

To Whom It May Concern:

The purpose of the following report is to describe the entire design process and the end product that is ready for adoption and to be marketed. If you have any questions or need to get in touch with our team, you may use the following information to contact us:

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Please do not hesitate to reach out to our team.

Sincerely,

OptiVols Solutions

Final Design Report for the Fiber Optic Bandage

And

Dr. Matthew Mihelic, MD

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OptiVols Solutions

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Executive Summary

OptiVols Solutions is designing a bandage integrated with fiber optics capable of emitting therapeutic light to better heal skin wounds. The scope of the original optical fiber bandage project proposal focused on the treatment of patients that had gone through a foot skin graft procedure; our fiber optic bandage, however, will not be limited to just treating skin grafts of the foot. It will be able to be used to in many different positions while remaining comfortable and not inhibiting the patient's motion.

The entire device can be broken down into several layers. The first layer is a clear, breathable bandage that will allow light to pass through, penetrate the skin cells, and stimulate tissue regeneration. The second layer is our actual fiber optic device, and the third is a layer of cotton gauze. Together, these layers allow our actual fiber optic device to be reusable which will save money and make our final product more marketable.

Background

The source of our design is from the need for a more effective way to heal skin grafts much faster and more efficient than some of the methods being used today. In order to achieve this, light therapy is used to stimulate skin growth in order for the area of the open wound to be healed faster. The light source will be attached to a bandage with optical fibers woven into it. The optical fibers will connect the light source to the bandage. The product that is being designed has no other product on the market consisting of an optical fiber woven bandage attached to a light source to treat an open wound. The clients affected involve patients in the wound care department that need a more effective way of healing the wound.

Opportunities and benefits associated with the device involve treating the wound with the light therapy. Normally, the skin graft is applied, and bandages, films, or foams will then promote the healing. By adding a light source, it is decided that the wound will be able to heal much faster and allow the graft to take up the blood supply from the wound and allowing blood vessels to grow. From prior literature, it is found that a certain wavelength promotes fibroblasts, which allows a wound to heal. The light therapy has previously been used to heal skin conditions such as acne, eczema, and psoriasis. There have not been any previous patents on the type of the device that is being designed. One article of research focused on the effect of LED phototherapy on fibroblasts with wound healing. The results found that red LED and green LED showed the significant increase in their numbers. The other article talked about ultraviolet radiation in wound care. The results found that UV irradiation causes both beneficial and damaging effects that are dependent upon the production of vitamin D in the skin.

The needs of the project to date continue to involve the wavelength of the light. The literature has stated that different wavelengths all work, but the goal is to find which one will work the best when the bandage is brought into the picture and making sure that the wavelength will not cause any damage. For example, if UV light is used, it must be assessed where the light

will not cause skin damage The edge emitting fiber optics will allow the light to go through the bandage in order to heal the wound.

Problem Definition

The problem that is trying to be solved is related to the skin graft and wound care procedure that occurs in wound therapy to date. The typical procedures have been found very ineffective in healing the wound in a timely manner. For the more serious wound issues involving skin grafts, the wound takes a very long time to heal and it has to be watched very close to prevent infection. In order for the project to be successful, it must prove that light therapy will work more effectively than ordinary procedures that are used on a day-to-day basis.

The goal of the project is to effectively heal a wound anywhere on the body with the light therapy. The original focus was on skin grafts, but the focus has broadened for any other types of wounds. There is a large focus on diabetic patients as well who come for therapy involving wound care. The project must be biocompatible where it can sell on a wide scale basis. The project must also be researched where it will be cost effective. It needs to work effectively while also making sure it is worth the price of the wound treatment. The primary clients will be the doctors performing the wound care. If it is proven that the product will work, they will be the ones who will determine whether the product is worth their time

The system that is designed will be designed to heal a skin graft anywhere in the body using light therapy. A certain wavelength of light source will be set so that the wound can heal the quickest, but also the wavelength of that light may not cause harm to the body. The optical fibers will connect the light source to the bandage where they will be placed on top of the bandage where it will be woven into a 3-D printed frame. The type of bandage chosen is Adaptic. It is non-adhering while also being very porous. Performance requirements of the system should be able to heal a partial skin graft within two to four weeks of the procedure being performed depending on the circumstances of each graft. It is understood that each person will have a different healing time but the focus is that the system is effective in healing the wound. The interfaces involve making sure that the system will be able to heal a serious wound. The assembling of the product will be the part that will be the most direct since it is very direct. The different conditions of the wound will be the part that needs to be considered. If a wound is more serious will it need a higher wavelength? These are the questions that will have to be thought of as the product is tested. Data requirements are fulfilled with cell cultures if time and money permit. Otherwise, the wound care visit and prior literature knowledge will fulfill data requirements. The non-functional requirements are the importance that the device is FDA approved. When our device is finished, it will need to be approved so that it can be used in the medical field. It needs to be reliable where it will not cause any harm to the patient with a certain wavelength. The device will be very easy to operate and very quick to set up. Enabling Requirements and the development of the device will be the responsibility of team OptiVols. The stakeholder, Dr. Matthew Mihelic, will assist along the way as well as professor Dr. Jeff

Reinbolt. The testing will occur after all parts are ordered by the end of January. As soon as the parts are delivered, testing will take place at the University of Tennessee Mechanical, Aerospace, and Biomedical Department. The constraints involved are figuring out which wavelength of light will work best. There is not enough time during the testing process to test different wavelengths. There must be a sufficient amount of prior research done with light therapy so a decision can be made. It will also be hard to test the product, because the team will not be able to use it to test a real-life situation on a human skin graft. Calculations must be done to prove the product will work effectively.

