A Model to Demonstrate Compression Sleeve Technology on the Lymphatic System

Team 12
Nicole Lavoie
Christine Tartaglia

Client Contact: Susan Callison
Lymphedema Sleeve Company
47 Westfield Rd,
West Hartford, CT 06119
sue@lymphedemasleeveco.com
Executive Summary

This project aims to create a physical model to show the effects of Solidea’s Silver Wave Slimming Sleeve on the subcutaneous lymphatic system of people living with lymphedema of the arm. The physical model of the arm will integrate the important factors of the sleeve’s compression gradient and wave pattern fabric, as well as the forces produced by the muscles, the volume change of the arm and the flow of lymphatic fluid through the lymphatic system. The model will be cylindrical in shape and be comprised of four layers, each modeling a specific system of the arm.

The inner layer will be a metal rod to imitate a human arm bone. Around the bone will be two inflatable bladders to simulate major groups of arm muscles. Input from the user will allow the upper bladder and lower bladder to inflate to appropriate levels, to demonstrate the pressure force exerted by the muscles onto the lymphatic gel layer during rest and movement. The gel chamber layer will be a rudimentary model of the lymphatic system at the subcutaneous level. It will comprise of gel that can be evenly distributed throughout the cylinder. It can then be increased at certain points along the model to demonstrate the swelling associated with lymphedema. To show the effects of the sleeve on the lymph fluid flow of the arm, a dye will be injected at the distal end and allowed to disperse throughout the gel. This layer will be in transparent plastic film holding chamber that can be removed from the end of the model to show the affects of the sleeve at any given point during testing.

A thin layer of sand will be placed on top of the gel chamber to model the skin of the epidermis and dermis. It will have a similar thickness to the human skin layer, and will be measured to appropriately simulate an adequate compression force on the gel layer. The sand layer will be in a plastic film chamber and will come in contact with the sleeve, allowing the transfer of the compression from the garment and the micro-massaging effects to the lymphatic gel layer. The model will have a metal framework structure at key points along the cylinder to produce the outlining circumference of the arm. This framework must be kept at a minimum to reduce deferment of force from the sleeve onto the metal.

The key features the user will be able to control in this model will be the pressure force applied by the muscles with a pump, the amount of gel injected at given areas of the model, and the removal of the lymphatic layer for proof that the garment is producing a movement of fluid.
1. Introduction

1.1 Background

Lymphedema is a condition in which there is an accumulation of interstitial fluid that occurs due to a blockage or interference with the lymphatic drainage in a part of the body. When a part of the lymphatic system is blocked or damaged, the fluid in the interstitial space does not drain, and therefore builds up in the tissues. This build up causes swelling within the area, or edema. While primary lymphedema occurs from naturally occurring damage or missing lymphatic vessels, secondary lymphedema most often occurs as a result of using radiation to treat cancer as well as by some surgeries, burns, and other injuries. Symptoms of lymphedema include swelling of the affected area, pain, heaviness and difficulty of use of the affected limb.

The client, Susan Callison, was diagnosed with breast cancer in 2008. As a treatment for the breast cancer, she had an axillary node dissection, which required the removal of 32 lymph nodes from under the arm. This surgery caused damage to her axillary lymph drainage system and thus caused a type of secondary lymphedema, coined breast cancer-related lymphedema. With breast cancer treatment involving radiation, mastectomies and/or axillary node removal, there is an average 1 in 4 chance that the patient will develop lymphedema at some point after treatment.

To manage the swelling associated with lymphedema, a compression sleeve can be applied to the affected limb. The sleeve increases the pressure placed on the interstitial fluid to increase movement of the lymph toward the venous system. Ms. Callison tried a medical compression sleeve after developing lymphedema in 2009, but found them unattractive and uncomfortable to use. She started to contact companies trying to find more discrete and comfortable ways to manage her lymphedema, and came across a company from Italy called Solidea. Solidea sells their compression sleeves as a means for weight loss and decreasing cellulite. The compression sleeve design contains wave-shaped ribbed fabric that is believed to act as a micro-massage to the subcutaneous tissue layer. Ms. Callison then founded the Lymphedema Sleeve Company, which uses the compression sleeves from Solidea to treat affected limbs of patients with lymphedema. The pressure exhibited by Lymphedema Sleeve Co. compression sleeve is less than that of previous medical compression sleeves, yet has been found to decrease the amount of fluid buildup in various areas that lymphedema often causes.
1.2 Purpose of the Project
Solidea’s compression sleeve has only been used previously as a means of weight loss for parts of the body. Solidea writes that one can use the fabric to lose weight and to cleanse oneself of toxins in the same process [1].

