

# Medical Textiles: Healthcare and Hygiene Products



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## Abstract:

An important and growing part of the textile Industry is the medical and related healthcare and hygiene sectors. The number of applications range from the simple cleaning wipe to the advanced barrier fabrics used for operating rooms. New cost-effective ways to protect both hospital staff and their patients from bacteria; viruses and body fluid invasions in operating room environments are being developed. This paper reviews the healthcare and hygiene products used extensively today.

## Introduction:

An important and growing part of the textile Industry is the medical and related healthcare and hygiene sectors<sup>2</sup>. Textile has always been a part of healthcare<sup>10</sup>. The range of products available is vast but typically they are used in the operating room theatre or on the hospital ward for the hygiene, care and safety of staff and patients. The number of applications range from the simple cleaning wipe to the advanced barrier fabrics used for operating rooms<sup>2</sup>.

Production of hygiene and medical textiles is on increase, as is the variety of applications in this important sector. By 2005, hygiene and medical textiles valued at US\$4.1 billion are predicted to account for 1.65 Mt (almost 12%) of the global technical textiles market<sup>8</sup>.

The medical textile products can be organized into three basic categories – patient specific, general patient management and procedure specific. The patient specific items include sponges, sheets, burn sheets, etc. Under-pads, adult diapers and wipes are supposed to be patient management products. The third category of procedure specific products include sterilization wrap, surgical gowns, drapes, table covers, face masks, head and shoe covers.<sup>1</sup>

An unorganized sector of manufacturers has been catering largely to the third and the biggest segment of the healthcare and hygiene products. Here too MNCs like Johnson & Johnson, Smith & Nephew, Kimberly Clark and Beiersdorf are the major players as they manufacture special type of bandages and wound care products compared to the simple ones made by Indian Companies<sup>10</sup>.

Manufacturers of textiles for medical applications know the challenges and the need to develop new cost-effective ways to protect both hospital staff and their patients from bacteria; viruses and body fluid invasions in operating room environments have occupied research labs and testing facilities for the last few years.<sup>11</sup>

## Products:

The healthcare and hygiene products are as follows:

**Medical and Pharmacy division:** Adult Incontinence pads, Rectangular pads, shaped pads, urine collector and bag, feminine maternity pad, cotton mesh maternity pads, nursing wipes, gauze, wound dressing, surgical drapes, gowns, plaster, face mask, operation room table and tray covers, head wear, under pads, X ray gowns, scrub suits, barrier and isolation gowns, patient exam gowns, ostomy bag, super absorbent fabrics, etc. are some products in this division.



**Table 1: Product Application**

Product Application	Fiber Type	Manufacture System
<b>Surgical clothing</b>	<b>Cotton, polyester, polypropylene</b>	<b>Non woven, woven</b>
<b>Gowns</b>	<b>Viscose</b>	<b>Non woven</b>
<b>Caps</b>	<b>Viscose, polyester, glass</b>	<b>Non woven</b>
<b>Masks</b>		
<b>Surgical covers</b>		
<b>Drapes</b>	<b>Polyester, polyethylene</b>	<b>Non woven, woven</b>
<b>Cloths</b>	<b>Polyester, polyethylene</b>	<b>Non woven, woven</b>
<b>Bedding</b>		
<b>Blankets</b>	<b>Cotton, polyester</b>	<b>Woven, knitted</b>
<b>Sheets</b>	<b>Cotton</b>	<b>Woven</b>
<b>Pillow cases</b>	<b>Cotton</b>	<b>Woven</b>
<b>Clothing</b>		
<b>Uniforms</b>	<b>Cotton, polyester</b>	<b>Woven</b>
<b>Protective clothing</b>	<b>Polyester, polypropylene</b>	<b>Non woven</b>
<b>Incontinence diaper/sheet</b>		
<b>Cover stock</b>	<b>Polyester, polypropylene</b>	<b>Non woven</b>
<b>Absorbent layer</b>	<b>Wood fluff, super absorbents</b>	<b>Non woven</b>
<b>Outer layer</b>	<b>Polyethylene</b>	<b>Non woven</b>
<b>Cloths/Wipes</b>	<b>Viscose</b>	<b>Non woven</b>
<b>Surgical Hosiery</b>	<b>Polyamide, polyester, elastomeric yarns, cotton.</b>	<b>Knitted.</b>

