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## Design and development of eco-friendly nebulizer face mask

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### Abstract

Asthma is one of the most common chronic diseases, with an estimated 300 million individuals affected worldwide. When it is treated the right way, people with asthma can live active lives. Nebulizer is one of the treatments given to asthma patient in the hospitals. A nebulizer is a device driven by a compressed air machine. It allows patients to take medicine in the form of a mist (wet aerosol). It consists of a cup, a mouthpiece or mask attached to a T-shaped part, and a thin, plastic tubing to connect to the nebulizer machine. There are many chances for infection without proper cleaning of nebulizer plastic face mask. In order to overcome this problem, the current study aspires to develop fabric nebulizer face mask which is both eco-friendly and disposable. For this, cotton twill weave fabric has been chosen and designed separately for adult and child and made into mask. In order to impart stiffness, the masks are finished with starch extract. The developed mask was taken to a chosen hospital and consulted with the doctor and feedback collected from patients. The feedback reveals that the patients are more comfortable and feel very hygienic while using the designed fabric face mask. Also, the cost of fabric mask is cheap and affordable by the patients.

**Keywords:** Asthma, nebulizer treatment, face mask, cotton fabric, disposable, hygienic, medical textile.

### 1. Introduction

Medical textile is an important product category with in technical textiles. It is one of the most important, continuously expanding and growing field in technical textiles. The hygiene products have immense market potential. The medical textile industry has diversified with new products and innovative designs.

Asthma is one of the common lungs problem which affect both adult and children. Nebulization is one of the asthma treatments which deliver the medicine to patient by using face mask. A nebulizer changes liquid medicine into a fine mist to let the patient breathe it into the airways. In the nebulizer treatment patient feel skin irritation with the plastic face mask. It is also considered unhygienic. The present study aims at studying the patients' difficulties regarding the plastic nebulizer face mask and based on their opinion, design and develop a fabric face mask.

The starch finish on the fabric face mask gives it the shape and appearance similar to molding type face mask. Dip and dry method was selected to give starch finishing on designed fabric face mask. Usually, particles present in the starch have gum substance which makes the yarns tight over the surface of the fabric and not allow the air to pass through freely. This aids in full uptake of medicine which is in mist form.

### 2. Methodology

#### 2.1 Patients' view on current plastic nebulizer face mask

In order to study the practical difficulties faced by the patients during nebulizer treatment, a self-administered questionnaire was prepared and patients' opinion was collected. Most of the asthma patients, both children and adult, expect changes in nebulizer plastic face mask currently used in the hospitals. Mainly, the patient asked for texture changes. Asthma patients did not ask for any shape changes but they demand for soft, light weight and

disposable nebulizer face mask. Table 1 below shows the patients' opinion on plastic face mask and their expectations.

**Table 1:** Patients' feedback on plastic nebulizer face mask

S. no.	Feedback on plastic face mask	% of respondents
1	Face difficulties while usage	95%
2	Causes skin irritation	92%
3	Expect changes	95%
4	Expect smooth surface and weightless mask	72%
5	Expect for texture change	80%
6	No change in shape	77%
7	Expect fabric face mask	100%
8	Expect disposable face mask	100%

**2.2 Selection of fabric**

To design the face mask 100% cotton (twill weave) woven fabric was selected. Cotton fabric is flexible and is easy to handle. Cotton fabric is suitable to design face mask but at the same time fabric face mask should not allow leakage of medicine. So, twill weave fabric with close construction was chosen. There are many benefits to a twill fabric. Twill has better ability to resist as well as recover easily from wrinkles and creases. Also, the pattern of twill naturally gives it an appealing, interesting look. Another huge benefit of twill is that it increases the sturdiness of the fabric.

