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*Review Article*

# Surgical gown fabrics in infection control and comfort measures at hospitals

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Emerging illnesses like Ebola hemorrhagic fever, hepatitis B and C, SARS and, most recently, the Covid-19 pandemic have underlined the importance of wearing personal protective equipment. Aprons, gowns, coveralls, masks or respirators, and goggles are examples of personal protective equipment. Surgical gowns, which are worn in the surgery room by doctors and nurses to prevent the transfer of germs and bodily fluids from surgical staff to patients and from patients to staff, are an important part of personal protective equipment in healthcare. Surgical gowns are originally constructed of cotton fibres, but modern gowns are made of a range of woven and nonwoven textiles, which may be reusable or disposable. Surgical gowns must control the spread of infections, while simultaneously allowing appropriate comfort, mobility without rubbing and chafing, resisting ripping and linting. A proper understanding of the parameters that affect the barrier properties is needed to design a surgical gown for desired use. This paper discusses various types of surgical gowns, their classification, parameters affecting the properties and the test methods used in surgical gown testing.

**Keywords:** Comfort measures, Cotton, Nonwoven, Surgical gown, Woven

## 1 Introduction

Surgical gowns introduced in late 1800's are used as protective clothing in the operating theatre to protect both the patients and the operating room staff from transmitting pathogens, body fluids and particulate debris; and therefore, they reduce the incidence of hospital acquired infections[1-6]. Smith and Nichols[7] defined surgical gown as an aseptic barrier made of any type of material placed between the operative incision and the possible source of bacteria. The first sterilized surgical gown made up of $140^s$ cotton, was considered to be acceptable because of its good permeability to air, softness, light weight and comfort. But, $140^s$ cotton fabric was suitable as a bacteriological barrier only in dry state since it lost its barrier properties after becoming wet[8]. Moylan and Balish[9] found instances of bacteria penetrating even in dry conditions. So, the use of traditional cotton gowns decreased significantly. In 1955 a disposable nonwoven single use surgical gown was introduced. Earlier research shows that this disposable gown was effective in preventing bacterial transmission because of smaller pore construction than the traditional one. Subsequently, nonwoven disposable gowns replaced the traditional reusable cotton gowns. Currently nonwoven fabrics constitute 80% of material used in the healthcare and hygienic sector. Over three billion yards of nonwoven fabrics are used in the U.S on an average every year for disposable and healthcare products, which costs $ 1.5 billion dollars. Sun *et. al.*[10] found that an average of three billion square yards of nonwoven fabric is consumed for surgical textiles each year. Technological breakthrough in 1980s led to washable medical textiles with better barrier protection, comfort and low flammability[11].

Several organizations have made recommendations on how to protect surgical staff as well as patients from exposure to blood borne pathogens and bacteria. The Center for Disease Control (CDC) proposed that surgical gowns and drapes, either disposable or reusable, should be impermeable to liquids and viruses and be comfortable to the wearer. The Association of Operating Room Nurses[12] suggested that the fabrics used for gown and drapes must minimize passage of bacteria from non-sterile to sterile areas and resist liquid transmission, abrasion, and punctures. The Association of Operating Room Nurses proposed rules to minimize occupational exposure to HBV, HIV and other blood borne pathogens through appropriate protective clothing. The type of clothing needed depends on the occupation task and degree of exposure. Liquid resistance gowns must be worn when the surgeons become contaminated through splashing of blood and other liquids. The protective clothing should not

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Table 1 — Characteristics to be evaluated and performance requirements for healthcare textiles (EN 13795-2: 2019)[16]

| Characteristic | Test method | Unit | Requirement | |
|---|---|---|---|---|
| | | | Standard performance | High performance |
| Microbial penetration (Dry state) | EN ISO 22612 | CFU | ≤ 100[a] | ≤ 50[a] |
| Cleanliness microbial / Bioburden | EN ISO 11737-1 | CFU/ 100 cm$^2$ | ≤ 100 | ≤ 100 |
| Particle release | EN ISO 9073-10 | log10 (Lint count) | ≤ 4.0 | ≤ 4.0 |
| Bursting strength (Dry state) | EN ISO 13938-1 | kPa | ≥ 40 | ≥ 40 |
| Tensile strength (Dry state) | EN 29073-3 | N | ≥ 20 | ≥ 20 |

[a] Test conditions- challenge concentration 108 CFU/g talcum and 30 min vibration time.

permit blood and other body fluids to reach or pass-through surgeon's clothes, undergarments, skin, and eyes under normal condition of use and for the duration of operative procedure [7,13-14].

