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# Review on Application of "Functional, Expressive, and Aesthetic Consumer Needs Model" in Designing Patient Gowns

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## ABSTRACT

*The perusal of the literature suggests that a conducive design process is required in designing apparel for specialized sectors or specialized needs such as surgical gowns and patient gowns, commonly referred to as hospital gowns, with a focus on the functional requirements and user needs. A design model such as the 'Functional, Expressive and Aesthetic (FEA) Consumer Needs Model'; which incorporates the user needs and requirements in designing apparel, has garnered attention from fashion design researchers in designing functional clothing such as clothing for the disabled, clothing for tennis players, etc. The literature and the design patents reviewed in designing patient gowns emphasize the need to include modesty and functional requirements essential during pre-or-post-operative treatments in designing. The FEA model conceptualized as the FMA model (functional, modesty, and aesthetic model), aids in understanding the patients' and caregivers' requirements in designing the patient gowns. The functional aspects reviewed mainly focus on designing the patient gowns that give access to the patient's body, donning and doffing, and provision of pockets for telemetry units. The patient gowns are implicated with the outbreak of bacterial pathogens and are generally laundered with suitable disinfectants following the hospital guidelines. Rendering the patient gowns with antimicrobial finishes would add to the functional requirements of minimizing the infectious agents' exposure to healthcare providers and the patients. Modesty as a design requirement is included in designing patient gowns. Little significance is given to the aesthetics of the patient gowns. This review paper focuses on the functional, modesty, and aesthetic requirements essential in designing patient gowns, emphasizing the functional requirements of material performance and design requirements.*

*Keywords: Designing patient gowns, FEA Consumer Needs Model, Material functionality, Design functionality*

## 1. Introduction

The term patient gown synonymously used as a hospital gown, medical gown, or exam gown (Ochao & Nalbone, 2008) is a specialized area of apparel design, which is often an overlooked topic among the fashion and apparel designers, design studies, and the studies in the field of the care environment (Iltanen-Tähkävuori, Wikberg, & Topo, 2012; Cho, 2006). The traditional patient gown design comprising of three panels (one front and two back panels) secured with a series of ties does not meet the requirements of the wearer, the medical staff, or the

caregivers (Koo & Min, 2014; Cho, 2006). Passive behavior of the patients is reported in the hospital environment, and there are interrelationships found between mental behavior (depression) and patient clothing (Bergbom, Pettersson, & Mattsson, 2017). The research in the area of patient satisfaction for hospital services enlists the patients' gowns provided along with necessary medical aid, humanistic aspects of good communication, and treating the patients with respect for the positive effect on the patient health outcomes (Junewicz & Youngner, 2015). The research in these areas reinstates the need to design patient gowns that address the psychological well-being of the patients admitted to the hospitals.

Designing apparel does not follow a specific design process and is based on the process followed in engineering, and architectural design. Here, the design process based on 'analysis-synthesis-evaluation' starts with identifying the problem in developing innovative solutions (Au, Taylor, Newton, 2004). The design model proposed by Au & Au (2018) in designing for fashion is conceptualized based on Johnson et al. mixed research model, which emphasizes the analysis phase (the phase produces requirement, goal, direction, and inspiration for designing), synthesis phase (this phase processes the outcome of analysis phase and provides solution and design as output), and evaluation phase (this phase based on synthesis stage produce the outcome). The outcome could be positive or negative, based on the design requirements. There is limited literature on the specific design process followed in designing for apparel, especially designing functional clothing. The designers' work in the studio generally relies on trial-and-error to reach the design solutions (Lee & Jirousek, 2015). In general, designing for fashion customers is mainly influenced by the 'aesthetic presence', inspired by different sources such as art, music, or literature. The design is aesthetically pleasing and often does not explain design functionality and end-users' requirement.