Concept Description

For the concepts considered there were two different ideas that the ideas spawned from. The first is from light sources, particularly fiber optics, and the second from the bandages that are used in wound healing. The ideas were found through observing wound healing center at University of Tennessee.

The basic idea has to do with using fiber optics as a light source for phototherapy. Phototherapy is the use of light to treat different types of diseases or ailments. Phototherapy is primarily used in treatment of skin diseases like psoriasis and eczema. The patient basically receives a set amount of light, which helps stimulate cell growth and fibroblast production, essential for the healing process. UV light has shown in recent studies to be a germicidal aide, and is used by many hospitals to help clean rooms and sterilize equipment. Other types of light: red, infrared, and green light, have been seen to help promote cell growth and fibroblast production in wound healing. Hopefully combining or having multiple different types of light could produce a favorable reaction when exposed to wound for wound care.

Fiber optic cables are the best way to have the light reach the wound. Most commercial fiber optic cables are end-to-end emitting, meaning that light is put in the end of the cable, and no other light is seen until the other end of the cable. The other type of cable is called edge emitting. Inside of the cable there is an inner cladding that causes the light to be reflected inside of the fiber optic, making the light only appear from each end. When the cladding is removed or changed, light from the cable can be emitted from the cable as if the entire cable where a large light bulb. Both types of cables will be considered for the project, but it seems as if the best way for the most light to reach the wound would be through the edge emitting, since more light can be given to the wound with less strands. The cables can be layered or put into a tennis racquet formation, with the different lights interwoven with each other, allowing multiple types of light to reach the wound and allow their healing properties to take place.

The second idea, the bandages, came from wound care of diabetics. Diabetics have a higher tendency to cause ulcers on their lower body due to stress on their feet and legs. The ulcers and sores that occur can take up to a year to heal, even if they are just a couple centimeters across. The original idea consisted of light interwoven into a cloth bandage that was wrapped

around the room. While seemingly a good idea, there are issues occurring with putting the fiber optic cables directly on the wound. Also, the fiber optics would be partially obscured by the bandage while it's on the wound. Therefore, a new way of placing the light source will be needed from this idea.

The third idea that arose from the light source was implementing the same type of light source in the casing of a cast or an offloading pressure boot that diabetics wear when they have a sore or ulcer on their foot. While a better option than placing the light source in the bandage, since the fiber optic cables would not be in direct contact in the wound, it also makes it difficult for the light to penetrate deep enough into the wound. Also, if the bandage covered the wound, the wound would be completely obscured from the light that would have been only partially obscured if the fiber optics were in the bandage. Therefore we get back to square one with how the lights need to be placed for the wound. While the fiber optics should not interfere with the wound, the light source needs to be close enough to the wound to have any effect on the healing process.

Dr. Mihelic during the first design review meeting also suggested looking into wet layer wound care. Patients who have recurring wounds tend to use a direct contact wound bandage that goes beneath the gauze layer that allows the wound to breath and ooze. The ones he suggested taking a look at was called Adaptic. Adaptic has holes in the layers that allow the wound to breath during healing, also very important in wound care. Gauze can be easily placed and removed off the top of the wet bandage layer, allowing easy care for the wound while still providing the right amount of air to reach the wound, and the wound to ooze away the gunk and nastiness. The wet bandages stay on the wound until the wound is mostly healed, because it allows the nasty gunk to pass through the holes and into a gauze layer that is easily changed once it is dirty enough. From researching the Adaptic, the next concepts considered was to create basically a new type of wet bandage that was made from fiber optics which allowed the wound to breathe, but also was able to be hooked up to a light source so that phototherapy can occur. While in theory the idea behind this is solid, the same issues arise from having the fiber optics implanted into the bandage. Direct contact with the wound brings up a host of issues regarding breakdown of fiber optics from the body fluids that ooze from the wound, and a host of FDA issues regarding patient health and safety.

So, due to the factors that come with inexperience with wound care, Dr. Mihelic contacted Dr. Stockton in the wound care center and set up a time to visit the wound care center. Many factors from the wound care center played into the concepts that were considered for the project. While at the wound care center, it was observed that the wounds there have occurred for over many months, some up to a year. The process for protecting a wound goes as follows.