In the United States, personal protection equipment (PPE) used in health care is classified as Class I (low risk), Class II (moderate risk), or Class III (high risk). According to the US Department of Labor, healthcare workers (HCWs) working in a high-risk group are required to wear four sets of PPEs each day, changing every six hours. These sets contain an N95 mask (with an exhalation valve), a gown, googles, and double gloves. Similar PPEs are required for Class II, but the requirement is reduced to two sets per day, i.e. 12 h of duration for medium and low-risk PPEs. Class I personal protective equipment includes a surgical mask, an apron, and gloves[15]. Numerous organizations have produced standards for the appropriate use of personal protective equipment (PPE) in healthcare environments, including isolation gowns. According to European medical device directive, PPEs are classified as surgical gowns, surgical gloves, examination gloves, face masks, and eye protection eyewear equipment. PPEs are classified into three risk categories for PPEs, ranging from Class I to Class III on a low-to-high risk index. The EN 13795-2: 2019 standard provides information on the characteristics of protective clothing used as medical devices for healthcare professionals, which is designed to prevent the spread of infectious microorganisms between healthcare staff and patients during surgical and other invasive operations[16] (Table 1).

In order to classify the barrier effectiveness, the Association for the Advancement of Medical Instrumentation (AAMI) published an advice sheet on gown selection and categorization criteria for barrier protection. PB70:2003 Liquid Barrier Performance and Classification of Protective Apparel and Drapes Intended for Use in Health Care Facilities[17]. The new AAMI standard (PB 70:2003), consists of four classification levels (Table 2). Using these classification levels, manufacturers are able to label their products according to the level of protection their product provides. Also, healthcare workers are able to easily identify the level of protection that the product provides. This standard covers all surgical gowns and other protective apparel.

Table 2 — AAMI protection levels for protective clothing for healthcare and hygiene applications

| Level | Test | Result |
|---|---|---|
| 1 | Spray impact penetration test (AATCC 42) | ≤ 4.5 g |
| 2 | Spray impact penetration test (AATCC 42)<br>Hydrostatic head test (AATCC127) | ≤ 1 g<br>≥ 20 cm |
| 3 | Spray impact penetration test (AATCC 42)<br>Hydrostatic head test (AATCC127) | ≤ 1 g<br>≥ 50 cm |
| 4 | Synthetic blood test (ASTM F1670)<br>Bacteriophage test (ASTM F1671) | Pass<br>Pass |

Table 3 — New defined levels of protection for surgical environment

| Protection level | Risk factor | Target area of uses |
|---|---|---|
| Level 1 | Low risk | • Routine care<br>• Standard isolation<br>• Visitor cover gown<br>• Typical medical ground |
| Level 2 | Low danger | • During blood collection<br>• Suturing<br>• Intensive care unit (I.C.U.)<br>• Pathology labs |
| Level 3 | Moderate risk | • Arterial blood draw<br>• Insertion of intravenous (IV) line in emergency room<br>• Trauma room |
| Level 4 | Considerable danger | • During lengthy, fluid-intensive operations or surgery<br>• During Non-airborne |

During the 2014 Ebola epidemic, there was a greater lack of awareness about the performance of protective garments used in health care, and a similar situation was faced by healthcare workers in the recent Corona pandemic. Table 3 outlines the new terminology for barrier protection levels of gowns and other protective clothing for use in healthcare facilities.

Apart from barrier protection, surgical gown should also provide comfort to surgeons. It should provide sufficient heat transfer during the surgical process, because if the surgeon feels too hot, he may not be able to perform the task effectively. The length of the operation time and the difficulty of the surgical operation may also affect the comfort of surgeons. Therefore, the surgical gowns must also provide breathability to avoid the accumulation of perspiration and therefore hyperthermia[18-19].

