Cerebrospinal Fluid Detection for Spina Bifida in Low-Resource Regions

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DUKE ENGINEERING POD DESIGN

Background

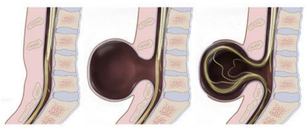
Spina Bifida is a neural tube defect caused by a lack of folic acid during pregnancy.

- Characterized by a meningeal sac filled with cerebral spinal fluid (CSF) and portions of the spinal cord
- In low-resource regions such as Ethiopia, families wait 1-2 months for corrective surgery
- Until surgery, the sac needs to be protected and monitored
- Families currently use plastic wrap to cover the meningeal sac

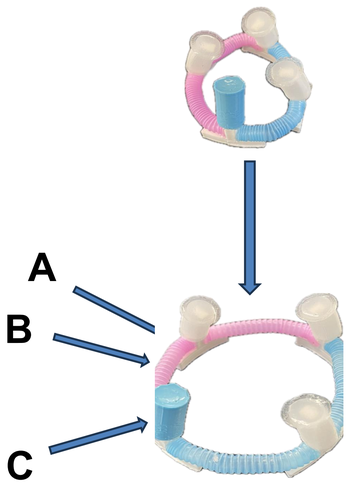
Design Problem

Our solution must:

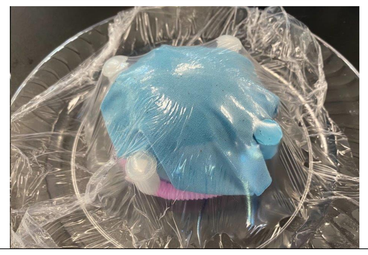
- **Protect** the meningeal sac
- **Detect** CSF and bacteria
- **Alert** the user if either is detected



Design



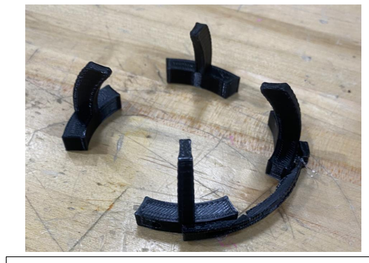
First prototype



Prototype attached onto water balloon to simulate meningeal sac

Different pieces of device

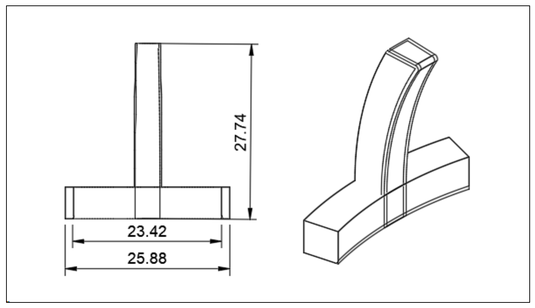
Different sizes of device's arches



Partially constructed device

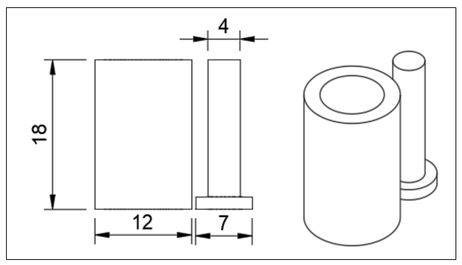
Legend

A. 3D printed structural supports



B. Arch Connecting Sleeve.

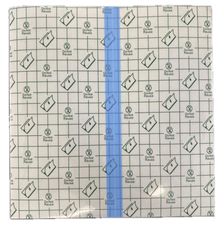
C. Silicone sleeve to cover 3D printed structure will go there



Design Criteria

- **Protection**: Will the meningeal sac be protected?
- **Durable**: Will the device be functional for a long term?
- **Easy to Use**: Will the device be user-friendly?
- **Low Cost**: Is it inexpensive to produce the device?

Included in Kit:
1) Structural device
2) Color Changing Cloth
3) No Sting
4) Medical Grade Adhesive
5) Medical Gauze
6) pH Strips
7) Instruction Manual



Testing

Criteria	Description	Test	Result
Protection	The product needs to be able to hold/withstand 4-12 pounds of weight (average weight of baby)	Continuously add weight in increments of 2 pounds starting at 4 lbs. and ending at 12 lbs.	Passed (The device will be able to withstand more than 12lbs)
Durability	The product needs to last longer than a month	Rub the device surface back and forth with a cloth 24 times and use a user-defined scale	Passed (There was no impact on the surface or integrity of device)
Easy to Use	The device needs to score at least a 4/5 on average on a user-defined scale (UDS) and Likert scale	Create a user-defined scale for the application and a Likert scale for how noticeable the color change is	Passed (10 people used for testing, average UDS score of 5.0)
Low Cost	Device needs to cost less than $20 since it is a reusable kit	Create a table and add up all the costs to see if the device is less than $20 USD	Passed (Kit costs $18.25 in total)

Conclusion & Future Work

We created a kit that targets all aspects of the design problem. The device is effective, deliberately simple and easy to use, and strong and reliable.

In the future, we would like to

Continue testing and start trials. This way children with Spina Bifida in Ethiopia and other low resource settings can actually start to use the device and see benefits.

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