#### Textile materials used in the operating theatre and emergency rooms:

These include surgeon's gowns, caps and masks, patient drapes and cover cloths of all sizes. The purpose of protective healthcare garments is to protect healthcare professionals from contamination from blood and other infectious fluids. Biological protective garments are defined by the Occupational Safety and Health Administration (OSHA) as follows: 'Personal protective clothing will be considered appropriate only if it does not permit blood and other infectious materials to pass through to reach a employee's work clothes, street clothes, undergarment, skin, eyes, mouth or other mucous membranes under the normal conditions of use and for the duration of time the protective equipment will be used. According to this definition, there are two basic requirements for a protective textile garment: it should prevent infectious materials from passing through the skin and it should last long enough. Protective apparel in the medical field should be affordable, breathable, comfortable, dependable, and effective<sup>3</sup>. Coating and Laminating technologies that lead to the development of lighter, comfortable, more protective clothing for superior protection of operating room staff and patients are being used in Canadian hospitals.<sup>11</sup>

#### Barrier fabrics:

It is essential that the environment of the operating theatre is clean and a strict control of infection is maintained. A possible source of infection to the patient is the pollutant particles shed by the nursing staff which carries bacteria. Surgical gowns should therefore act as a barrier to prevent the release of pollutant particles into the air<sup>2</sup>. Barrier requirements can be partial (resistant) or total (proof) ranging from particulates and bacteria to fluids and viruses. In general, a hydro head of > 40 cm is required to compete in this market. To date, the only products that consistently pass the viral barrier test are fabrics reinforced with impervious film. For sterilization wraps, % BFE tests with Staph aureus are > 85% for SMS and <80% for wet -laid fabrics. Efforts to reduce and control the level of bacterial particles in the O.R. environment have focused on engineering of ventilation systems and improving the types of garments worn by O.R. personal<sup>1</sup>.

With the rapid increase in blood borne diseases, such as hepatitis C and HIV, the need for medical workers to wear garments that provide a barrier to fluids such as water, blood and alcohol have become critical. These items can be in the form of simple slip-on body covers and instrument wraps to complex 3-D shapes such as masks. The major requirements for barrier fabrics are that they resist the penetration of liquids, particularly blood and at the same time be

sterile, breathable, flexible and inexpensive. Because of these requirements most of the barrier garments are made from non woven fabrics that are relatively inexpensive and can be thrown away after each use, thus reducing the need for re-sterilization. In some cases special breathable films are being added to fibres and fabrics. In other cases, ingredients are being added directly into polymers being used to make the fibres<sup>14</sup>. Theatre drapes are intended to form a barrier against infection both to and away from the patient. The complex series of requirements for such a product are as follows:

- The material should constitute a barrier to moisture and bacteria. For drapes, the material should be:
  - a) plasticized;
  - b) laminated or partly laminated with a plastic sheet
  - c) treated to render it water- and moisture-repellant or impermeable.
- The material should be steam-sterilizable. In the case of wraps, it should be steam permeable.
- The material should not allow bacteria to penetrate through. One must quantify the time of penetration if, any.
- The material must be able to withstand prolonged handling and lengthy procedures.
- The material should have a non-slip surface.
- It must have passed flammability tests.
- It must be tough and waterproof when wet.
- It must be flexible, draping smoothly on application, readily conforming to the patient's shape.
- Any dyes used must be fast and non-irritant.
- The colour used must not cause any glare to the eyes. Autoclave tape must be removed without tearing the drape.
- The material must be able to hold towel clips without tearing.
- The drape must be easy to apply – no complicated folding needed – and clearly marked with instructions for unfolding.
- It must be easy to adjust or extend the opening.
- The drape should not give rise to wetness or sweat from the patient's skin.
- The material must comply with anti static requirements.
- The price must be economical when compared with equivalent items.
- The drape must not be produced to the exact requirements.
- The material should be burnable.
- Assurance of delivery is necessary.
- The material should be lint-free.