## 2 Types of Surgical Gowns—Reusable and Disposable

Surgical gowns are of two types, namely reusable and disposable. Reusable gowns are made from woven fabric and often contain cotton, polyester or a blend of these two fibres in plain weave or trilaminate construction. Trilaminate fabrics are composed of a microporous membrane between layers of woven polyester and knitted polyester. The reusable surgical gowns are laundered and sterilized after use in order to remove stains and kill bacteria. The greater advantages with reusable surgical gowns include less solid waste from limited disposal and more comfort to the wearer. However, they lose durability and barrier protection after repeated washing[20]. Laufman *et.al.*[21] observed that reusable Pima cotton fabrics treated with a water repellent finish did not allow bacterial transmission even after 55 laundering cycles. Khomarloo *et. al.*[22] studied the bacterial penetration performance of surgical gowns made of a single layer fabric of 234 g/m$^2$ (86/14 viscose/polyester) and a three-layer fabric of 218 g/m$^2$ [outer layer (plain weave) + middle layer (breathable liquid barrier membrane) + inner layer (warp knitted tricot 99/1 polyester/carbon)]. After 70 laundering and sterilizing cycles, they concluded that three-layer gowns provide superior protection, have a barrier index of 6, and can be worn for extended surgery hours. Single-layer gowns with a low barrier index and a high cumulative penetration ratio are not recommended for lengthy operations[21]. Absorbency of the fibre plays an important role in the transmission mechanism involved. Highly absorbent fibres halt the movement of bacteria to a limited extent by trapping it within the fibre structure. Low absorbent fibres repel water-based liquids but allow wicking along the fibre surface, enhancing capillary movement of bacterial containing liquid. Cotton reusable surgical gowns are usually more comfortable than surgical gowns made from other fibre contents because of its better water vapor transmission which enables water to wick from surgeon's skin. Development of micro fibres and ultra-fine fibres has led to meet the high specifications of barrier fabrics, by increasing the surface area of the fibres and thereby trapping the pathogens within the structure. Polyethylene or polyurethane membranes/coatings are also used sometimes to increase the barrier performance, which make the fabrics completely impervious and therefore uncomfortable during long procedures[22-23].

Few studies reported that reusable fabrics allowed some liquid penetration and bacterial transmission but disposable fabrics with an impervious layer prevented liquid penetration [15,24]. The disposable surgical gowns are made from a variety of nonwoven fabrics with the most common being a spun bonded/melt blown/spun bonded (SMS) polypropylene composite, polypropylene spun-bond or wood pulp/polyester spun-lace construction. Figure 1 shows the disposable surgical gown of SMS construction. The SMS nonwoven fabric consists of two outer spun-bond webs that act as the load bearing layers and a melt blown web (M) sandwiched between two spun-bond webs (S), acting as filter or a barrier. The melt blown layer contains micro fibres web and these finer fibres

