Journal of Textile Science & Engineering

ISSN: 2165-8064

Nassar and Abou-Taleb, J Textile Sci Eng 2014, 4:5
DOI: 10.4172/2165-8064.1000167

Reserach Article Open Access

Evaluation of Moisture Management and Antimicrobial Properties for Surgical Gowns: A Case Study in Egyptian Hospitals

Nassar K* **and Abou-Taleb EM**

Department of Applied Arts, Helwan University, Egypt

***Corresponding author:** Nassar k, Department of Applied Arts, Helwan University, Egypt, Tel: +201271779239; E-mail: khaled.mansour@gmail.com

Rec date: Sep 04, 2014; **Acc date:** Sep 15, 2014; **Pub date:** Sep 25, 2014

Abstract

Surgical gowns are supposed to act as a pathogen barrier and provide physiological comfort for surgeons. This study was concerned with both of the aforementioned aspects. For this purpose surgical gowns used in public and private hospitals in Egypt were surveyed and one was chosen as it represented the most common type of gowns used in those medical facilities. The antimicrobial properties as well as the physiological comfort represented by its moisture management capacity were tested to evaluate its functional performance with regard to those specific areas. The results revealed that as far as acting as a pathogen barrier, according to Parallel Streak Method, the tested surgical gown proved to have an efficient inhibition zone because of the antimicrobial treated PET fibres and to the very poor overall moisture transfer capacity as a fabric (OMMC=0). As for the physiological comfort the opposite proved to be true as the very poor moisture management capacity (OMMC=0) meant diminished physiological comfort which was proven to affect surgeon's performance in previous studies.

Keywords: Antimicrobial; Moisture management; Surgical gown; Moisture management tester; Physiological comfort

Introduction

A number of studies have reported on the protective properties of fabrics [1,2]. Moreover in health care section there is an interest in protecting health care workers from diseases that might be carried out by patients. Especially for surgical gowns, protection from bloodborne pathogens play a paramount importance in protecting surgeons and the accompanying team from infection. Gowns should be able to prevent strike through or wetting out of the fabric, and so surgical gown materials should not only have antimicrobial properties but also blood barrier properties. For hygienic reasons nowadays textiles for surgical gowns, patient drapes, laboratory coats, coveralls, and other kinds of protective clothing are primarily made of nonwoven fabrics [3].

The protective nature of the surgical gowns has to be complimented by yet another important feature which is clothing comfort. Clothing comfort cannot be explained by one aspect or property as many components contribute to the overall feel of comfort. Studies have concluded that clothing comfort can be explained in the light of their respective thermal, non thermal, and wear conditions. It has been shown that physical activities can change our perception of how comfortable we feel wearing a certain type of clothes if this particular fabric becomes wet or damp [4,5]. As a result, surgical gowns play a critical role in modifying the medical personnel's response to temperatures in the operating room and should assist in maintaining an isothermal environment for healthcare workers. Surgeons usually perform a demanding job under stress; therefore improving their thermal comfort should take precedence over all the other healthcare workers' during the operation. Thermal comfort of surgeons which is in part related to the thermal properties offered by the used surgical gowns during operations has been shown to play an important role in the safety of the operational procedure. The thermal comfort of the clothing is directly influenced by the type of the materials used and the properties of those materials, including thermal conductivity, water vapor permeability, air permeability and water impermeability [6].

This paper is concerned with the thermal comfort of surgical gowns used in Egyptian public and private hospitals for their paramount effect on the performance of the surgeons inside operation rooms. Thermal comfort can be in part assessed through measuring the moisture management capacity of clothes. Moisture management often refers to the transport of both moisture vapor and liquid away from the body. Moisture vapor can pass through openings between fibers or yarns. This action prevents perspiration from remaining next to the skin.