On the contrary, the design of functional clothing requires an in-depth understanding of the end-users' requirements. The design development follows a systematic design process with a mix of creativity and practical requirements of the end-users (Au et al., 2004; McCann, Hurford, & Martin, 2005). The literature on designing functional clothing highlights the application of the '*Functional, Expressive, and Aesthetic Consumer Needs Model* (FEA model)' developed by Lamb & Kallal (1992), which mainly targets the end-user requirements in designing apparel. Application and adaptation of the FEA model are researched in designing clothing for various functional purposes such as:

- Stokes and Black (2012), designing garments for adolescent girls with disabilities;
- Chae (2017), designing tennis wear for female baby boomers;
- Jin and Black (2012), designing tennis wear for male tennis player;
- Chau (2012), designing swimwear for children with special needs;
- Agbo and Ibgo (2017), design and development of garments for bedridden women;
- Bye and Hakala (2005), designing sailing apparel for women;
- Lee (2016), determining clothing needs of female bike riders;
- Trends and Studies (2014), design development to assess the aesthetic quality perception of functional apparel developed for cosmetologist;
- Hwang, Chung, and Sanders (2016) analysis of consumer intensions towards purchase of smart clothing (focusing on solar-powered clothing);
- Romeo and Lee (2015) application of FEA model for studying the apparel-related issues faced by plus-size female teens in purchasing apparel.

The model mainly aims to meet the psychological, physiological, and physical well-being of the consumers, which as per the design process, can be conceptualized into three design themes: functional, expressive, and aesthetics (Cho, 2006; Koo & Min, 2014). The model as given in *figure 1* is

displayed as a diagram of a concentric circle with the target customer (end-user) at the center and requires a designer to develop the user's profile, thus enabling the interrelationships of functional, expressive, and aesthetic aspects of designing apparel. The model also considers the culture's influence on the target customer displayed as the second circle in the diagram.


**Figure 1. 'FEA Consumer Needs Model (Lamb & Kallal, 1992)'**

Understanding and analyzing the user requirements, which is the core in FEA model as applied to designing hospital gowns reviewed, draw attention to the multifaceted requirements that include modesty and self-esteem, ease of use by patients and staffs (caregivers), laundering and manufacturing, the life cycle of the garment, and cost (Gordon & Guttmann, 2013). The focus is on the need to design gowns that uphold the patient's dignity in the hospital, especially where they have little control of the situations and are exposed to caregivers' gaze (Walsh & Kowanko, 2002; Matiti & Trorey, 2008). Hospital gowns as a means of patient dignity is emphasized in design patents applied (Shamam, 2002; Garza, 2002) and clinical research as one of the essential considerations in patient services provided in the hospitals (Junewicz & Youngner, 2015). The patients' clothes are considered as practical yet represents as a symbol of illness, objectification of the patient (emphasis on the disease), loss of self-image, and depersonalization leading to depression, which may cause an obstacle to recovery (Bergbom et al., 2017; Edvardsson, 2009; Freeman, 1986).

The review to gain insights in designing patients gown (a term used for a gown worn by the patients at the hospital) focuses on the FEA conceptualized as the FMA model ('Functional, modesty, and aesthetic model') (Koo & Min, 2014), keeping in view the need for dignity and modesty of the patients in the hospital. Accordingly, this paper is structured into three main sections - functionality, modesty, and aesthetic consideration in designing functional apparel such as patient gowns.

## 2. Functional requirements

Functional considerations of the FEA model relates to its utility, which differs according to the requirements of customers'/end-users. It is mainly concerned with the ability of the product to perform varying tasks of the customers. For instance, design consideration for female tennis players needs to address the requirements of comfort, fit, movement, breathability, and protection from the sun (Chae, 2017). Such requirements in designing the patient gown (either disposable or reusable gowns) reviewed through the patents highlights that the patient gown is commonly a box-like design with sleeves and body sewn together and the back secured with numerous ties (Dye & Dillard, 1992; Palm, 1955; Neal, 2004). The design is justified as intended to provide functional requirements such as easy access to the patient's body for examination by doctors and nurses, ease of identification, being comfortable to the patients, and protecting from the infection (Kaur & Brar, 2017). However, as per the research patents reviewed, the patient gown requires the caregivers to untie the gown for access to the subject portion of the body leading to undue exposure and exertion. The gown also lacks the adaptability to various nursing treatments (Cho, 2006; Truitt & Southwell, 1992; Neal, 2004).