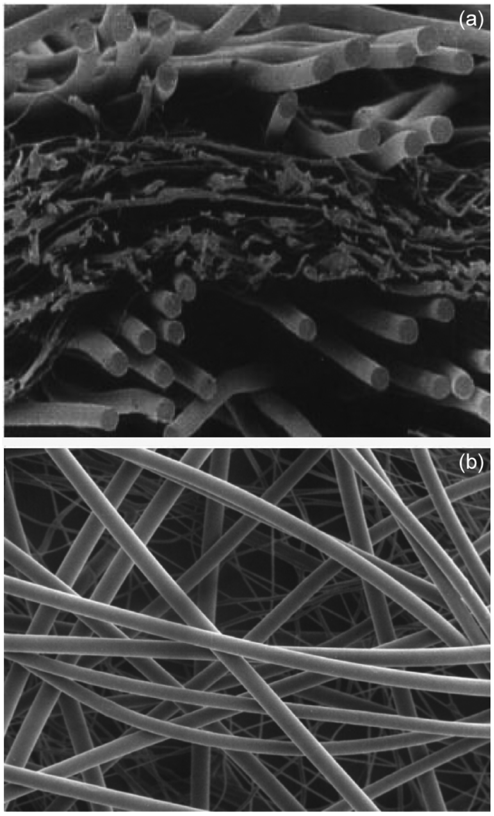

Fig. 1 — (a) Cross-sectional and (b) top view of SMS structures

(1-3 μ as compared to 10-20 μ for spun-bond layer) have higher surface area and the finer pore size distribution, and acts as liquid barrier layer. Higher number of layers, greater surface area and finer pore size distribution in the melt blown layer produced by the micro denier fibres offer greater resistance to the passage of pathogens. For greater barrier protection, the number of spun-bond or melt-blown layers can be increased to make them SMMS, SMMMS or SSMMMS[2, 19, 24].

Midha *et. al.*[25] studied the suitability of surgical gowns utilizing polypropylene fibre based spun-bond, SMS, and spun lace fabrics weighing 35 g/m$^2$ and 50 g/m$^2$. It was reported that the SMS fabric complies with AAMI requirements and offers level 2 protection. In comparison, spun bond and spun lace fabrics offer only level 1 protection, without any chemical finishes. However, the barrier resistance of fabrics improved, when the fluorochemical finishes and antibacterial finishes were applied. SMS fabric with a fluorochemical finish (Apexial waterproof 268) of 4% and 7% and a 1.5 % antibacterial finish (Zycrobial quaternary ammonium salt-based compound) gives level 4 protection. Further, they reported that single-layer fabrics (spun bond) require a higher fluorochemical finish (4%) than multilayer fabrics (SMS), which require only 1% fluorochemical finish to obtain level 2 protection.

Disposable surgical gowns offer a wide range of advantages over reusable, such as they don't require washing after use as the reuseables; they are already sterilized prior to use; by adding a breathable finish, they can be made impermeable to bacteria. In addition, although a plastic film (polyethylene or polyurethane coatings) added to disposable fabrics can increase protection, it could make the fabric bulky, uncomfortable to the wearer and increase the problems for disposal. Aslan *et. al.*[26] conducted wear trials on two reusable and two disposable surgical gowns to evaluate their comfort and microbiological prevention. They observed that the microfibre polyester woven gown had the best thermal comfort and microbiological resistance outcomes based on subjective wear trials and microbial resistance tests. Even though disposable nonwoven gowns had higher permeability and lower resistance values, they were less comfortable. The subjective evaluation in Aslan's case study is given in Fig. 2.

Reusable polyester microfibre and polyester/cotton woven gowns (1 and 2) perform better than disposable nonwoven textiles (3 and 4) in terms of comfort evaluation findings. The polyester microfibre gown (1) was found to be more comfortable than the spun-lace gown (4),

The problems associated with disposable fabrics are cost, risk of contamination with disposal outside of the hospital setting, and other environmental issues related to disposal. From the cost point of view, reusable gowns have higher initial costs as compared to disposables, but the cost per use is less for reusables. Aslan *et. al.*[26] recommended the use of biodegradable fibres for the production of disposables to reduce the environmental concern. While selecting the appropriate material, it is critical to prioritise the barrier property against bacteria. Additionally, it is critical to evaluate their resistance to moisture, abrasion, and ripping, as well as the fabric's linting and comfort.

Besides above, numerous medical textiles have been made in recent years using novel techniques, such as chemical treatment and nanotechnology, to help hospitals and healthcare workers stay healthy by preventing the spread of disease-causing bacteria[27-30].

## 3 Factors Affecting Liquid Barrier Properties of Surgical Gown

It is well known that wet bacterial penetration occurs as a result of liquid strike through. So, if the liquid passes through the fabric, the micro-organisms in the liquid will also pass through the fabric unless they are filtered out. Therefore, there is a direct

