

Smart Prevention: Utilizing Design Thinking and IoT Technology to Prevent Pressure Ulcers in Healthcare

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ABSTRACT: - This paper aims to address the prevalent issue of hospital-acquired pressure ulcers (HAPUs) in India, which affects a significant proportion of hospitalized patients. HAPUs commonly occur in patients who are immobile and unable to shift positions independently, leading to pressure sores. Although repositioning patients every two hours and using pressure-relieving mattresses can prevent HAPUs, the compliance of caregivers with these guidelines is often inadequate in healthcare facilities. In addition, there are challenges in continuously monitoring patient positions and alerting caregivers of necessary turns. The proposed solution involves a Design Thinking method that tracks the patient's position by means measuring their Temperature, Pressure, Sensory perception, Mobility, Activity and communicates wirelessly with a tablet to alert caregivers of necessary turns, following hospital policies. The IoT technology allows for centralized monitoring, recording and updating of patient positions and turning operations. In a controlled environment, the system successfully tracked patient positions and identified common poses. an IoT-based approach to prevent HAPUs is a promising solution that can significantly improve compliance with turning guidelines, reduce the workload on caregivers, offer centralized monitoring, minimize the risk of HAPUs, and offer a non-invasive and patient-friendly solution to HAPU prevention

Keywords: Pressure Sores, Pressure Ulcers, Repositioning, Prevention, Design Thinking, Internet of Things

1. Introduction: -

A pressure ulcer, also known as a pressure sore, decubitus ulcer, or a bedsore, is a type of injury to the skin and underlying tissue caused by pressure, shear, or friction. The application of pressure to a particular area of the body can result in reduced blood flow and oxygen supply to the tissues, leading to tissue ischemia and cellular damage. Elderly individuals with reduced mobility, impaired mental capacity, and increased skin friction and shear are at a higher risk of developing pressure ulcers.

According to a study conducted by the Agency for Healthcare Research and Quality (AHRQ), pressure ulcers are a significant problem in U.S. hospitals, affecting approximately 2.5 million patients each year. The study found that pressure ulcers were associated with longer hospital stays and increased healthcare costs, with an estimated cost of \$9.1 to \$11.6 billion per year. The study also noted that certain patient populations, such as older adults, those with limited mobility, and those with chronic medical conditions, were at higher risk for developing pressure ulcers. The AHRQ recommends several strategies to prevent pressure ulcers, including implementing a pressure ulcer prevention program, using pressure-reducing support surfaces, and training staff on proper patient positioning and turning.

To prevent pressure ulcers, healthcare providers employ various strategies, such as repositioning the patient or using pressure-relieving pillows or mattresses to reduce the duration or magnitude of pressure at the skin's surface. Intrinsic factors, such as the patient's skin's ability to resist damage and remain intact, also play a role in pressure ulcer prevention.

In addition to pressure ulcer prevention, maintaining adequate nutrition, circulation, and hydration can help reduce the risk of pressure injury. Malnutrition has been found to be positively correlated with the frequency and severity of pressure ulcers. Reduced calorie intake, dehydration, and decreased serum albumin levels can make the skin and underlying tissues less resistant to pressure, friction, and shearing force, increasing the risk of skin disintegration and delaying wound healing.

Pressure ulcers are associated with poor health outcomes, high treatment costs, and future legal judgments. Therefore, the use of appropriate support surfaces and repositioning schedules are crucial preventive strategies for pressure ulcers. Traditionally, hospitals have employed a 2-hourly schedule for repositioning patients, but patients in a prolonged state of unconsciousness may not move positions independently, making it challenging for caregivers to adhere to this schedule.

To address this issue, the proposed solution involves a wearable device that continuously monitors the patient's sensory perception, moisture, activity, mobility, nutrition, friction, and shear. The system wirelessly communicates with a tablet to notify caregivers when it is time for the patient to be turned, in accordance with hospital policies. The use of cloud technology allows for centralized monitoring and recording of patient positions and turning operations, offering a promising solution to the need for effective HAPU prevention

2. LITERATURE SURVEY: -

"Prevention of pressure ulcers in the elderly through the use of intelligent assistive technology: A systematic review." This literature survey conducted a systematic review of studies related to the use of intelligent assistive technology in preventing pressure ulcers in elderly patients. The authors found that while the use of such technology was promising, further research was needed to assess its effectiveness and cost-effectiveness.

"The effectiveness of different support surfaces for preventing pressure ulcers in patients: A systematic review and network meta-analysis." This literature survey focused on comparing the effectiveness of different types of support surfaces in preventing pressure ulcers in patients. The authors found that while there was limited evidence to support the superiority of any one type of support surface, some surfaces such as alternating pressure mattresses and high-specification foam mattresses may be more effective than others.