As a result, any negative effects resulting from trapped moisture especially in hot conditions where the wearer will feel tired or in cold conditions where the wearer will suffer from chilling and hypothermia can be greatly minimized. A side effect for trapped moisture is also the heavy feeling of the clothes as a result of the accumulation of moisture inside the fabrics or clothes. This trapped moisture can also lead to skin chafing. Accordingly, moisture management has the ability to control the microclimate between the body and the garment, as well as the thermal contact feeling of the wearer, and the thermoregulatory response of the body [7].

Moisture management can be accessed through a series of individual tests such as vertical and horizontal wicking tests, wetting tests, and spray test among others to study how liquid behaves when it comes in contact with fabrics. This set of tests can be very time consuming. Thus this is why this study depended on recently developed testing equipment (Moisture Management Tester abbreviated as MMT) [8] which are used for testing method AATCC 195 – 2012 [9] to evaluate the moisture management properties of the surgical gowns. This test evaluates physiological comfort of the sample by assessing the fabric's moisture management properties. When moisture is transported in a fabric, the contact electrical resistance of the fabric will change and the value of the resistance change will depend on two factors: The components of the water and the water content in the fabric [5]. As a result this study is concerned with both the antimicrobial properties and physiological comfort offered for surgeons wearing those gowns used in the majority of operating theatres in both public and private hospitals.

Experimental

Material

After surveying both the major public and private hospitals, it was found that the majority of the surveyed hospitals use a certain branded product for their surgical gowns used by surgeons in those hospitals. Accordingly, a sample of this surgical gown was sourced from the aforementioned hospitals and implemented as a sample for this study. The testing sample was a disposable nonwoven 100% antimicrobial treated PET fabric of 34 g/m^2 and 0.24 mm thickness according to ASTM D3776-09 [10] and ASTM D1777-2002 respectively [11].

Moreover, the outward side from the skin of the gown was thermally calendared (referred to in this study as bottom side). Contrary, the next to skin side (referred to top side in this study) was not calendared. The sample was tested for antimicrobial activity by the Parallel Streak Method according to AATCC Test Method 147-2011 [12]. The aforementioned standard is used when there is a need for a relatively quick and easily executed qualitative method to determine antimicrobial activity of diffusible antimicrobial agents on treated textile materials. In the Parallel Streak Method, the agar surface is inoculated making it easier to distinguish between the test organism and contaminant organisms which may be present on the unsterilized specimen. In addition of the aforementioned test method, the physiological comfort of the sample was tested by assessing the fabric's moisture management properties through the evaluation of the wetting time (sec), absorption rate (%/sec), maximum wetted radius (mm/sec), one way transport index, and overall moisture management capability according to AATCC 195-2012 on the SDL Atlas MMT tester where [5].

- Wetting Time (Top surface and bottom surface) - The time period in which the top and bottom surfaces of the fabric just start to get wetted respectively after the test commences measured in seconds.
- Absorption Rate (Top surface and bottom surface) - The average moisture absorption ability of the fabric top and bottom surfaces in the pump time respectively measured in %/second.
- Maximum Wetted Radius (Top surface and bottom surface) - The maximum wetted ring radius at the top and bottom surfaces respectively measured in millimeters.
- Spreading Speed (Top surface and bottom surface) - The accumulative spreading speed from the centre to the maximum wetted radius measured in millimeters/second.
- One-way Transport Index - The difference of the accumulative moisture content between the two surfaces of the fabric.
- Overall Moisture Management Capability (OMMC) - An index to indicate the overall capability of the fabric to manage the transport of liquid moisture, which includes three aspects of performances:

Moisture absorption rate at bottom side

One way liquid transport capability

Moisture drying speed at bottom side, which is represented by accumulative spreading speed.

The moisture management capabilities of the tested fabrics are classified according to the MMT manufacturer grading system [7] as listed in Table 1.

Grading scale	Indication of moisture management capacity
0-2	Very poor
4-Feb	Poor
6-Apr	Good
8-Jun	Very good
>8	Excellent

Table 1: MMT grading system

All the tests were carried out in standard environmental testing conditions according to ASTM 1776.

