
Redesign of a vein detector for use on kids

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Many individuals face problem of finding a vein when getting injected

Low vein visibility may be accounted to:

- Thin veins
- High fat content below skin, makes it difficult to feel stiff veins
- Dark skin tones do not highlight veins

Due to this reason, they are pierced several times in order for a successful vein access

Effects of multiple punctures

Patients may experience Traumatic ulcers, local infections and stiffening of the veins (thrombosis) in case of multiple punctures

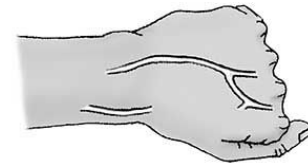


Thick veins for IV injections and cannula drip can be found in two areas of the human body

Most common areas being: Forearm and back of wrist



Forearm is more often used for instantaneous IV access like blood donation or sampling



Back of wrist is mostly used when the vein needs to be accessed for a longer duration- like in case of admitting at a hospital, when a cannula needs to be inserted for continual vein access

Other areas like the jugular vein on the neck, ankle and scalp are also used in case potent veins are not found in the Wrist or forearm

Preference towards wrists for venipuncture in kids

Pacifying a child before injecting is a known task for doctors and attendants

Due to their small hands, vein finding and successful cannulization becomes difficult

Wrists are preferred for inserting a cannula for two reasons-

1. Veins in kids are more developed in the wrist as compared to forearm (which develops as the physical activity of the body increases with age)
2. Once cannulated, kids keep moving their hands, hence a restrainer is used to restrict any movement. This cannot be done on a forearm



Wooden stent taped onto a patient for arresting motion post cannulization

The venipuncture hold



Source: Self, location: KEM hospital, Mumbai



Source: youtube- IV insertion in kids

Kids are extremely fidgety and fear needles a lot, hence doctors hold their wrists in a typical fashion
The hold allows for

- Uncluttered access to skin surface for vein identification and puncture
- The thumb is used for providing traction which helps in vein stabilization
- Needle insertion on a stretched skin is known to be less painful

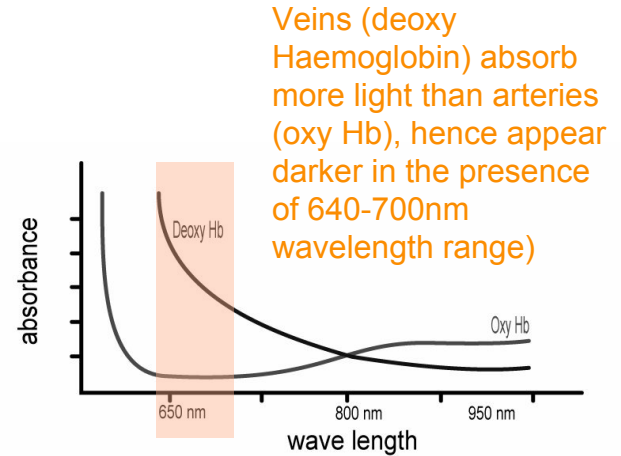
Current techniques used for easy vein identification

- Transillumination using near InfraRed LEDs
- Ultrasound
- Using an IR camera and image processing to determine venipuncture location

Transillumination is the most cost effective of the three

How does transillumination work?

- A vein detector uses light rays which penetrate the skin and the subcutaneous fat layer to highlight the veins
- Muscle mass diffuses the incident light while blood vessels absorb it due to the presence of iron in them
- Veins are differentiated from arteries when we use a near infrared beam of light. Due to the presence of deoxygenated blood



Usage of Multiple colors for transillumination

Red colored (620-650nm wavelength) vein transilluminators are most common and they effectively show deeper veins, but a recent patent filing by VeinLite in 2015 has shown the efficacy of using orange light (580-620nm) in viewing superficial veins and especially for darker skin tones

The combination of Red and orange color lights for transillumination has proven to be effective

Existing vein detectors for kids



Phillips Wee sight



Stihler Astodia



Existing vein detectors for kids



Phillips Wee sight

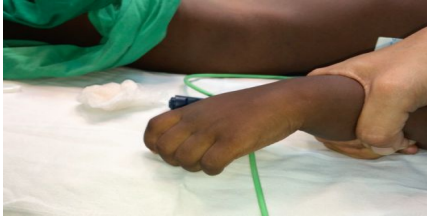
Pros	Cons
Small form factor- can be used with a lanyard	Very low brightness makes it usable only on new borns