First, the wound is cleaned and scraped. The doctor takes a scalpel and scraper and uses them to clear away all the gunk and bad tissue on the wound. Dr. Stockton claims he wanted the wounds to be slightly bloody and scraped up because it helps promote healing. The scalpel is

used to cut away any bad or infected tissue that may have built up over the time the patient was not in the wound care center. The wound after this stage is red and slightly bloody.

Second, the wound has some sort of graft or substituting graph placed onto the wound to also help facilitate tissue growth. No actual skin graphs were observed in the visit, but it is a valid procedure when treating wounds. The wounds were usually covered with a type of substituted skin graft called Epifix. Epifix is made from the placenta of a baby's wound that had been repurposed for a substituting skin graft. The Epifix is basically another layer that is used to help facilitate skin growth by providing growing nutrients and cells to the area. The epifix is around 1,000 dollars for a 5cm by 5cm square, making the graft fairly expensive. However, the epifix is much cheaper than other alternatives like actual skin grafting or Apligraf, which can be upwards of 3,000 dollars for the same size of graft.

Finally, the wound is covered with a type of wet bandage to allow the wound to breathe and be easily cleanable. The primary wet bandage used by Dr. Stockton was called Mepitel One, but serves the same purpose as the adaptic does when used for wound healing. The Mepitel creates a breathable layer over the wound, but also helps protect the wound from being irritated or having direct contact with a gauze layer that has a tendency to stick to a wound, and can remove growing skin when cleaned or replaced. The wet bandage provides a good base and protection to the wound, and allows the wound to be easily accessible and cleaned, because the Mepitel itself is clear to allow the doctor or nurse to see how the wound beneath it looks.

The concepts learned from the trip were very beneficial to the overall project idea. The last concept considered had to do with replacing the wet bandage layer with a fiber optic layer made by senior design group; however, direct contact with the wound is somewhat troublesome. Therefore, it is determined from the group that a new layer of fiber optics would be introduced into the system, instead of trying to replace a layer. Leaving the wet bandage layer means that direct contact with the wound is not possible, and due to the fact that the wet bandages are clear allows light to pass through to the wound, allowing phototherapy to occur. The fiber optic layer will be placed on top of the wet bandage layer, but must also be porous to allow the fluids that ooze from the wound to make it through that layer and into the gauze that can be easily cleaned and removed.

So in conclusion, the bandage must be flexible enough to be used in multiple situations where the light sources can affect the wound, but not directly interact with the wound. This can be done through clever placement of the fiber optics in the bandage system, and using the correct fiber optic cables and sources to allow for good penetration of the different types of light needed to stimulate the wound healing process. The actual selection of the particular parameters will be seen below.

Concept Selection

After much consideration, several concepts were determined to have more potential than others. For one, using multiple wavelengths of light instead of just one would allow us to incorporate multiple beneficial effects while also increasing the fibroblast production. UV light is commonly used to kill bacteria in clinical settings, so incorporating this into our light could potentially clean the wound through phototherapy. UV-B light also promotes fibroblast production, so it would be an interesting consideration. One thing to consider when using UV light is the negative effect it could have on the patient. UV light is known to be mutagenic, and could damage the tissue and cells of the patient if too much dosage is given. This could be particularly problematic for our purposes, as the area of interest on the patient will likely have less skin, allowing the UV light to affect the tissue more directly.

One concept that was discarded was weaving the optical fibers into the bandage itself. This would prove to be difficult, as the light would struggle to permeate all of the different layers involved in wound care. A potential solution for this was to weave the optical fibers into the non-stick mesh that made up the first layer of bandaging. This would bring the optical fibers close to the wound and nothing would stand between the light and the wound. This also proved to be problematic for two main reasons. The first reason is that weaving fibers into the mesh could compromise the actual function of the mesh, which is to isolate the wound and allow it to 'breathe'. The other reason had to do with biocompatibility. It seemed less than ideal to have optical fibers directly touching an open wound, as they are not sterilized as effectively as the bandage material. It was decided that the best solution to these issues would be to make the optical fiber bandage its own layer in the bandage process. This allows the lights to be close to the wound, without the threat of mechanically interfering with the healing process or potentially contaminating it.

A third major concept that needed consideration for our design was the logistics of the optical fibers. Using side-emitting optical fibers in a mesh pattern seems to be the best solution. The mesh pattern is essential to allow the wound to secrete fluids through it. This allows the cotton pad to soak up fluids and keep the area clean. If a mesh pattern were used, side-emitting optical fibers would be a necessity. Normal optical fibers are end emitting; meaning light inside reflects to such a degree that it travels through the length of the fiber without escaping through the sides at all. Side-emitting optical fibers are designed to not only allow light to travel through the cord, but it is emitted through the sides as well, illuminating everything around the wire. This design would allow us to give an even distribution of light across the entire area of interest, without interfering in wound healing.

Concepts	Design Criteria Met
Multiple Wavelengths/ UV light	Promote fibroblast development
	Clean wound
Optical Fibers on separate layer	Close proximity to wound
	No direct contact with wound
Side-emitting fiber mesh	Even, thorough distribution of light
	Does not inhibit fluid secretion

Product Description

The design consists of 3 main parts. The Gozinto chart below displays how the prototype is designed and the parts it consists of.