Results and Discussion

Antimicrobial

The results for antimicrobial activity assessment of Textiles are illustrated in Figure 1. By examining the incubated plates for interruption of growth along the streaks of inoculums beneath the specimen and for a clear zone of inhibition along a streak on either side of the test specimen, it is clear that it has effective antimicrobial properties.

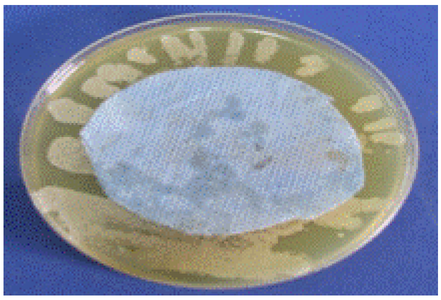

Figure 1: Microorganism *S. aureus* Incubated plates for interruption of growth, showing the clear zone around specimens denoting an effective antimicrobial properties according to AATCC 147 – 2011

This can be explained by the effect of the antimicrobial treated PET fibres used in the production of the surgical gown which in turn inhibits microorganisms' development which leads to bacterial contamination and odour formation [13].

Moisture management measurements

The results for the moisture management properties are listed in Table 2. By investigating the result for each index it can be revealed that the wetting time for the top and bottom surfaces are both poor and very poor respectively.

Liquid Moisture Management Indices		Average	Grade	Indication of moisture management capacity
Wetting Time(Second)	Top Surface	9.1094	3	Poor
	Bottom Surface	119.953	1	Very poor
Absorption Rate(%/Second)	Top Surface	190.9471	5	Good
	Bottom Surface	0	1	Very poor
Maximum Wetted Radius (mm)	Top Surface	5	1	Very poor
	Bottom Surface	0	1	Very poor
Spreading Speed (mm/Second)	Top Surface	0.5552	1	Very poor
	Bottom Surface	0	1	Very poor
One-way Transport Index		-1251.32	1	Very poor
Overall Moisture Management Capability (OMMC)		0	1	Very poor

Table 2: Liquid moisture management indices of the test sample (surgical gown)

The Wetting times of top and bottom surface are 9.1 and 119.953 second respectively as listed in Table 2. By checking the grading system in Table 1 it is clear that wetting time for both top and bottom surfaces are poor and very poor. Despite of the poor results of wetting time for both surfaces, the top surface scored a better result in wetting times compared to the bottom one. This can be explained by the difference in surface roughness between both surfaces as only the bottom surface was calendared, unlike the top one. As with the increase of surface roughness, the spreading of water along the surface becomes faster due to the troughs offered by rough surface leading to a better wetting time. On the contrary to the top surface, the bottom surface (outward side from the skin) was thermally calendared which led to a smooth surface without any troughs [14].

As observed in Table 2, absorption rate of top and bottom surface are 190 and 0%/second respectively which are good and poor respectively according to the grading system listed in Table 1. For the top surface the satisfactory result can be explained by the light weight and thin nature of the fabric. Contrary, the poor absorption rate for the bottom side can be explained by its smooth impermeable surface due to the thermal calendaring carried out on that surface. As this has caused the fibres to partially melt and form an impermeable smooth because of the decreased interspaces on the surface which in turn has greatly hindered the absorption rate as witnessed from the results.

At first glance the absorption rate of the top surface may seem incomprehensible, but after reviewing the equation for determining the absorption rate it is obvious that it measures the percentage of increase in sample weight after liquid absorption compared to its dry weight. This can be calculated as follows [15].

Water Absorbency = ((B-A) X 100)/A

Where;

A = specimen weight before immersion (g)

B = specimen weight after immersion (g)

Maximum Wetted Radius (mm) of top and bottom surface is 5 and 0 mm respectively, and Spreading Speed of top and bottom surface is 0.55 and 0 mm/second respectively which both are classified as very poor results according to grades in Table 1. Those results can be attributed to the inert nature of PET fibres due to their high crystalline molecular structure and lack of reactive groups. Accordingly, this prevents spreading of the liquid through- plane. More over the bottom surface is thermally calendared which added to the poor performance of the test sample.

