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Regulation of Temperature and Perspiration within a Prosthetic Socket to Improve Amputee Quality of Life

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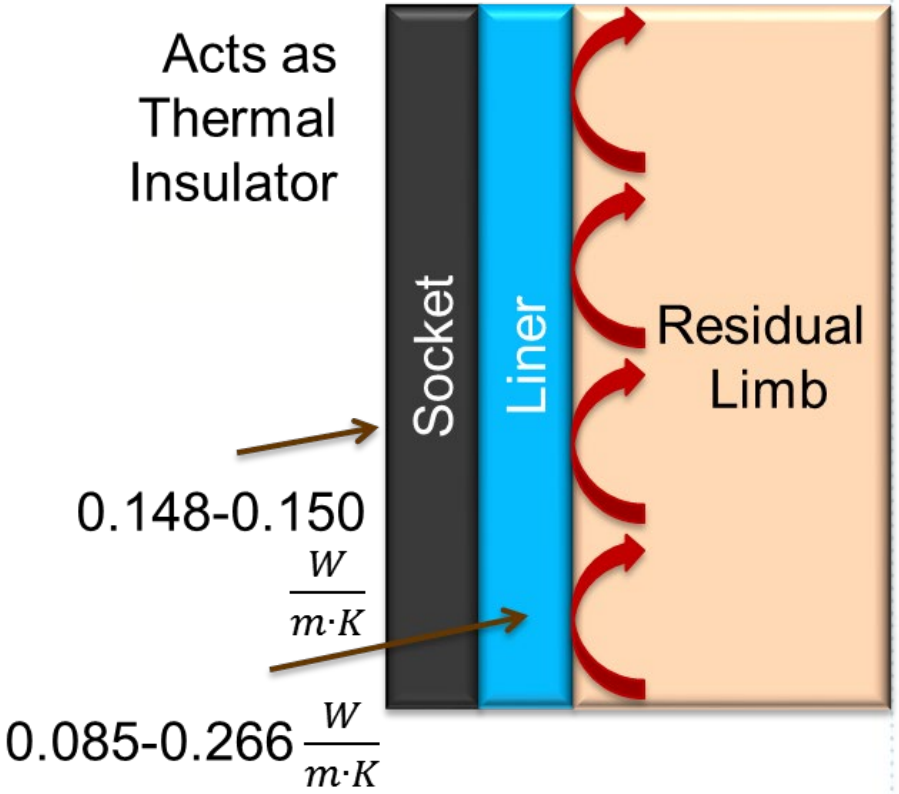
SmartTemp Liner

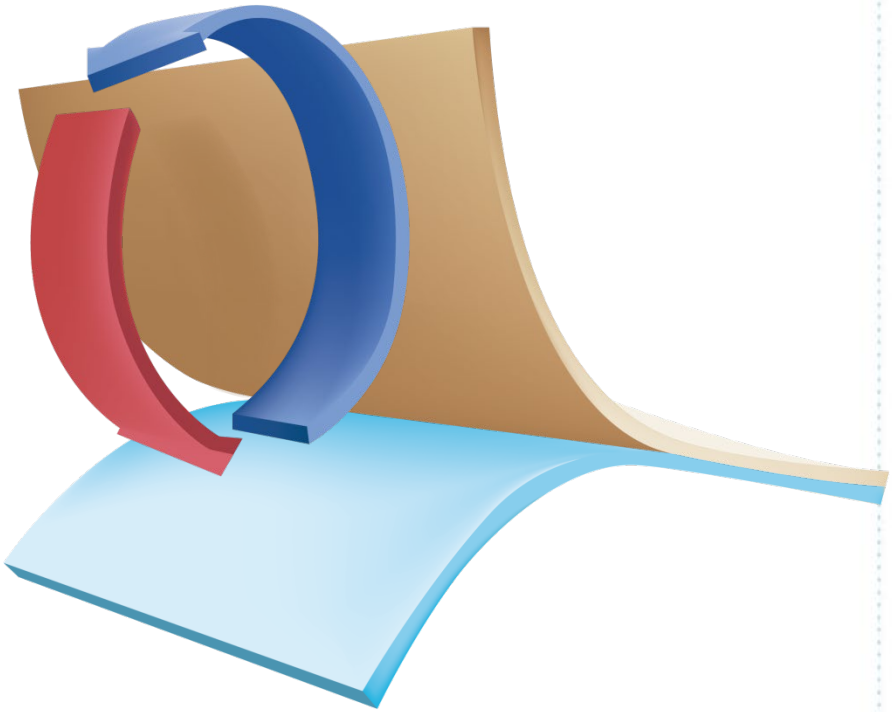
- Heat and perspiration are the leading complaint resulting in a reduced quality of life
- Warm and sweaty limbs increase risk of infection and formation of blisters and may affect suspension



