Asthma is a chronic inflammatory lung disease that inflames and narrows the airways, causing less air to flow to the lungs. Asthma is a serious condition that causes more than 10,000 fatalities in the United States each year. It is therefore important to take preventative measures to protect against asthma attacks and symptoms.

To address this issue, a heating mask/respirator hybrid has been developed. Included in the design, there will be a copper, metal heat exchanger to moderate the temperature fluctuation in respired air while the wearer is exposed to cold weather. A small piece of N95 filter covers the port to prevent moisture buildup that may irritate the user. Temperature fluctuations can occur within the mask- could be enough to trigger an attack. After several experiments varying path length, copper density and heat exchanger size, a prototype based on pressure differentials and temperature fluctuations was chosen. The heat exchanger, which includes a ¾" heat exchanger path length, 0.8 g of copper mesh per square inch of mask space, and a volume of 122 in3, has comparable temperature fluctuations to the PolarWrap, a commonly used passive heat exchanger mask using the same copper based heat exchanger technology, and has a pressure gradient across the mask most similar to that of the ideal case - a simple scarf.

This cold weather mask was found to be as successful as PolarWrap in terms of heating the inhaled air and breathability. The inclusion of port and filter provides a fast access to medication during an asthma attack and protects the user from asthma triggers such as particulates. These additions make the cold weather mask a novel and useful prevention device for asthmatics.

Clinical Need: Preventive Treatment for Asthma

What is asthma?

- Disease of lungs; muscles of bronchial tubes tighten and thicken; air passageways become mucous filled
- Defined as chronic obstructive pulmonary disease
- Asthma is an inflammatory lung disease that inflames and narrows the airways, causing less air to flow to the lungs
- Accounts for 2 million emergency visits and 10,000 deaths in the U.S. per year
- Difference in temperature between exhaled and inhaled air
- Sudden drops in temperature and humidity can trigger bronchial spasms
- Can cause hospitalization for children
- 34.1 million Americans diagnosed with asthma; 9 million of those diagnosed are under 18
- In the most common chronic condition among children, it is 5th leading cause of hospitalization for children

Who is affected by asthma?

- 1.9 million Americans diagnosed with asthma; 9 million of those diagnosed are under 18

What causes asthma and what can we do to prevent it?

- Triggers of Cease: N95 filter protects against outside air particulates and dust or spores buildup within the mask
- PolarWrap mask (positive control)
- Fleece pouch containing no heat exchanger (negative control) (scarf)
- Big pleather pouch, high density of copper, long airflow pathlength (B/L/H)
- Big pleather pouch, high density of copper, short airflow pathlength (B/Sh/H)
- Small piece of N95 filter covers the port to prevent moisture buildup that may irritate the user
- Difference in temperature between exhaled and inhaled air
- Sudden drops in temperature and humidity can trigger bronchial spasms
- Most common causes are pollen, dust, cold, and exercise are common causes
- Studies have found that sudden drops in temperature and humidity can trigger bronchial spasms
- Moisture accumulation against face can be uncomfortable
- Routes from particles to pollen, dust, and exercise are common causes

Experimention

Results:

- 1/8" thick rubber cap glued to inside of flap; acts as stopper to port
- Polyurethane port not using the port
- 1/16" HD, 1/2" ID, 5/8" thick on the bottom half; 1/2" thick on the top half
- 1/8" thick, circular insanity front was glued into port to act as a pass-through
- A small piece of N95 filter covers the port to prevent moisture buildup that may irritate the user
- Breathability is greatest for the scarf, second greatest for the large mask, with a short pathlength and low copper density, and third greatest for the large mask with the long pathlength and high copper density
- Hairy exercise: mask temp reached its lowest for the scarf. The big mask with the short pathlength and low copper density has a slightly lower max temp than the other masks
- Temperature difference between inhaled and exhaled air is generally within 5 degrees Fahrenheit of each other
- If a mask is used to maintain a constant temperature, it is difficult to prevent the effect of sudden temperature drops outside the mask


