Use of Nonwoven textiles in surgical mask: A perspective

Chinta SK1,2, Shridhar Dhumal2

1. Professor, D.K.T.E Society’s Textile & Engineering Institute, Ichalkaranji (MS) 416115, India
2. Research Scholar, D.K.T.E Society’s Textile & Engineering Institute, Ichalkaranji (MS) 416115, India

*Corresponding author: Department of Textiles D.K.T.E Society’s Textile & Engineering Institute, Ichalkaranji (MS) 416115, India, e-mail: chinta.sk@gmail.com

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ABSTRACT
The medical industry is challenged by the presence of microorganisms and the negative effects they cause. Cross contamination, deterioration, defacement and odours are all dramatic effects which occur from the microbial contamination of surfaces as varied as carpeting to medical nonwoven fabrics. These surfaces can also act as a microbial “harbour” as most often ideal environments for the proliferation of microorganisms that are harmful to humans and textiles. The ability to make surfaces resistant to microbial contamination has advantages in many applications and market segments. This is especially true in medical markets where many products have contributed a higher degree of aseptic sophistication. Regardless of many precautions that hospitals take today, 5-10% of the hospital patients will develop a nosocomial infection during their study in hospital. Surfaces used in medical applications have unique microbial problems and their control is a complex task. The microbiological integrity of surfaces has been the object of numerous studies ranging from bacterial loading of carpeting to the evaluation of the barrier properties of nonwoven fabrics. For more than 70 years, the surgical mask has been used under operations as part of the maintenance of aseptic conditions in the operational field. Over the last ten years the usefulness of the surgical mask has been disputed several times, and a few controlled clinical trials have been able to confirm any benefits associated with use of surgical masks. This paper illustrates the various surgical masks used and their importance in the medical textile field.

Keywords- Technical textiles, Medical textiles, Mask, Antimicrobial property
1. INTRODUCTION

1.1. What is Surgical Masks?

A surgical mask is a medical device covering the mouth, nose and chin ensuring a barrier that limits the transmission of an infective agent between the hospital staff and the patient (Russell, S.J., 2007; Romney, M. G. 2001). It was originally developed to contain and filter large droplets of microorganisms expelled from the mouth and nasopharynx of healthcare workers during surgery, thereby providing protection for the patient.

Surgical masks, on the other hand, can be labelled as face masks, laser, isolation, dental or medical procedure masks. Surgical masks are plain masks that cover the nose and mouth and are held in place by fabric ties or with elastic straps around the ears (Huang J.T. and Huang V.J, 2007). These are generally available in two configurations, molded cup shape with an elastic cord around the head and non-molded which may be further available as a pleated or a flat paper shield with two ties or ear loops. Furthermore, pleats can be either two ply or three ply. Modern surgical masks are made from paper or other non-woven material, and should be discarded after each use.

Simple surgical masks protect wearers from being splashed in the mouth with body fluids and to prevent transmission of body fluids from the medical professional to the patient (Surgey A. Grinshpun et al. 2009). They also remind wearers not to touch their mouth or nose, which could otherwise transfer viruses and bacteria after having touched a contaminated surface (fomite). They can also reduce the spread of infectious droplets (carrying bacteria or viruses) that are created when the wearer coughs or sneezes. They are not designed to protect the wearer from inhaling such particles. They will trap some particles but are much less effective than respirators, which are designed for this purpose. Many western countries wear face masks during flu pandemics such as the swine flu (H1N1) pandemic in 2009/10, in places such as America and England people wear N95 or NIOSH masks these are different to the surgical mask as they provide better protection due to their shape and securing straps.

1.2. Why Surgical Masks is getting importance today?

Surgical masks are designed to help prevent contamination of the work environment or sterile field from large particles generated by the wearer (e.g. spit, mucous) (Romney M. G. 2001). Surgical masks may also be used to help reduce the risk of splashes or sprays of blood, body fluids, secretions and excretions from reaching the wearer’s mouth and nose.