Hagberg 2001, Kohler 1989, Naylor 1955, Akers 1972, Legro 1999, Klute 2007, Webber 2014

SmartTemp Liner

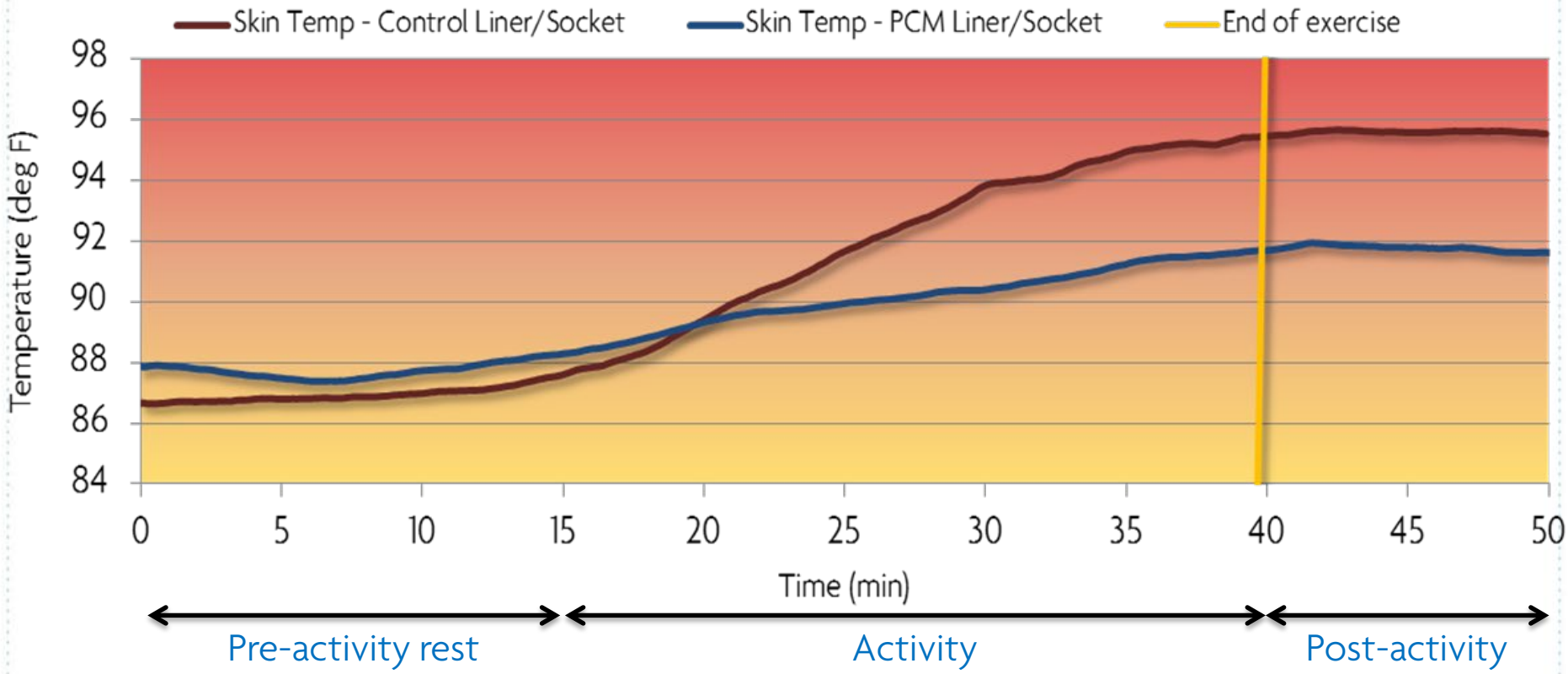
- A passive liner system with improved thermal properties
  - Incorporate Phase Change Material (PCM)
  - Improves latent heat



