Breathe Easy: Designing an Inhaler Device

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Engineering 101: Engineering Design and Communication

Problem Background

GOAL:

- To decrease the amount of force and the range of motion necessary for the activation of an inhaler.

WHY?:

- The current, standard inhaler requires too much force and mobility for individuals who lack hand-strength or hand-functionality such as young children or those with hand degenerative conditions (i.e. arthritis).
- This forces our target populations to rely on others to administer the inhaler for them, which poses a serious safety concern in the event of an asthma attack.

PROPOSED SOLUTIONS:

- In order for our target population to use inhalers independently, we have designed two attachment devices.

Design Objectives, Constraints

Design Objectives, Constraints (listed in order of importance)	Performance Criteria	How each performance criterion was selected/ justified
Force Decrease (objective)	Force decreased by 30%-40% (down to roughly 28.87 Newtons)	Research determining the limitations of our users
Portability (objective)	< 1 lb of added weight, and < 4-5 inches in diameter	Consultation with client
Easy Set-Up (objective)	Simple to assemble, assessed with a user survey and users able to set up in <30 seconds	Consultation with client
Durability (objective)	>500 squeezes	Consultation with client
Readjustment Between Uses (objective)	Users agree that readjustment after use is less burdensome than other solutions, assessed with a user defined scale	Consultation with client
Price (constraint)	<$25	Consultation with client

Lever Prototype

How it Worked:

- Slides across the top of the inhaler depressing the canister.

Why We Didn't Develop

- Too much force was being lost to the horizontal force component and to kinetic friction instead of being directed linearly downwards.

Development Process

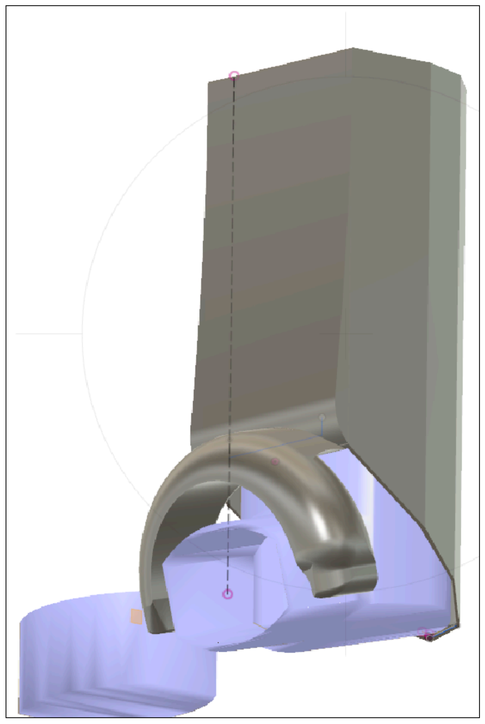
Design Criteria	Weight	Remote + CAM	Angled Squeeze Lever	Button + CAM	Temperature Sensor + CAM	Bite Lever	Wind up Spring
Force Decrease	0.40	5	3	5	5	5	4
Portability	0.15	3	5	2	1	5	4
Easy Set-Up	0.15	4	5	1	2	3	5
Durability	0.10	3	5	2	1	5	4
Price	0.10	2	5	2	1	3	4
Readjustment Between Uses	0.10	2	3	4	4	5	1
Total	1.0	3.75	4.0	3.25	3.05	4.50	3.85

1. Brainstorming: Came up with ~50 ideas through iterative brainstorming sessions.
2. Decomposition: Broke down our ideas into these design blocks:

Activation Methods	Mechanics	Grip Method	Materials	Durability

3. Screening: Screened all of our ideas into ~7 main solution combinations of our blocks.
4. Scoring: Scored each solution on our original design criteria, identifying two to develop further.

Solution #1: Bite



FEATURES

- An o-shaped mouthpiece attached to an inhaler-fitted container.

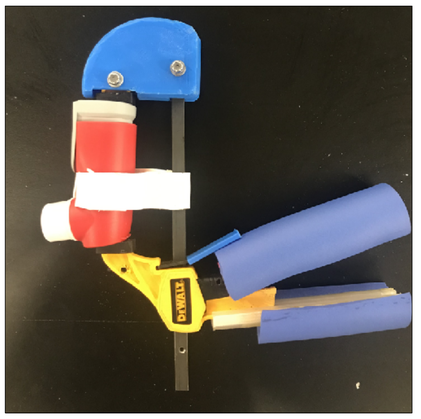
HOW IT WORKS:

1) User places mouth over mouthpiece
2) User bites down and inhales

BENEFITS:

✓ No necessary hand mobility to administer dosage
✓ Portable
✓ Fits varying canisters

Solution #2: Clamp Mechanism



FEATURES:

- Trigger Activated Clamp that secures around the top and bottom of the inhaler
- Large foam-covered handles
- Resetting Lever
- Inhaler Securing Strap (Aquaplast)

HOW IT WORKS:

1) User places inhaler on the base of the clamp, securing it
2) User places mouth over inhaler mouthpiece
3) User Squeezes handles and inhales

BENEFITS:

✓ Minimal hand mobility required
✓ Fits any model
✓ Customizable Appearance

Testing

1. Client Meeting: Clamp and Bite Mechanism successfully met her expectations.
2. Class Testing: Both solutions decreased the force required to use the inhaler, tested on classmates.
3. Meeting with Respiratory Therapist: Confirmed the clamp wouldn't restrict the use of a spacer and decreased the force necessary to administer dosage.
4. Testing on ALS patient: confirmed that clamp device is easier to use than a regular inhaler with the addition of wider handles and a stabilizing stick.
5. Measurement Testing: A scale shows it takes 400 grams of force to push down on the clamp handles rather than 2000 grams without the device.

Future Work/Conclusion

Our test results indicated that both the clamp and bite mechanisms limit the range of motion and force necessary to use an inhaler. Our next steps include to test the bite mechanism on patients, and replicate all of our tests on patients of varying hand functionality to confirm or refine our solutions.

Acknowledgements/References

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