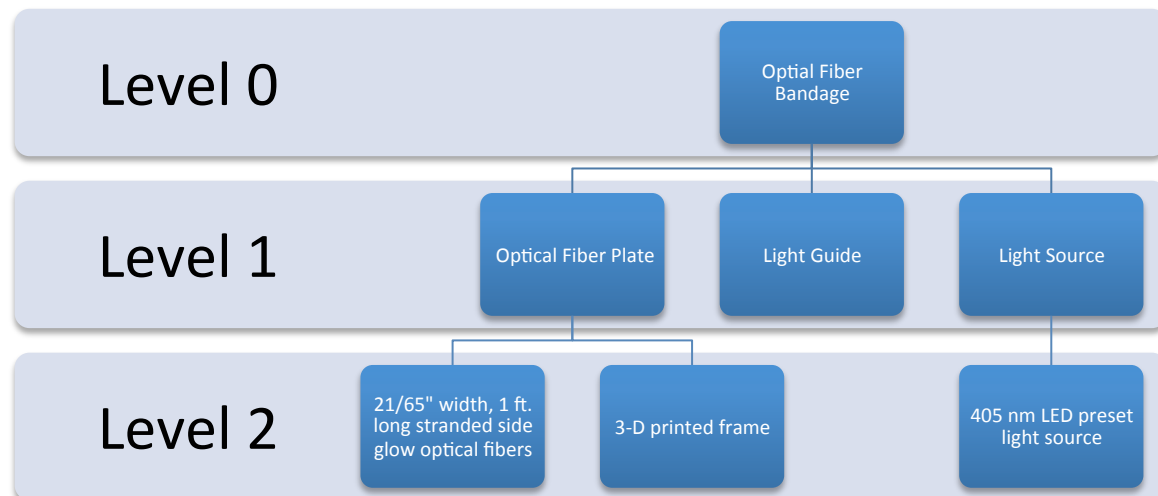


Figure 1: Gonzito chart

The bandage consists of three main parts, the fiber optic threaded frame, the liquid light guide, and the light source. The frame consists of 21/65" of fiber optic bundle and the 3-D printed frame. The frame material is biocompatible and FDA approved. The light from the source goes through the liquid light guide and into the fiber optics in the frame. The liquid light guide allows

for minimal loss from the source into the frame. The light source as 405 nm allows for initiation of wound healing based on prior research. The wavelength was found to be 405 ± 25 nm at the end of the source.

The ideal bandage, if used in wound therapy departments, would have a frame and fibers that would need to be reordered based on each patient. The ideal situation would allow for the light source and the light guide to each be reused with each patient to make the process much cheaper than current methods.

The product assembly is very easily accessible. The only thing that would take time would be the threading of the fibers into the frame. That would take about 10 minutes to thread after the process is learned. It will then be attached to the end of the light guide and the product will be complete. The figure below displays the 3-D printed frame. The holes on the sides will have the side emitting cables attached to it.