Pilot Study

- Pilot Testing
  - TF and avid bicyclist who reported much less sweat while cycling with PCM liner
  - 15 minute rest period after donning liner and socket
  - 25 minute bicycle ride in 80° room
  - 10 minute rest period

Pilot Study Results



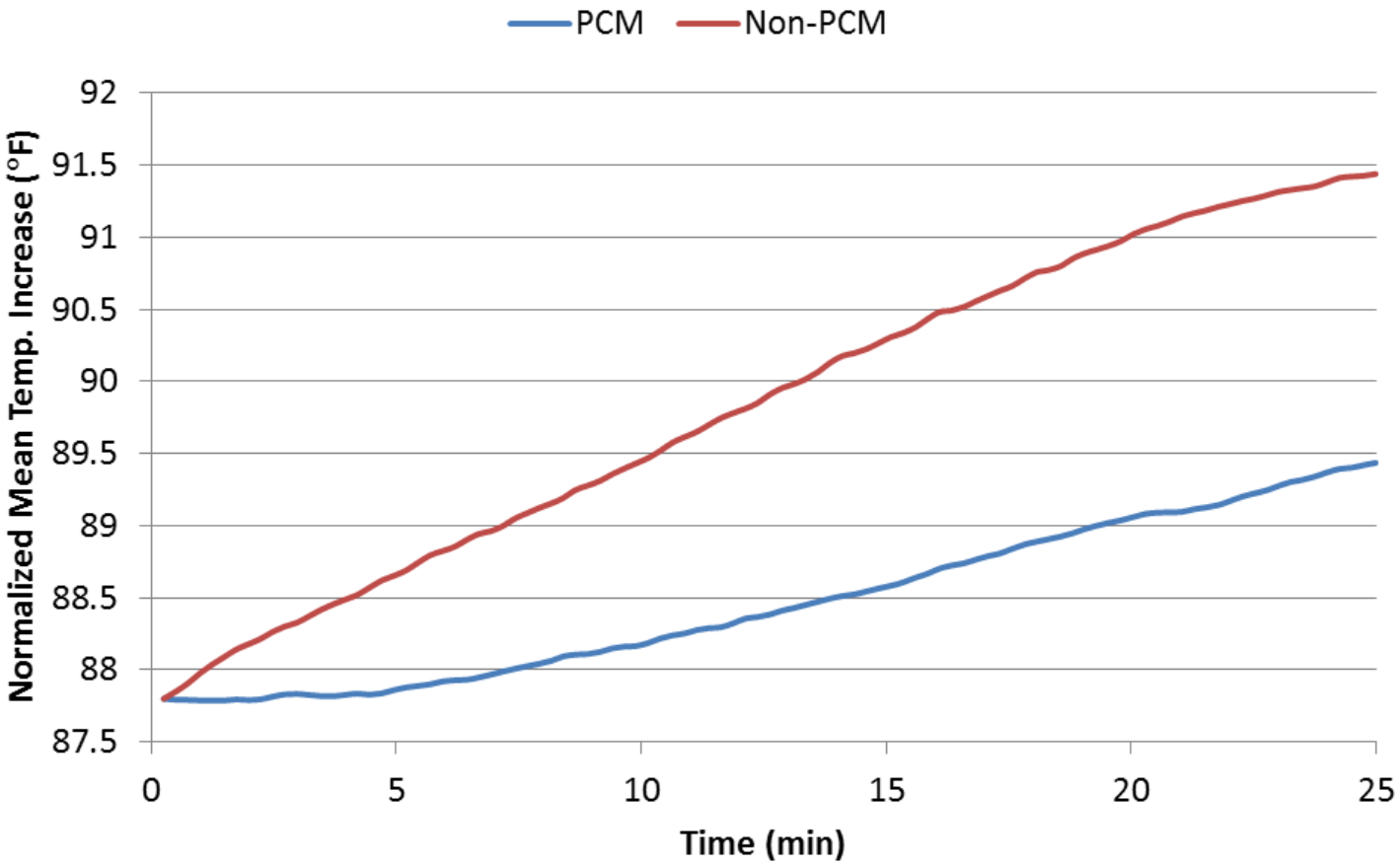
- The SmartTemp liner resulted in a slower temperature increase during activity and a faster temperature decrease after activity.

