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Development of Dual Finished Surgical Gown

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Abstract: Background: Protective clothing is mandated for hospital support staff in operating rooms, isolation areas, emergency rooms and intensive care units. As part of personal protective equipment, surgical gowns are used widely in healthcare facilities.
Objectives: The objective of the current research is to develop a dual finished surgical gown. 100% cotton plain woven fabric was used.
Methods: The fabric was treated with chitosan and fluropolymer using pad-dry-cure method. The finished fabric was characterised using scanning electron microscope. The developed surgical gown was tested for blood repellency, antibacterial and mechanical properties.
Results: The developed gown has better antibacterial property and little blood was observed on the surface. The chitosan treated sample includes antibacterial activity against gram positive and gram negative bacteria.
Conclusion: The developed muslin fabric treated with chitosan and fluropolymer should be used for functional reusable surgical gowns.

Introduction:

A major source of cross infection is Bacteria-contaminated fabrics in hospitals. Among the most common Hospital acquired infection, Postoperative infections is a major component. Operating staff and patients are both sources of postoperative infection, since bacteria can find their way into an open wound and cause sepsis. Morris et al (1983) used an antibiotic as an antimicrobial agent to impart antimicrobial properties to cotton. They found that fabrics treated with antibiotics retain excellent bacteriostatic activity.

Points et al (2004) used a fluorochemical as a repellent finishing agent on spun laced nonwoven fabrics. The surface tension of blood and body fluids ranges between 42 and 60 dyne/cm; to maintain blood repellency, the surface tension of fabrics has to be much lower than that of blood. In an operating room, a patient's blood can penetrate surgical gown material and possibly contaminate the surgeon's skin if not well protected. Several blood-borne pathogens have the potential to spread in this manner, the most important being the human immunodeficiency virus (HIV) and the hepatitis B virus (HBV), which are related hepatitis and AIDS (Tyrone 1981).

Bacteria contaminated fabrics in hospitals are known to be a major source of cross infection (Jeong – Sook, 1997). Postoperative infections, in particular, are the most common hospital-acquired infection. Operating staff and patients are both sources of postoperative infection since bacteria can, by a variety of routes, find their way into an open wound and cause sepsis. Postoperative wound infections develop in 2 to 5% of patients undergoing surgical procedures (Ha-Sor Seong et al, 1999). Surgeon gowns and drapes used surround the operative field acting as an effective aseptic barrier between the underclothes of the surgeon between the patient's bodies other than the prepared area. In the operating room, however, liquids such as blood, sweat, and saline solutions can carry bacteria with them. If a liquid is wicked from a surgical gown to a non sterile surface,

one or both sides will become contaminated. Currently there is great interest in protecting health care workers from diseases that might be carried by patients.

Therefore, in order to protect patients from contamination by surgical staff during operations, and also to protect the surgical team from infectious blood and other body fluids, surgical gown materials should have antimicrobial properties and blood repellency properties.

Materials and Methods:

100% cotton plain fabric which was scoured, desized and bleached is used as the material with a basis weight of 138 GSM. The chemicals Chitosan, Fluropolymer, Dimethyl Dihydroxy Ethylene Urea (DMDHEU) supplied from M/s. LEO Chem Pvt. Ltd. , Zinc Nitrate(NICE) from M/s. The Precision Scientific Co, and Acetic acid, a solvent, supplied from M/s. Mahalakshmi Scientific Company were used in the fabric.

Dual Functional Finish:

First the Chitosan powder is dissolved in 2% Acetic acid solution.For the dual function finish, the specimens pretreated with the antimicrobial finishing agent were then treated with a blood repelling finishing agent by the pad-cure method. Antimicrobial treated specimens were further treated on a laboratory padder with aqueous solutions containing 3,4,5 and 6% of fluorchemical to a wet pick up of about 70%, and cured at 160^0C for 2 minutes before rinsing.

Characterisation Of Dual Finish:

The surface morphology of plain woven fabric was examined by Scanning Electron Microscope (SEM) with an accelerating voltage of 20Kv and current 10mA which is used to collect SEM images of the samples. The samples were analysed through SEM for the purpose of confirming the deposition of chemicals on the fabric.

Functional Testing:

Antibacterial testing:

To investigate the antimicrobial activity of woven and knitted fabrics impregnation was done with titanium dioxide nano particles separately. Antibacterial Test AATCC 100-2004 was carried out against Staphylococcus Aureus(gram positive organisms) and Klebsiella Pneumoniae (Gram negative organism). The percentage reduction of bacteria by the 100% cotton fabric is reported as R .