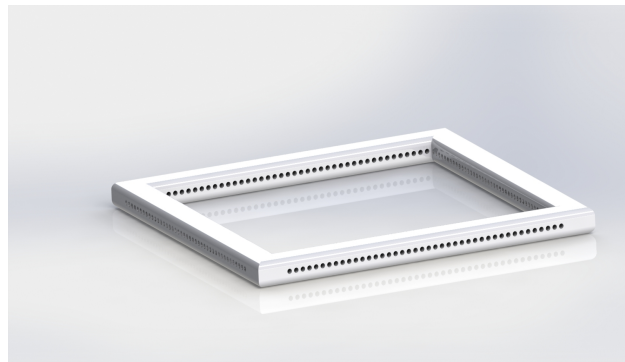


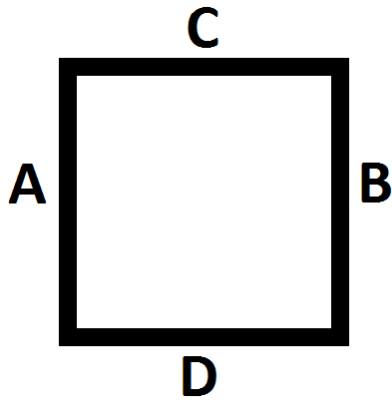
Figure 2: 3-D printed frame

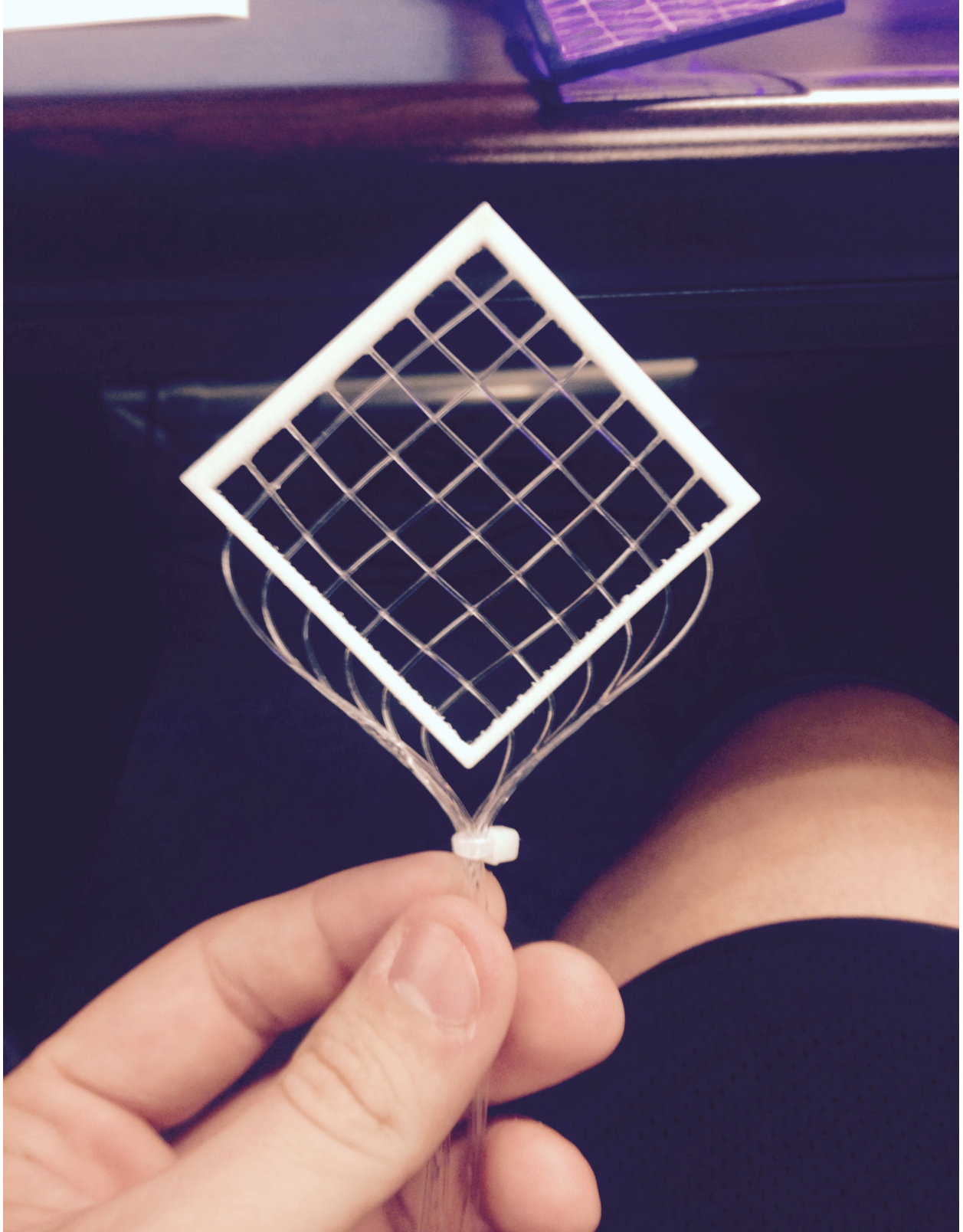
Stakeholder expectations were met and the product was approved. Dr. Matthew Mihelic thought the newer frame was much better than the original and thought the device could be successful if manufactured.

The manufacturing process is demonstrated below:

- Step 1 – Specify desired frame dimensions.
- Step 2 – 3-D Print necessary materials.
 - Print frame to specified dimensions.
 - Print optical fiber clip.
- Step 3 – Thread optical fibers through frame.
 - Thread first set of fibers through side A.
 - Stretch across frame.
 - Attach to side B.
 - Thread second set of fibers through side C.
 - Weave through A-B fibers.

- Attach to side D.
- Step 4 – Fix free ends of both sets of optical fibers to optical fiber clip.
- Step 5 – Connect optical fiber clip to the optical fiber cable.
- Step 6 – Connect the optical fiber cable to the light source.





Picture of the final device iteration

Design Evaluation

In order to determine the quality of our light source, several criteria needed to be tested. First, we needed to confirm the wavelength of light output by the source. We set two standards for the wavelengths; one based off of the wavelength advertised from the manufacturer, and one based off of the range of wavelengths effective for killing bacteria. The manufacturer advertised the wavelength of the LED to be 405 nm. In order to test the light source accuracy, the requirement set was at 405 +/- 20 nm. Meeting this qualification would ensure that the light source was outputting a relatively accurate wavelength. The other requirement we were testing was that the wavelength fell within a range of 405 - 470 nm; which, according to research was effective at killing both *Staphylococcus aureus* (MRSA) and *Pseudomonas aeruginosa*. In order to test the wavelength, we used a spectrometer under the supervision of Dr. Zhang. It was only necessary to have a sample size of 1, as we were only testing the accuracy of the device and it is a continuous light source. The results were present immediately, and can be seen in the appendix. The wavelength ranges from about 390 nm to 420 nm, with a peak intensity at 405 nm. This confirms both the accuracy test, as the vast majority of wavelengths fell within 20 nm of 405 nm, and also passed the efficacy test, as it fell within the optimal range. In summary, the wavelength testing was completely successful.