Randomized Clinical Trial

- 8 amputees (4 TF and 4 TT)
- Cycle for 25 minutes
- 80°F room
- Outcomes: Temperature (1 location) and Perspiration
- H_1 – PCM liner will lower temperature increase and amount of perspiration during activity

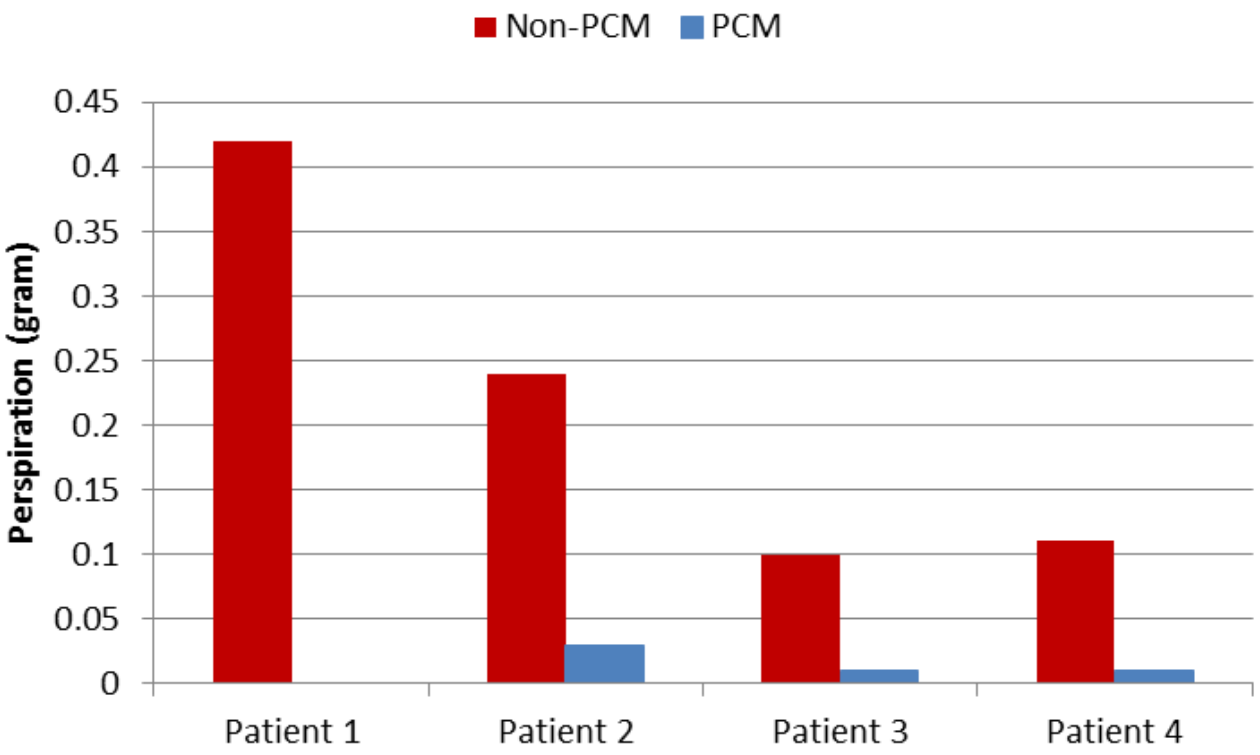
Temperature Results

- Temperature increase significantly reduced ($p<0.05$) with PCM liner
- 2° difference at the end of the activity period



