Trine University
Biomedical Engineering

Parkview Hospital Fitted Sling Project

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PARKVIEW HEALTH

Introduction:

Nurses are required to reposition non-ambulatory patients every two to four hours for pressure ulcer prevention. Parkview Hospital utilizes ceiling lifts in hospital rooms, but nurses are not using the current sling and lift systems due to the fact set up requires multiple steps. The current system is not user friendly, resulting in nurses manually repositioning patients, causing high rates of musculoskeletal injury rates among nurses. The team designed a fitted bedsheet that would double as a sling for repositioning patients. The specifications for the fitted sling include being strong enough to hold up to 450 pounds, maintain proper comfort parameters to not increase risks of pressure ulcers, and be reusable as current slings are one-time use. Proper design and material selection were the key components for success of the project.

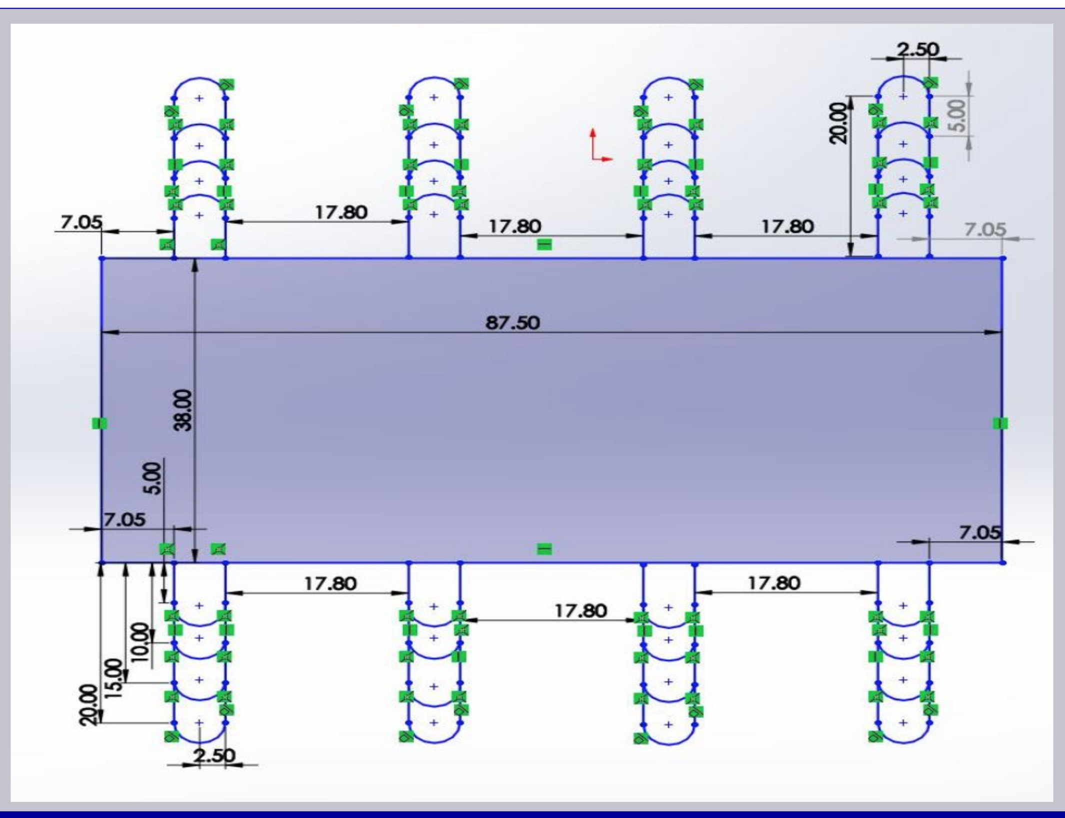

Figure 1. The Solidworks drawing is the planned prototype. This would be taken to consult with Angola Canvas before ordering the prototype and would be adjusted as needed based on prototype testing results.

Testing and Modeling:

Testing for material selection was conducted using polyester, nylon, and spacer mesh samples and comparing results to testing with the current sling.

- Tensile testing was conducted using ASTM D 5035. Samples were cut 1”x5”, and 5 samples were tested in the Instron machine. Average maximum loads and load at break were recorded for each material.
- Breathability was conducted using ASTM E 96. Samples were 5" by 5" and placed over a dish with water with a rubber band. Over 8 days, mass was recorded and mass loss versus time was reported to find water vapor transmission rate, WVTR.
- Moisture Wicking was conducted using AATCC TM 197. 1" x 5" samples ends were placed in water and height water traveled over 30 minutes was recorded to find wicking height at certain time.

Three strap attachment site designs were modeled and free body diagram calculations were conducted. Perpendicular, narrow, and wide modeling calculation identified which models produced the safest working loads. Angle of strap attachment was used in calculations to find load distribution. Other variables involved were the length of straps, height of loops, and the max force of 450 lb.

