Phototherapy Light

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Objective:

Jaundice is present in most newborns and is usually benign (Moerschel, Cianciaruso & Tracy, 2008). It affects 60% of the full-term infants and 80% of premature infants in the first three days of birth (Henny-Harry & Trotman, 2012). It is also said that among the factors that increase the likelihood in contracting jaundice are low income, hospital setting, and genetics. In addition, persons of African, Mediterranean, Middle Eastern, or Southeast Asian descent are more likely to contract jaundice (Gurley, Halder, Streatfield, Sazzad, Huda, Hossain & Luby, 2012).

With this in mind, we may infer that Filipinos belonging to lower-income households would be more susceptible to this disease, and so are communities with little access to medical services.

A secondhand phototherapy light unit costs roughly 100,000 php which makes it highly financially inaccessible to public hospitals and community health centers belonging to the low-income bracket. While these health-care facilities may be able to afford these phototherapy light units, chances are, the number of units will not be able to keep up with the number of patients in need of treatment. Thus, multiple patients may have to share with a single phototherapy light unit and be exposed to the phototherapy light in a shorter-than-optimal period of time; thus getting subquality treatment which may result to the recurrence of the disease or, worse, its persistence.

We have to note that among the effects of high levels of bilirubin (the main indicator of jaundice) caused by rapid RBC metabolism is the increased levels of carbon monoxide in the body, which sometimes causes neurologic dysfunction (Moerschel, Cianciaruso & Tracy, 2008). Jaundice may also be linked to Hepatitis E Virus (HEV), since bilirubin relies on the liver to be eliminated from the blood stream and HEV causes a dysfunction of the liver. In turn, an overly rapid increase of bilirubin in the blood stream may also make things difficult for the liver to process, making the liver more vulnerable to HEV (Gurley, et al., 2012). Therefore, we have to note that the recurrence of jaundice or its persistence can have astounding and long-standing effects on the health and overall welfare of the child.

The objective of this project is to make phototherapy light more accessible to low-income households, rural health units, and urban public health-care centers because phototherapy light units are extremely expensive. Since alternatives like exposing the baby to directly to the sun is present, most hospitals and healthcare centers opt to not avail of...
phototherapy light units. However, we also have to consider that this alternative also exposes the baby to other light spectra and kinds of light, such as the UV rays, and this may be harmful to the child later on. Likewise, the child will not receive the optimal amount of blue light through this method because it is extremely time-bound. Sunlight is not available during the evenings and is harmful to the skin for most of the day, especially from late morning to mid afternoon, meaning that the child may only be exposed to the sun in the mornings, and only for a limited amount of time. This may also pose difficulties in instances when the sun is not present, such as on rainy days and in the presence of typhoons and the intermittence of the treatment may cause the persistence of the disease.

Current technologies and their limitations:

The largest limitation of the existing technologies in phototherapy light remains to be its inaccessibility due to its price. As was previously mentioned, a secondhand unit costs approximately 100,000 php. From this, we can deduce that brand new units would cost at least a few hundred thousand pesos—something way beyond what local and public hospitals can afford to shell out.

Nonetheless, some organizations team up with public hospitals and donate phototherapy light units. One of these organizations is the Firefly Project, which donates infant phototherapy light units to hospitals. However, the price of the phototherapy light still remains an issue, because as we may see in published articles online, the phototherapy light the Firefly Project provides is limited and several babies have to share a single unit.

Most phototherapy lights are composed by Light-Emitting Diodes (LEDs) and these deteriorate over time. How long before they deteriorate is something yet undetermined and how this deterioration affects the potency of the product is something also yet to be discovered by the team. However, the team has devised a way to maintain and keep things in check through the photosensor and the spectrometer. The photosensor determines whether the LED is 100% functional and the spectrometer checks whether the wavelength of the LEDs remain constant and is appropriate for curing jaundice.

