SYSTEMATIC REVIEW

Mobile Health Application To Improve The Visual, Clinical Assessment, And Performance Towards Decubitus Ulcer Prevention Review Article

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ABSTRACT

Introduction: Decubitus ulcers are damage to the skin and congenital soft tissues that appear due to prolonged lying in bed and depression, usually occurring in people with diabetes and spinal cord injuries. The development of information technology can have a positive effect on the detection, prevention, and treatment of decubitus ulcers. The purpose of this study was to determine the visual appearance, clinical assessment, and performance of several applications in terms of detecting, preventing, and treating decubitus ulcers. **Methods:** A systematic literature review that is narrative by making Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) as reporting items. **Results:** The study found that there is an application visualization that has several applications, reliable ulcer wound assessment, and application performance that follows technological developments using artificial intelligence (AI) features. **Conclusion:** Although some applications still get less visualization, especially in some learning modules, suggestions and input from some informants can be used as a stepping stone for future application updates and/or development.
Malaysian Journal of Medicine and Health Sciences (2025) 21(SUPP3): 182-189. doi:10.47836/mjmhs.21.s3.28

Keywords: Decubitus ulcer, Visual, Clinical Assessment, Performance, Mobile app

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INTRODUCTION

Decubitus ulcers commonly known as pressure injuries and also known as bedtime injuries are damage to the skin and/or congenital soft tissues that arise from lying too long in bed and/or depression for too long, usually occur in patients who are paralyzed and often sit in chairs(1)(2), Ulcers are characterized by damage to the skin and/or swelling or ulcers. The severity varies, ranging from the appearance of patches on red skin to extensive and open wounds in muscles and bones(3). Some of these definitions allow that all patients who cannot move for too long can suffer from decubitus ulcers.

A study states that there is an ulcer prevalence rate of 37% in residents of long-term care institutions(4). Ulcers are also reported to increase in incidence each year(5). Although there are studies that mention a decrease in the incidence of ulcers, this wound needs adequate prevention and treatment so that it can approach the absence of cases(6). Ulcer wounds can be caused by diabetics, especially on the feet, or can be known as Diabetic foot ulcers (DFU)(7). This chronic wound can demoralize patients and expensive medical costs that make some sufferers worry (8)(3). Besides being caused by diabetes, decubitus ulcer injuries also occur due to spinal cord injuries, a study says that 40% of ulcer sufferers also have previous spinal cord injuries(9).

Nowadays, information technology can help human work, especially in efforts to prevent disease through education and promotion through videos, images, and reading texts, although traditional lecture methods are effective in changing people's behavior and understanding, the use of electronic media in the health sector can be used as an effort to maximize personal learning in patients and the general public(10), A study states that the role of technology today can provide effective changes in people's behavior in a positive direction(11). In addition to making a positive impact on society, rapidly evolving technology systems also help nurses and other professionals in their work to better accurately and compare the data they have(12).

In recent years, mobile health applications known as

mHealth have made health services easily accessible to anyone and anywhere, mHealth is very helpful for health professionals in carrying out their work, but significant application developments and the absence of strict regulations make some health professionals less confident in the development of this technology(13). This study aims to assess mobile applications that help patients and families of patients to detect, prevent, and/or treat decubitus ulcer wounds and nursing and health professionals in detecting ulcer wounds. In addition, researchers also want to see the level of visualization, clinical assessment, and performance of the mobile application used.

MATERIALS AND METHODS

The method used in this study is a systematic literature review that is a narrative review. Article review reporting using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)(14).

Literature Search

Literature is searched using appropriate keywords for several terms available on MeSH MEDLINE which are categorized as keywords that can be used as a benchmark in finding the desired literature. Some keywords found by researchers for the theme of mobile health applications include; "android" OR "iOS" OR "mobile applications" OR "mobile" OR "application" OR "software app" OR "app" OR "mobile app" OR "smartphone". As for keywords regarding pressure ulcers, keywords were found; "pressure ulcer" OR "pressure injury" OR "bedsore" OR "decubitus" OR "ulcers" OR "decubitus ulcers". Once keywords are determined, researchers search for literature on Google Scholar, MEDLINE/PubMed, and Scopus. The criteria for the article desired by the author is in 2018-2024.

Study Selection

Researchers review the title, abstract, and content of the article on all articles searched, review the title for the category in accordance with the available keywords, and review the abstract and content to see the inclusion and/or exclusion criteria that have been set. The inclusion criteria for the articles sought are; (1) Research by reviewing existing applications/systems on mobile phones, (2) Entering names and/or terms for applications, (3) There are strengths and weaknesses of applications. The exclusion criteria in this study are that the study does not mention the name of the application and does not contain or mention strengths and weaknesses.