Perspiration Results

- PCM significantly reduced perspiration ($p<0.05$)
  - Note, data from all 8 subjects included in statistics, but 4 were excluded from graph because they did not sweat with either liner

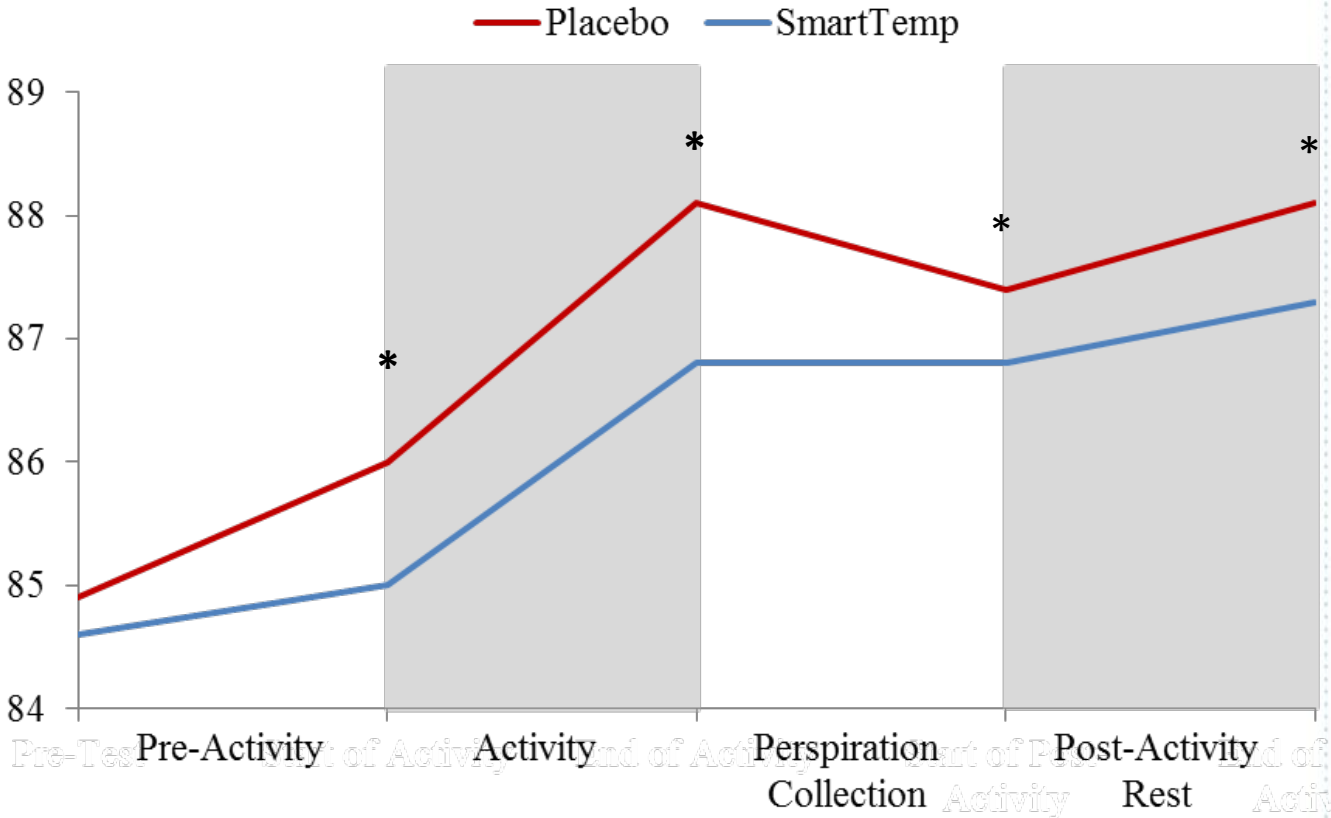


Randomized Clinical Trial

- 16 TT amputees
- Cycle for 25 minutes
- 10 minute rest
- 80°F room
- Outcomes: Temperature (4 locations) and Perspiration
- H_1 – PCM liner will lower temperature increase and amount of perspiration during activity

