Vibrational Therapy and Thermographic Monitoring for Deep Tissue Injuries

Kevin Li, Linda Pucurimay, Bodhi Nguyen
2015 SIMR Bioengineering, Stanford University

Introduction
Deep Tissue Injuries (DTIs) are a form of pressure ulcers which usually occur in immobilized patients. Ulcers increase in severity from Stage 1 to Stage 5, depending on the depth tissue damage. Earlier stages are characterized by blanching of the skin with subsequent stages manifesting in open wounds and DTIs. Currently, DTIs are monitored by visual inspection and can only be diagnosed at Stages 3-4 when open wounds are already present, requiring invasive treatments. We developed a two-prong solution using vibrational therapy and thermal monitoring. This device would ensure effective monitoring and prevention of DTI progression to stages 3-4.

Need Statement
A way to monitor and prevent Stage 1-2 Deep Tissue Injuries in the buttocks from progressing to Stage 3-4 open wounds in immobilized patients.

Need Specifications

<table>
<thead>
<tr>
<th>Must Haves</th>
<th>Nice To Haves</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1) Prevents Stage 1 DTIs from progressing to open wounds</td>
<td>B1) Prevents Stage 2 DTIs from progressing to later stages</td>
</tr>
<tr>
<td>A2) Minimally invasive - (method)</td>
<td>B2) Non invasive</td>
</tr>
<tr>
<td>A3) Able to detect abnormalities in the tissue through thermographic means</td>
<td>B3) N/A</td>
</tr>
</tbody>
</table>

Thermographic - able to detect differences in thermal recovery rate of tissue using <5 minutes of imaging4

A4) Easily used by medical personnel with an one-hour training session | B4) Easily used by medical personnel with no previous experience (0 sessions) |
| A5) N/A | B5) Comfortable |
| A6) N/A | B6) Affordable for nursing homes |

Concept Analysis

MIST Ultrasound Therapy
- Saline mist
- Delivers low frequency ultrasound
- Stimulates cell movement
- Promotes wound healing

SEEK Thermal Camera
- Thermal camera attachment
- Shows differences in temperature
- Low-cost alternative

Vibrational Therapy
Studies have shown a correlation between vibration and inhibiting DTI progression2. Our vibrational component uses four vibrating motors embedded in layers of memory foam. Motors can be individually controlled to isolate specific areas.

Thermal Monitoring
Infrared thermography is an effective diagnostic tool for DTIs3. Skin surface temperature response to a cooling stress is assessed to detect ischemia and inflammation. Our concept incorporates a thermal camera which logs data for the user to monitor the progression of their injury.

Prototype

Our prototype fully functioned when tested on subjects weighing 105 to 200 pounds. On a comfort scale ranging from 1-5, the average comfort levels with no vibrations and vibrations were 2.9 and 4.05, respectively, with 1 being extremely uncomfortable and 5 being extremely comfortable to sit on. Future work includes cosmetic improvements, structural improvements, and electronic integration. A portable IR camera compatible with a standard smartphone app will be developed to supplement therapy with monitoring.

Conclusion

We would like to thank Stanford University, Allison Mateo, Heather Rogan, Elaine Ng, Akshay Maheshwari, Courtney Gegg, Ross Venook, Colleen Rhode, and James Kintzing for their guidance and assistance throughout the 8 weeks of this program. We would also like to thank the Amgen Foundation for supporting the SIMR program.

Acknowledgements

References