As observed in Table 2, One-way Transport Index is -1251.3209. Again this number indicates very poor performance as per results in Table 1. This number refers to the difference in the cumulative moisture content between the two surfaces of the fabric in unit testing time period. The negative one-way transport capacities indicate that the liquid cannot diffuse easily from the next-to-skin surface to the opposite side and will accumulate on the top surface of the fabric.

From results listed in Table 2, Overall Moisture Management Capability (OMMC) for the surgical gown is 0 indicating a very poor result as seen in Table 1. As this is an index to indicate the overall ability of the fabric to manage the transport of liquid moisture, which includes three aspects of performance: moisture absorption rate of the bottom side, one-way liquid transport ability, and moisture drying speed of the bottom side (represented by the maximum spreading speed), so by consulting the results in Table 2 for each index it was clear that only the absorption rate of the bottom surface scored a good result (190.9%/second) which has resulted in overall poor performance in the field of moisture management for the tested surgical gown. From the previous results the tested surgical gown has proved to be an effective antimicrobial barrier unlike its poor physiological comfort due to its poor performance in the field of moisture management.

Conclusion

This study mainly focused on the antimicrobial properties and moisture management capacity as an indication for physiological comfort for a certain type of surgical gown used in the majority of operating theatres in both public and private hospitals.

The results can be summarized as follows:

- The tested surgical gown proved to have acceptable antimicrobial properties mainly because of the antimicrobial properties of the antimicrobial treated PET fibres.

- The Overall Moisture Management Capacity (OMMC) of the tested surgical gown was very poor which aided in the protecting nature of the fabric as a barrier to pathogens, but in the same time led to poor physiological comfort related to the poor moisture management capacity.
- A balance has to be achieved between its nature as a barrier to pathogens and its physiological comfort as both have a great effect on the surgeons' performance and safety inside the operating theatres.

References

1. Horrocks AR, Anand S, Anand S (2000) Handbook of Technical Textiles. CRC Press, USA.
2. Scott RA (2005) Textiles for Protection. Elsevier, UK.
3. Anand S (2006) Medical textiles and biomaterials for healthcare : incorporating proceedings of MEDTEX03 International Conference and Exhibition on Healthcare and Medical Textiles, Wood head, UK.
4. Bishop PA, Balilonis G, Davis JK, Zhang Y (2013) Ergonomics and Comfort in Protective and Sport Clothing: A Brief Review. J Ergon S2: 005.
5. Hu J, Li Y, Yeung KW, Wong ASW, Xu W (2005) Moisture Management Tester: A Method to Characterize Fabric Liquid Moisture Management Properties. Text Res J 75: 57-62.
6. Bartels VT (2011)Hand book of medical textiles. Textile Institute,Oxford: Woodhead Publishing, Manchester, UK.
7. Ozdil N, Supuren G, Ozcelik G , Pruchova J (2009) A study on the moisture transport properties of the cotton knitted fabrics in single jersey structure. J Text apparel 19: 218-223.
8. SDl Atlas (2012) Moisture Management Tester, MMT brochure. SDL Atlas, USA.
9. AATTCC (2012) Liquid Moisture Management Properties of Textile Fabrics, AATCC Test Method 195-2012, USA.
10. ASTM (2013) Standard Test Methods for Mass Per Unit Area (Weight) of Fabric, USA.
11. ASTM (2002) Standard Test Method for Thickness of Textile Materials, USA.
12. AATCC (2011) Antibacterial Activity Assessment of Textile Materials: Parallel Streak Method, AATCC Test Method 147-2011, USA.
13. Prince AP (2009) Modification of polyester (PET). Indian Text J, India.
14. Das B, Das A, Kothari VK, Fanguiero R, de Araújo M (2007) Moisture transmission through textiles Part I: Processes involved in moisture transmission and the factors at play. Autex Research Journal 7: 100-110.
15. Das B, Das A, Kothari VK, Fanguiero R, de Araújo M (2009) Moisture flow through blended fabrics-effect of hydrophilicity. J Eng Fibers Fabr 4: 20-28.