The other criteria we needed to test was the output power of the device. Power is necessary to determine the dose required to kill the bacteria. If the power is insufficient, it doesn't matter what wavelength of light is used. According to research, *Staphylococcus aureus* was killed with a dose of 1 J/cm², but *Pseudomonas aeruginosa* was killed at 10 J/cm². We estimate that a power of at least 50 mW will be able to produce these doses within a reasonable time. We were able to determine the power emitted by the device by using a thermal sensor. We performed several trials, and measured the power output at different intensities. It was necessary to measure the power output of the liquid light guide rather than the light source. This will account for the power loss in the adapter between the two, as well as any loss in the light guide itself. With our limited resources, we were unable to measure the power of the light dispersed through the device, as it was too unfocused. This means that in order to get 50 mW dispersed through the device, the adapter connecting it to the liquid light guide would need to have minimal loss. We determined that the power output at low intensities came out to be about 50 mW, and at high power it came out to be about 100mW output. These results allowed us to declare the power test a success.

With a 100 mW output, we would be able to produce the effective dosage within a reasonable amount of time. The following calculations determine the amount of time necessary to meet the

$$\begin{aligned} 1 \text{ J/cm}^2 &= \frac{50 \text{ mW}}{25 \text{ cm}^2} \times \text{time} \\ \text{time} &= 500 \text{ sec} = 8.3 \text{ min} \end{aligned}$$

$$\begin{aligned} 1 \text{ J/cm}^2 &= \frac{100 \text{ mW}}{25 \text{ cm}^2} \times \text{time} \\ \text{time} &= 250 \text{ sec} = 4.17 \text{ min} \end{aligned}$$

doses stated in the articles.

The equation on the left represents the minimum dosage to kill MRSA, with the device set to low power. As you can see, it would take just over 8 minutes to deliver the appropriate dose. At high

$$\begin{aligned} 10 \text{ J/cm}^2 &= \frac{50 \text{ mW}}{25 \text{ cm}^2} \times \text{time} \\ \text{time} &= 5000 \text{ sec} = 83.3 \text{ min} \end{aligned}$$

$$\begin{aligned} 10 \text{ J/cm}^2 &= \frac{100 \text{ mW}}{25 \text{ cm}^2} \times \text{time} \\ \text{time} &= 2500 \text{ sec} = 41.7 \text{ min} \end{aligned}$$

power, it would take over 4 minutes, as seen on the right equation.

The equations above represent the minimum dose to kill both MRSA and *Pseudomonas aeruginosa*. As the dose is 10 times as much as the dose from the first equation, it takes 10 times as long. But 41.7 minutes is a reasonable amount of time to receive a full dose and clean the wound properly.

The biggest issue with the device is the adapter that connects it to the liquid light guide. A significant amount of light is lost through this piece, so the actual device is not outputting the full power that the light guide is. This means that further testing needs to be done in order to determine the actual time needed for dosing, or a new, less “leaky” adapter is needed. The light source and liquid light guide work effectively, and will be reused for every time the device is used. The part of the system that is replaceable is the fiber optic bundle and the frame attached to it. This is relatively cheap to replace, it should cost about \$10 to replace it in the way the prototype was made - with a 3D printer and with a small order of fiber optic cables. On a larger scale, manufacturing would reduce this cost significantly. If a mold were used rather than a 3D printer, it would be a fraction of the cost. And if the fiber optic cables were ordered in bulk, the price would be significantly less.

Recommendations and Future Work

Work on this project has proven the concept could work very well in the future. A working prototype has been established, and the validity of the design has been confirmed in the design parameters set up by the team. The recommendations for future designs are developing a better connector between the apparatus and the actual bandage. There was significant light loss