Results and Discussion:

The AirKnit 61 spacer mesh had a 0.309 (g/hr · m^2) water vapor transmission rate compared to the original bedsheet 0.327 (g/hr · m^2). The spacer mesh reached a maximum height of 12 cm after 24 minutes compared to the original bedsheet of 10 cm after 20 minutes. The average maximum loads from Instron testing were 33.22 lbf and 88.034 lbf for the original sling and spacer mesh cut with the grain, respectively. Scaling showed the spacer mesh being 2.65 times stronger than the original sling. The strap material maximum load was 400 lbf.

The perpendicular mathematical model, with inner straps angled at 90° during lifting, was shown to most effectively distribute weight with the most valid combinations of different loops for use. The calculations also displayed that the angle of the patient during use would provide the most comfort and safety for patients.

Planned Action:

Due to the COVID-19 pandemic the embodiment of the planned solution was brought to a halt. Despite having to stop progress, the team had detailed plans for action:

- Order and receive initial prototype from Angola Canvas
- Conduct mannequin testing with nurses at the Mirro Center of Innovation and Research
- Complete a nurse feedback questionnaire
- Instron test thread and seam strength
- Reevaluate current design, adjust as necessary
- Order final prototype

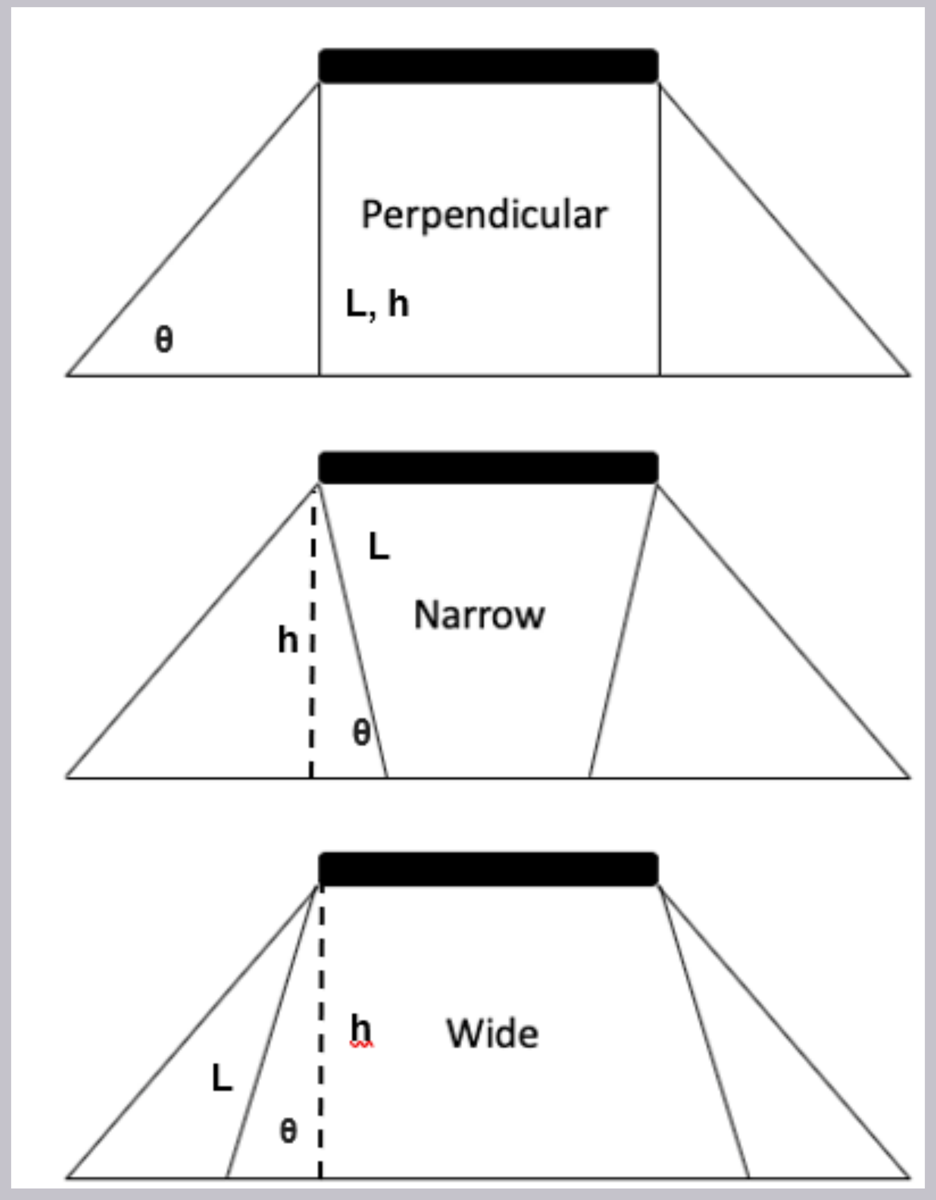

Figure 2. The three prototype models are shown above. Engineering calculations were conducted to determine load distribution and validate perpendicular as the best model

Figure 3. This is the current sling being used with the ceiling lift at the Mirro Center at Parkview Hospital.