The client believes that the wave pattern of the Solidea compression sleeve, seen in Figure 1, applies a graduated pressure along the arm, as well as a zigzagging pressure across the arm allowing microcirculation to occur similar to methods used to treat lymphedema. There are doubts by some customers that a sleeve that does not apply as much compression as other sleeves may not work as effectively. However, Ms. Callison believes that the sleeve allows lymph to be drained from the swollen area similar to the way manual lymphatic drainage massage helps to drain swollen, lymph-filled areas. The sleeve will be able to act as a continuous massage, allowing consistent drainage of the lymph by being worn at all times. She hopes this will become a more modern sleeve to be used for those suffering from lymphedema. For now, she would like proof that the sleeve is acting upon the lymphatic fluid and, moreover, aiding the damaged lymphatic system. She would like a physical model to be built that displays the effect of the patterned fabric of the Solidea compression sleeve on the lymphatic system in the arm. She hopes this will allow her customers, who have lymphedema, to see the benefits when wearing this sleeve.

![Figure 1: Wave pattern of compression fabric shown in a computer model (A) and from the actual compression sleeve garment (B).](A) (B)

The model should be able to replicate how the lymphatic system is affected with or without the compression sleeve. When the model is put into a mode of “lymphedema”, it should be able to display the compression and the aid that the sleeve supplies on the system.
1.3 Previous Work Done by Others

1.3.1 Products
After conducting research, no former designs regarding a physical model of the lymphatic system of an upper limb have been found. There are certain products however, that can relate to the project, mathematical and computational models to simulate lymphatic flow as well as compression garments used to treat lymphedema.

Computational Models
Macdonald et al. published an article in January 2008 in the American Journal of Physiology – Heart and Circulatory Physiology titled Modeling flow in collecting lymphatic vessels: one-dimensional flow through a series of contractile elements. This article explains the development of a one-dimensional computational model for the coupled fluid flow/wall motion in lymphatic vessels. The model is able to reproduce the pumping behavior of a real lymphatic vessel using simple contraction function producing fast contraction pulses traveling in the retrograde direction to the flow [3]. This model was built off of two other computational models developed in 1977 and 1992 dealing with flow through lymphatic vessels.

The compression sleeve being used in conjunction with the physical model from the Lymphedema Sleeve Company is actually a product of an Italian company named Solidea. Solidea promotes their compression garments for fitness shape wear, athletic wear and maternal wear. There are other companies that produce compression garments similar to the SilverWave Slimming Sleeve to treat lymphedema.

Lymphedema Sleeve
The Juzo Silver Strong Arm Sleeve 20-30mmHg is a garment produced and sold by Juzo® to help prevent or manage mild to moderate lymphedema [4]. It has a similar micro-massaging weave in the fabric and is manufactured with a silicone border to help keep the arm sleeve in place. It is 73% polyamide and 27% elastane. It’s medical grade compression ranges from 20 mmHg directly below the shoulder and gradually increases to 30 mmHg at the wrist. It comes in 6 different sizes and is available in 3 different colors. This compression garment also has silver ions built into the garment to promote cleanliness of the fabric. Unlike Solidea’s design however, this garment stops at the shoulder rather than forming an around the back sling.
The 20-30mmHg compression is typical pressure that is suggested and prescribed by physicians to patients dealing with lymphedema. The retail price for this product is $57.19.

**Previous Sleeve Testing**
In the January-March 1999 Issue of Fleboligica – Official Organ of Italian Association of Phlebology, researchers for Solidea published an Article titled, *A New Elastic Support for the Treatment of Liposclerosis and Lipodystrophy* [5]. The article describes the testing done on the *micro massage magic* fabric currently being used in this design project’s lymphedema compression. The garment being tested was an elastic pantyhose made of 80% polyamide, 18% elastane and 2% cotton. The test was conducted on 100 human patients suffering from liposclerosis for at least 3 years. Venous stasis was present in 45% of the patients and lymphedema of the foot was percent in 3% of the patients. The patients were given 5 pairs of compression pantyhose and were required to wear them every day for a varying 2 weeks or 2 months. Patients then voluntarily filled out surveys evaluation the effectiveness, and tolerability of the garment. After the study, 97% of the participants said they felt an effect of the garment on their body and 88% felt the garment was effective in treating cellulite. The article mentions that detailed analysis was done on the pressure exerted of the garment on the skin. It showed that the non-homogenous wave structure of the fabric showed an alternating pressure within 2 mm intervals on the skin. The procedure of the analysis was not described however, but the article mentions that the processing of the fabric and the alternating movement is what produces the effect of cutaneous and subcutaneous massage while the patient was walking, therefore creating the “micro massage” effect of the compression garment.