Stihler Astodia

Pros	Cons
<ul style="list-style-type: none">• Use of RED and ORANGE light source• Handheld probe allows for easy hand gripping	<ul style="list-style-type: none">• Single LED gives localized results and is effective only for lighter skin tones• Expensive

Procedure timeline



Patient's wrist held in tourniquet action by assistant



Doctor (Cannula administrator) palpating the vein for activation



Key holding grip for cannulization



Notice how Doctor's hand is used to grip, while its thumb stretches the skin



Second hand used for inserting needle while first hand continues to stretch skin and keep patient's wrist stationary



Angle of needle is reduced once the needle has pierced skin



Thumb of first hand grips cannula in order to safely remove the inner needle



First hand remains in gripping posture

The procedure takes about 2-3 minutes from start to end if vein can be identified in the first go
Difficult veins may take upto 15 minutes and multiple punctures for cannulization

Key observations



An assistant is available for preparation, pacification and holding the child stationery

Index and middle finger do not move in the procedure

Thumb is first used to stretch the skin, then is used to support cannula while needle is taken out

One hand is dedicated to hold the patient's wrist, the other is used to insert needle



Design brief

Redesign a vein detector to be used on kids at Hospital pediatric wards for pre admission procedure

→ **Not to be missed aspect**

Enhance the process of potent vein identification

→ **Usability aspect**

Be comfortable to use for doctors, attendants and nurses alike without need for training

→ **Ecosystem aspect**

Be easy to store and maintain in a hospital setting

→ **Manufacturability aspect**

Keep the device cost in check by keeping a low part count and easy assembly

Even though it is a device to be used on kids, it should not be forgotten that it is an assistive device to the medical team

Target Users

PRIMARY USER

Key User



Anaesthetist

Vein identification, pacification, choice of veni puncture site



Assistant/intern

Stabilizing patient, strapping and post veni puncture dressing



Patient

In patient- to be admitted to ward post operation

Role

SECONDARY USERS



Hospital staff

Maintenance, cleaning and storage of equipment

Form should be soft visually

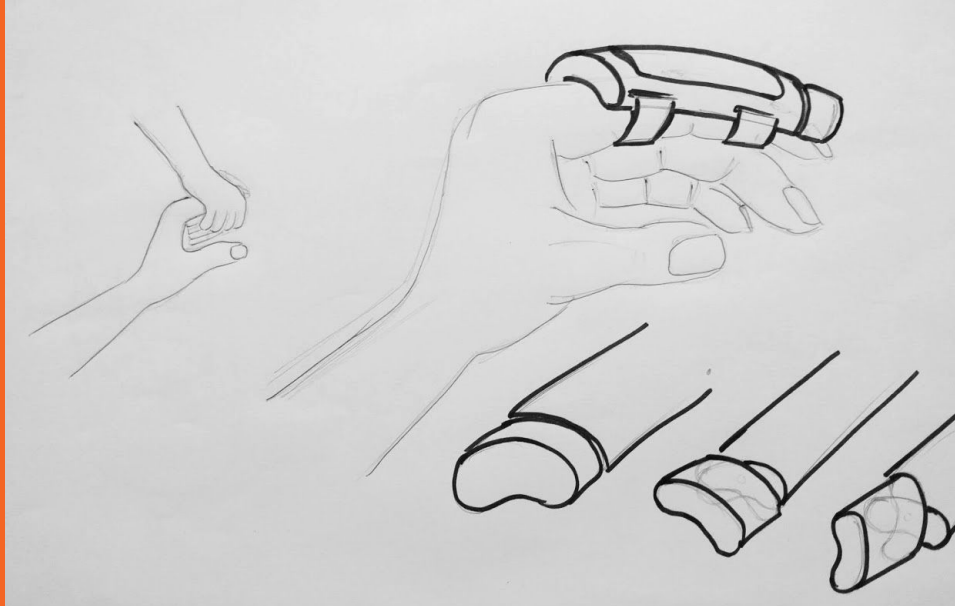
Prevent patient's exposure to bright IR lights

Avoid sharp ends on parts which interfaces with patient

No parting lines or germ collecting details on areas which are in contact with skin

