SUSTAINABLE DESIGN OF MOBILE TRANSILLUMINATOR VEIN FINDER DEVICE

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Abstract- around Up to 80% of all patients admitted to hospitals worldwide will have a peripheral intravenous line inserted in the forearm or hand to administer fluids, medications, and blood products. Because PIVC is a common procedure, it is easy to forget the potential for serious complications and safety risks to the patient, as well as to the medical staff. Vein finder devices drastically reduce the amount of time it takes to find a vein. They eliminate wasting needles, syringes, PICC and midline trays on stick after stick. They are non-invasive because all they do is make use of light so you can see veins in subcutaneous tissue. In this article we try to show our work in sustainable design of this type of devices. Our desire is to have Echo-design with low price for Georgian medical market. We use Minimal and simplicity design theory in our structural model to strip down our design to fundamental elements as possible as we can, to reduce material and manufacturing cost of our device.

Keywords: Product Design- Sustainable Design-Transilluminator Vein Finder -Ecodesignn-Minimal Design

1. Introduction

Around Up to 80% of all patients admitted to hospitals worldwide will have a peripheral intravenous line inserted in the forearm or hand to administer fluids, medications, and blood products. Sometime this procedure can be difficult for paramedics or others in such cases like infants and elderly people [1]. Vein finder devices drastically reduce the amount of time it takes to find a vein. They eliminate wasting needles, syringes, PICC and midline trays on stick after stick. They are non-invasive because all they do is make use of light so you can see veins in subcutaneous tissue [2]. The important thing is that because this type of devices are not mandatory in PIVC procedure our device must be have economic price. If the price will be too much maybe medical parts do not want to buy it. So price has an important issue for presenting this devices to medical part especially in developing countries medical market.

Theory of Transilluminator Vein Finder device:

Fact 1: As you can see in Figure 1-left Here we have Absorption spectra of the oxygenated and deoxygenated hemoglobin molecules. So in region between 600 nm to 800 nm deoxygenated hemoglobin (Hb) absorbs more light compare to oxygenated one (HbO_2).

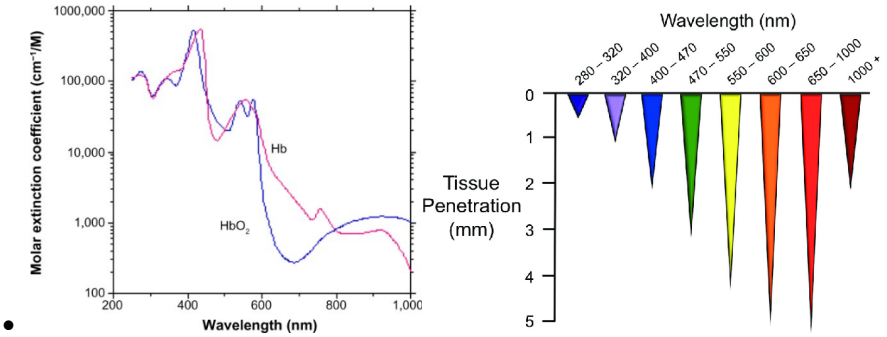

Figure 1. Left: Absorption spectra of the oxygenated and deoxygenated hemoglobin molecules, Right: Penetration depth of light of different wavelengths in skin tissue.

Fact 2: In Figure 1-right. You can see penetration depth of light of different wavelengths in skin tissue. So infrared red light has penetration about 4-5 mm in skin.

Result: Infrared red light is a good candidate for visualization of superficial veins for PIVC procedure.

2. Methodology

Engineers follow a process to make new products.[3] The engineering design process is a series of steps that engineers follow to come up with a solution to a problem.

The steps of the engineering design process are to: [3]

- Define the Problem
- Do Background Research
- Specify Requirements
- Brainstorm Solutions
- Choose the Best Solution
- Do Development Work
- Build a Prototype
- Test and Redesign

Also we use Minimal and simplicity design theory in our structural model to strip down our design to fundamental elements as possible as we can, to reduce material and manufacturing cost of our device.
Minimal design [4]:

- Strip down our design to fundamental elements.
- Simple functionality and user interaction.

3. Results & Conclusions

Now we present our design model. It is necessary to mention that this is primary design and it will be developed and improved in future work. As we mentioned in minimal design we try to strip down our design to fundamental elements. So here we strip down our device element into 2 main parts;
1- Arms: LED Transilluminator, Illustrate Red LED light to locate Veins as a shadow line between two arms.
2- Body structure: this part has 2 main function; first it contain electrical charging part and second it help users to handling device in comfortable and proper manner.
Now here in Figure 2-left. We can see our first structural model of our device. In the figure 2-midle first physical model for experiments and in figure 2-right we can see shadow of veins in picture when we use devices on arm in dim light room.

Figure 2. Left: Structural model of device, Middle: First physical model, Right: First experiment of device on case

We use 2 coin battery (Sonny 3 volts lithium cell- CR2032) and 2 red LED (LED 614 LD08-R HU-B 8000.MCD 30`) with 8000 MCD for illumination.

Conclusion

We use minimal design to reduce materials (in production and also when we use disposal plastic cover for operating our device in patient cases) to have an ecodesign. Device can work in dim light situation but the maximum penetration in about 4-5 mm. For future work we hope we can work on NIR device with cheap price and in most effective practical way.

References

[1] Peripheral vein locating techniques/ Gali Cantor-Peled, Moshe Halak & Zehava Ovadia-Blechman/ Department of Medical Engineering,Afeka Tel Aviv Academic College of Engineering, Tel Aviv, Israel/Department of Vascular Surgery, Sheba Medical Center.-
[2] https://thingsnurseslike.com, June 2018.
[3] https://www.sciencebuddies.org/science-fair-projects/engineering-design-process-guide /Jan. 2019.
[4] https://designshack.net/articles/layouts/minimal-design-how-to-design-more-with-less/ June 2019.