**1.3.2 Patent Search Results**
Patent searches for both a model of the lymphatic system and a fabric similar to that of the Solidea fabric were run. A search on “micro massage” fabric yielded a patent for a knit fabric that is believed to aid in therapy for lymphedema.

*Circular Knit Fabric For Use In Compression Therapy by Karl Achtelstetter, Pub. No.: US 2009/0275873*

This patent article, published November 5, 2009, describes a fabric with a micro-massage fabric that can aid in treating effects of lymphedema. The fabric uses protuberances within the fabric to aid in the pressure difference to allow lymphatic fluid to be drained from the arm. As seen in Figure 2, the fabric has a knit that rises and falls giving an uneven texture to the garment.
versus previous compression sleeves used to treat lymphedema.

Figure 2: Compression sleeve fabric for Pub. No.: US 2009/0275873

The patent suggests that the fabric is a more comfortable fit with less compression than previous compression sleeves. It also states that the micro-massage occurs as the body moves and the fabric exerts its pressure. Further research yielded no product for a compression sleeve like this under the patent writer’s name. However, this reinforces that compression sleeves with a protuberance pattern within the sleeve like the Solidea compression sleeve, appear to have a similar effect to the Solidea fabric.

It has been made clear that there are very few models, if any, for the lymphatic system when exposed to a compression sleeve. One patent search yielded a patent for a model of the lymphatic system using infrared imaging.


This patent article, published July 8, 2010, describes a generation of a model of both the internal and external features of the body via collection of simultaneous images and calibration of the model by comparing what has been obtained. The patent describes using multiple imaging devices to retrieve such a model, including creating a curvilinear feature map that processes the
external anatomy while an infrared image is taken of the internal anatomy. The patent also mentions the ability to measure response to a stimulus by taking multiple images over time. Such responses to stimulus that could be measured include microexpressions, pulse, respiration rate, head and arm motions, and posture and gait. The infrared image is able to create a sequence of images by observing the thermal changes in the body produced by the stimulus. Meanwhile, a 3D visual camera is able to record coordinate points on the body that correspond to the points on the body taken via infrared imaging. This method works especially well when multiple infrared imaging cameras can be used to connect all thermal responses to the 3D coordinate points assigned.

Infrared imaging, or IR imaging, can obtain external or internal images of the body depending on the sensitivity of the thermal imaging in addition to number of angles the image is being taken. If one were to take images of blood vessels inferior to the skin, they must increase the number of images being taken from different angles. As movement occurs within the body, the depth of the blood vessel is derived relative to the movement recorded from multiple angles. All vessels and other parts of the body emitting a thermal change within a particular body segment can be identified and then measured individually by producing stimuli to cause each to react. Once the lymphatic system’s vessels have been identified, the patent mentions that the ability to measure changes over time can be used to quantitatively measure effects of diseases like lymphedema. Specifically, 3D images of compression garments being worn in different positions and over different kinds of breathing cycles could be measured quantitatively. Beyond quantitatively measuring the amount of swelling over time, the IR imaging can measure the amount of undulations of the lymphatic vessels over time as well as the speed of the fluid inside the vessels. While this patent is not a generic model of the lymphatic system extraneous to a human test subject, it could provide quantitative comparison of different compression sleeves on human tests subjects suffering from lymphedema. If the number of subjects tested wearing a compression sleeve were raised to a high value for this device, the accuracy of information gained from testing the sleeve on human test subjects could prove invaluable.
2. Project Description

2.1 Objective
The physical model of an arm wearing the Solidea compression sleeve will be an approximation of many properties of the arm that are known to affect the lymphatic system. The properties to be optimized within the arm include the volume change that occurs throughout the arm, the volume and force of the muscle in the arm, the lymphatic volume change within the arm, and the density change within the lymphatic fluid.