The functional requirements are conceptualized for review under design functionality and material functionality. The design functionality would focus on the

design requirements that aid in carrying out different activities in the hospital (Cho, 2006) and material functionality on performance characteristics of the fabric (May-Plumlee & Pittman, 2002; Li et al., 2006).

### 2.1 Design functionality

The patient gowns are designed to meet three significant functions of protection, treatment, and caring (Ng, Hui, & Wong, 2011), which can be grouped as (i) requirements of end-users (patients) and (ii) requirements of caregivers. The end-users' requirements need to address the physiological and psychological requirement for warmth, comfort, aesthetics, and modesty. The requirements of the caregivers are functional and include easy access to patient's body, ease of donning and doffing, and administering medical care (Cho, 2006; Jha, 2009). The patient gown generally used in the hospitals is reported by patients as uncomfortable to wear with proven adverse effects on the patients' psychological outlook and highlight the design requirement that promotes patient's dignity, mobility, and well-being (Morton et al. 2020). To have an in-depth understanding of the functional requirements, the researcher reviewed the patented designs of the patent gowns, which have references from the 1920s to 2020. The terms patient gowns or hospital gowns are synonymously used to describe the gowns worn by the patients in the hospital. It is observed that about 100 patents are filed in designing clothing for hospital requirements, which are classified for the review as:

i) Design for easy access to the patient's body,
ii) Design for ease of donning and doffing,
iii) Design of improved medical gowns with unique features,
iv) Design for special needs (such as neonatal infants, lactating mothers, disabled, etc.),
v) Design for improved dignity.

A few patents are randomly selected and referred to outline the research progress in designing functional patient gowns. Design for improved dignity is discussed in section 3, under the requirements of modesty.

**Design for easy access to the patient's body:**

Carter et al. (1966) design on 'Patient's Comfort Gown' addresses the requirement of utilitarian value, which includes ease of application and removal, comfort and freedom of movement of the wearer, and ready access to the patient's body. The garment design provides fastening at the sides throughout the length and detachable sleeves, which aids in easy removal of the garment.

Price (1987) design of the patient gown addresses the gaping at the back using panels in the front and back connected on either side of the body with fastening straps for easy handling of the material. The design provides ready access to the body for the caregivers from the side of the patient (either front or back of the gown) and additionally keeps the patient's body fully covered.

Sawicki and Herb (1988) design of the patient gown addresses the functional aspect of the easy access to the patient's body and the fit of the gown. The garment has a slit running from the neck to the patient's arms, which provide immediate access to the patient's chest area. The design also has a slit in the form of 'T' running through the entire length in the front, configured with hook and loop fasteners that aid in securing and adjusting the gown to accommodate different sizes apart from casts and enlarged bandages. Other functional elements included in the design comprise a front pocket for the placement of telemetry units and a loop/buttonhole/hook-like means located below the wearer's waist to hold the bladder drainage bag.

Mucci et al. (1993) design of 'Hospital Garment with Quick Release Mechanism' accommodates the requirement of providing easy access to the injured part of the body and the IV locations of the patient's body. The design features series of releasable fastenings at the side, the front portion of the body, and to the limbs on either side.

**Design for ease of donning and doffing:**

Spriggs (1984) design of 'Hospital Gown' addresses the shortcomings of the existing design, such as inability to cover the patient's body, difficulty in dressing and undressing, unattractive non-form fitting blousy gown. The gown patented design includes the use of a quadrilaterally shaped unitary body portion that can be wrapped around the patient's body with the openings secured through long straps. The material suggested for the gown includes natural, synthetic, or blended woven fabric, preferably cotton or cotton blended with polyester, nylon, polypropylene.