Concepts

Concept 1- finger assist



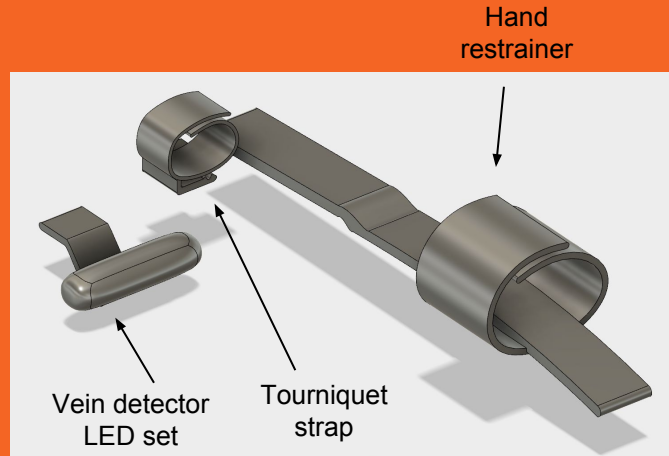
This concept uses a parental finger hold as a basic premise for the device.

This form allows for a regulator to alter the brightness of the LED

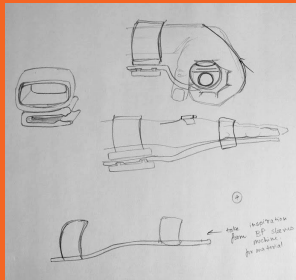
The size and construction of the device using thin surface mount LEDs and battery would result in high heat dissipation as the High wattage LEDs dissipate a lot of heat and would not be usable for extended periods of time



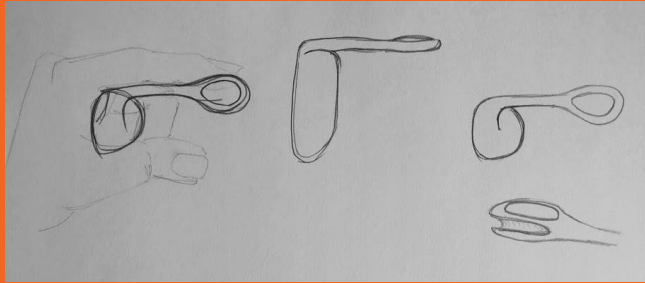
Concept 2- vein detection plus hand restrainer



The tourniquet strap is first placed on the patient's forearm and the LED module set is placed in the clip below the strap. The module would later be swapped for the hand restrainer

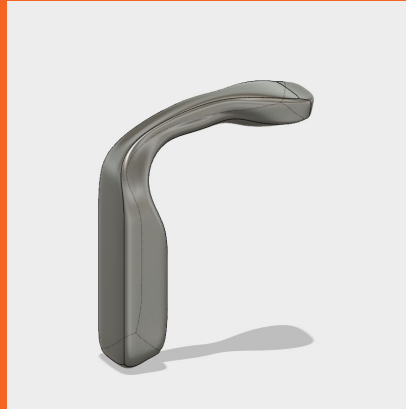


Concept 3- finger assist

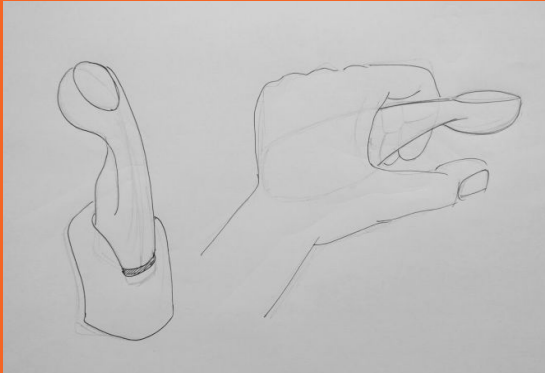


The hand held device grips on to the doctor's palm and follows the index finger to make use of a natural fit

Quick mockups helped test the structure in its fit in the hands and test usability