Volume change that occurs throughout the arm refers to the change in (approximate) circumference from the wrist to the elbow and elbow to shoulder. Because it would be difficult to fabricate an arm with such changes in cross-sectional area, a cylinder would be substituted that must account for these changes. This cylinder must somehow correspond to this change in cross-sectional area from length to length along the arm. A challenge of this factor will be the precision and accuracy over a particular length of the model arm due to the continuous change in cross-sectional area across the arm.

Volume and force of the muscle within the arm must be accounted for as well. Within the length of the arm, there are multiple muscles that can contract and relax. It is believed that the muscle activity is a key factor in the activation of the compression sleeve as a micro-massage device. A model of the muscle must be created that correlates to not only the volume that the muscle takes up within the arm but the pressure it exerts across the lymphatic system while in a relaxed or contracted state. The muscle that is simulated must therefore be capable of changing in volume and pressure at a certain rate that simulates and muscle activity when performing everyday tasks.

The lymphatic volume change within the arm must also be considered. Volume change should correlate to the average amount of lymphatic fluid within the arm when it is in a normal state or has been affected by lymphedema. While the creation of a lymphatic system composed of vessels may not be feasible at this time, a volumetric representation could be used to compare different states of the lymphatic system. Other things to when modeling the lymphatic volume change is where swelling due to the “lymphedema” should be occurring and how drastic should the swelling be. Also, what are the maximal and minimal parameters to set for the swelling of the arm model.
Another factor of the lymphatic system is the density of the fluid as a result of protein concentration in the system. Because protein is filtered through the lymphatic system, concentration of protein adjusts depending on the state of the lymphatic system. For example, in a state of swelling, the affected area has a decreased protein concentration. The density throughout the “lymphatic system” that is created should therefore account for that. A dye must be considered that carries a similar density to the lymphatic fluid to track the general direction that the properties of the arm are carrying it.

The model must also account for a support structure to house these properties. The structure must be able to break down in some way to see the lymphatic system inside the arm after or during testing, as well as not inhibit any of the factors that affect the lymphatic system during testing, aside from supporting them in a way that is similar to the structure of a real arm.

When working with volume changes, possible implementation of a pumping system versus implementation of materials that carry similar physical properties must be considered, which can then be adjusted in size to account for change in the system of the arm.

2.2 Methods
When creating a model for the lymphatic system with compression sleeve acting upon it, all other parts of the body affecting the system must be considered as well. As seen in Figure 3, various forces aside from the compression sleeve drive fluid through the lymphatic system. Note that effects of protein are not taken into account and bone in Figure 3. The model must take into account how these forces interact amongst one another. Additionally, Figure 3 brings into question not only the pressures affecting the lymphatic system but also the structure of the bone that is the core of the entire arm and how that will be emulated within the model.
Figure 3: Forces affecting the lymphatic system

*The Structural Framework of the Design*

The overall goal of the project is to create a model that can have the forces depicted in Figure 3 (in addition to the force of density of the lymphatic fluid) acting upon the subcutaneous vessels of the lymphatic system continuously for a period of time to show how the lymphatic fluid is affected. One of the aspects of the model that must be considered is how to view the lymphatic system before, after, and possibly during the procedure as forces are acting upon the lymphatic system. The lymphatic fluid is inferior to the sleeve and skin but superior to the muscles and bone, therefore a structure must be created that can either see through both the compression sleeve and skin structure, or the framework of the design must have two types of structures. These structures would involve a cylinder that exists within a cylinder, as seen in Figure 4. This double cylinder would allow a portion of the model arm to be taken out for viewing of the movement of flow of the lymphatic chamber after the procedure. A drawback to this approach would be the inability to view the model during the procedure. For this reason, the support system for the arm may be reconsidered.
The support structure in Figure 4 would have the sleeve and skin structure on the outside support structure and the muscle on the inside, external to bone cylindrical rod structure. It has yet to be determined where the lymphatic system will reside. This is due in part to the anatomical location of the lymphatic system in the arm. The superficial vessels of the lymphatic system, will be the modeling in this design, are located in the subcutaneous layer, just beneath the skin, as seen in Figure 5.

In Figure 5, the subcutaneous layer where the superficial lymphatic system resides is an associated part of the skin tissue. While it may be easier to model the lymphatic system on the inner bone cylinder to take out for viewing, it may be more accurate to have the lymphatic chamber on the outer cylindrical structure where it is more closely linked to the skin structure.
More research must be done to better simulate where the lymphatic system should be more closely associated.