Maria (1999) design of the patient gown addresses easily donning and doffing of the gown with the inclusion of two detachable panels (one front and one back), including an arm section attached with Velcro. The utility of the patient gown is enhanced with the addition of an implement support pocket (to house a medical drainage pouch), a utility pocket (to house personal items of the patient), and or a leg/feet cover (detachable segment only attached when necessary to keep the patient's legs and feet warm).

Chen (2001) design addresses patient gown requirement, which is easy to put on, worn comfortably, and also enable the temperature of the patient recorded conveniently from the armpit without having to untie the cords at the back. The design has two segments of front pieces (first and the second edge of the front side and front shoulder) and two segments of back pieces (first and the second edge of the back side and back shoulder). The first side of the front and shoulder sides is sewn to the first side of the back and shoulder. The second side of the front side and shoulder is provided with a plurality of fasteners, which aids in the comfortable wearing of the garment along with the easy opening of and recording the temperature.

Richards (2007) design of patient gown called 'Separable Hospital Gown' explicitly addresses the separable portions of the gowns joined with color-coded fasteners, allowing the medical personnel to quickly and conveniently secure the garment about the patient.

Clauder (2016) design of a 'Quick Donning Hospital Gown' addresses the problems of tying and untying the strings at the back of the gown generally used in the hospital. The design consists of a pair of overlapping panels secured with magnetic components, which helps in easy detachment of the gown. Other design details included are a shoulder access slit, which aid in introducing medical device wires or fluid hoses.

Clauder (2017) with a design extension of the patent filed in 2016, has an opening at the lower front portion of the garment, which provides an attachment point to support a Foley catheter used by a patient.

**Design of improvised medical gowns with unique features:**

Scroggins (2003) patent is a specially designed patient gown with various accessibility features such as enlarged pockets to receive heart monitor and aperture that accommodates medical tubing, heart monitor wires, etc.

Sheward and Sheward (2009) design of patient gown addresses the patient's mobility and privacy. The design details include specific pockets and slits that allow mounting of the catheter bag inside the patient's gown without exposing the patient's dignity. The closures of the gown include the snap fasteners, tie straps, hook and eye type fasteners.

Trouillot (2010) application for patent addresses the need for routing lines running under the gown, creating irritation, infection, and stress. The gown's design has a plurality of slits that runs the tubes and wires with increased patient's modesty, comfort, and reduced skin contact to decrease the risks of irritation, infection, and stress.

**Designing for special needs:**

Feinberg (1984) the patent design, is a garment design solution for the convalescents confined to the wheelchair specifically designed for maximum utility, safety, and comfort. The design provides slits on either

side of the garment, which aids in drawing the strap portions of the pelvic or other wheelchair restraint to the outside of the garment, which can be fastened on the back of the wheelchair. The garment also features color-coded detachable sleeve, which facilitates the separation of the segment for injections, blood pressure examination, etc.

Freeman (1987) patent of the patient gown addresses the limitations of the patient gowns in terms of being uncomfortable for a mother to nurse the child without removing the gown, and specific examinations such as thorax and upper abdomen, which requires the patient to remove the gown. Other limitations highlighted include the use of metal snap fasteners unsuitable for use in X-ray and washing.

Ochao and Nalbone (2008) design of hospital gown for pediatrics, juvenile, and adolescent patients, address the limitation of oversized gowns not suiting the children's requirement admitted to the hospital. Other design requirements included are ease of wearing without the caregivers' assistance, modesty, and privacy of the patients. Pockets incorporated in the design aids in storing patient records or data. Snap fasteners at the bottom of the gown designed help close the same, forming a pair of leg openings. This arrangement, especially in the gown for children, prevents the child from tripping or falling while ambulating.

