DREXEL UNIVERSITY
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# 14 Portable Hypercapnia System for Assessment of Cerebrovascular Reactivity (CVR)

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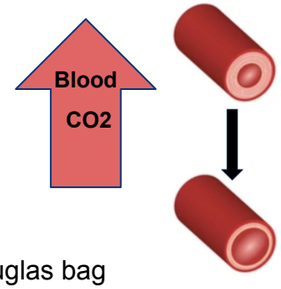
## Problem

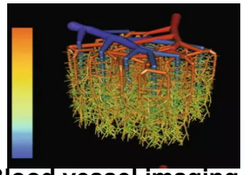
Neurological disorders cause cerebral microvascular dysfunction

**CVR:** Blood vessel dilation in response to hypercapnia




**•Existing**
- •Douglas Bag
  - Time consuming and bulky
- The solution removes the need for the douglas bag by using rebreathing mechanism

**•Need**
- User has the imaging technology to measure blood vessel dilation
- Needs device to induce hypercapnic stimulus

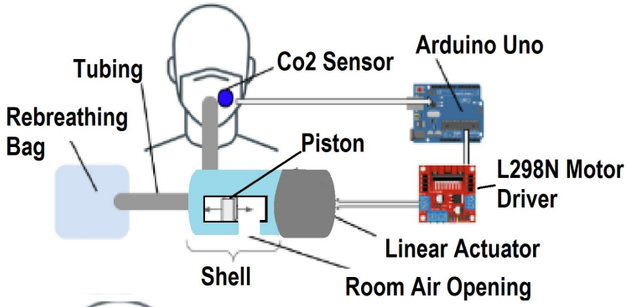


Blood vessel imaging

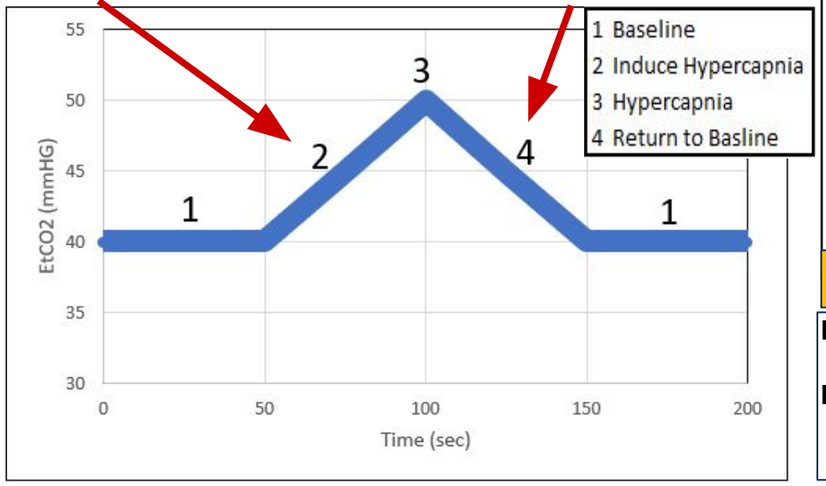
**•Objective**

Develop portable device to induce hypercapnia and return to normocapnia

## Solution




**Stage 2** - Hypercapnia Induction **Stage 4** - Normocapnia Return




## Design Inputs

| | |
|---|---|
| **C1** | Must not exceed 7% Co2 increase for 6 minutes |
| **C2** | No interference with normal breathing rhythm |
| **C3** | >22 mm tube diameter to prevent condensation buildup |
| **R1** | Increase EtCO2 10 mmHg from baseline |
| **R2** | Return EtCo2 within ±2 mmHg of baseline |
| **R3** | No air leakage up to 6.8 kPa |

## Verification

**Air Leakage test**

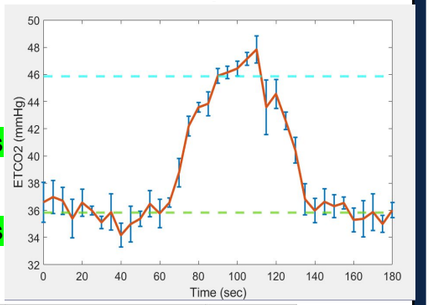
- Tests the air leakage in the system.
- Apply soap solution to shell
- Duct tape all openings
  - and put a balloon on one end
- Blower will introduce airflow

Look for bubbles forming on the shell

- No bubbles = Success

**Induce Hypercapnia & Return Normocapnia**

- Increase the EtCO2 level by 10 mmHg from baseline
  - Achieved in 5 minutes = Success
- Return to baseline within 2mmHg
  - Achieved in 5 minutes = Success




| Verification Test | Criteria | Observed Result | Pass/Fail |
|---|---|---|---|
| Air leakage Test | No Bubbles | No Bubbles* | |
| Induce Hypercapnia | Baseline + 10 mmHg | 35.78 → 48.12 mmHg | |
| Return to Baseline | Baseline ± 2 mmHg | 36.11 mmHg | |

## Future

**Revision**
- Implementation of Software to enable Hypercapnia maintenance

**Impact**
- Make the use of CVR as a test metric more convenient
- User can assess Neurovascular Dysfunction