$R = 100 (B-A)/B$

Where R is the % reduction.

A = the number of bacteria recovered from the inoculated treated test specimen swatches in the jar incubated over 24 hours.

B = the number of bacteria recovered from the inoculated treated test specimen swatches immediately after inoculation (at ‘0’ contact time)

Blood repellency test:

The blood repellency of the sample was assessed by using Impact Penetration Test and Spray test. The synthetic blood was prepared by using distilled water , a surfactant (Acrysol G 110 , Rohm and Hass Co) and red dye (direct red 081) according to ASTM F 23.40.01 for testing the resistance of clothing to synthetic blood.

Impact penetration test:

According to AATCC 42-2000A of impact penetration test, a volume of water/synthetic blood was allowed to spray against a taut surface of the test specimen backed by a weighted blotter. The blotter was then reweighed to determine water penetration and the specimen is classified accordingly. The specimen 178 x330

mm and the blotting paper were conditioned in an atmosphere of 65+2%RH and 21 C temperature for atleast 4 hours before testing. The increase in mass of the blotter in grams was calculated and the average result of the three tests was reported.

Spray test:

According to AATCC 22-1996 procedure water is sprayed against the taut surface of a test specimen under control conditions produce wetted pattern whose size depends on the relative repellency of the fabric. Specimen of 18x18 size was conditioned at 65+2 % RH and 21+1 C .

Evaluation is accomplished by comparing the wetted pattern with the observations as mentioned in the following rating chart.

Standard rating	Observation
100 (ISO-5)	Sticking or wetting of upper surface
90 (ISO -4)	Slight random sticking or wetting of upper surface
80 (ISO-3)	Wetting of upper surface of spray points
70 (ISO-2)	Partial wetting of the whole upper surface
50 (ISO-1)	Complete wetting of whole upper surace
0	Complete wetting of whole upper and lower surface

Laundry test:

To test laundering durability, the specimens were washed on a short-time program for 30–45 min at 60 ˚C using an automatic washing machine. In order to prevent any adverse effects of detergent, soap (2% own) and sodium carbonate (1% owm) were used. Antimicrobial activity was noted after 5, 10, 15, 20 and 25 washes.

Results and Discussions:

The results made through SEM analysis indicate the traces of chemical deposition on the fabric clearly.

Anti bacterial test results:

Qualitative analysis was carried out by inoculating staphylococcus aureus (s. aureus) and Eschorichia coli (E. Coli) with treated samples as shownn in table 1. The chitosan treated sample includes antibacterial activity against gram positive and gram negative bacteria.

Table 1.0 Antimicrobial activity of treated sample

Bacterium used	Width of clear zone (mm)
S. Aureus (Gram positive)	12
E.Coli (Gram negative)	9

Blood repellent test result:

The artificial blood repellency was evaluated with the specimen treated with fluorochemical, because human blood is an emulsion consisting of 78% water and 22% solid particles, it is impossible to spray samples with blood of a constant weight. The blood was poured onto the samples according to the procedures for the impact penetration test. The amount of human blood sprayed on the specimens was about of human blood sprayed on the specimens was about 10 ml. From the nonwovens' surface, we can see that little blood was absorbed into the sample. Therefore, samples treated with fluorochemical solution had excellent blood repellency for human blood.

Impact penetration test on treated sample:

The treated samples are washed and analysed at 5th cycle, 10th cycle, 15th cycle, 20th cycle. The 20th washed fabric samples shows the slight reduction in antibacterial activity and that 20th washed fabric sample shows the slight reduction in blood repellent activity also.

Table 2.0 Comparison of antibiotic between washed and Unwashed samples.

Bacterium used	Width of clear zone before washing.	Width of clear zone after washing.
S. Aureus (Gram positive)	12	10
E. Coli (Gram negative)	9	8

The washed sample allows the blood to penetrate little more than unwashed sample.

Conclusions:

The bacterial and blood barrier properties of treated and untreated surgical gowns material have been assessed. The results show strong implications for the development of bacterial and blood barrier materials for reusable surgical gowns. There was no significant reduction in use ability of the treated material when compared to untreated material. The findings of this project suggest that muslin fabric treated with chitosan and fluropolymer should be used for functional reusable surgical gowns.

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