Anticipated Regulatory Pathway and Future Work

- This mask would have to be tested broken for
- No N95 filter against outside air particulates and dust or spores buildup within the mask
- PolarWrap mask (positive control)
- Fleece pouch containing no heat exchanger (negative control) (scarf)
- Big pleather pouch, high density of copper, long airflow pathlength (B/L/H)
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Design of a Cold-Weather Mask for Asthmatics

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Executive Summary

Asthma is a chronic inflammatory lung disease that inflames and narrows the airways, causing less air to flow to the lungs. Asthma is a serious condition that causes more than 10,000 fatalities in the United States each year. It is therefore important to take preventative measures to protect against asthma attacks and symptoms.

To address this issue, a heating mask/respirator hybrid has been developed. Included in the design, there will be a copper, metal heat exchanger to moderate the temperature fluctuation in respired air while the wearer is exposed to cold weather. A small piece of N95 filter covers the port to prevent moisture buildup that may irritate the user. Temperature fluctuations can occur within the mask- could be enough to trigger an attack. After several experiments varying path length, copper density and heat exchanger size, a prototype based on pressure differentials and temperature fluctuations was chosen. The heat exchanger, which includes a ¾" heat exchanger path length, 0.8 g of copper mesh per square inch of mask space, and a volume of 122 in3, has comparable temperature fluctuations to the PolarWrap, a commonly used passive heat exchanger mask using the same copper based heat exchanger technology, and has a pressure gradient across the mask most similar to that of the ideal case - a simple scarf.

This cold weather mask was found to be as successful as PolarWrap in terms of heating the inhaled air and breathability. The inclusion of port and filter provides a fast access to medication during an asthma attack and protects the user from asthma triggers such as particulates. These additions make the cold weather mask a novel and useful prevention device for asthmatics.

Design

- Designed as an outer covering
- Slip on exterior of the mask directly in front of mouth to allow for port access
- 1/8" thick rubber cap glued to inside of flap; acts as stopper to port
- Polyurethane port not using the port
- 1/16" HD, 1/2" ID, 5/8" thick on the bottom half; 1/2" thick on the top half
- 1/8" thick, circular insanity front was glued into port to act as a pass-through
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Experimention (Continued)

- Temperature difference between inhaled and exhaled air is generally within 5 degrees Fahrenheit of each other
- If a mask is used to maintain a constant temperature, it is difficult to prevent the effect of sudden temperature drops outside the mask

Novel Innovations

- N95 filter protects against outside air particulates and dust or spores buildup within the mask
- PolarWrap mask (positive control)
- Fleece pouch containing no heat exchanger (negative control) (scarf)
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Estimation of Product Costs

- Manufacturing Cost: $24.47
- Retail Price: $35.00
- Profit: $10.53
- Comparable price of existing PolarWrap mask
- 47% masks would have to be tested broken for

Market Description

- Asthma market worth $15.1 billion worldwide
- Market share in the asthma market: GlaxoSmithKline, AstraZeneca, and Merck
- Insurance does not cover any accessories for asthma treatment
- Product Advantages
- Acts as an immediate preventative measure against asthma attacks
- Temperature fluctuations can occur within the mask- could be enough to trigger an attack
- Moisture accumulation against face can be uncomfortable
- Routes from particles to pollen, dust, and exercise are common causes
- Triggers of Cease: N95 filter protects against outside air particulates and dust or spores buildup within the mask
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Figure 1. Schematic of layers present in the cold weather mask. Please note the rubber cap glued to inside of flap and N95 filter on the port of the mask type. Ambient temperature is 6°C.

Figure 2. Pressure drop across each mask at room temperature.

Figure 3. Temperature difference between inhaled and exhaled air is generally within 5 degrees Fahrenheit of each other.

Figure 4. Difference in temperature between inhaled and exhaled air is generally within 5 degrees Fahrenheit of each other.

Figure 5. Manufacturing cost for cold-weather mask

Figure 6. Average temperature of heated air for different mask types. Ambient temperature is 6°C.