Low-Cost Silo Bag to Treat Gastroschisis in Uganda

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Problem and Motivation

Problem: Our team has been tasked with designing a low-cost silo to treat gastroschisis in low-income countries like Uganda.

Figure 1: Current Silo Design (~$240)

Motivation: Gastroschisis is a birth defect in the abdominal wall that leads to an infant's intestines protruding out of his or her stomach. In developed countries, a silicone-based silo bag is used to treat gastroschisis by placing the intestines within the bag and pushing them back into the child over a few days. This silo bag effectively allows for a near 100% survival rate in more developed countries. However, due to the $240 price tag of this bag, Ugandan hospitals cannot afford to use it, resulting in a 98% mortality rate associated with this condition in Uganda.

Figure 2: Baby with Gastroschisis

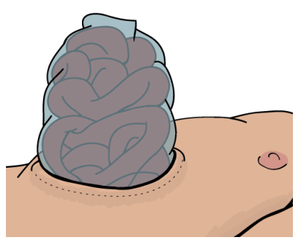

Figure 3: Gastroschisis Treatment

Design Criteria

Table 1: Target Values of Design Criteria

Design Criteria	Target Value
Diameter (Constraint)	= 5 cm
Volume	500 - 750 mL
Cost	< $10 USD
Reusability	> 100 times
Ease of Use	> 3/5 (usable by midwives)
Ease of Manufacturing	> 6/10 (Likert Scale)
Watertightness	< 1.00 mL/s
Stiffness Ratio	1 - 2

The diameter of the bag is our only design constraint, meaning that it must be satisfied. The ease of use is defined based upon who can actually use the bag, with our aim being for midwives and people with medical training to be able to use the bag. The ease of manufacturing is based upon ratings given to us by peers who construct the bag. Ratings are given on a scale of 1-10 based on a Likert scale.

Prototypes and Final Product

Prototypes

Plastic Sheeting + Zip Tie

This prototype demonstrated that we could use a clothes iron to heat seal the bag. However, this prototype was deemed unsuitable as our final solution due to the zip tie creating a sharp edge on the corner of the bag, which would be unsafe for the baby.

Figure 4: Prototype 1, Plastic Sheeting and Zip Tie

Plastic Sheeting + Female Condom

This prototype demonstrated that we could use a ring from a female condom as the opening of the bag. However, this prototype was deemed unsuitable as our final solution due to the difficulty in acquiring plastic sheeting in Uganda.

Figure 5: Prototype 2, Plastic Sheeting and Female Condom Ring

Final Product

Our final product, The Baby Bag, is made from:

- 1 Urine Collection Bag (UCB)
- 1 female condom ring

It is constructed by:

- Cutting the UCB into a flat sheet using scissors
- Sealing the UCB into the bag shape using a clothing iron
- Positioning the female condom ring at the opening of the bag
- Sealing the female condom ring using the clothing iron

The Urine Collection bag was suggested to us by a Ugandan doctor because they are readily available in hospitals. From our client, we learned that female condoms and clothing irons are easily accessible in Uganda.

Figure 6: Low-Cost Silo (~$1)

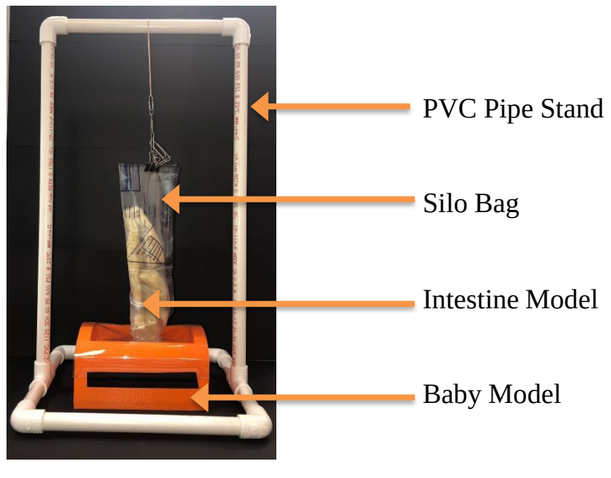

Figure 7: Low-Cost Silo in Use

Testing

Testing Data

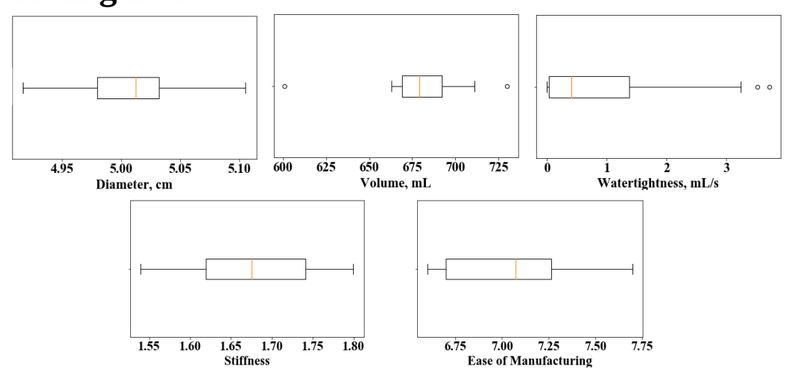

Table 2: Testing Data compared to Target Values

Design Criteria	Target Value	Median of Testing Data
Diameter (Constraint)	= 5 cm	5.012 cm
Volume	500 - 750 mL	679 mL
Cost	< $10 USD	$1
Reusability	> 100 times	Not Tested
Ease of Use	> 3/5	Not Tested
Ease of Manufacturing	> 6/10	7.075
Watertightness	< 1.00 mL/s	0.41 mL/s
Stiffness Ratio	1 - 2	1.67

= Not Tested

For the design criterion of watertightness, we can see from the box plot that there are data points that do not satisfy the target values. We will work to refine our manufacturing manual so that all of the silos manufactured will be watertight to an appropriate level. For the ease of use, we plan on having people with varying levels of a medical education actually try using the bag on a model of a baby. For the reusability, we plan on determining how many uses it takes for the bag to develop a defect that makes it unusable.

Future Work and Conclusion

Future Work

- Test Reusability
- Test Ease of Use
- Refine and improve the manufacturing manual
- Create a video about the final product

Conclusion: The testing data indicates that our final product is functionally equivalent to the more expensive silo; however, we must test the reusability and the ease of use to ensure that.

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