Data Extraction

Researchers will collect some of the results found, then detail and adjust to the main theme of this study, including; visualization, clinical assessment, and performance of the application. If one or more of the main themes are not found in the discussion, it will not be reported in this study. This research will focus on discussing the three main themes entered so that it can be a benchmark for the results of several articles reviewed. In-depth analysis in this research article will be entered in the Microsoft Exel application then detailed one by one and copy it in Microsoft Word.

RESULTS

The study found 985 articles on Google Scholar searched through additional Harzing's Publish or Perish (PoP) applications, 1436 PubMed articles, and 29 for Scopus. The overall results of articles found in the journal database were 2450, the final conclusion of articles that entered the criteria was as many as 11 articles. The results of the search and selection of studies can be seen in Figure 1 on the PRISMA reporting item.

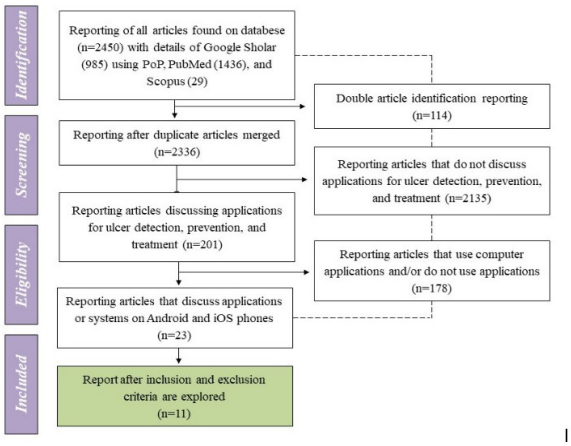

Figure 1: Reporting article items using PRISMA

These results found several studies whose targets or subjects of application measurement were patients, informal caregivers, and nurses. There are also studies that test the effectiveness of the application in providing an assessment of ulcer images sourced from patients as well as online images. Some apps also provide education on ulcer prevention and treatment. The overall results of the analyzed articles can be seen in the table below.

Visual Application

This study found aesthetic visualization of the application and the visualization of the application is easy to understand, so some users feel that the appearance of the application can add enthusiasm in reading and or watching learning videos about decubitus ulcers(18)(19)(22). Some informants also complained that there were learning modules in the application that were less aesthetic, the information provided was small, and the text conveyed was too long and small so that it could saturate the reader(18)(22).

Clinical Assessment

The results of this study found that some applications can provide very high-reliability ratings, from 0-1 intra-

rater reliability values for the reliability of length, width, and area of wounds checked in applications ranging from 0.978-0.992(15), Other studies also revealed a high-reliability score in the applications they studied, namely in the range of 0.967-0.985(16), Likewise, other studies have found the reliability value of mobile applications in conducting clinical checks for decubitus ulcer wounds ranging from 0.933-0.994 which means that the reliability in providing wound measurement results by several applications is very high(23)(25).

Application Performance

Some applications are already AI-based to improve their performance, the use of AI is usually as an additional assessment to detect injuries in real-time(21). The development of applications to assess decubitus ulcer wounds has entered 3D images, especially in measuring the depth and volume of wounds(24). These results also say that a mobile app can improve knowledge, skills, and motivation about decubitus ulcers (17), So many of the users are interested in some applications(20).

Table I : Results of analysis of relevant articles

Author	Study design & N	Name App	Assessment Parameters	Main results	Advantages	Shortages
Chan et al(15)	Studi prospektif cross-sectional (52 patient)	WoundAide (WA) imaging system	The 3D camera on the tablet device (iPad) uses a laser projector and applies an invisible infrared camera to the target object so as to depict the targeted object to determine the length, width, and extent of the wound.	Measuring reliability using Intra-class correlation statistics (ICC), found intra-rater reliability values in 3 images using WA of 0.978-0.992 / very good.	The WA imaging system serves as an additional medium to detect wound boundaries in ulcer patients, there are large wound image samples of as many as 1621.	WA imaging systems are limited to the accuracy of certain measurements for some patients.
Fong et al (16)	Studi prospektif cross-sectional (82 Patient)	Tissue Analytics (TA)	TA is a smartphone application that can be run on Android and iOS devices that functions to take pictures by placing a small green dot next to the patient's wound so that it can determine the length, width, and area of the ulcer.	Measuring reliability using Intra-class correlation statistics (ICC), there are intra-rater reliability values of the length, width, and area of ulcers on iOS of 0.967-0.985/very good and on Android devices of 0.977-0.984/very good.	TA worked well to very well in monitoring ulcer healing, there was a large sample of wound images to analyze with a total of 2334.	There is a difference in the reliability of wound measurement in patients with dark skin, which needs to be combined with clinical assessment by health professionals.
Polychronis et al(17)	Quasi-Experimental Study (45 Informal Caregivers)	Mobile health applications (mHealth apps)	mHealth apps provide real-time data, precise scheduling, and automation that saves costs and improves patient satisfaction. This study measures the utility, convenience, and knowledge gap in using mHealth apps in outpatients at risk of pressure ulcers (PU)	The findings in the mHealth application can increase the knowledge, skills, and motivation of IC to participate in disease prevention including PU.	The mHealth app can be a promising tool to encourage IC in an effort to prevent PU.	The younger CI age group was found to be more able to develop their knowledge and skills in using the app when compared to the older age group.