Brucato and Lipps (1988) patent of the 'Special Garments for the Disable and Infirm' design addresses the disabled and infirm individuals with problems of inconsistency and or drooling. The design includes functional design elements of removable bib attached to the garment, front and back covering a portion of the garment. The front comprises the inner front part (made of fluid-resistant material) and the removal outer front portion. The garment's back portion can be kept open when the wearer is seated (to prevent the garment from becoming soaked or soiled due to incontinence of the wearer) and closed when the wearer is standing to avoid embarrassment.

Howsden (1997) patent addresses the specific requirements of infant clothing, especially for neonatal intensive care unit wherein the design should provide easy access to any and all parts of the body. The design is a T-shaped garment with detachable fastenable closures along the top/or shoulder portions and down the garment's front.

Hamilton et al. (2009) design of patient gown are for nursing mothers, providing coverage of the desired portion of the body and coverage of a nursing child as desired.

### 2.2 Material functionality

The hospital gowns from the inception in the late 19$^{th}$ century are made using cotton muslin or polyester-cotton blend. These fibers, due to their hydrophilic nature, help in being comfortable owing to their air and water permeability. They also provide an additional advantage of stability against wash/reusability (Rutala & Weber, 2001; Krishnasamy, Senthilkuamr, & Neelakandan, 2017). However, these fibers are naturally absorbent and allow the blood-strike through the gown (Granzow et al., 1998), which causes a significant source of cross-infection (Rutala & Weber, 2001; Elshafei & El-Zanfaly, 2011; Balci, 2016), presence of objectionable odor, dermal infection, product deterioration, etc. (Singh et al., 2005). The cellulose content of the fabric, under appropriate conditions of heat and moisture creates condition for the growth, proliferation, and long-term survival of bacterial and fungi, leading to cross-transmission of healthcare-associated infections. This makes it essential to treat textiles used in the hospitals with antimicrobial properties that act as a barrier against microorganisms (Krishnasamy et al., 2017; Rozman et al., 2017).

The patents reviewed mainly address the functionality in terms of design elements provided as per the user requirements but do not address the material functionality that pertains to the performance of the textiles such as comfort, water permeability, etc. which are reported as essential design requirements in designing functional garments such as tennis players, bike riders,

etc. One patent by Freeman (1986) is found to address the functional aspects of comfort and dignity in designing the patient gown through the use of material (an opaque 50% cotton 50% polyester blend) which aids in providing privacy and suitable thermal characteristics that allows patient being comfortable both in bed or moving about a hospital even during an extended period of recovery.

The application of antimicrobial finishes, which plays a prominent role in designing for the healthcare environment, is reviewed for its impact on the material performance and its durability to washing.

A variety of antimicrobial finishes applied in the field of textiles includes different natural dye extracts (Joshi, Ali, Purwar, & Rajendran, 2009) obtained from plant sources such as Quercus infectoria (Singh et al., 2005), pomegranate, myribalan, henna, etc. (Gupta, Khare, & Laha, 2004); biopolymer extracts such as sericin from Bombyx Mori silkworms, chitosan from crabs; herbal extracts such as neem oil, aloevera, etc. (Uddin, 2014; Ayyoob, Khurshid, Asad, & Shah, 2015); and use of nanoparticles such as silver, fluorocarbon, zinc oxide, etc. (Rajendra, Balakumar, & Ahammed, 2010; Li et al., 2006; Krishnasamy et al., 2017).

The cellulosic fabrics for commonly found hospital pathogens is treated with natural derivatives such as chitosan (Lim and Hudson 2003), sericin extracted from Bombyx mori (Rajendran, Balakumar, & Sivakumar, 2012); metallic salts of Copper sulfate and Zinc sulfate (Nakashima, Sakagami, Ito, & Matsou, 2001); and nanoparticles (Li et al., 2006; Krishnasamy et al., 2017). The antimicrobial finishing of cellulosic fibers has advantages of biodegradability, hygiene, and microorganism comfort, economical for healthcare purpose, apart from being comfortable worn next to the skin (Uddin, 2014). Polyester/cotton blends are mainly treated with metal oxides nanoparticles to impart antimicrobial activity (Eid, El-Sayed, Ibrahim, & Habib, 2019).