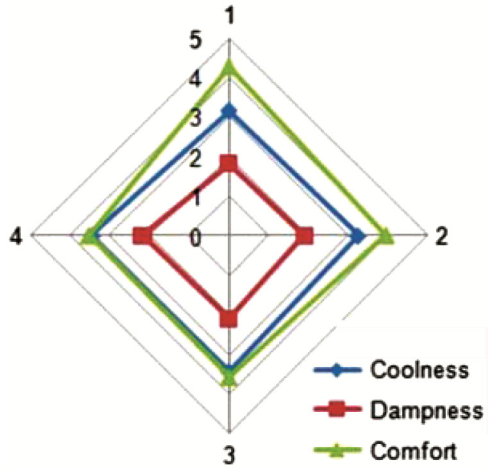

Fig. 2 — Subjective evaluation of high activity part [Fabrics: 1– 100% micro fibre polyester (reinforced woven+ membrane+ knitted); 2 – 65/35 % Polyester/ cotton (reinforced 100% polyester); 3 – SSMMS (reinforced with microporous membrane); and 4 – 55/45% cotton/ polyester spun lace bonded nonwoven (reinforced with microporous membrane)][26]

relationship between wetting by liquids and bacterial penetration in surgical gown fabrics[31,32]. The micro-organisms that are suspended in liquid can be less than one micron in diameter, while the particles in the air can carry the micro-organisms about 10 microns in diameter. Therefore, wet penetration tests are reliable means for evaluating and differentiating between barrier materials than the dry penetration test. The rate of penetration of microorganisms is directly related to the rate of liquid strike through[33].

Liquid penetration through a fabric is affected by many factors, i.e. surface tension of the liquid, its viscosity, its volume, porosity, thickness and surface characteristics of the fabric[34-35]. The interaction between liquid and textile material includes contact angle, time of exposure and pressure. Surface tension is the force acting on the surface of a liquid tending to minimize the area of the surface (Fig. 3). Lower the surface tension of the liquid, lesser is the resistance to penetration through the fabrics[36]. Figure 4 shows the surface tension data for untreated fabrics, liquids and fabric treated with hydrocarbons, silicones and fluoropolymer base water repellents. So, if the solid's critical surface tension is higher than the liquid's, the liquid will wet the cloth. The cloth will resist the liquid if the solid's critical surface tension is less than the liquid. Commonly used textile fibres have surface free energy in range of 23-72 mN/m. Surfaces that exhibit low interaction with liquids are referred to as low energy surfaces. Alcohol, blood and most other body fluids have a relatively low surface tension (20-55 mN/m at 25°C), while water and saline have a high surface tension (65-74 mN/m at 25°C). In the operating room there are many liquids which differ in surface tension; by considering this case the lowest surface tension liquid may be used for the test. For a more typical challenge the test can be done with synthetic blood which simulates the surface tension and viscosity of the human blood (~42mN/m at 25°C) [7,33-36].

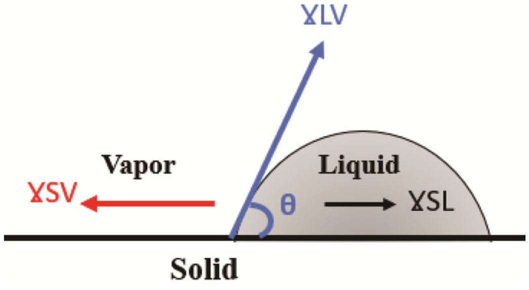

Fig. 3 — Interaction among vapour, liquid and solid surface

According to various investigations, textile fabrics, in general, have higher surface free energy than the liquids being used in hospitals, including water. Therefore, any of the textile materials is not able to restrict the passage of these liquids. The water repellency of the textile materials can be achieved with the help of chemical finishes, shown in Fig. 4. In addition to the water repellent finishes, few researchers suggested the use of antibacterial finishes to inhibit bacterial growth on the fabrics and thereby enhance the protection in levels in surgical gowns. Huang and Leonas[2] reported the application of a combined repellent and antibacterial treatment to