CONTINUE

Table I : Results of analysis of relevant articles. (CONT.)

Author	Study design & N	Name App	Assessment Parameters	Main results	Advantages	Shortages
Shirai et al(18)	Qualitative research study (9 informant)	Pressure Ulcer Target (PUT)	Participants are given an iPad equipped with PUT, and participants who do not have the application are given a download guide. Participants were given two weeks to use the PUT application. Structured interview questionnaire using MARS.	Informants shared their experiences using the PUT application: 1. The appearance of the application is attractive; Although the appearance of the image is too painful for them 2. In some modules, long text is too boring for readers 3. Some informants explained that their experiences of pressure injury/ulcers (PI/PU) motivated them to learn more 4. Visual display suggestions for applications are also obtained, especially the need for adding animations to improve the experience in learning the prevention and treatment of PI / PU.	Aesthetic display, easy navigation, and useful as well as useful for further knowledge about the prevention and treatment of PI/PU.	In some modules it is necessary to add useful information, visualization, and visual aesthetics need to add animated images and videos.
Salome and Ferreira(19)	Descriptive	Prevenɜro e Tratamento da Lesro por Pressro	Application development	Made simple and easy to use, it also provides data on PI risk factors, procedures for cleaning pressure wounds, and how to treat PI.	Simple and easy interface, acceptable price.	Not yet available on iOS, the only languages spoken are Portuguese and Brazilian, and no research has been done on its validation and reliability.
Ploderer et al(20)people with diabetic foot ulcers (DFUs	Qualitative evaluation (11 informant)	MyFootCare	The evaluation used structured interviews about informants' experiences with Diabetic Foot Ulcers (DFU) in using the MyFoodCare app and the extent to which the app improved their self-care.	Informants reported several experiences in using the application including: 1. Take photos of their leg ulcers to monitor their progress 2. Six of the informants routinely use applications on their cell phones, the rest only use them to call and send messages 3. Seven out of eleven participants were interested in using an app on their phones to support treatment.	Involve patients in their use and sharing of information and data.	Many of the informants complained about the difficulty of using the application, the obstacle was also found that using the application on adults would increase their work.
Lau et al(21)	Not described	You Only Look Once version 4 (YOLOV4)	Evaluation and development of AI-based applications by taking images from the Medetec Wound Database and other similar sources are then reviewed by professional nurses as a comparison of application accuracy.	144 images were found and the results were found, that the YOLOV4 application managed to detect injuries in real-time through the phone's camera.	Using AI features as stage assessment of PI.	Image size, image dimensions, and distance from the phone's camera can affect the results in the app. Only available on Android.

CONTINUE

Table I : Results of analysis of relevant articles. (CONT.)

Author	Study design & N	Name App	Assessment Parameters	Main results	Advantages	Shortages
McKeown et al(22)	Mixed methods study (32 Informal Carers)	iCare app	Informal patient caregivers/caregivers were given web qualtrics questionnaires filled out over 1, 2, and 6 weeks plus semi-structured interviews and "think aloud".	This study found that the average SD in the range of scores 1-5 obtained scores, including; Usability (3.84), aesthetics (3.46), information provided (4.13), and application quality (3.62), these scores were classified as medium-high in the assessment. on the other hand, it was found that SD was low in the impact felt due to the use of the iCare app, which was 2.1. It was found that the average knowledge score at the time before using the application increased after using the iCare application.	Good video content is felt by several companions/ caregivers, and the information in the application is concise but right on target.	Many informal caregivers don't understand about apps and they complain that the font size on apps is too small.
Chang et al II(23)	Studi prospektif cross-sectional (28 patient)	CARE S4WO UNDS [C4W] app	The C4W application auto-detects wound dimensions and aims to monitor the progress of healing by medical professionals. Can be used on iPads and iPhones, in comparison researchers also measure wounds manually.	Measure reliability using Intra-class correlation statistics (ICC). A total of 547 images of wounds were analyzed. The results showed excellent intra-rater reliability values in three different shots, ranging from 0.933-0.994.	Its accuracy in assessing the length, width, and area of the wound is very useful for monitoring the progress of the wound.	The accuracy of the application depends on the camera used, it is not available on Android, and it cannot judge the depth and damage to the wound.
Jun et al(24)	Retrospective review	Three-dimensional measurement system (3DWMS)	After the wound is cleaned, a 3D camera system is used on iPad mini, sensore, and online applications. Measures the width, length, depth, surface area, and volume of the wound. As a comparison data, manual measurement is also carried out.	26 decubitus ulcer lesions were reviewed based on their stage, mean values for width, length, and surface area were not statistically significant, while mean differences for wound depth and volume were found to be significant.	3DWMS can reliably measure wounds on 2D images, especially in length, width, and area of wounds.	3DWMS has not been able to precisely measure the depth and volume of the wound using 3D.
Khac et al(25)	Validation study (59 patient)	mHealth ImitoMeasure	See the difference between manual measurements by health professionals and automatic measurements by the ImitoMeasure app, measuring the length, width, and area of wounds.	Using Intraclass correlation coefficients (ICC) to measure application reliability, an overall intra-rater reliability value greater than 0.97/excellent was obtained.	Available on iOS and Android devices, with high wound measurement reliability, the application can be applied to clinical practice and is easy to use.	There is a low value on the assessment of curved wounds, large wound samples are not too many.

