate that this app is considered useful and has an important role in improving knowledge, simplifying care, and increasing user satisfaction.

Features such as automatic mobilization repositioning, reminders of repositioning times, and monitoring of temperature, humidity, and weight were found to be very useful and helpful in facilitating patient care. Nonetheless, there are some suggestions for improvements and enhancements that need to be considered, such as the addition of educational content in the form of writing, improving comprehension by providing additional languages or WiFi connection, and adding TTV monitoring or laboratory/nutrition results. It is important to continue to pay attention to the visual and usage satisfaction of the application by adding color variations and font size

setting options according to user needs. Integration of the app with hospital SOPs can also expand the scope of decubitus prevention and ensure consistent care st rs are applied across different care units.

Thus, the "SinoBed" application can be considered as an effective solution in improving the quality of care for stroke patients and helping to reduce the risk of decubitus formation, evaluation and development to improve the functionality and effectiveness of this application according to user needs and expectations need to be improved.

6. CONFLICT OF INTEREST

The authors state no conflict of interest.

7. ACKNOWLEDGMENTS

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