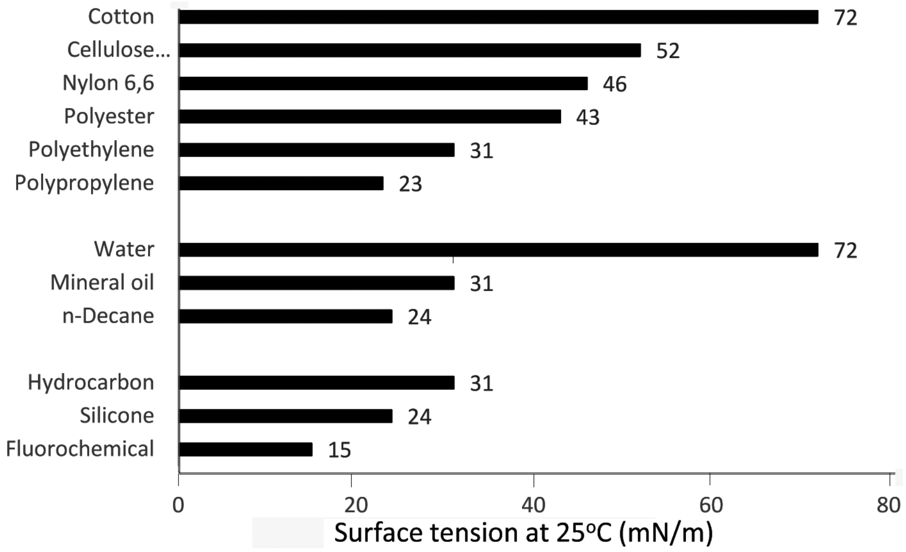

Fig. 4 — Surface tension data for untreated fabrics, stains and fabrics treated with hydrocarbons, silicons and fluoropolymer based water repellents

nonwoven surgical gown fabrics to improve their performance[22]. To enhance the repellency of a surface, the surface free energy is reduced by treating (finishing) the fabric with chemicals. Surfaces that exhibit low interaction with liquids are referred to as low energy surfaces. Fluorocarbon-based finishes are most commonly used in protective apparel for healthcare workers. This class of repellent finishes is successful in reducing the surface energy of the fabric sufficiently to repel both water and oil-based liquids. They provide a fabric that is water resistant (will shed small amounts of water) but not waterproof, so they are comfortable. Surface free energy ($\gamma_L$) of water (at 73 mN/m) is 2-3 times greater than surface free energy ($\gamma_L$) of oils (20– 35 mN/m). Therefore, oil repellency finishes with fluorocarbons ($\gamma_C$ = 10–20 mN/m) always achieve water repellency, but fluorine-free products, for example silicones ($\gamma_C$ = 24–30 mN/m) will not repel oil. Although these treatments provide excellent protection from dirt and stains, they get easily removed after several washes in water or dry cleaning [7,34,36].

Other finishing auxiliaries used with fluorochemical polymers are[37]:

(i) Cross-linker (DMDHEU) is used to provide durability to the finish.

(ii) Wax or alkene aliphatic are used to improve performance and minimize fluorochemicals.

(iii) Non-rewetting agent (fugitive wetting agent), such as isopropyl alcohol is used. These fugitive wetting agents evaporate or flash off during curing.

Larger volumes of liquid are more likely to penetrate through the fabric than smaller volumes of liquid. This is due to the more pressure exerted on the fabric surface by the larger surface area and weight of the bigger droplets. A liquid with high viscosity is likely to take longer time to penetrate through a material. The liquid barrier resistance decreases as the pressure of striking liquid increases. Leaning against the table leads to lower pressure (0.52 psi), whereas reaching for an instrument develops higher pressure of 0.70 psi[7]. Liquid penetration also increases as the time of exposure of a liquid on textile surface increases.

Fabric characteristics of importance include pore size and surface characteristics. Pore size and geometry, which influence the porosity of the fabric, are determined by fabric construction characteristics. A fabric with smaller pores has better barrier resistance as compared to a fabric with few larger pores, even if porosity is same. As the pore size decreases to the microscopic range, the fabric becomes film like and uncomfortable. Therefore, the porosity of the barrier fabric should be controlled to meet both liquid barrier requirements and thermal comfort properties for surgical gown fabrics. The most commonly used plain woven fabric construction in reusable gowns is susceptible to the formation of capillary forces that enhance the passage of the liquid through the fabric. As the thread density increases, the yarns come closer together (more tightly packed) resulting in a smaller pore size but more effective capillaries. If the interlacing pattern is irregular (as in a twill weave), the orientation of the yarns or fibre to one another is disrupted, the capillaries are shorter and the penetration through the fabric is reduced[36]. Khomarloo *et. al.*[22] reported that the pore size in woven surgical fabrics increases with laundering, especially in single layer fabrics due to fabric structural destruction. The amount of twist in the yarn significantly influences the yarn properties. Lower the twist, bulkier is the yarn with increased voids between the fibres. These interstitial spaces allow for the trapping of particles that move through the fabric. In the case of staple yarns, lower twist also results in protruding fibres ends at the surface of the yarn. These small projections are ideal for trapping small particles. Additionally, they create an irregular surface, which disrupts the formation of capillary forces as well, inhibiting the liquid movement[22,37].