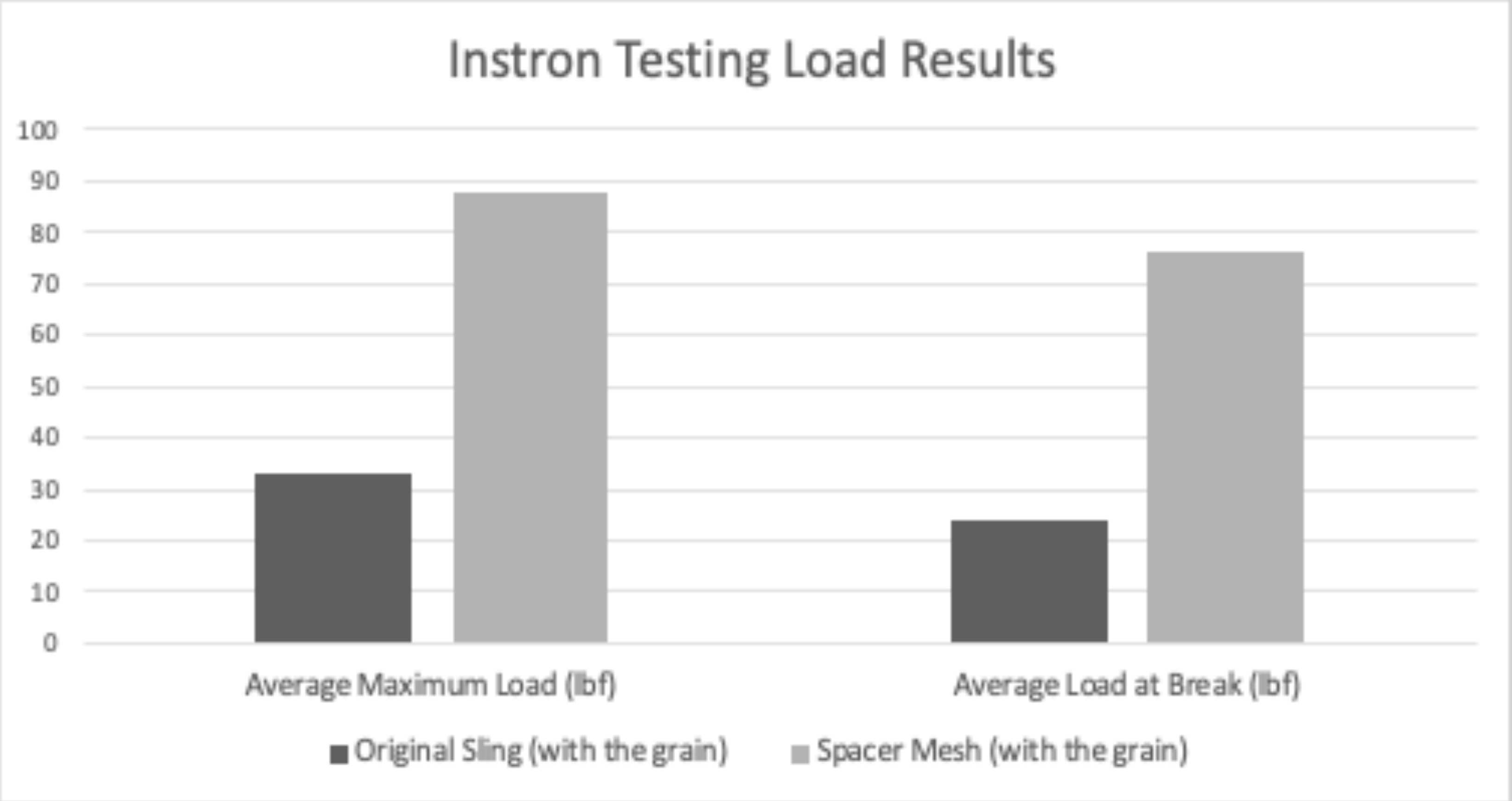

Figure 4. Instron testing results for the original sling and spacer mesh are reported. The spacer mesh was stronger than the original sling and was the planned material for the prototype.

Conclusion:

Producing a prototype meeting Parkview’s specification will reduce manual lifting, ultimately reducing nursing injuries. Although no prototype was made, the team had many successes. After a setback early on, the team chose Angola Canvas as the seamstress for the prototype. Angola Canvas provided the team with material samples which were tested for strength, breathability and moisture wicking. The AirKnit 61 spacer mesh was identified as a material that successfully met Parkview’s specifications. Engineering modeling and calculations validated the prototype design. Parkview Pack worked effectively as a team to meet objectives up until the project was halted by COVID-19.

Future Work:

The following are ideas to be explored for further improvements of the fitted sling:

- Test multiple layers of fabric
- Explore different stitch and seam patterns
- Additional reinforcements at strap attachment sites

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