



Review

Approaches that use software to support the prevention of pressure ulcer: A systematic review



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ABSTRACT

Context: The incidence and costs for pressure ulcer (PU) treatment remain high even though preventive methods are applied. Approaches that use software to support the prevention of PU are presented in the literature to make it more effective.

Objectives: Identify the state of art of the approaches that use software to support the prevention of PUs. *Methods:* A systematic literature review was performed to analyze approaches that use software to support the prevention of PU. ACM, IEEE, PubMed, Scopus, CINAHL and Embase databases have been searched with a predetermined search string to identify primary studies. We selected the ones that met the established inclusion criteria.

Results: Thirty-six articles met the inclusion criteria. To support prevention, most approaches monitor the patient to provide information about exposure to pressure, temperature level, humidity level and estimated body position in bed providing risk factor intensity charts and intensity maps. The main method to perform patient's monitoring is using sensors installed on the mattress, but recently, alternative methods have been proposed such as electronic sensors and tactile sensory coils. Part of the approaches performs automated management of the risk factors using ventilation tubes and mattresses with porous cells to decrease body's temperature and movable cells to automatically redistribute the pressure over the body. Matters as cost of the approach, patient comfort and hygiene of the monitoring equipment is only briefly discussed in the selected articles. No experiments have been conducted to evidence the approached may reduce PU incidence.

Discussion and conclusion: Currently, approaches that use software to support the prevention of PU provide relevant information to health professionals such as risk factor intensity charts and intensity maps. Some of them can even automatically manage risk factors in a limited way. Yet, the approaches are based on risk factor monitoring methods that require patient's contact with the monitoring equipment. Therefore, some matters need to be considered such as patient's comfort and the hygiene or replacement of the equipment due to the risk of infection. With the emergence of new alternative methods of monitoring, new technologies that do not require contact could be explored by new researches. Randomized Control Trials could also be conducted to verify which approaches are really effective to reduce PU incidence.

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1. Introduction

In the hospital setting, bedridden patients with limited movement may not change their position regularly. In this scenario, the same set of body regions is exposed to pressure for a long time and, thus, becomes more susceptible to lesions called pressure ulcer (PU).

PU is a lesion caused by prolonged exposure to pressure. When a part of the body is under pressure, nutrients are not properly provided for the tissue cells resulting in their death and therefore the appearance of the lesion. Apart from exposure to pressure, elevated body temperature and high skin humidity may also contribute to the formation of the PU's, which appear as an irritation in the upper layers of the skin and may be increased to reach muscles and bone tissue [29].

There is a direct impact of PU's on the quality of life of bedridden patients because they are extremely painful, they may extend the hospital stay so that it can be treated and may even be the cause of the patient's death. In order to minimize these risks, preventive methods are applied. The most common preventive method is the change of decubitus. This method consists in health professionals changing the patient's position in bed from time to time to switch regions under pressure to decrease the risk of PU's formation.

Even though preventive methods are applied, there is still a high incidence of PU. In Brazil, for example, a study in a Brazilian Hospital verified an incidence of 39.81% [31]. In addition, there are high costs arising from the extension of hospitals stay and the treatment itself, as in the United States, where an average of \$11 billion is spent annually [3]. Based on these facts, the importance of approaches that can support the prevention of PU to avoid patient's suffering and increased hospital costs is evident.

In the literature, several approaches that use software to support the prevention of PU can be found. Like in [8], which presented an application called Pressure Ulcer (PU) Manager that can predict a patient's PU risk based on electronic health record data. More specifically, some of these approaches are able to automatically monitor bedridden patients and provide real time information to support health professionals' decision making. As an example, in [40], that presented a system consisting of pressure sensors and classification algorithms to automatically monitor the patient's position.

In order to objectively identify the state of art of the approaches that use software to automatic monitor bedridden patients and support the prevention of PU, a systematic review of the literature is presented in this article.

2. Methods

This systematic review is based on the process established by [19], which defines three phases for its realization: planning, conducting and disseminating results. Initially, in the planning phase,

Table 1

Systematic review databases.

Name	Electronic address
ACM	http://dl.acm.org/
IEEE	http://ieeexplore.ieee.org/Xplore/guesthome.jsp
Pubmed	http://www.ncbi.nlm.nih.gov/pubmed/
Scopus	http://www.scopus.com
CINAHL	https://www.ebscohost.com/nursing/products/cinahl-databases
Embase	http://www.elsevier.com/online-tools/embase

the article databases used to identify primary studies, the search string and the criteria for selecting articles are defined. Then, during the conduct of the review, the search and selection of articles following the defined protocol are executed. In this systematic review, both steps were performed by one of the authors and reviewed by the others. Finally, the extracted data from the selected articles where analyzed by the authors and the results were presented. At all stages of this systematic review, the StArt tool was used to assist in the organization and execution [42].

2.1. Inclusion and exclusion criteria

Articles that present approaches to prevention of PUs that use software were selected. More specifically, the ones that provide some kind of automatic monitoring. The following inclusion criteria was used:

- The paper presents an approach that uses software to automatically monitor patients and support the prevention of pressure ulcers.

Bedridden patients are the risk group that is in the scope of this review. Therefore, articles which present an approach that does not include that group were rejected. There was no restriction regarding date of publication.

2.2. Search strategy

The scope of the selected articles involves both the prevention of PUs and the use of software. Therefore, search for primary studies was conducted on article's databases focused on researches in the fields of medicine and computer science. The list of these databases and their electronic addresses is presented in Table 1. The search was conducted on 02/22/2015.

Synonyms of pressure ulcers and words related to the use of software (system, technology, software and algorithm) were considered to formulate the search string that is presented below:

- (“pressure ulcer” OR “pressure ulcers” OR “bed sores” OR “pressure sores” OR “decubitus ulcers”) AND (“system” OR “technology” OR “software” OR “algorithm”)

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