Cotton treated with 1% concentration of chitosan derivative exhibited 100% bacteria inhibition, retained at 99% even after 50 cycles of home laundering (Lim & Hudson, 2003).

Chitosan, and citric acid applied on cotton, show antimicrobial activity retained even after 20 washes and tumble drying process. Citric acid alone applied on cotton fabric exhibits antimicrobial activity. However, the strength retention of the fabric is improved with citric acid and chitosan treatments (Chung, Lee, & Kim, 1998).

Rajendran et al. (2012) suggest sericin extract from Bombyx mori silkworms as a valuable antimicrobial ingredient and, when applied to cotton fabrics, exhibit antimicrobial activity with percentage reduction levels of 89.4% for *S. aureus* and 81% for *E. coli*.

Encapsulation of neem extracts and Mexican daisy on cotton fabric exhibits potential antimicrobial activity, retained even after 15 washes (Thilagavathi, Bala, & Kannaian, 2007).

Nakashima et al. (2001) work on cotton fabric treated with metallic salts of Copper sulfate and Zinc sulfate exhibited a high degree of antibacterial activity maintained even after ten laundry cycles for different pathogens.

Nano particles of nanosilver (NS) and nanoflourocarbon (NFC) exhibited increased antimicrobial activity when applied to cellulosic fabrics. The air permeability of the fabric, which depends on the number and size of pores in a fabric reduced with the increased concentration of NS and NFC, which is attributed to the deposition of the nanoparticles on the fabric pores. Similarly, the moisture vapor permeability increased with increase in NS concentration up to 5g/L (Krishnasamy et al., 2017).

Silver nanoparticles are also an effective antimicrobial agent applied to polyester cotton blend fabric with a 99.9% rate of inhibition to *S. aureus*, *E. coli,* and *C. Albicans pathogens* and high durability to the washing (Tremiliosi et al., 2020).

Nanoparticles of silver nitrate and titanium dioxide showed a reduced risk of transmission of infectious diseases (Li et al., 2006).

The polyester-cotton blend fabric activated with an enzyme before treating with zinc oxide nanoparticles exhibit better antimicrobial activity than the parent fabric treated with zinc oxide nanoparticles without activation with an enzyme. Activated fabric showed exceptional antimicrobial activity revealing excellent durability to washing (Al-Balakocy, El-Badry, & Hussain, 2013).

## 3. Modesty requirements

In addition to the requirements of the caregivers, a patient gown design also needs to address the requirements of dignity and modesty that can contribute to emotional comfort and satisfaction levels of the services provided in the hospital (Jha, 2009; Junewicz & Youngner, 2015). Modesty and improved privacy as design requirements for the patient gowns have been researched and patented for the design.

Gordon and Winkler (1990) design of the patient gown termed as 'Dignity Gown', mainly aimed at the gown construction that decreases loss of dignity or dehumanization of people admitted to the medical care centers. The gown consists of a fully closed back portion and the front segments (lower segment and upper segment) capable of being detached temporarily through Velcro, plastic breakaway zipper, and adhesive strips.

Jakub (1991) the patent for the hospital gown design facilitates the medical examinations and treatments without requiring its removal. The gown design is comprised of a wrap-around lower segment with a waist drawstring and a series of releasable fasteners along the overlapped seam. The vertical overlapped openable seam on one side of the front of the gown is held with a series of hooks and loop fasteners. Thus, the gown provides easy access to the entire chest area with the lower portion covering the wearers' anatomy without any openings to satisfy the wearer's modesty.

