Biomedical Device for Detecting Postpartum Hemorrhage

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Motivation & Problem Statement

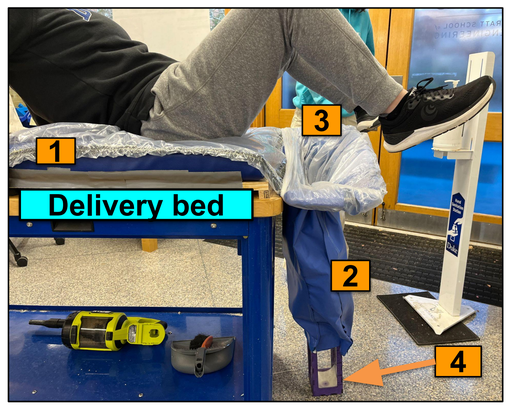
- Postpartum Hemorrhage (PPH) is a deadly condition that results from the inability of a woman's uterus to contract following childbirth. In failing to prevent bleeding, the patient can lose an alarming **>1000 mL of blood** if gone undetected by medical personnel. Due to the absence of a detection device, **PPH often goes undetected in Uganda because visual estimation alone is used. PPH accounts for 25% of Uganda's maternal mortality.**
- In order to detect and prevent PPH from devastating the lives of patients, Ugandan medical personnel need a **low-cost**, **reusable** device that is capable of **collecting and measuring blood** during and after childbirth.

Final Design Components

1. Flap with sewn elastic for attaching outer bag to delivery bed. Elastic allows for adjustability to different bed dimensions.
2. Outer bag for holding inner disposable bag and directing blood flow to measuring box. Opening is supported by an aluminum wire hoop. Waterproof canvas material is chosen for durability and reusability.
3. Inner disposable plastic bag tied around outer bag's opening for blood collection.
4. Measuring box with volume markers up to 1500 mL for measuring blood loss.
5. 3D-printed component inside measuring box for fitting inner plastic bag to shape of the measuring box.
6. Velcro for connecting measuring box to outer bag

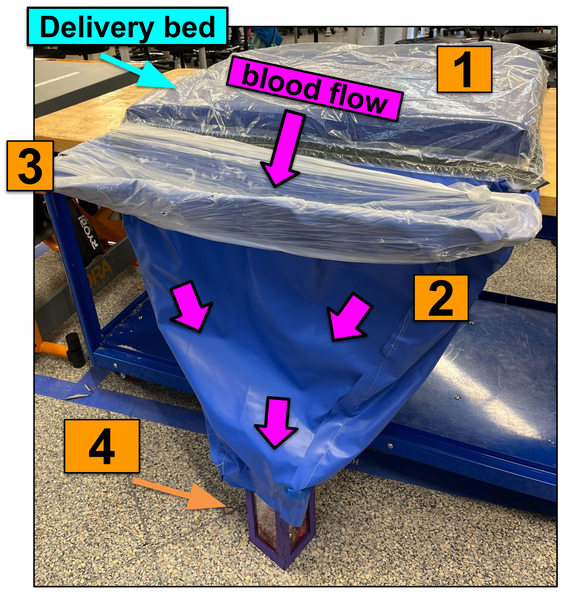
Final Design Solution

Side View with Patient

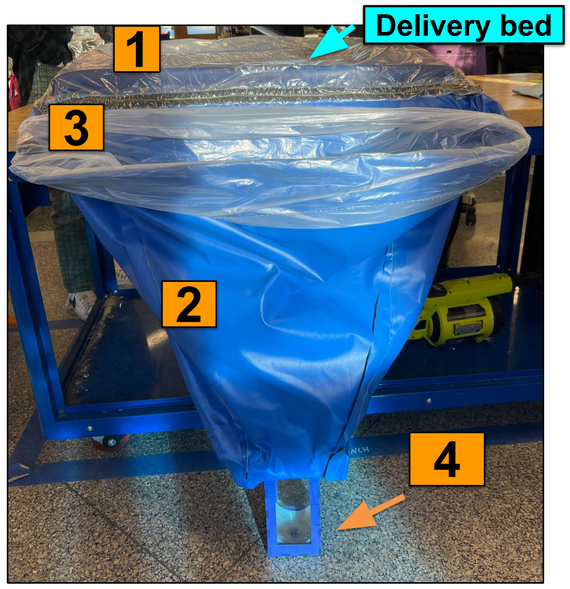


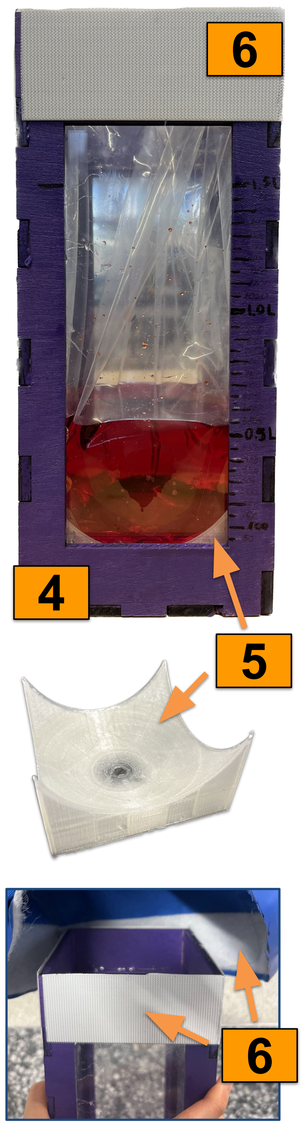
Top View

Set-up & Demonstration



Front View





Design Criteria & Testing

Design Criteria	Target Value	Testing Procedure	Results
Accuracy	Accurate to ±50 mL	Measure 1000 mL of water using graduated cylinder. Pour water into the device. Record final measurement by device. Repeat for 5 trials.	**Success:** 5/5 trials recorded a final liquid measurement of 1000±50 mL.
Safety	10/10 safety rating by professionals in healthcare and Biomedical Engineering	Send a survey to 3 OBGYNs and 3 Duke Biomedical Engineering faculty mentors. Survey asks for strengths, weaknesses, and recommended changes for the device in hospital vaginal delivery setting.	**Success:** 6/6 survey respondents gave 10/10 rating on device safety.
Durability	Reused ≥ 200 times	Add water to device continuously up to 3000 mL. Observe strength of each device component. Repeat for 3 trials.	**Success**: 3/3 trials showed all device components without deformation or breakage.
Reusability	Cleaned in ≤ 10 minutes	Spill red-dyed water on device. Clean device with local sanitizing materials (sodium hypochlorite/isopropyl alcohol) for ≤10 min. Inspect device cleanness.	**Success**: Device is effectively cleaned in ≤ 10 min with isopropyl alcohol.
Cost	≤$10	Calculate cost of all components. Evaluate device cost-effectiveness with durability and reusability	**Fail**: ~$20 *Durability and reusability of device and disposable inner bag component may compensate for additional cost.

Conclusion & Future Work

The final design consists of an **outer bag** sewed onto a **plastic, elastic flap,** a **box with volume markers** attached to outer bag with **velcro** and a **disposable inner bag**.

Future work:
- Design component for adhering top of inner bag to flap and bottom of inner bag to measuring box for higher accuracy
- Address potential issue of plastic flap for patients with latex allergy
- Change the outer bag's opening design for it to be more bendable for greater adjustability.
- Test device with blood analogue

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