Concept 4- Torch hold



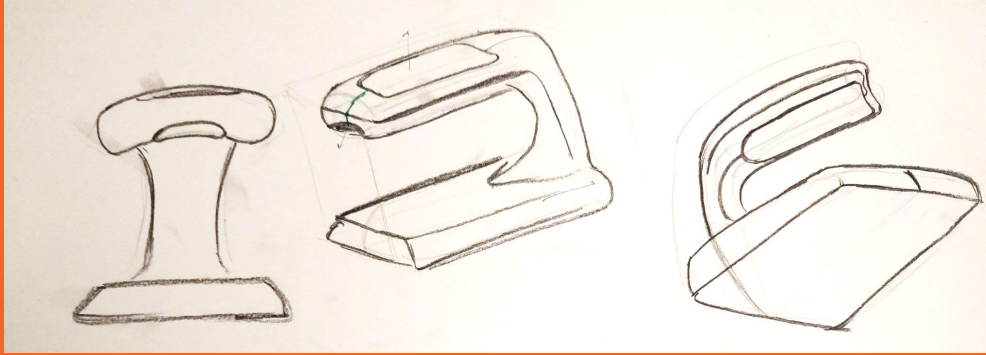
The doctor felt pressure in the wrist as the form has to be held from a side and the weight had to be supported by their forefingers which would otherwise be used for stretching the skin



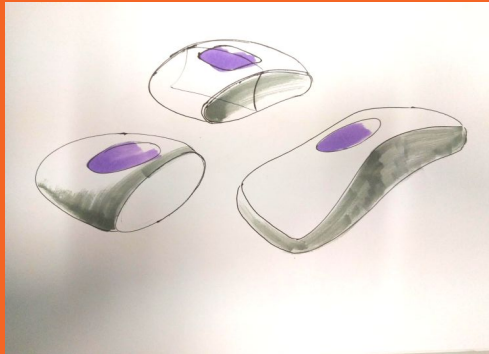
The doctor felt pressure in the wrist as the form has to be held from a side and the weight had to be supported by their forefingers which would otherwise be used for stretching the skin



Concept 5- rested base



Extending the finger assist concept with one which can be rested on the patient's bed for transferring the weight of the device



The concept also makes use of the semantics of a lamp

Concept 6- finger hold with rested base

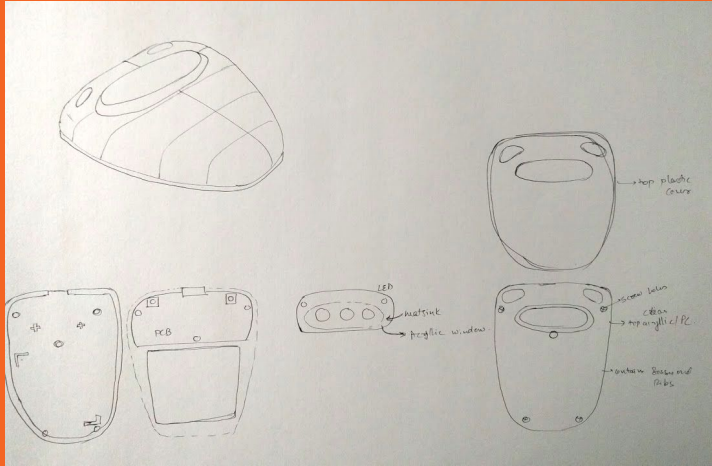


Smaller sized forms were found to be more usable than larger ones

The splitting of finger for enhanced grip was appreciated by the doctor as it replicates their natural holding grip

Once used, the device could be kept away safely and the round curvy forms were appreciated more than edgy ones as pressure needs to be applied while stretching the skin and the edgy forms would have left a mark on the patient's hand

Concept 7- palm hold



A slim hand held form factor which can be sandwiched between the doctor and patient's hand



Sleek form



Boxy structure



Curvy

User feedback



Evaluation criterion

Dr Ketan Kulkarni from KEM Hospital evaluated the different forms from the doctor's perspective

- Ease of use for doctor
- Fitting of technology
- Ease of storage
- Manufacturability
- Novelty



