Assisted Leg Holding Device For Medical Procedures

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Team 1

Funded by:
Rehabilitation Education Research Center

Client Contact Information:
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Introduction

- In the United States, about 51.2 million people are disabled
- Leg holding devices are required for many medical procedures
  - Important for patients to have a positive experience as to keep up with preventative screenings and to reduce anxiety
- Problems with traditional leg-holding devices.
  - Lack of adjustability, patients outside the “normal” range
  - Practitioners have difficulty positioning patients who are overweight or have severe disabilities
Purpose

To create an improved leg holding device to include an anti-gravity component to simplify the positioning process.
Requirements

- Comfortable
- Versatile (can be used by a wide variety of patients)
- Adhere to medical standards
- Low cost
- Compact and easy to relocate
- Easy to sterilize
- Not imposing or intimidating
- Durable and reliable
Product Research

- Allen Yellofin™ Lithotomy Stirrups
  - intra-operative repositioning of patients
  - mimics natural motion of the hip
  - prevents excessive pressure on the calf
  - Accommodates patients up to 500 lbs
Patents

- **2714541**
  - approved in August, 1955
  - One of the earliest patents found pertaining to this subject, stirrup only supports the patient’s foot
  - extremely compact and can be easily stored to maximize space within the operating room

- **4809687**
  - approved in September 1989
  - cushioned shell that supports a patient’s foot and lower leg
  - accommodates for patients with joint or muscle disease

- **5802641**
  - approved in September 1998
  - can be adjusted to support a patient against gravity
  - uses a motorized system
Patients benefiting from this device:

- **Phylis** rheumatoid arthritis, joint stiffness, pain
- **Jerry** Parkinson’s disease, tremor, rigidity, and decreased range of motion
- **Jamie** T11 spinal cord injury
- **Betty** limited and asymmetrical lower extremity range of motion, limited strength in her right leg, pain caused by her hip
- **Violet** short stature
- **Paul** two below-the-knee amputations
Subunits

Proposed Assisted Leg-Holding Device
\[ \sum F_y = 0 = F_{y,+} - W_{\text{device}} - W_{\text{leg}} \]

\[ F_{y,+} = k \cdot \Delta x \cdot \sin(180 - \Phi - \Theta) \]

\[ k \cdot \Delta x \cdot \sin(180 - \Phi - \Theta) = W_{\text{device}} + W_{\text{leg}} \]

\[ \cos(\Phi) = \left( \frac{a^2 + (c + \Delta x)^2 - b^2}{2a(c + \Delta x)} \right) \]

\[ \cos(\Theta) = \left( \frac{a^2 + b^2 - (c + \Delta x)^2}{2ab} \right) \]

\[ K = 94.6 \quad \text{pounds/inch} \]
Crank

Rotate to draw in cord

cord

crank

45 degrees

cord

crank

A

Nylon cord

Crank

Nyloń cord

spring

table

spring

Nylon cord

Nylon cord
Foundation Bar

T-Slotted Aluminum Profile

8020.net

Deflection $= \frac{l^3 \cdot w}{3 \cdot E \cdot I} = .707\text{ inches}$
Movement and Locking Mechanism

- Table leg
- Pivot nub
- Connecting joint
- T-slotted aluminum bar
- Handle
- 180 degree pivot piece
- T-slotted aluminum bar
\[ \sum F = F_{\text{pivot}} + F_{\text{spring,y}} - T_{\text{cord,y}} - (W_{\text{knee}} + W_{\text{foot}}) = 0 \]

For all cases

\[ \sum M_o = M_{\text{pivot}} + F_{\text{spring,y}} \times 3 \text{ in} - T_{\text{cord,y}} \times 3 \text{ in} - (W_{\text{knee}} \times l / 2 + W_{\text{foot}} \times l) = 0 \]

\[ M_{\text{pivot}} = -839 \times 3 + 799 \times 3 + (20 \times 18 + 20 \times 36) \]

\[ M_{\text{pivot}} = 960 \text{ pounds} \times \text{in} \]
Foot and Knee Supports

www.orthopaediclist.com
# Budget

<table>
<thead>
<tr>
<th>Material Description</th>
<th>Used For</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Springs</td>
<td>Lifting component</td>
<td>$41.52</td>
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<tr>
<td>Aluminum Pieces</td>
<td>Foundation bar, knee and foot supports</td>
<td>$73.42</td>
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<tr>
<td>Single Flange Linear Bearing</td>
<td>Movement of supports</td>
<td>$196.40</td>
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<tr>
<td>Linear Bearing Brake Kit</td>
<td>Braking</td>
<td>$8.00</td>
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<tr>
<td>180 Degree Pivot Assembly</td>
<td>Movement of foundation bar</td>
<td>$49.00</td>
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<tr>
<td>Living Hinge Assembly</td>
<td>Movement of foundation bar</td>
<td>$42.80</td>
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<tr>
<td>Machining</td>
<td>Various components</td>
<td>$41.00</td>
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<tr>
<td>Additional Screws/Nuts</td>
<td>Construction</td>
<td>~$20.00</td>
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<tr>
<td>24”x12”x1” UHMWPE Sheet</td>
<td>Handle, telescoping pole system</td>
<td>$46.90</td>
</tr>
<tr>
<td>Supports</td>
<td>Foot and Knee Support</td>
<td>$750.00</td>
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<tr>
<td>25’ Nylon-Coated S.S. Rope</td>
<td>Crank system</td>
<td>$34.00</td>
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<tr>
<td>Extra Aluminum-Sheet</td>
<td>Random</td>
<td>~$40.00</td>
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<tr>
<td>Extra Aluminum-Tube</td>
<td>Random</td>
<td>~$25.00</td>
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<tr>
<td>Springs</td>
<td>Spring-loaded pins</td>
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<tr>
<td>Velcro</td>
<td>Securing patient into device</td>
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<tr>
<td>Medical Table</td>
<td>Testing and building prototype</td>
<td>$250.00</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>$1667.94</strong></td>
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</table>
Ideally, the cost of the prototype is roughly 35% of the price of available, similar units currently on the market.

It should also be noted that not all units currently available will include all the options that are proposed for the prototype, and this should be considered when comparing costs.

<table>
<thead>
<tr>
<th>Device Name</th>
<th>Cost (U.S. dollars)</th>
<th>35% of Cost (U.S. Dollars)</th>
<th>Difference between prototype and 35% of cost (U.S. Dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Candy Cane Stirrups by CinTech</td>
<td>450</td>
<td>157.5</td>
<td>1509.5</td>
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<tr>
<td>Leg Positioners by CinTech</td>
<td>990</td>
<td>346</td>
<td>1321</td>
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<tr>
<td>Assisted leg lifting device</td>
<td>4395</td>
<td>1538.25</td>
<td>129</td>
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</table>
Conclusion

- The proposed design will
  - be low cost, durable and compact than the traditional leg holders.
  - provide orthotic leg support to disabled patients
  - be flexible for the patients or the practioners to position the leg for comfort
Acknowledgement

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Dave Price

References

- http://www.newexamtable.com/_ACCESSORIES.html