Benstock (1993) design of the 'Versatile Patient Gown' provides access to the torso in the front or back without removing the gown. The gown's versatility includes its use for the intensive care unit with the opening at the sleeve to place IV's; for the critical care with the front pockets that could hold the telemetry units; for the mammography by the exposure of the chest without removal of the entire gown.

Trautmann (1999) design of the 'Patient Privacy Gown' incorporates the slit opening beginning beneath the neckline and terminating above the lower hemline. The opening is claimed to provide modesty to the patients while allowing the doctors access to the patient's torso.

Shamam (2002) design patent address the requirement of patient's modesty, and patient's care and examination. The design patented is a closed rear gown provided with a front opening that allows the patient to dress and undress by himself/herself. The design is equipped with closing at the top of the shoulder to provide access to shoulder, arms, and back of the patient for medical examination. The design thus provides modesty and convenient access to the patient's body for medical examination. The gown also includes a provision of pocket to place the telemetry units.

Garza (2002) design of the patient gown provides an opening from either side to examine the selectable parts of the torso while substantially providing the cover over the unexamined portions of the body.

Kerr (2008) patent of hospital gown addresses the requirements of the convenience of the wearer and the requirement of medical professionals in the diagnosis, treatment, and care of the patients. The patient gown patented shows enhanced privacy features, including a single-piece panel of front and back sections connected along the shoulder seam by plurality of releasable fasteners. The design had a provision of selectively opening front and rear panels at the side that allows access to the patient's body.

Ward (2019) design of the hospital gown addresses the disadvantages of the known hospital gowns with rear opening that generally do not cover the nether region of

the patient completely and requires the gown to be removed for any procedure required for front body area. The design claims to improve the patient's dignity with the design features of three panels and a plurality of releasable seams that allow easy access to the patient's body without the removal of the garment.

## 4. Aesthetics requirements

Aesthetic considerations in designing apparel products relate to the expression of inherent desire for beauty expressed through the use of design elements to create a pleasing design(s). All apparel products designed move along with the aesthetic to functional continuum, addressing the functional requirements and the aesthetic needs of color and texture (May-Plumlee & Pittman, 2002). Aesthetics included as a design element in designing patient gowns help reduce the negative feelings of tension, anger, stress, and psychological depression and contribute strongly to psychological comfort and thus enhance patient recovery process (Cho, 2006). A similar study conducted by Stokes and Black (2012) on clothing requirements for adolescent girls with difficulties, recommend the functional design requirements of fit, easy donning and doffing, consideration on type and placement of fastener, mobility, safety; expressive consideration of designing the garments that do not entangle with the supporting equipment causing embarrassment in public; and aesthetic concerns of fashionable garments meeting the requirement of body-garment-near environment relationship.

Agbo and Igbo (2017) investigate designing garments for bedridden women, highlighting the importance of aesthetic requirements in designing as an interlay of line, form, texture, and color of the garment along with other materials applied artistically.

Dye & Dillard (1992), a garment design for health care purposes resembling the pajama and shirt, addresses both aesthetic and functional requirements.

Thrift (1996) design of 'Wearing Apparels with Transformation Abilities' considers aesthetic in print patterns and shapes applied to the outside of the socks.

Cho & Paek (2006) patent of patient gown termed as 'Papilla Gown', which means breast gown, considers the aesthetic requirements and good accessibility to a drainage system essential after breast surgery and ease of wearing.

Sampson-Howlett (2012) design of patient gown called 'Versatile Hospital Gown', mentions the use of aesthetically pleasing material or fabric apart from complementary colors or prints in the different components of the design.

Clauder (2017) patent mentions the use of textiles with plurality of colors/and or aesthetically pleasing patterns or that provide both physical and emotional comfort during wearing.

## 5. Insights on designing of patient gowns

Design, which is a process of developing innovative solutions to the problems, requires a designer to understand the design requirements, explore the design possibilities, create the prototype, and test the product developed. It is a human-centric process that requires a designer to gain an empathetic understanding of the requirements of the end-users. The design model developed by Lamb & Kallal (1992) provides such a framework for understanding the functional, expressive, aesthetic requirements of the consumer in designing apparel. The model has been widely used in designing for functional clothing, focusing on needs assessment with equal emphasis on the requirement of expressive needs of self-esteem, self-image etc., along with the aesthetics.