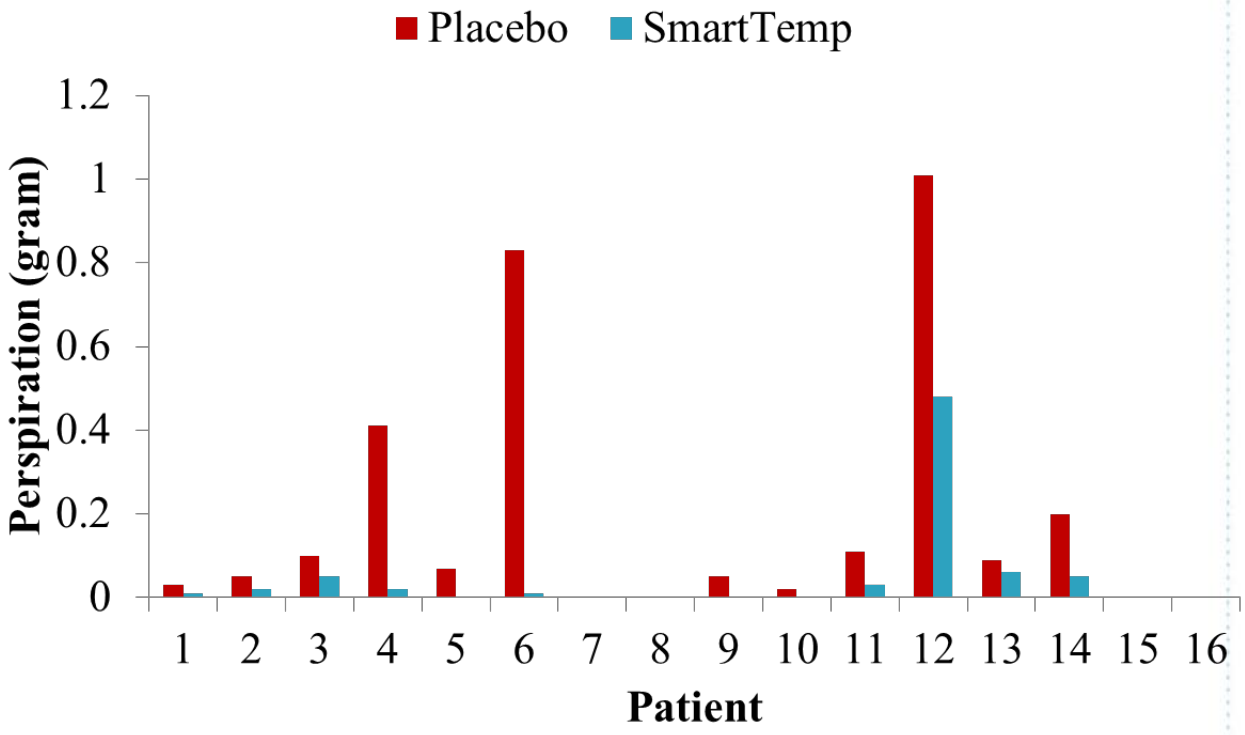
Temperature

- SmartTemp liner significantly reduced mean skin temperature, denoted by *



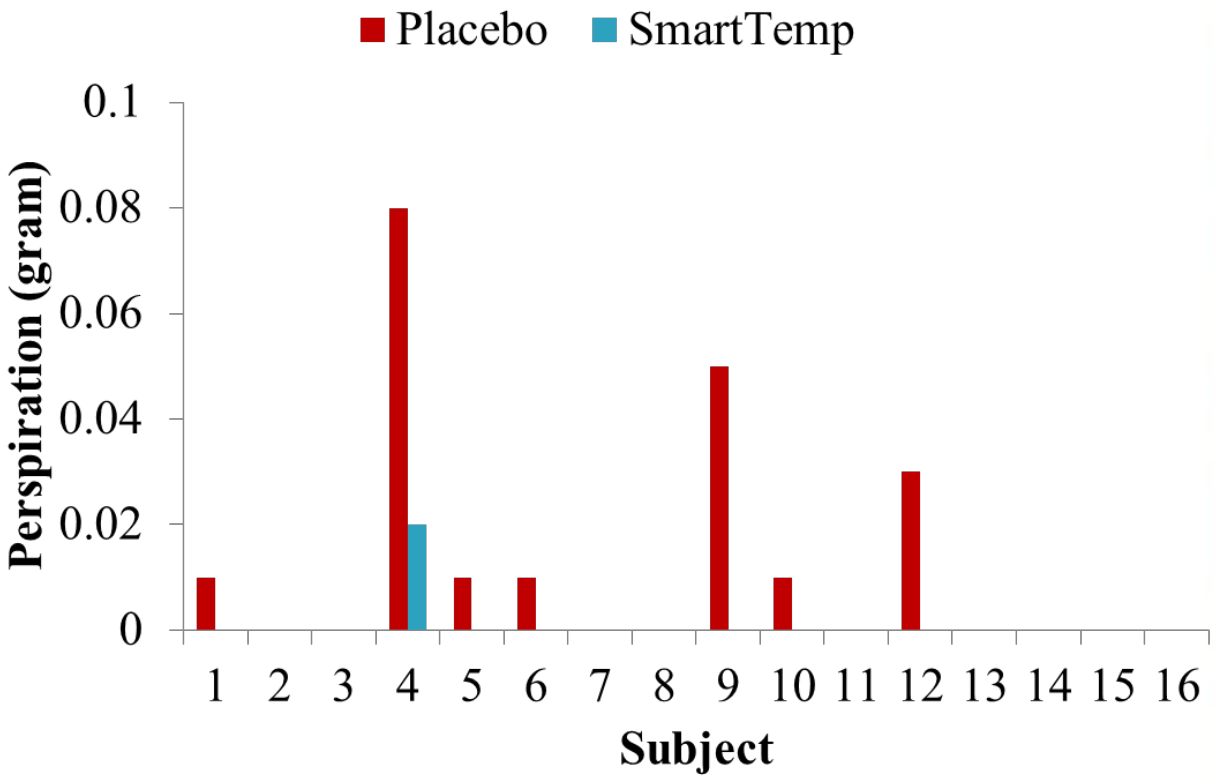
Perspiration: Activity

- SmartTemp liner significantly reduced mean skin perspiration collected immediately after activity
- 12 of 16 subjects had less perspiration with the SmartTemp liner.
- No subjects had more perspiration with the SmartTemp liner