"A systematic review of repositioning interventions for the prevention of pressure ulcers." This literature survey focused on examining the effectiveness of repositioning interventions in preventing pressure ulcers. The authors found that repositioning interventions, particularly those that were more frequent and involved a greater range of positions, were more effective in preventing pressure ulcers than less frequent or less varied interventions.

"Barriers and facilitators to implementing pressure ulcer prevention strategies in nursing homes: A systematic review." This literature survey examined the barriers and facilitators to implementing pressure ulcer prevention strategies in nursing homes. The authors found that factors such as staff training, communication between staff and residents, and the availability of resources and equipment could all impact the effectiveness of pressure ulcer prevention strategies in this setting.

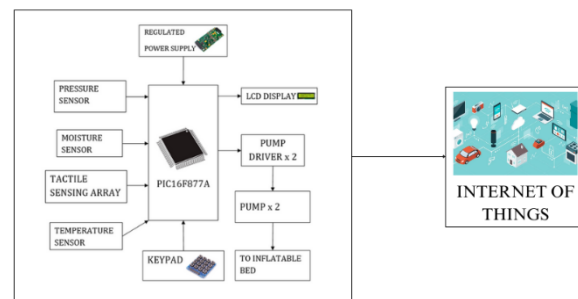
"The impact of nutritional interventions on pressure ulcer healing: A systematic review." This literature survey

focused on examining the impact of nutritional interventions on the healing of pressure ulcers. The authors found that while there was limited evidence to support the effectiveness of any one nutritional intervention, interventions such as protein supplementation and multivitamin supplements may be beneficial in promoting healing of pressure ulcers.

3. EXISTING METHOD: -

The existing methods for preventing pressure ulcers include repositioning the patient regularly, using pressure-relieving mattresses, and addressing the intrinsic factors affecting skin resistance, such as nutrition and hydration. Repositioning the patient every two hours can help redistribute the pressure at the skin's surface and prevent the development of pressure ulcers. The use of pressure-relieving mattresses can also help reduce the duration and magnitude of pressure at the skin's surface. In addition, addressing intrinsic factors such as nutrition and hydration can help improve skin resistance and reduce the risk of developing pressure ulcers. Malnutrition and dehydration have been linked to increased frequency and severity of pressure ulcers. Therefore, it is important to ensure patients receive adequate nutrition and hydration. Other interventions may include the use of skin moisturizers, pressure-relieving dressings, and education of patients and caregivers on proper skin care techniques.

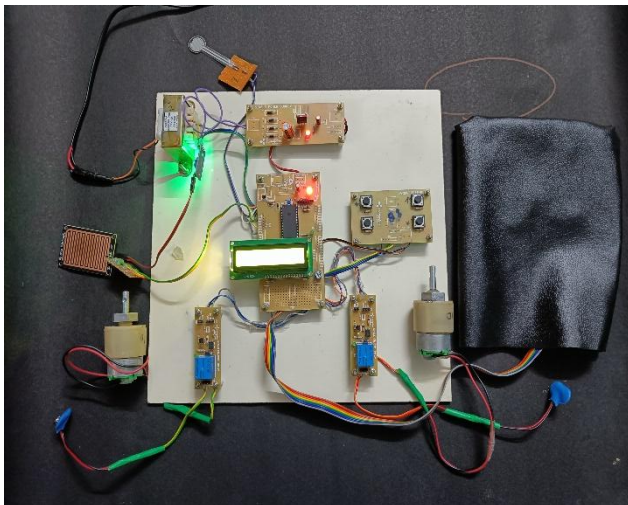
4. PROPOSED SOLUTION: -



The development of the proposed system, which utilizes IoT technology, aims to continuously monitor and assess the health status of patients in healthcare settings. The use of IoT in healthcare has proven to be a game-changer, allowing for better patient care, early detection of diseases, and real-time monitoring of health status. The system assesses several critical parameters, including Sensory Perception, Moisture, Activity, Mobility, Nutrition, Friction, and Shear. Sensory Perception is crucial in evaluating the patient's capacity to recognize and respond to discomfort or pain resulting from pressure on specific areas of the

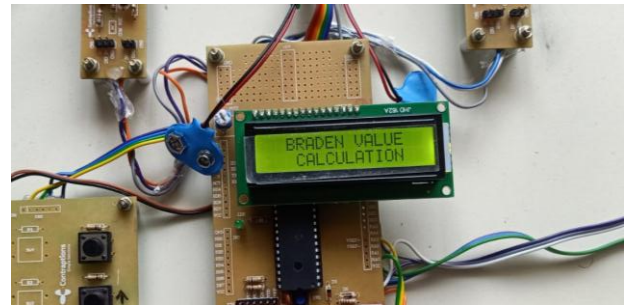
body. This parameter includes the patient's pain perception as well as their level of consciousness and cognitive response to pressure-related discomfort.