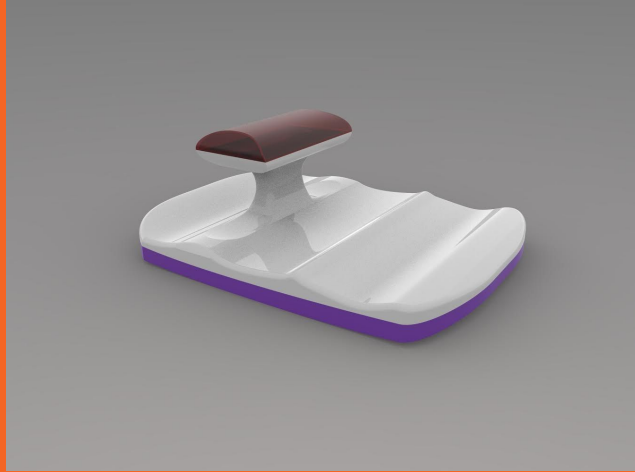
Finalised for further improvement

Concept explorations

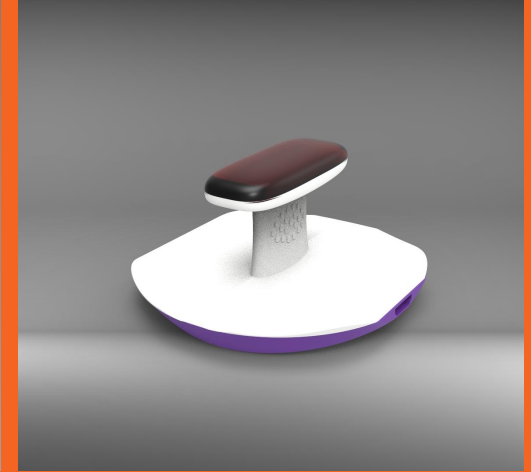


Conservative long form with large battery for week long use

Probe is kept designed to be kept between index and middle fingers



Profile of fingers built into the base to guide usability

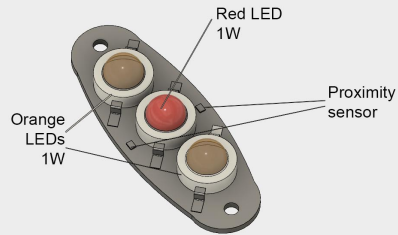


Soft and round form given to base with smaller battery profile which would give 2 hours of constant usage

Curved bottom edge also hints towards portability

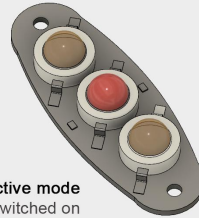
Technology and usability

Three modes of LED working



Proposed LED array

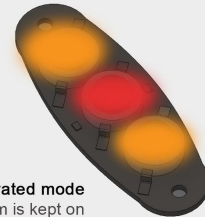
Inactive mode
Power button not switched on



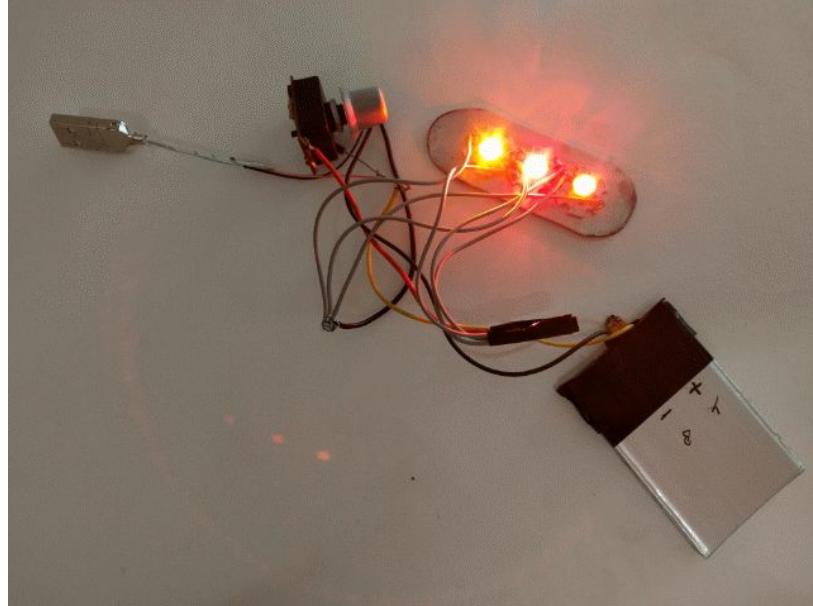
Power ON mode



Activated mode
When patient's palm is kept on the LED surface detected by proximity sensor

