CHAPTER 1

INTRODUCTION

1.1 Background

Technical Textiles are textile materials used for non-conventional applications for certain technical performance due to various functional properties there off. These textiles find applications mainly in automobiles, construction technology, geotechnical engineering, filtration, protection, sports, healthcare and medical textiles. Medical textiles are defined as, 'the type of technical textiles having application in the field of medical and clinical care and are manufactured primarily for their technical performance and functional properties rather than their aesthetic or decorative characteristics.' The Medical textiles cover a huge range of applications such as aprons, adhesive tapes, bandages, beddings, castings, chitin, diapers, dressings, eye pads, gauzes, hosiery protective clothing, sutures, surgical covers, surgical clothing, sports applications, swabs, sanitary products, uniforms of hospital personals etc. The very main objective of use of medical textiles is to improve the quality of health care and enhance the standard through disposable products by minimizing the risk of infections [1].

(a) Classification of medical textiles

The various applications of textile material in medical and healthcare industries may be broadly classified as follows:

- **Implantable**: These are materials implanted on or in the human body either temporary or permanent basis, such as sutures, heart valves, vascular grafts, artificial veins, artificial tendons and ligaments, artificial joints and bones, artificial skin, artificial cartilage etc.

- **Non-implantable**: These are finished textile materials such as wipes, swabs, wound dressings, bandages, gauzes, plasters, pressure garments, orthopaedic belts, etc.

- **Extra corporeal**: These are extra corporeally mounted devices used to support the function of vital organs, such as kidney, liver, lung etc.

- **Therapeutic Textiles:** The products used for treatment and cure of diseases due to ill health, such as heating pads, neck belts etc.

- **Healthcare Textiles:** These are important area of the medical textile primary healthcare products meant for protection, general health care and hygiene. The range of products available for healthcare and hygiene is vast, but they are typically used either in the operating theatre or in the hospital wards for hygiene, care and safety of the staff and patients. The healthcare garments can be woven, knitted or non-woven. They could be washable or disposable. Traditionally various range of products available in the healthcare textiles are apparel, beddings, bed sheets, blankets, caps, diapers, drapes, facemasks, head and shoe covers, mattress covers, pillow cases, wipes, uniform and protective clothing of doctors and nurses including surgical hosiery products and surgical gowns. Significantly developed market of non-wovens is especially consumable textiles such as incontinence care pads, nappies, tampons, sterilization wraps, etc.for operation theatre etc. In order to avoid contamination, disposable non-woven is more common as compared to woven fabrics.

(b) Medical garments

Medical garments are apparel designed for people with medical problems and/or medical personnel for the functions within protection and treatment domains. Medical garments can be classified on the basis of their specified functions [2]. Basically, there are three main functional domains:

- **Protective**: One of the basic functions of medical garments is to provide protection for medical personnel or patients from bacteria, physiological liquids, biological pollution and various harmful substances. Most significant examples are scrubs, masks, patient gowns, surgeons' clothes, surgical gowns and laboratory coats.

- **Treatment**: Medical garments can also have a significant impact on healing during medical treatment. Post-operative compression garments play a vital role in the recovery process in cosmetic surgery viz. pressure garments are the major treatment modalities for hypertrophic scars and compressive stockings used for the prevention and treatment of varicose veins.

- **Caring**: Some personnel with physical and mental disabilities would have difficulties in dressing due to their impairments. The health applications of garments for caring them are pressure garments, compression stockings, wet dressing, hip protectors, wound dressing, incontinence diapers etc.

(c) Surgical gowns

Surgical apparel are devices that are intended to be worn by operating room personnel during surgical procedures to protect both the surgical patient and the operating room personnel from transfer of microorganisms, body fluids and particulate material. It includes surgical caps, hoods, masks, gowns, operating room shoes covers, isolation masks and gowns. Surgical suits and dresses commonly known as scrub suits are excluded.

Medical gowns are personal protective equipment used in health care settings to protect the wearer from the spread of infection or illness if users come in contact with potentially infectious liquid and solid material. They may also be used to help prevent the gown wearer from contaminating vulnerable patients, such as those with weakened immune systems. A few of the many terms that have been used to refer to gowns intended for use in health care settings include surgical gowns, surgical isolation gowns, nonsurgical gowns, procedural gowns and operating room gowns. The reusable gowns in general are made from durable woven material whereas disposable gowns are made using nonwoven fabrics. The main advantages of using non-woven materials in medical textiles and surgical garments are lighter weight, more comfortable and economical.

The use of surgical gowns by the doctors and supporting staff is a part of an infection-control strategy. In 2004, Food and Drug Administration (FDA) recognized the consensus standard American National Standards Institute/Association of the Advancement of Medical Instrumentation (ANSI/AAMI) PB70:2003, “Liquid barrier performance and classification of protective apparel and drapes intended for use in health care facilities” [3]. New terminology in the standard describes the barrier protection levels of gowns and other protective apparel intended for use in health care facilities and specifies test methods and performance necessary to verify and validate the newly defined levels of protection such as:

Level 1: Minimal risk, for example, during basic care, standard isolation, cover gown for visitors, or in a standard medical unit,

Level 2: Low risk, for example, during blood draw, suturing, in the Intensive Care Unit (ICU), or a pathology lab,

Level 3: Moderate risk, for example, during arterial blood draw, inserting an Intravenous (IV) line, in the Emergency Room, or for trauma cases,

Level 4: High risk, for example, during long, fluid intense procedures, surgery; when pathogen resistance is needed or infectious diseases are suspected (non-airborne).