Phototherapy light units are also mainly run by electricity, making it dependent on the stability of electrical lines. The problem with this is that electricity may be cut in times like typhoons, tropical depressions, and heavy rains. Having a back-up source of electricity, such as a solar panel or batteries may resolve this issue.

Another limitation of the present technology and the project is its aesthetic appeal. In this aspect, the team intends to invite people from the fine arts to help in the conceptualization of more aesthetically pleasing devices.
Description of Work

The first thing the team accomplished was to do a preliminary research on jaundice and phototherapy light. For this, they looked up articles on online journals and proceeded from there.

With values from related literature available, the team then proceeded to experimentation. Four types of light were subjected to experiments: LED Christmas Lights, Blue Compact Fluorescent Lights (CFL), Motor Cycle Tail Lights, and LED strips. The experiment included measuring the wavelength and irradiance of the particular lights, which was then compared to the figures stated in the literature. This was made possible through the do-it-yourself spectrometer which involved a web camera (later on, a cellphone camera) with a DVD strip coating to allow the prism to pass through. It was enclosed in cardboard and the resulting image was plugged into an open-source spectrometer online. The results of this spectrometer were compared to a commercial spectrometer from the Physics Department and the team discovered that the figures conjured by the two spectrometers were roughly the same; only that the open-source spectrometer lags by 2 nanometers (nm). This lag, however, may be resolved by software magnification through Windows Excel.

The results showed that the LED Christmas Lights provide the specific figures that may be found in the literature whereas the LED strips and the motor cycle tail light lag a little farther behind, but not significantly. The Blue CFL is completely rejected because it emits light from the green spectrum. While the LED Christmas Lights provide the exact figures, the problem it poses are the following: its bulky bulbs are difficult to manage for lay-out purposes, it has pulsing settings that come with the product and completely irrelevant to the product, costing 250 – 500 php, it also is significantly more expensive than LED strips which cost only 60 php, and it cannot be downscaled easily due to its electronic configuration (LED strips may be cut to groups of three, whereas Christmas lights require more processes to reconfigure). The choices were then between the motorcycle tail light and the LED strips but the LED strips were chosen for their flexibility and convenience in layouting.

With this, the prototypes were built. Below are images.
After making the device, they underwent stress test to see if it can last for a long period of time without heating up or malfunctioning. The team found that, after 24 hours of continuous use, the LED temperature didn't go high.

After the tests, prototyping, and other experimentations, the team contacted the baranggay captain of Barangka to discuss the possibility of deployment and prototyping of the device and testing.

Technical results of the tests are available upon request.

**Problems still need to be solved, lessons learned, insights made:**

Among the problems that still need to be resolved would be to find a way to be able to log the activities of the device and the treatment period of the babies. For this, we will have to have partnerships with physicians and health care units. We will also need to have constant contact with the clinics for updates about the device. The team also needs to add other parts, such as adding sensors or spectrometers to check the intensity of the setup. Another problem is to create a frame to set the device to the optimum intensity with the least moving parts and requiring the least amount of maintenance. Presently, the device relies on direct plug-in, so the team will have to add other parts such as timers and switches to the device. Lastly, with the goal of making phototherapy light with low cost, phototherapy light units have to be produced the lowest cost, greater efficiency, and aesthetic appeal.

One thing to realize about this project is that it can branch out to other projects. For example, the DIY spectrometer has been used by other members of the faculty, such as Dr.
Greg Tangonan for their algae project and Mr. Carlos Oppus of the ECCE Department also saw the value of a low-cost spectrometer and proceeded on taking one of the prototypes.

With this, we may conclude that things may be produced more cheaply, and products such as these may be produced locally. This research has a lot of potential, definitely, and the problems involve more of the social aspect, more than anything else. The Philippines gives little importance to diseases such as jaundice. Likewise, development for research and innovation isn't a field given much importance. However, this does not mean that we will allow this to hamper our spirits and stop.

References