The Association of Medical Professionals with Hearing Losses (AMPHL) has embarked on a very exciting advocacy project promoting the production of a clear face mask (Huang J.T. and Huang V.J, 2007; Surgey A. Grinshpun et al. 2009). These AMPHL members noted that standard face masks inhibit lip reading. This presented difficulties in clinical rotations and in work settings. For example, health care professionals with hearing loss often have to use caption reporters or note-takers in the operating room because they could not lip read others. Due to these difficulties, many AMPHL members have avoided working in environments where masks are used frequently. AMPHL members began to realize that a mask with see through capabilities could greatly expand their professional options, and that it could be beneficial to patients—hearing or deaf—as well. As AMPHL officers discussed their hopes with others, they heard many stories: the deaf patient who had to rely on her husband to interpret immediately after their baby was born because she could not lip read the masked health care providers, the child who was in isolation and could never see the smiles of her mother who had to wear a mask to prevent her child from getting an infection, and the child who was frightened about going to the dentist because he could not see the dentist’s face.

In fact (Angela Weber et al. 1993), the clear surgical mask patent inventor, Skip Carlson, created with the idea after his daughter was highly traumatized about going to the dentist. He hoped that this mask could "put the smile back in healthcare." Because of its wide applicability, a clear surgical mask could potentially have a huge market demand.

1.3. The design of the surgical masks

The design of the surgical masks depends on the mode; usually the masks are 3 ply/3 layers (Surgey A. Grinshpun et al. 2009). This 3 ply material is made up from a melt blown placed between non-woven fabric, the melt-blown material acts as the filter that stops microbes from entering or exiting the mask. Most surgical masks feature pleats/folds commonly 3 pleated are used allowing the user to expand the mask so it covers from the nose and under the chin. Currently there are 3 different ways to secure the masks. The most popular is the ear loop; this is where a string like material is attached to the mask and placed behind the ears. The other methods are the tie on and the head band. The tie on straps consists of four non-woven straps that are tied behind the head and the elastic strap is similar to an elastic band that is placed behind the head.

Currently several new masks are about to market new mask features. One feature is a no-strap design that uses adhesive to secure the mask to the face, leaving no gaps (Angela Weber et al. 1993). Another is a PIT mask that is
inserted up each nostril. The PIT mask is becoming more popular in western countries as the mask is not visible unlike the standard mask. Cotton and gauze masks are also available but they do not serve as surgical masks as they do not offer adequate filtration of microbes.

Surgical masks consist of following components:

a) outer layer (non-woven material)

b) filter media

c) inner layer

d) instructions and other printed information

e) outer nosepiece (flexible coated aluminum that conforms to the nose)

f) inner nosepiece (foam material to provide comfort)

g) headband (elastic rubber straps)

1. OUTER LAYER: The mask indicates when it is time to replace or clean it, perhaps by changing colour or appearance. As the mask becomes damper from breathing, it loses its protective power. Other people, especially medical care givers, get an early warning signal when a patient wearing a mask is a higher risk.

2. INNER LAYER: The mask has a way to capture moisture and drainage for people who are sick. The inner layer acts as a tissue that can be pulled away from the mask, discarded, and replaced. A common problem with masks is they get uncomfortably warm on the face. Perhaps the inner layer could provide some agent that evaporates to provide a cooling sensation.

3. FILTER MEDIA: The mask’s filter has bacteria-killing properties. It sanitizes. Perhaps it is coated with a drug (like a drug-eluting stent) to administer Tamiflu or other disease-fighting agents. The filter could aid in breathing with an asthma agent or sinus-clearing vapour (Surgey A. Grinshpun, Hiroki Haurta, Robert M Eninger, Roy T Mckay, 2009).

4. INSTRUCTIONS: The mask tells people whether the wearer is being protected or is helping to protect others (in other words, that the wearer is sick or not).

5. OUTER NOSEPIECE: The mask helps hold the person’s nostrils wider to promote better breathing (like the Breathe Right nasal strip). Alternatively, it may pinch the nose shut to prevent drainage in certain severe situations (Angela Weber, Klaus Willeke, Ron Marchloni, Roy Mckay, Jean Donnelly, 1993).

