

From Chevys to Breast Pumps: Clever Reuse of Hardware for Active Learning Stations in a Respiratory Course

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INTRODUCTION

The Carle Illinois College of Medicine has developed Medical Engineering Discovery and Innovation (MEDI) sessions which focus on integrating engineering into medicine. Group work during MEDI sessions offers a pragmatic approach to deliver active learning given a student population with a wide variety of individual skills and experiences. With limitations around accessing specialized equipment for educational purposes, there was a desire to develop a novel simulator to demonstrate airway dynamics to improve student learning over past years. The goals for the session were as follows:

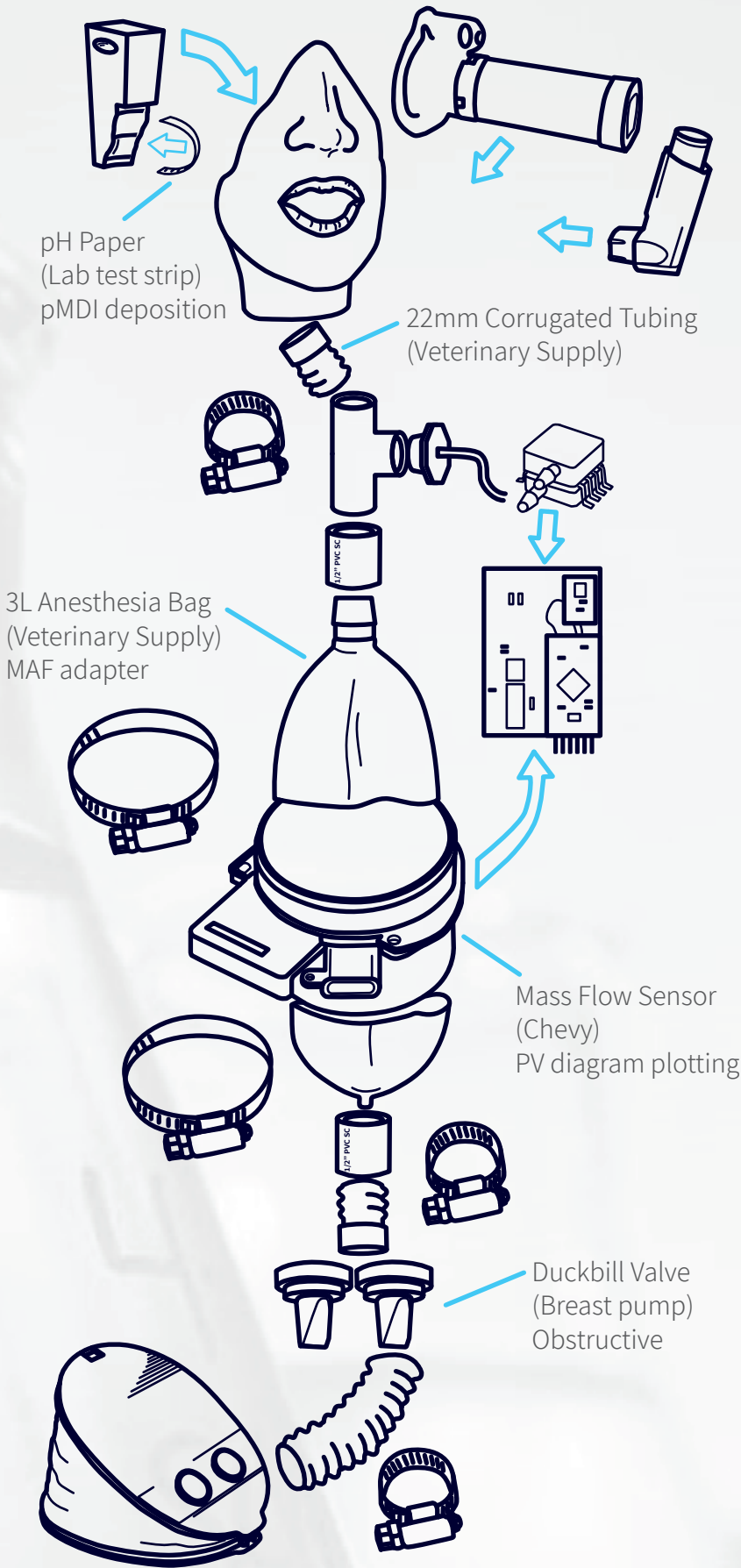
1. Introduce Pressure-Volume (PV) diagrams
2. Compare/contrast obstructive and restrictive diseases
3. Demonstrate the mechanics of inhaler medication
4. Provide intuition for how fluid dynamics and mechanical properties relate to respiratory physiology

METHODS

4 Stations (modifications to model):

- Restrictive Lung (Leaky foot pump valves)
- Obstructive Lung (Leaky duckbill valve in-line)
- pressure metered dose inhaler, a.k.a. pMDI (No sensors)
- pMDI Image Analysis (Computer only, no model)

At the restrictive and obstructive lung stations students followed an interactive program (Jupyter Notebook) to read and analyze pressure and air flow data from sensors embedded in the models. The full model is shown center page. At the pMDI station, students photographed pH paper to detect aerosol medication deposition on a model oropharynx with and without the use of a spacer. Medication deposition was quantified through a computer vision routine at the final station. Two open ended discussion questions were asked at each station to reinforce the key concepts. Responses were collected and feedback provided post-session.



Cost (One full circuit)	~\$250 (parts only, no tools)	
Cost Commercial (Static Model)	~\$975 Simulaids	~\$2,250 Laerdal
Session Design	4 students per station 1.5 hrs per 16 students	
Mean Student Survey Score, Past	2.6 / 5.0, N = 25 (Past, no simulator)	
Mean Student Survey Score, Present	4.0 / 5.0, N = 20 (Current, with simulator)	

STUDENT PERCEPTION

The end-of-course survey included an integer rating question regarding the quality of the engineering session, 1 = low quality, 5 = high quality (see table above). Students were also asked to provide short response comments.

Positive comments specific to this session included:

- Helpful and well aligned to course
- Well organized and efficient use of time
- Interesting and engaging

Negative comments included:

- Technology and concepts were basic, not innovation focused

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