Nonwoven fabrics have depth pores, as opposed to surface pores in woven structures. A nonwoven fabric restricts the passage of pathogens due to the torturous path it has to follow before passing through the different layers in the fabric, even if the pore size is larger than the pathogen. Leonas and Jinkins[38] studied disposable surgical gown and found that improved repellency and reduced pore size of these gowns contributed to barrier protection. Katoh *et. al.*[39] investigated the fluid repellency of nonwoven fabric structures H, J, V, M, and C, as illustrated in Figure 5 and established a correlation between sliding angle measurement and viral carrying capacity. They reported that fabric samples treated with a water-repellent finish had a decreased risk of virus transmission when compared to nonwoven gowns coated with a water repellent finish. They also stated that in the case of fabric, V & C droplets did not roll-off when the stage was tilted to a 90° angle.

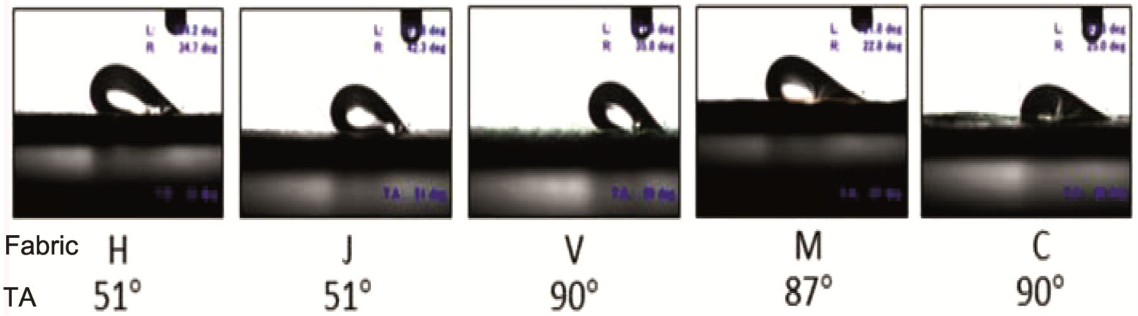

Fig. 5 — Sliding angle measurement on different fabric structures with a tilt angle (TA), advancing contact angle (left, L), and receding contact angle (right, R) [Fabrics: H- Nonwoven polypropylene (S/M/S) + water repellent finish, J- Non-woven polypropylene (S/M/S) 5 layers + water repellent finish (S- spun bond, M- melt blown), V- Flash spun high- density polyethylene, M- Laminated fabric (Polypropylene+ microporous film), and C- Fabric with polymer coating][39]

## 4 Test Methods for Fluid Barrier Properties of Surgical Gowns

The test methods required for measuring the barrier performance of the surgical gown are given hereunder.

### 4.1 Impact Penetration

Impact penetration test is performed according to the AATCC 42. A sample (178 × 330 mm) with pre weighted blotting paper is placed on an inclined surface at an angle of 45°, as shown in Fig. 6. One end of specimen is clamped under the spring clamp at the top of inclined stand. Another clamp of 0.4536 kg is clamped to the free end of sample. A 500 mL of distilled water is poured in the funnel of the tester and allowed to spray onto the specimen from a height of 60cm. The blotting paper is removed and reweighed. The amount of water passing through the fabric is given by the change in weight of the blotting paper, which can be used as an indication of water repellency.