Several non-woven fabric constructions are considerations for this application, including wet-laid materials, which may be scrim-reinforced, and dry –laid viscose fabrics of around 60 g/m<sup>2</sup>, often laminated to a polyethylene barrier layer. Random-laid structures are less prone to tearing away by clips. Similar fabric requirements are necessary for other hospital applications such as variety of gowns, masks and caps. Less critical end uses include sheets, pillow cases, bibs, over shoes and wipes<sup>7</sup>.

#### **Sterilization wrap:**

Single room sterilization wraps also called as (Central Supply Room) wraps are sold as flat sheets made to specific sizes. The use is primarily for wrapping trays and large instruments in the hospital central supply room.<sup>1</sup>

#### **Gowns, Drapes and Caps:**

Gowns come in a variety of designs such as unreinforced and reinforced. Performance features are tear resistance, fluid barrier, abrasion resistance and breathability. Drapes are sold as flat folded sheets with film backing in most cases and a variety of special pads and backings.<sup>1</sup>

### **Incontinence care products:**

The word “incontinence” means an unplanned occurrence of the bladder and bowel functions. Incontinence is not a rare condition. Products for such conditions may be in the form of mattress protector. The soft polyester and bottom absorb all the moisture while the vinyl centre prevents the passage of fluids. Dignity pants with wide dry-guard barrier panel for secure leak proof and bowel protection made of polyester and cotton. Developments include a belt fixing arrangement, use of short fibre, air laid cellulose and super absorbent cores used in products used for light incontinence<sup>5</sup>.

In general, the design challenges for adult incontinence products are considered to be similar to infant diapers and market segment considered to be relatively small<sup>1</sup>. The disposable diaper is a composite article consisting of an inner covering layer (cover stock), an absorbent layer and an outer layer. The inner covering layer is either a longitudinally oriented polyester web treated with a hydrophilic finish, or a spun laid polypropylene non woven material. A number of weft and warp knitted pile or fleece fabrics composed of polyester are also used as a part of a composite material which include foam as well as PVC sheets for use as incontinence mats<sup>19</sup>.

With the continuing growth in the market for adult incontinence products, the amount of body fluid to insult a diaper is required to withstand has created more stringent performance criteria for wicking of cover stock surface.

### **Cloths and wipes:**

Are made from non woven bonded fabrics which may be soaked with an antiseptic finish. The cloth or wipe<sup>17</sup> may be used to clean the wounds or the skin prior to wound dressing application, or to treat rashes or burns<sup>2</sup>.

### **Surgical Hosiery:**

With graduated compression characteristics is used for a number of purposes, from a light support to the limb, to the treatment of venous disorders. Knee and elbow caps that are generally shaped during knitting or circular machines, and may also contain elastomeric threads, are worn for support and compression during physically active sports, or for protection<sup>2</sup>.

### **Masks:**

The medical face masks market, representing 6% of yardage consumption in the US market, is a \$60-plus million market, worldwide. The opportunity here is for inner and outer linings, filtration media and the ties<sup>1</sup>.