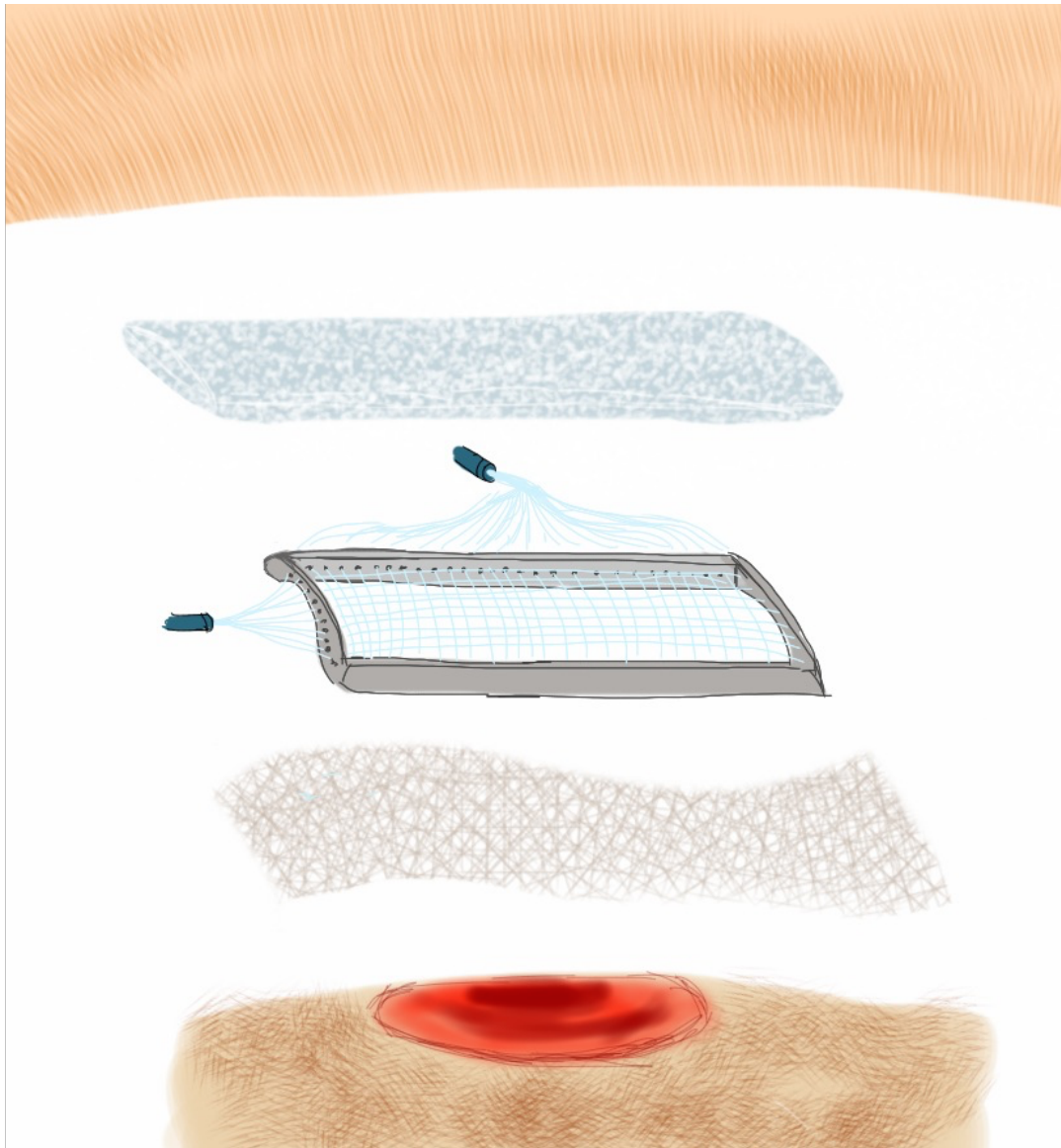
before the light reached the bandage, and could easily be cut down with a better adapter. Another recommendation is getting a clinical trial to show the results of how useful light is for healing open wounds. Some papers have shown this, but if a person did not have to get a skin graft every time a new wound opened, the price of \$10 for a single printed bandage or \$2,000 for a new graft is very significant. Not only would it easily pay for itself if it had the same healing qualities, but it would also allow patients to come in and be checked on for light therapy fairly often.

Future work for the device would be getting a clinical trial. Getting FDA approval through a clinical trial would be necessary for the product to be marketed in the system. Clinical trial is the next vital step for proving that the light is beneficial and can be used effectively with this device. The purpose of the design was proved, but experimental results would need to corroborate that the device was outputting a large enough dosage of light to be effective.

Appendices

Bumah, V. V., Masson-Meyers, D. S., Cashin, S. E., & Enwemeka, C. S. (2013). Wavelength and bacterial density influence the bactericidal effect of blue light on methicillin-resistant *Staphylococcus aureus* (MRSA). *Photomed Laser Surg*, 31(11), 547-553. doi: 10.1089/pho.2012.3461

Guffey, J. S., & Wilborn, J. (2006). In vitro bactericidal effects of 405-nm and 470-nm blue light. *Photomed Laser Surg*, 24(6), 684-688. doi: 10.1089/pho.2006.24.684