Fig. 6 — Spray impact penetration test

### 4.2 Hydrostatic Pressure Test

Hydrostatic pressure test is performed as per AATCC-127 to measure the hydrostatic pressure necessary to force water to penetrate through a textile material under defined conditions. A test specimen mounted under the orifice of a conical well is subjected to water pressure constantly increasing at 10 ± 0.5 cm per minute until three leakage points appear on its surface (Fig. 7). The higher the column height achieved before appearance of third water droplet on fabric surface, greater is the water resistance of the specimen.

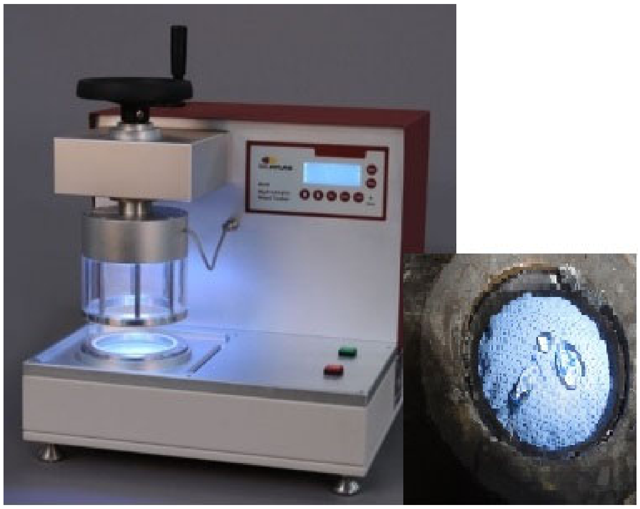

Fig. 7 — Hydrostatic pressure test

### 4.3 Blood Repellency Test

The blood repellency of the fabric samples is assessed by resistance of material to penetration of synthetic blood according to ASTM F1670. Synthetic blood is made from distilled water, surfactant and red dye with a surface tension of 42dyn/cm, similar to human blood and other body fluids. A fabric specimen of 7×7 $cm^2$ is mounted in the test cell and a retaining screen is placed on the top of the sample to prevent the sample from expanding when subjected to pressure. The test cell bolts are tightened to 13.6 Nm by using torque wrench. The test cell chamber is filled with 60 mL of synthetic blood. The specimen is subjected to synthetic blood at the ambient condition for 5 min; the air pressure is raised to 2 psi of pressure for 1 min, after that the air pressure is released and returned to ambient condition for 54 min. The penetration of synthetic blood is monitored through viewing chamber.

### 4.4 Bacteriophage Test

In order to measure the resistance of material to penetration by blood borne pathogens, a bacteriophage test is done using a surrogate microbe, under conditions of continuous liquid contact at 0 kPa for 5 min, followed by 13.8 kPa for 1 min, followed by 0 kPa for 54 min, with or without a retaining screen. Materials passing test method in ASTM F1670 should then be tested against bacteriophage penetration test using the same test cell with the Phi-X174 bacteriophage challenge suspension having surface tension of 0.042 N/m. The surrogate microbe (Phi-X174 Bacteriophage) has no envelope and is one of the smallest known viruses (0.027 µm). After the test, samples that exhibit no detectable (<1 PFU/mL) Phi-X174 in the assay titer, pass the test.

Breathability aspect of the fabrics can be estimated using the water vapour permeability and heat transmission behaviour tests using cup method, desiccant inverted cup method and sweating guarded hotplate method[40].

## 5 Conclusion

Although reusable surgical gowns are desirable due to their comfort and handle characteristics, their protection ability is limited, which further decreases during laundering. Nonwoven disposable surgical gowns, which surely have advantages in terms of microbial protection, are being preferred over the woven surgical gowns especially in developed countries to maximise the protection from hazardous microorganisms. Reuseable surgical gowns fabrics without any treatment provide low level of barrier protection. SMS nonwoven disposable surgical gown fabrics without any finishing treatment can provide moderate levels of barrier protection. The barrier protection in the fabrics can be enhanced using finishes that reduce the surface free energy of the fabrics like fluorochemicals. Antibacterial agents can be added to further inhibit the growth of bacteria. Careful selection of fibre content, fabric type and constructional parameters along with finishing treatment must be carefully selected to achieve the desired level of protection in the fabrics.

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