Another concern of the structural support system is the ability of the skin and compression sleeve, which should be exterior to the outside support structure, to interact with the lymphatic system. For this reason, the outer support structure may have circular supporting wires or some other kind of cylindrical support system made of a type of metal. This will allow the sleeve and skin structure as well as the muscle structure to act upon the lymphatic system. This structure would be a cylindrical framework of wires rather than a full cylindrical shape that allows access into the inside of the cylindrical framework. With this framework, the model should be able to have an inner cylinder that will allow viewing either the inside of the outer support or onto the outside of the inner support structure.

The Change in Volume of the Arm

Because the volume of the arm changes along the length of the arm, the pressure that is exerted along the arm changes as a result. The cross-section of the model arm will remain constant, a change in pressure must be applied along the length of model arm to signify a change in volume.

When considering what the average cross-section at each length of the arm should be, the Solidea compression sleeve gives reference to what size each part of the arm should be for a medium-sized sleeve. These values are recorded in Table 1. The circumference of the arm supplies information on the overall cross-section of the arm. As the size of the cross-section increases, the volume of the arm for a length, dL, increases, thereby decreasing the pressure. However, the exact pressure that should be applied along the length of the arm will need to be calculated for a specific number of points along the arm. It is uncertain at this time how many changes in pressure should be calculated to simulate the change in volume of the arm.

<table>
<thead>
<tr>
<th>Circumference</th>
<th>Wrist Circumference (Centimeters)</th>
<th>Elbow Circumference (Centimeters)</th>
<th>Bicep Circumference (Centimeters)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>16-19</td>
<td>24-28</td>
<td>30-37</td>
</tr>
</tbody>
</table>

Table 1: Circumference values at different locations along the length of the arm

When considering how to create the volume change however, the compression sleeve’s own graduated pressure change along the sleeve should be taken into account. The Solidea
compression sleeve contains a decreasing graduated pressure going up the arm due to the need to apply less pressure as lymph fluid gets closer to the trunk of the body. If the decrease in pressure of the sleeve is a result change of the elasticity of the sleeve material, equal amounts of pressure by the volume of the arm must be applied to the sleeve in order to get adequate pressure exerted on the lymphatic system. The increase of force applied by the muscle to the sleeve when there is an increase of arm volume as a result of muscle volume must be considered for this situation. Therefore, not just overall volume of the arm must be considered, but volume from materials causing force to be applied to the lymphatic system.

To mirror the aspect of skin, and how the fabric leaves an impression on the skin, sand or some other kind of particulate within an enclosed chamber of unspecified thickness may be used. Further research must be done to examine of the sand or other particulate would be an appropriate choice for our model of the skin structure.

**Modeling the Muscles in the Arm**

To model the muscular system in the arm, a series of inflatable bladders or balloons will be built into the design. The upper and lower arms are composed of many muscles. For simplicity of the model, the biceps, brachialis, and flexor muscles will be grouped together and modeled by a single balloon that will be positioned on the top of the bone structure, while the extensors and triceps muscles will be modeled by a second balloon positioned below the bone as seen in Figure 6.

The balloons will be filled to a certain base pressure to simulate resting tone of the arm muscles. Using a pressure pump, the balloons will then be inflated to an average maximum pressure to simulate the muscle force on the bone and lymphatic system during movement. A challenge in this design is deciding the appropriate pressure levels for a resting and moving arm, since each muscle exerts its own force and has its own movement. Grouping the muscles together into just a two balloon system means the level of inflation of a simulated moving arm and resting arm will have to be determined. Research will have to be conducted to find an average force of each large group of muscles, and the amount of inflation will then have to be adjusted to meet these pressure levels. It is important to have a variable muscle force system to demonstrate the effects of the muscles on the lymphatic system during movement in conjunction with the sleeve being worn.
Figure 6. Figure modeling the inflatable balloon system to represent arm muscles.