6. INNER NOSEPIECE: The mask has a way to monitor the person’s body temperature by direct contact with the skin of the nose. Perhaps it changes color or other property if a person has a temperature above a certain level (fever stage). This could trigger other functions of the mask’s components such as releasing a drug like Tylenol to reduce the fever.

7. HEADBAND: The mask is situation dependent and it adjusts as needed. On airplanes, the straps are earphones that also hold the mask comfortably in place. For people wearing glasses or an eye shield, the straps assist in holding them up. The straps integrate with other clothing like hats or hood (YingeQian, Klaus Willeke, Sergeey A. Grinshpun, 1998).

1.4. Composition and Shape

Surgical masks are mostly disposable devices, generally based on non-woven material. Cellulose material, synthetic fibres such as polypropylene (especially spun bonded polypropylene available in a variety of weights: 18g/sqm, 20g/sqm, 25g/sqm), constitute the main compositions available on the market. Some of them also contain latex but since this component can be allergic a lot of suppliers sell surgical masks by indicating clearly ‘latex free’ (YingeQian, Klaus Willeke, Sergeey A. Grinshpun, 1998). Surgical masks can be bought in different colours – blue and green surgical masks are well known, but other colours and even patterns are possible, especially good for contagious children patients.

They are available in three general configurations:

- A ‘paper shield’ that may be pleated, which has two ties for around the head and a flexible nose bridge
- A ‘flat or pleated shield’ that has ear loops
- A molded cup shape held in place by an elastic cord around the head

Surgical facemasks normally comprise three layers – a barrier layer, such as polypropylene, usually separates the inner and outer layers. The most common design is flat and pleated with horizontal ties and a metal strip shaped over the nasal bridge (Shu-Kang Chen, Donald Wesley, Lisa M. Brosseau, 1994). Masks can be found in various shapes with different features and are selected according to personal protection needs and personal preference of style and fit.
Flat-fold tie-on, duck bill, cone shaped, flat-fold with shields, and duckbill with shields is the most common styles worn in the operating room. For the choice of a surgical mask, size and flexibility for easy and frequent use are key factors.

1.5. Specification of Surgical Masks
Specifications developed by the American Society of Testing and materials (ASTM) are generally accepted as the industry standard and include the following:

a) Bacterial Filtration Efficiency (BFE) which specifies the percentage of 3.0 microns sized aerosols containing Staphylococcus aureus sized 0.8 microns which are filtered out.

b) Particulate Filtration Efficiency which specifies the percentage of aerosols of particle size 0.1-5.0 microns which are filtered out.

c) 'Separating' Efficiency tested for both solid (sodium chloride) and liquid particles (paraffin oil) which is denoted by either of the two letters, 'P' or 'N'. Swedish and European standards (SS-EN) use the letter 'P' - P3 separating 99.95% and P2 94.0% of both solid particles and oil mist. American standards use the designation 'N' which indicates that these have not been tested for liquid particles - N95 is presumed to separate 95% of solid particles only.

d) Other tests which have a bearing on the acceptability of SFMs include the Pressure Differential (Delta-P) which measures the air flow resistance of masks and is an objective measure of ‘breathability’. A Delta-P over 5.0 is uncomfortable for general use, whereas a mask with a Delta-P under 2.0 allows air movement across but is less effective. The Fluid Resistance (FR) reflects the mask’s ability to transfer fluids from the outer layers to the inner layer as the result of a splash or spray. ASTM specifies testing with synthetic blood at pressures of 80, 120 or 160 mm of Hg to qualify for low, medium or high fluid resistance.

2. CONCLUSION
A mask is indispensable for the prevention of air-borne infection and droplet infection (Fred R. Becker, 1971). A mask is defined to be used for a patient with such an infections disease not to diffuse the particulates containing organisms that may diffuse at the time of coughing or sneezing by wearing a mask. (William H. Bird, 1974) Today, facial protection devices are available with a wide range of features, fit, efficiency and elements of performance to meet the challenges faced by the changing demands. Better protection, through the use of improved facial protection devices, an understanding of the applicable regulations and guidelines; and the implementation of effective policies and procedures, is essential to reduce the risk of occupational exposure and infectious disease transmission for all preoperative personnel.

REFERENCE