1.2 Need for development

In recent years, various medical textiles have been developed using newly fabric structures and chemical treatments including nanotechnology especially to control microbial growth which can be useful to the hospitals and health care professionals in preventing infections. The basic demands to be fulfilled by surgical gowns are known, but no concrete data has been given for comfort related properties usually. A surgical gown must also demonstrate good wearing comfort whilst keeping the surgeon and team comfortable, particularly in longer operations. Medical personal feel physically and mentally fit, only when they feel thermally well during the procedure. The thermal comfort of the clothing system can be predicted when the ambient climate conditions, workload and physical parameters of clothing layers are known. The ambient conditions of operating theatre (OT) are maintained by use of operating room heating, ventilation and air conditioning (O.R.H.V.A.C.) system. Generally temperature and Relative Humidity (R.H.) are maintained at 22°-23°C and 40%-60% respectively.

A disposable medical garment need not be cleaned or reused after a single use. Some medical gowns can be cleaned and maintained only for a limited number of usages. It becomes unusable when it is heavily soiled or damaged after being used for several times. The reusable durable medical garments are designed for repeated cleaning to provide acceptable performance with reasonable durability with acceptable performance. All types of medical gowns would be rendered unusable if they are damaged on being used or contaminated during medical procedures. The surgical gown in general should meet all the requirements as per the standards especially for the safety of surgeons and patients as well.

In designing surgical gown, the main aspects considered are:

- Comfort
- Breathability
- Air permeability
- Resistance to infection transmission

The pore size in woven fabrics is an important factor in microbial transmission as is the water repellence of fabric. The more-compact structures achieved by shorter thread floats and higher thread densities made the fabrics more water-resistant but less-permeable to air; thus designer has to determine the appropriate compromise between protective properties and comfort. The

fabric used in the manufacturing of the surgical gown should have pore size less than the size of microbes to prevent the microbes to pass to the body of the user through the fabric. In case of woven structure, interlacing four threads form the square pore and during the use it might not be possible to maintain the pore size, to prevent microbes to enter through the fabric, especially for the microbes like virus. However in case of nonwoven fabric the most pores are triangular formed by three fibres. Conventionally most surgical gowns are made from woven fabric using a single layer.

Both natural and synthetic fibres are used for gown fabric such as cotton, silk, viscose, wool, polyester, polypropylene and a polyester-cotton blend. The woven surgical gowns are either made from cotton or polyester-cotton blend. Some special gowns are also made with double-layer using linen and cotton fabrics due to the high costs of laundering and sterilization for reuse. The recent trend is to use nonwoven materials which can be disposed off after single use. Whether the surgical gown is of the disposable or re-usable type, wetting by any such liquid from the wearer or the surgical environment may compromise the barrier properties of the gown material. The transfer of bacteria through contact between fabrics was found to be aided by the presence of moisture and the application of friction. Among the different fabrics bacterial transfer was found to be highest for polyester followed by viscose rayon, whilst polypropylene showed the least transfer.

The nonwoven surgical gowns made from Polypropylene (PP) fibre with a coating of Polyethylene (PE) is comfortable and light in weight. It is also easy for processing in injection moulding and good in dimensional stability during autoclave sterilization. The most common type of nonwoven fabrics used for surgical gowns and drapes are spun lace, spun bond–melt blown–spun bond (SMS) and wet-laid [4].

The disposable surgical gowns mainly made from synthetic polymeric materials are neither cost effective in the long run nor eco-friendly. There is a need of eco-friendly fabric for making reusable surgical gowns having potential to prevent infections and is comfortable, cost effective in long run. Such medical garments are designed for repeated cleaning and for providing reasonable durability with acceptable performance. However, considering the economical and pollution aspect due to use of synthetic polymers between reusable and disposable surgical gowns, the disposable gowns made from eco-friendly fibres should be preferred. For this purpose, a suitable fabric structure has to be developed and special antimicrobial coating needs to be applied to the fabric for repeated usages.

1.3 Research Outline

In the present study various fabrics of different structures have been considered to evaluate its characteristics and enhance the important properties for the use in surgical gowns. Three different fabrics have been selected viz. cotton vat dyed woven fabric, viscose polyester (95:05) spun laced embossed non-woven fabric and viscose polyester (95:05) spun laced plain nonwoven fabrics. Nano cellulose has been applied to the samples using padding mangle at different dip-nip levels. These fabric samples have been treated with nano cellulose particles at different concentrations. Polyester cross-linking agent has also been added into nano cellulose solution of different concentrations. Treated fabric samples have been tested for physical and mechanical properties. Selected samples have been treated with aqueous solution of Neem seed oil solution to improve antibacterial property of the fabric. These samples are then tested for growth of gram positive and gram negative bacteria to evaluate the antibacterial property of the treated coated fabric.

Different hospitals have been visited to study the different types of surgical gowns in use, their cleaning process and related parameters. It was observed that in most cases reusable cotton woven gowns have been preferred and only in few cases disposable nonwoven gowns used in surgical procedures. Moreover the fabrics of the gowns are lagging in antimicrobial and water repellent properties. Such surgical gowns are prone to severe bacterial infection and can lead to serious problems for the surgeon and patient.

Thus, the present study has been undertaken with the aim to enhance the performance of surgical gowns with following objects:

- To develop suitable fabric from cellulosic materials for surgical gown.
- To apply nano cellulose coating on the surface of the fabric.
- To impart the antimicrobial property of the fabric.

To evaluate antimicrobial characteristics of the coated fabric.