### **Materials used:**

There are many applications for non woven textile products in the medical and healthcare sectors. Non wovens have distinct advantages over more traditional forms of fabric formation as they can be manufactured directly from fibres at relatively lower cost. The non woven method is therefore suitable for the production of disposable products, which contribute greatly to the high levels of hygiene required in medical applications by limiting the incidence of cross infection.<sup>4</sup> An extensive product line of disposable non woven is now available for products which require liquid barrier protection, absorbency, filtration efficiency, softness, etc. A dramatic increase in the rise of reusable linen products resulting from a rise in labour costs and a greater awareness of hygiene issues have increased the use of non woven disposable products.<sup>4,5</sup> Adhesive bonded non woven fabrics are majorly used for hospital usage and sanitary applications, including nappy liners and complete throwaway items. It is these areas that disposables are established on the basis of practicality and hygiene. The development of low bulk density non-woven fabrics helps to achieve the cloth-like characteristics for surgical-care products, such as softness, opacity, substance, surface texture, absorbency, low static, comfort, acoustic deadness, porosity and improved liquid holding capacity, and fast drainage<sup>7</sup>.

## **Sterilization Stability:**

Sterilization is the process used to inactivate microbiological contaminants and thereby transform the non sterile items into sterile ones<sup>6</sup>. It is essential for hospital applications that sterile products are employed, and there are various techniques by which this can be achieved. Sterilization by steam, dry heat, ethylene oxide, and irradiation process are used depending on the product type and fibre characteristics. A sterilization process can bring about changes in properties as strength, absorbency and appearance<sup>7</sup>.

Many hospitals have added peroxide plasma systems, such as STERRAD, to their standard steam autoclaves and ethylene oxide chambers in the Central Supply Room. When designing fabrics for sterilization it is essential to understand the impact of sterilization procedures on fabric performance features. In the U.S., steam autoclaves generally operate at 250-270<sup>0</sup> (121-132<sup>0</sup>C). In Europe, flash sterilization temperatures up to 138<sup>0</sup>C have been proposed in respect to concerns about Jakob-Cruze Disease. The polymer selection must be made with this type of temperature exposure in mind. <sup>1</sup>

## **Antimicrobial textiles:**

Treated textile articles can include medical textiles such as pads, face masks, surgical gowns, ambulance blankets, stretchers, filter materials and diapers<sup>9</sup>.

## **Antimicrobial fibres:**

High performance fibres have been developed which prevent hazardous bacteria from build up and will find applications in the fields of personal hygiene where build up of dangerous bacteria can be hazardous to health: the fibre basically contains a combination of antimicrobial compounds, based on metallic salts which ultimately controls bacteria and fungi. The compounds are embedded in the matrix of fibres which renders it impervious to washing and wear<sup>15</sup>.

## **Testing of healthcare garments:**

Laboratory tests include water repellency, launderability (if recyclable), burst strength and tear strength. The design of barrier fabrics is driven by the concern over HIV. Therefore for these fabrics test methods that would assist in the characterization of products as blood-resistant, blood proof or viral proof. These methods have been established as ASTM 1670-95 and 1671-97.

The demand wettability method of measuring the absorbency characteristics of fabrics have been described by Lichstein. This technique measures both capacity and absorption rate simultaneously at zero hydrostatic head. It is applicable to different absorbents, wicking fluids and multiple-ply structures with the absorbent at any angle to the fluid and under different pressures<sup>7</sup>. Other textile products used in hospitals include bedding, clothing, shoe covers, mattress covers, etc.

## **Current Issues:**

### **Transmission of blood borne diseases to healthcare workers**

The main issue in the design and use of operating room fabrics can be protection of the patient from contamination by the environment and by health-care workers, as well as the preservation of sterility of the instruments used in invasive procedures. With escalating concerns over AIDS and hepatitis, the requirement for protecting health care workers from contamination by the blood and body fluids of patients has been raised to equal status. <sup>1</sup>

## **Summary:**

With the spread of HIV and other blood borne diseases, the importance of protecting medical personnel is growing which demands development of more effective protective textiles. Needle sticks and sharp objects are the main causes for infection of medical professionals by HIV. Current focus is on development of protective materials that will prevent penetration of needles and sharp objects. Proper sealing of seam areas is critical.

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