The model reviewed in designing patient gowns highlights the importance of including modesty in designing. Hence, the research review conceptualized '*Functional, Expressive, and Aesthetic Consumer Needs Model'* as '*Functional, Modesty, Aesthetic Model*' as per Koo et al. (2014). The patents reviewed for the understanding of the requirements considered in designing and

patenting hospital gowns highlights the needs of designing the patient gowns that enable the functional requirements of donning and doffing through the use of suitable fasteners, modesty, incorporation of design details that aid in placing the telemetry units and drainage bags, possibilities of incorporating the tubes and wires, designing separate garments for different purposes such as gown for lactating mothers. The focus of designing patient gowns balances the requirements of the caregivers as well as the patients. Fit as a functional requirement is not addressed in the patents with most of the designs including the principle of 'one size fits all.'

The patents reviewed do not include the aesthetics or the material suitable for designing the patient gowns. In contrast, the advances in designing functional clothing such as clothing for tennis players, bike riders, sportswear, for wheel chair users etc., place importance on the type of the material and its performance as an important component in designing. Modesty as a requirement in designing patient gown is well researched and found in the design patents reviewed. Aesthetics in designing hospital gowns reviewed through the patents are scarce, with a few garments intended for particular purposes.

Additionally, the material used in hospitals is reported to be reusable gowns made of cotton or blend of cotton-polyester which is washed and sterilized after each use to remove the bacteria. The hospital gowns are the significant source of bacterial dissemination caused by multi-resistant *S. Aureurs*. The use of antimicrobial finishes on patient gowns has been less researched with very few patents, including the recommendations for the fabrication of the design invented with antimicrobial substances topically applied or inherently available in the fabric (Clauder, 2016; Clauder, 2017). The research reviewed on antimicrobial treatment pointed at an increased research work pertaining to the application of natural dyes and natural derivatives which retains the antimicrobial activity for repeated washing.

Inclusion of material functionality in the FMA model in designing patient gowns would help meet the requirements of the end-users and the technical requirement of antimicrobial fabric to protect the patients and caregivers. The suggestion is substantiated with Merrifield 2014 research report on antibacterial hospital gown, that recommends of wearing and using treated textiles in hospital settings. It is reported that patients wearing treated textiles exhibit significantly lower infection levels than wearing regular textiles in hospital settings.

## 6. Conclusions

The research paper and the patents reviewed suggest that designing patient gowns has not been achieved as per the requirements of the caregivers and the patients. The current design with tie-ups at the rear end does not provide ample coverage of the patient's body and often causes embarrassment and a sense of loss of dignity. The ill-fitting gown currently used in hospitals evokes physiological and psychological discomfort to the patient and lacks understanding of the user requirements in designing. A model incorporating the needs of the end-users psychological well-being of the patient without compromising on the functional requirements of the caregivers is essential for providing the holistic approach to designing functional clothing. The review paper highlights on the FEA model conceptualized as FMA model keeping in view the patient's modesty, which directly relates to the dignity and self-esteem of the patient. The design patents reviewed emphasize the patient gown's evolutionary development of the patient gown with the modesty and functional requirements being met. Early patents focus on designing segments of the garment that aids in ready examination by the doctor, mobility, and comfort to the patient. Recent advances in the patient gowns patents focus on the design requirements that include the inclusion of elements that aid in passable tubes, placement of telemetry units, etc.

The papers reviewed point out the need to arrive at a conducive design process that addresses the FMA model with both patients and caregivers in the center of the model as end-users. Implementation of the model with the understanding of the user requirements is required to design the patient gowns with the inclusion of functional, modesty, and aesthetic consideration are suggested for further study and analysis.

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