Concept Design

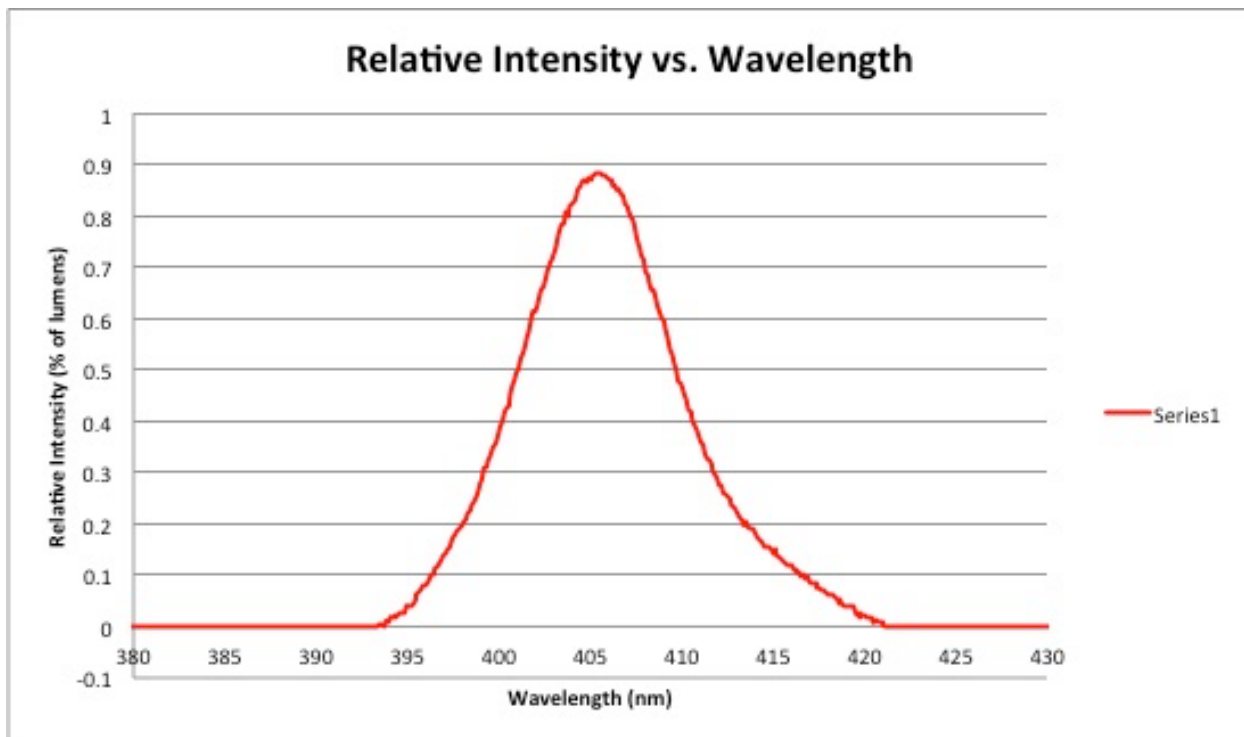
Appendix - Test Procedure

OptiVol Solutions - Deliverable 20			
Test Number:		W001	
Test Identifier:		Wavelength Check	
Specification Method:	Measure wavelength of light emitted by device.		
Acceptance Criteria:	Wavelength must fall within appropriate range.		
Device Requirement:	405 - 470 nm	LS Requirement:	405 +/- 20 nm
Sample Size:	1	Test Duration:	Immediate results
Planned Start Date:	04/24/15	Planned End Date	04/24/15
Planned Test Phase:	Qualification Phase		
Planned Test Location:	Dougherty Building, University of Tennessee Knoxville, TN 37996		
Assigned To:	Cameron Pilkey		
Requirement Sources:	http://www.ncbi.nlm.nih.gov/pubmed/23621894 http://www.ncbi.nlm.nih.gov/pubmed/17199466		
Notes:			

OptiVol Solutions - Deliverable 20			
Test Number:		P001	
Test Identifier:		Power Check	
Specification Method:	Measure the wattage of the light through the light guide.		
Acceptance Criteria:	Wattage must be sufficient to provide minimum dosage.		
Device Requirement:	N/A	LS Requirement:	Minimum 50 mW
Sample Size:	3	Test Duration:	Immediate results
Planned Start Date:	05/05/2015	Planned End Date	05/05/2015
Planned Test Phase:	Qualification Phase		
Planned Test Location:	Dougherty Building, University of Tennessee Knoxville, TN 37996		
Assigned To:	Cameron Pilkey		
Requirement Sources:	http://www.ncbi.nlm.nih.gov/pubmed/17199466		
Notes:			

Appendix - Test Results

OptiVol Solutions - Deliverable 24			
Report Number:		W001	
Report Identifier:		Wavelength Check	
Status:		Active	
Results:	Range of wavelengths from 390-420 nm.	Device Results: P/F	Pass
		LS Results: P/F	Pass
	Peak at 405 nm.	Actual Sample Size:	1 (Continuous)
Actual Start Date:	05/05/15	Actual End Date	05/05/15
Completed By:	Cameron Pilkey		
Notes:	See Graph.		



OptiVol Solutions - Deliverable 24			
Report Number:		P001	
Report Identifier:		Power Check	
Status:		Active	
Results:	~50 mW at low power.	Device Results: P/F	N/A
	~100 mW at high power.	LS Results: P/F	Pass
		Actual Sample Size:	3
Actual Start Date:	05/05/15	Actual End Date	05/05/15
Completed By:	Cameron Pilkey		
Notes:	This is a measure of power output through the light guide. In order to maximize power output through the device, the loss due to the device/light guide adapter must be minimized.		