DISCUSSION

This study focuses on the visualization, clinical assessment, and performance of cellular applications to detect, prevent, and treat decubitus ulcers. This research does not really discuss the security of an application because of the limited data and articles obtained in the data search process. According to the results of research on patient users, there needs to be motivation and self-will in detection, prevention, and treatment because they are required to learn independently when using the application, while caregivers and nurses who accompany patients need to provide direction and wound detection in real time to patients who are accompanied. Mobile applications can improve wound care, especially on the feet of diabetics, independently.

Researchers found evaluation results on several applications where there is a charming display, images, and video displays that are easy to understand so that some users are comfortable using the application. Although there are some who complain about the limitations of the application in providing information, small text, and some modules that are incomplete, overall the application can function well in terms of learning. Especially for mobile applications that provide

learning modules to prevent and treat decubitus ulcers, it turns out to be able to have a positive effect on the knowledge and health condition of users(26). Learning applications, especially about decubitus ulcers, need to have good visualization to provide a sense of comfort to the reader. Visualization of appropriate text, images, and videos that are easy to understand is the key to user comfort and motivation in using the application because mobile applications can improve wound care independently(27)(28).

In this study, it was found that the reliability of the application in detecting decubitus ulcers is very high, so it can be concluded that several mobile applications can be used as a reference by nurses and caregivers to detect wounds in their patients or even patients themselves can make one or several applications to find out the development of their wounds. One study suggested that clinical detection and measurement applications could be useful for new nurses who are inexperienced in measuring the length, width, and area of wounds(29). All existing applications need to be evaluated in-depth so that there will be changes and better developments in the future (26).

Some applications in this study have used AI systems to help read an image of a wound so that it can be more accurate, the latest smart technology can provide better benefits for detecting decubitus ulcers(30). The performance of the application is not only seen from the availability of AI, but more than that, the application can further increase its performance if the phone used is better also performance. Just as the specifications of the cellphone camera used can affect the results and accuracy of clinical assessment in ulcer wounds, although some studies have found images taken at different temperatures will differ in the accuracy of clinical assessment, the difference is not too significant to drastically change the measurement results(31), So it can be concluded that most applications are worth using.

This research found several weaknesses that according to users are not too significant, but need to be improved and further research so that in the future it can be better. Weaknesses found in several cellular applications in this study include; (1) on the visualization theme, it was found that there was a lack of material in some learning modules, animated images and videos were still lacking, too much text in some modules, and applications that were difficult to use (2) on the clinical assessment theme, there were differences in measurement results in some patients, differences in skin color could affect the quality of measurements, and the quality of mobile phone cameras and the quality of images could affect the results of clinical assessment (3) In the application performance theme, deficiencies were found, especially in some applications only available on one Android or iOS device, unable to measure the depth and volume of wounds, and some applications only use local languages. Although this study found many shortcomings in several cellular applications, these shortcomings can be used as a reference to further improve and develop applications in the future.

CONCLUSION

This study found visualization in several applications, very high clinical assessments in terms of measuring the length, width, and area of wounds, and the performance of applications that already have by adding AI features to the application. Some applications still need development in terms of display, navigation, and adding videos or images to help readers understand more about decubitus ulcers. The application also needs to be improved in detecting wounds, especially differences in the patient's skin color, temperature differences, distance of pictures taken, and so on. This study does not discuss security and validity, so the researchers recommend further research to assess the validation and security of the application so that users are not too wary of the application they use.

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