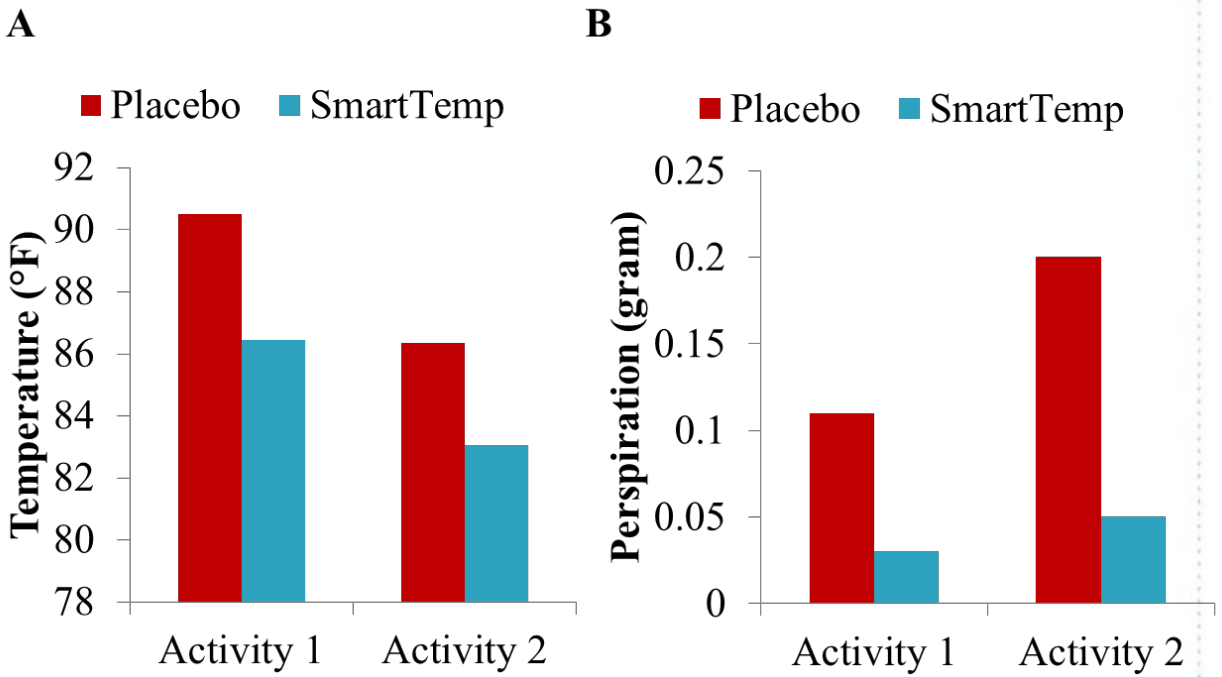
Perspiration: Post-Activity

- SmartTemp liner significantly reduced mean skin perspiration collected after post-activity rest
- Only 1 subject continued to perspire during the post-activity rest with the SmartTemp liner (Subject 4).



Bilateral Subject

- For 1 bilateral transtibial amputee subject, the SmartTemp liner always resulted in lower skin temperature and less perspiration.



Discussion

- PCM material significantly reduced temperature increase of the skin during activity and during post-activity rest
- PCM material significantly reduced the amount of perspiration during activity and during post-activity rest
- May promote skin health and reduce skin injury

Publication

SmartTemp Prosthetic Liner Significantly Reduces Residual Limb Temperature and Perspiration

Matthew M. Wernke, PhD, Ryan M. Schroeder, BS, Christopher T. Kelley, MS, Jeffrey A. Denune, CP, James M. Colvin, MS

ABSTRACT

Introduction: Common materials used for prosthetic liners and sockets have poor thermal properties, thus insulating the residual limb resulting in thermal discomfort and increased perspiration. The purpose of this work is to compare the temperature increase and amount of perspiration between traditional silicone liners and the SmartTemp liner, which incorporates phase change material to improve the thermal properties and mitigate perspiration.

Materials and Methods: Sixteen individuals with transtibial amputations participated in a double-blind, randomized clinical trial. Participants were asked to cycle on a stationary bike for 25 minutes followed by a 10-minute rest period. This activity was completed once for each treatment with a 1-hour rest period between treatments. Temperature and perspiration data were collected as outcomes, and a paired 1-way Student *t*-test was used to compare the data.

Results: The SmartTemp liner resulted in significantly reduced mean skin temperature and perspiration during the activity and postactivity periods when compared with the placebo liner.

Conclusions: Use of the SmartTemp liner can positively impact the internal socket conditions. Reducing temperature and moisture within the socket can improve comfort and suspension, and reduce the risk of skin injury for persons with amputation who use a prosthesis. (*J Prosthet Orthot*. 2015;27:134–139.)

KEY INDEXING TERMS: phase change material, prosthesis, socket, interface, heat, amputation, lower limb

Elevated skin temperature and perspiration are commonly associated with wearing and using prosthetic limbs. Results from questionnaire responses[1] from prosthesis users have documented heat and perspiration as the leading complaint resulting in a reduced quality of life. These conditions may also negatively impact the health of the person with amputation's residual limb.

Sterling, OH, USA) incorporates phase change material (PCM) into a traditional silicone liner. Phase change material has the ability to store and release thermal energy as it changes physical state from a solid to a liquid (latent heat of fusion) and back to a solid, maintaining the conditions of the surrounding environment for longer periods. The purpose of this work is to compare the residual limb skin temperature inside the liner and amount

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Questions??