Moisture is another parameter that is monitored and recorded by the system. The excessive and continuous moisture of the skin can lead to maceration of skin tissue, putting the skin's integrity at risk. The Activity parameter reveals the level of physical activity of the patient, which is critical as inactivity can promote tissue breakdown and muscular atrophy. Mobility parameter evaluates the patient's ability to change their body position independently, including their willingness to move and their physical ability to do so. A patient's nutritional status is also assessed by examining their daily eating habits, where a small number of meals or an imbalanced diet may indicate a higher risk. The proposed system's objective is to monitor patients' health status continuously, allowing for early detection of potential health risks, particularly pressure ulcers. Pressure ulcers are a severe problem in healthcare, particularly in patients who are immobile or have limited mobility. Early detection of pressure ulcers is crucial as they can lead to severe complications such as infection and sepsis. The proposed system, utilizing IoT technology, provides an effective solution to prevent pressure ulcers from developing, making it a valuable tool in healthcare. The system's continuous monitoring and assessment of the patients' health status will provide healthcare providers with real-time information, enabling them to provide better patient care and improve patient outcomes.

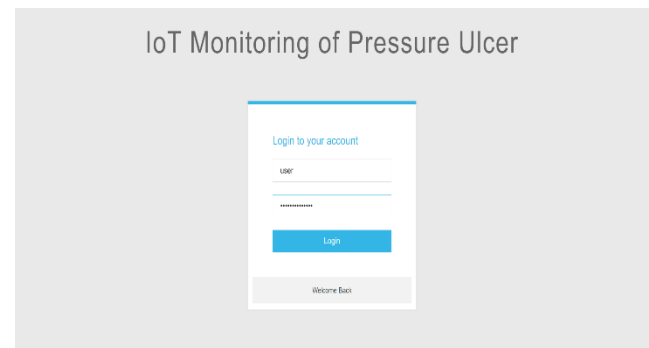


5. RESULT: -

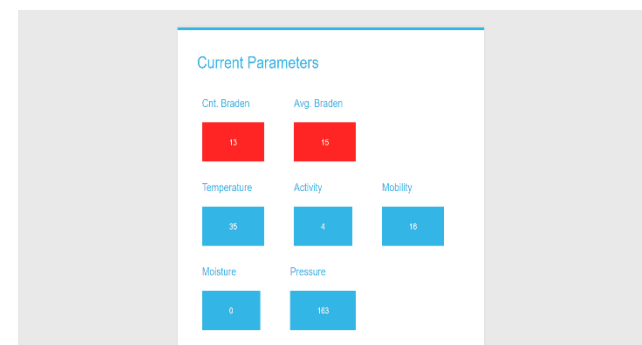
The results can be displayed in the LCD. First it displays the **Braden Scale for Predicting Pressure Ulcer Risk**.



This Braden Value Calculation shows the Sensory Perception, Moisture, Activity, Mobility, Nutrition, Friction and Shear.



The above figure shows the Web UI for Monitoring the Status of the patients.



The above figure shows the Parameters such as Temperature, Pressure, Mobility, Activity, Moisture etc.

6. CONCLUSION: -

The proposed method for preventing and monitoring pressure ulcers and various health parameters involves the use of advanced technology. The system is designed to automatically inflate the bed to assist patients who are unable to move and change positions independently. This not only helps to prevent the development of pressure ulcers but also aids in the continuous monitoring of several important parameters such as Sensory Perception, Moisture, Activity, Mobility, Nutrition, Friction, and Shear.

The system can be used to prevent and monitor pressure ulcers by ensuring that the patients are repositioned and relieved of pressure on certain areas of the body. By doing so, the risk of developing pressure ulcers is greatly reduced. Additionally, the system continuously monitors the patient's Sensory Perception, which evaluates their ability to recognize and respond to discomfort or pain caused by pressure on certain areas of the body. Moisture levels are also monitored to prevent skin tissue from becoming macerated and at risk of erosion, while activity levels are assessed to ensure that patients remain physically active, which reduces the risk of tissue breakdown and muscular atrophy.

Mobility is another important parameter that is continuously monitored by the system. It evaluates a patient's capacity to change their body position on their own, including their willingness to move and physical ability to do so. By monitoring mobility, the system can determine when it is necessary to inflate the bed to assist patients in changing positions.

In addition to these parameters, the system also monitors the patient's nutritional status and friction and shear levels. The nutritional status is evaluated by examining the patient's eating habits and looking for signs of a higher risk of developing pressure ulcers, such as eating only small amounts of food or having an unbalanced diet. Friction and shear levels are also monitored to ensure that the patient's skin is not subjected to excessive friction or shear forces that can cause skin breakdown and pressure ulcers.

In conclusion, the proposed method is an advanced and effective way to prevent and monitor pressure ulcers and various important health parameters. By automatically inflating the bed and continuously monitoring these parameters, the system provides an essential tool for healthcare providers to ensure the well-being and health of their patients.

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