Lymphatic Fluid and Volume Change in Arm

To simulate the lymphatic system, an enclosed chamber of gel may be used to replicate fluid within a closed system. While vessels may not be easily incorporated into the model, the bulk volume of fluid could be measured in relation to what may be in a normal human arm at any particular instant versus an arm afflicted with swollen areas due to lymphedema. The amount of fluid within the arm could be easily adjusted by filling the chamber with a specific volume of the gel. However, a particular challenge may be using gel to simulate a swollen area of the arm versus the rest of the arm with evenly distributed gel throughout the model. Furthermore, there needs to be a set parameter between the outer structural framework and the volume of the swelling being produced for the model arm. One thing to take into consideration is how the chamber of gel can be manipulated to more closely resemble vessels. Further research must be done in order to see if there is an alternative method to procuring or creating “superficial lymphatic vessels” for the design.

When determining which gel to use to resemble lymphatic fluid, the density of the liquid should be considered. The density should theoretically be consistent through a normal lymphatic system versus a system afflicted with lymphedema. When creating a situation in which there is lymphedema in the model arm, the lymphatic fluid should mirror a density that is found in patients who suffer from lymphedema. In an article on breast cancer-related lymphedema, it was found that in the area swollen with lymphatic fluid that there was little to no concentration of protein. Whereas other areas without swelling in a patient with lymphedema, it was found that concentrations were either high or normal [7].

The dye that will be used as a means of tracking the movement of the lymphatic fluid should have a density that is the same as the lymphatic fluid’s density within the system.
3. Budget

The budget shown in Table 2 is just a rough estimate of what it will cost for the parts determined to be useful at this time. Since some of the structural work of the model is still being researched, there is uncertainty of which materials would work better for the bone, outer framework, and cylindrical shaping, if any. Until further research is done on which type of gel would best simulate gel lymphatic fluid, it is undetermined in price. The lowest cost for inflatable bladders is designated in the table below, but may have range in price depending on the specificity that is needed.

<table>
<thead>
<tr>
<th>Part</th>
<th>Estimated Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 gauge aluminum wire</td>
<td>10.00</td>
</tr>
<tr>
<td>aluminum metal sheet (6x12”) x2</td>
<td>6.00</td>
</tr>
<tr>
<td>round steel rod</td>
<td>5.00</td>
</tr>
<tr>
<td>metal support stand</td>
<td>10.00</td>
</tr>
<tr>
<td>5 lb bag of fine sand</td>
<td>15.00</td>
</tr>
<tr>
<td>gel</td>
<td>TBD</td>
</tr>
<tr>
<td>dye</td>
<td>5.00</td>
</tr>
<tr>
<td>stretch polyethylene film</td>
<td>15.00</td>
</tr>
<tr>
<td>rubber inflatable bladder with pump x2</td>
<td>20.00</td>
</tr>
<tr>
<td>caulk gun</td>
<td>6.00-15.00</td>
</tr>
<tr>
<td>20ml Dispenser Ink Syringe</td>
<td>7.00</td>
</tr>
<tr>
<td>Solidea Compression Sleeve</td>
<td>Supplied</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$134.00 + unknown gel price</td>
</tr>
</tbody>
</table>

Table 2. Estimated budget for design.
4. Conclusion

The design of a physical model of an arm undergoing effects of a compression sleeve will supply the client, Susan Callison, and others suffering from lymphedema proof for a new technique for combating effects of their condition. Without the compression sleeve, forces including the muscle, the concentration of the protein, the volume of the arm, and pressure from the skin are known to aid in drainage of the lymphatic system. For those who have lymphedema, additional care must be taken to aid in the drainage of lymphatic fluid due to the weakness of the vessels or other abnormalities within the lymphatic system. The Solidea compression sleeve is believed to create a micro-massage effect as a result of the pattern on the fabric, and its interaction with muscle activity of the arm. A design of an arm will be created, “wearing” the Solidea compression sleeve, which has the built in structures that typically help to stimulate or hinder lymphatic fluid flow. These cost-efficient structures will simulate properties of parts and systems within the model arm, specifically, the forces applied onto the lymphatic system. The design will prove the efficiency of the sleeve in draining fluid by tracking movement of dye through the lymphatic chamber of the model arm. Once this design can prove that it is the specialized fabric of the Solidea compression sleeves in combination with the other systems within the arm that are lessening the symptoms of lymphedema, the Solidea compression sleeve may be put on the forefront of lymphedema therapy techniques. Using the Solidea compression sleeve as a new method to lessen swelling and pain will give people with lymphedema the opportunity to wear a sleeve that is more comfortable, easier to put on, and overall, more fashionable than previous sleeves used.

5. References