

The Non-Electric Dental Pump

Anna Bandecca, Katie Beittenmiller, Samantha Shoemaker, Margaret-Anne Smith Advisors: Conrad M. Zaparta, Ph.D., Nicole Huang, Angela Lai



MOTIVATION

- Dental decay affects 3.5 billion people worldwide
- Resources for dental care are scarce in impoverished areas
 - Facilities have no electricity
 - Dental tools are bulky, heavy, & difficult to transport
- Procedures to treat dental decay require suctioning of blood, saliva
 - Traditional pumps use electricity
 - Other solutions are uncomfortable for the patient, expensive

NEED STATEMENT: A portable method to provide fluid suction for medical practitioners in any location to allow for increased mobile medical services.

IMPORTANCE

- 92% of people aged 20-64 have had at least one cavity¹⁶
- 190 million new cases of dental decay emerge each year¹⁵
- Volunteer organizations (e.g. Global Medical Brigades) treat dental decay cases
 - No electricity, difficulty transporting tools

Current Solutions for Fluid Suction



Solution 1: Personal battery powered vacuum

- 1 3 hour battery life 110 – 240V battery
- Small collecting canister



Solution 2: Dixie cup – used in mobile clinics in rural areas

Inefficient (slows procedure) Uncomfortable for patients

OUR SOLUTION

- Utilize fluid mechanics to generate suction
- Requires pressurized air to flow through diameter reduction (venturi)
 - Pressure in smaller diameter decreases to compensate for increased air velocity → Suction generated (Bemoulli's principle, below)



Compact

simple & easy to clean

FINAL PROTOTYPE

- Pumped up via manual foot pump to minimum of 40 psi in~45 minutes
 - Run time of ~25 minutes
- Carrying suitcase for portability
- Aluminum air tank to hold pressurized air
- Foot pedal for controlling suction
- Pressure regulator to extend run time
- Collecting canister on side of tank



CAD model of final prototype

RESULTS



Simulated runtime with pressure regulator at 40 psi

- <u>Stage 1 Testing (Water)</u>: Ensure backflow is eliminated, flow through the tubing is smooth and uninterrupted, and determine a relative suction rate
 - \rightarrow Results: 10 mL/15 sec = 0.66 mL/s suction rate, no backflow
- Stage 2 Testing (Glycerol as Imitation Blood): Determine if increased viscosity affects device performance

 \rightarrow Results: 8 mL/15 sec = 0.53 mL/s suction rate

Due to the increased viscosity, pressure built in the venturi that was enough to drive liquid through the air tubing to the foot pedal Liquid was found coming out of the 3rd connection spot from the pedal

Conclusions: While the pump had no issues suctioning water, increased viscosity led to backflow and pressure buildup. Therefore, we recommend the device be used for basic dental procedures involving minimal blood rather than major procedures.

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