**2.3 Design and construction details of fabric face mask (adult and children)**

While designing nebulizer face mask, two different sizes – one for adult and one for children – were considered for proper fitting of the face mask on the patient. The design of the plastic nebulizer face mask available in the market was adopted. The shape of the plastic face mask is traced by paper. The pattern was created for fabric by using tracing paper. The face mask is designed and constructed by using the pattern. Separate fabric face mask was constructed for children and adult as follows:

Adult Face Mask  
Length - 13cm  
Width - 12cm

Children Face Mask  
Length - 12cm  
Width - 8cm



**Fig 1:** Plastic face mask



**Fig 2:** Fabric face mask

**2.4 Selection and extraction of starch**

The method used for extraction of starch from tapioca is sundry method. Fresh tapioca tubers were collected and washed in fresh water. The outer brown skin was removed and the inner part was cut into small chips. These chips were dried under direct sunlight for three consecutive days. After complete drying, the chips were ground into a fine powder and sieved. Then the starch powder was stored in an airtight container.

500ml of soft water was taken in a pan and 100gm of starch powder was added into the water and mixed thoroughly. The mixture was brought to boiling state and kept stirring for 15 minutes. After 15 minutes starch paste is obtained. The starch paste was allowed to cool.

**2.5 Finishing of starch on designed fabric face mask (dip and dry method)**

The designed children and adult fabric face masks were immersed in the starch paste for 1 hour. The face masks were dried under direct sunlight. The starch finished fabric face masks were stores in airtight polybag.

**2.6 Collection of feedback on fabric nebulizer face mask**

The asthma patients, selected for the study, were given with the developed fabric face mask for nebulizer treatment. The feedback about the fabric face mask was collected from the same 60 asthma patients in the asthma clinic.

**2.7 Costing for designed fabric face mask**

1 meter cotton twill weave fabric cost = Rs.150

**Table 2:** Costing of fabric face mask.

	Children mask	Adult mask
1 meter cloth	31 small mask can be stitched	25 big mask can be stitched
Per mask	Rs.4.90	Rs.6
Stitching charge	Rs.10 per mask	Rs.10 per mask
Starch	Rs.1	Rs.1
Designedmask cost	Rs.16 per mask	Rs.17 per mask
Selling cost	Rs. 19/-	Rs. 20/-

**3. Results and Discussion**

**3.1 Collection of feedback on the developed fabric face mask**

The following tables 3.1 and 3.2 show the patients' feedback on the developed face mask.

**Table 3.1:** Patients' feedback on fabric face mask

S. no	Feedback on fabric face mask	Excellent	Very good	Good
1	Overall rating of fabric face mask	35%	30%	35%
2	Comfort level of fabric face mask	30%	28%	42%
3	Texture of fabric face mask	25%	40%	35%
4	Good feel while usage	28%	45%	27%
5	Hygiene of fabric face mask	67%	23%	10%

**Table 3.2:** Patients' feedback on fabric face mask

S. no	Feedback on fabric face mask	Yes	No
1	Cost of face mask is reasonable	98%	2%
2	Any difficulty using fabric face mask	0%	100%
3	Willingness to reuse fabric face mask	70%	30%

**3.2 Physical assessment of unfinished and finished fabric**

The fabric chosen for face mask construction have been tested for some physical properties before and after application of starch finish. The results are tabulated below:

**Table 4:** Physical properties of the fabric

S. no	Test	Unfinished fabric	Finished fabric
1	Fabric weight (GSM)	230.6	234.4
2	Fabric thickness (mm)	0.46	0.514
3	Fabric stiffness (g cm)	9.097	17.692
4	Fabric strength (kgf)	23.18	27.33

From the above table 4 it is pragmatic that weight, thickness, stiffness, and strength of the starch finished fabric are higher than unfinished fabric. Hence, these are the evidences for improvement or modification of the fabric properties so that it is suitable for making nebulizer face mask.

#### 4. Conclusion

Now-a-days, people around the world are shifting their focus towards the use of eco-friendly products and adopt more natural way of life. Most of the health care and hygienic products were non-biodegradable which cause environmental hazards and human health hazard with several side-effects leading to numerous diseases. Textile material is easily disposable and bio-degradable. The above study interprets that the recent trend is the use of disposable products to control the cross infection from one person to another person. The recent approaches that are dealing with non-biodegradable products like plastic are taking a back step leaving the eco-friendly and disposable products forward.

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