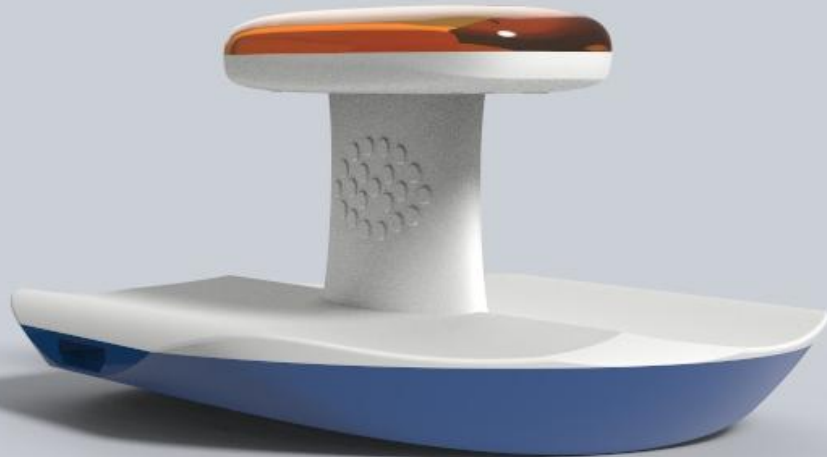


Working Rig

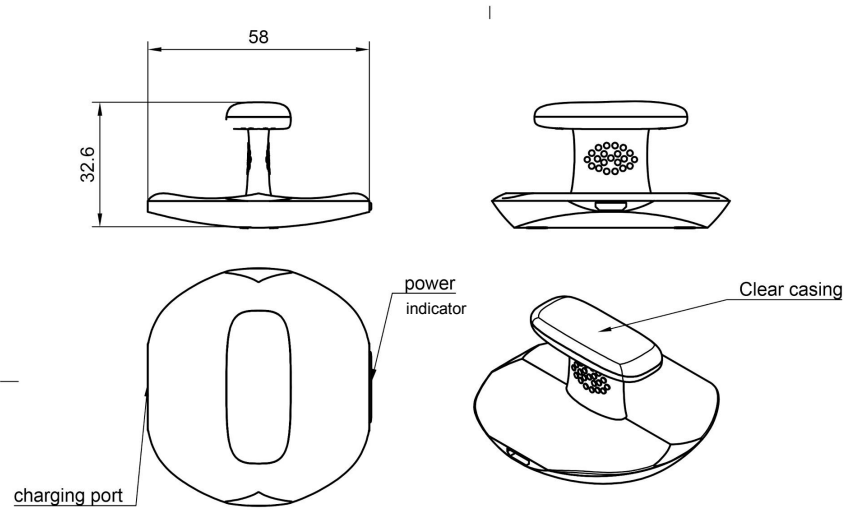


A working rig was made to test the effectiveness of the concept on a dark skin tone while placing the light source under the wrist

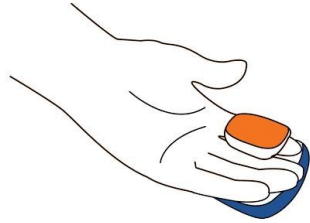
Final concept



Final concept



Instructions for use



Step 1:
Holding the device
between the fingers

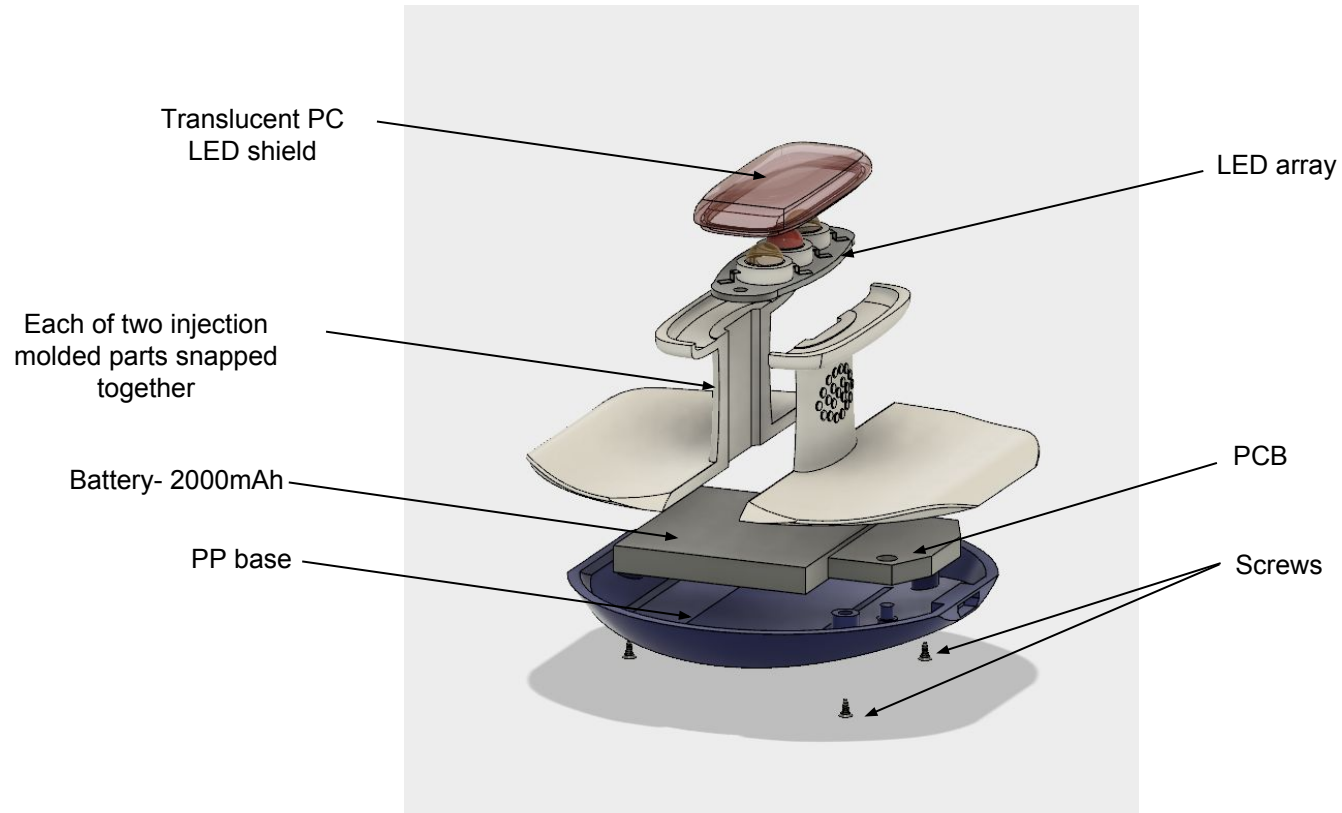


Step 2:
Placing the patient's wrist on the
device, power on and locate the vein
Confirm the location by tapping on the
vein
Stretch the skin using your thumb



Step 3:
Injecting using the
enhanced vein view

Assembly





Now eliminate subjectivity from Vein viewing when administering IV procedures on kids



CANUSSIST

Your ideal assistant for pediatric IV procedures

CANUSSIST™

Your ideal assistant for pediatric IV procedures

- The strong led light does not emit heat which could make it gentler on even the most delicate skin. Cannussist is designed to lie flat on a surface to allow the clinician to use
- Grooves allow doctor's to keep CANUSSIST in hand while adapting to their fingers for a natural wrist hold
- large unobstructed area over wrist for cannulisation. Shape of upper LED curve allows use on hands of varied age groups
- Rechargeable and runs easily for 2 weeks (or 400 views) on a single charge

I have been using this device since 6 months and I found this to be very helpful in locating the "hard to locate" veins and insert the IV. This is designed at the right size to hold while placing the IV. Prior to using this, placing IV in kids was a dreaded thing, now it is sooo easy to do it! It can be used in any pediatric patient and it helps!
Thanks to Cannussist

- Dr Rajagopalan Reddy, Mumbai

I work in an inpatient pediatric unit and I use my Cannussist frequently for IV starts. It does not require a pitch black environment, therefore I can see the veins and see my equipment (what a boon!). It can even transilluminate an adult hand effectively. It is conveniently mobile, easy to clean, and it fits handily into the palm of my patients' hands. My coworkers are always wanting to borrow it. Well worth the money.

- Dr Hemlata, Tamil Nadu

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