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Characterisation of single use scrub suits using a thermal manikin

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ABSTRACT
Over the last years scrub suits were gaining acceptance in the healthcare institutions and today are the most used materials for single-use medical clothing. Being the most used medical clothing by health professionals, scrub suits must be comfortable. The purposes of this paper is the study of thermal comfort regarding twelve commercially available scrub suits and relate the properties to determine some conclusions about the importance of thermal comfort in this specific clothing systems. Thermal properties were evaluated using a thermal dry manikin that simulates human body temperature.

Keywords: single-use scrub suits, thermal comfort, thermal properties

1. INTRODUCTION

Over the last years scrub suits produced with non-woven fabrics were positioned in the health textiles market as the most used single-use clothing, according with the Association of Operating Room Nurses (AORN 1995), because the scrub suit promote high-level of cleanness and hygiene within the practice setting in the operating room (O.R.). This topic still very unknown and health professionals need to pay more attention regarding this suits, the comfort issues and related textile materials, once the scrub suits could prevent infection in the O.R. and at the same time promote comfort to the user.
The thermal comfort is an important requirement for the best performance of the scrub suit. The breathability, heat and moisture management of the textiles are characteristics that should be considerate when selecting scrub suits for the O.R., because it plays a crucial role in optimally supporting the physical and mental performance of the health professionals which are exposed to stress situations that promote heat and sweat and that need to be regulated by this specific clothing system (Abreu, 2012). There are four properties that need to be evaluated to establish some information regarding the thermo-physiological comfort, namely, thermal insulation, water vapor permeability, water permeability and air permeability. This paper proposes to evaluate the thermal insulation property of scrub suits to determine its thermal comfort. The thermal insulation of clothing is dependent upon their specific design, size and fabric characteristics, particularly air space between skin and clothing (Braga, 2008) Several studies have been developed around this matter because of the importance of thermal comfort related to the style and dress of disposable scrub suits. (Pamuk and Abreu, 2007)

2. MATERIALS AND METHODS

2.1 Quantitative analysis

Twelve scrub suits from different commercial brands classified as P01 to P12 were tested.
For the identification of raw materials present in each scrub suit, according to (ISO 1833-17:2006) were performed quantitative analysis on the nonwoven materials. These test consist in dissolving a sample in xylene, at ebullition point during 10 minutes. When it's dissolved, we can confirm it is 100% polypropylene. When the sample isn't completely dissolved, the sample must be put to solve in another reagent, namely concentrated sulfuric acid during 20 minutes. If the sample still do not dissolve it´s needed another reagent, called formic acid. Also we have to adapt the different dissolvent through the material type, according with specifications present in the ISO 1833-17:2006.

2.2 Thermal properties

The thermal insulation was evaluated by using a thermal manikin. Thermal manikin, positioned 0.1 m from the floor, was kept standing with their legs and arms held in vertical position without any motion. The test was performed at standard atmosphere according to EN 20139. Heat flux lost was recorded and thermal insulation calculated according to equation (1)-global method. Global method is a method for calculating thermal insulation less susceptible to significant variations where $\bar{T}_{sk}$ [°C] is the mean skin temperature, T_0 [°C] is the room temperature, $\dot{Q}_s$ [W/m^2] the sensible heat flux of the manikin and f_i represents the relationship between the surface area of segment i of the manikin (Braga, 2008). The heat flux results from heat conduction phenomenon that happens because of the quick touch of skin with the clothing system.

$$I_T = \frac{\sum_i (f_i \times \bar{T}_{sk,i}) - T_0}{\sum_i (f_i \times \dot{Q}_{s,i})} \qquad (1)$$

3. RESULTS AND DISCUSSION

3.1 Quantitative analysis

The scrub suits are made mostly from polypropylene which was completely dissolved in xylene at ebullition point. Two scrubs, named, P08 and P12, dissolved partially in xylene, the rest of it was polyethylene, and the samples weren't dissolved in xylene or concentrated sulfuric acid.

3.2 Thermal properties

The heat loss of scrub suits represented in
Figure 1, have no significant changes when compared with those of Figure 2. This can be explained by scrub suits having different designs and it would have an effect on thermal insulation through air space between skin and clothing (Cho, 1997). When the manikin is dressed with P07 the heat loss has the lower value, contrary to P09 that has the higher heat loss. When the value of heat loss is lower the value of thermal insulation is higher as we can see, for example in; scrub suit P07 has higher thermal insulation than scrub suit P09, 0.106 Km^2/W and 0.065 Km^2/W, respectively. This can be confirmed through calculation of thermal insulation values that are represented in Figure 3.
The lower is the value of heat flow, the higher is the thermal insulation and the lower is the warm feeling, for the particular application and the user will be more comfortable (Abreu, 2004).

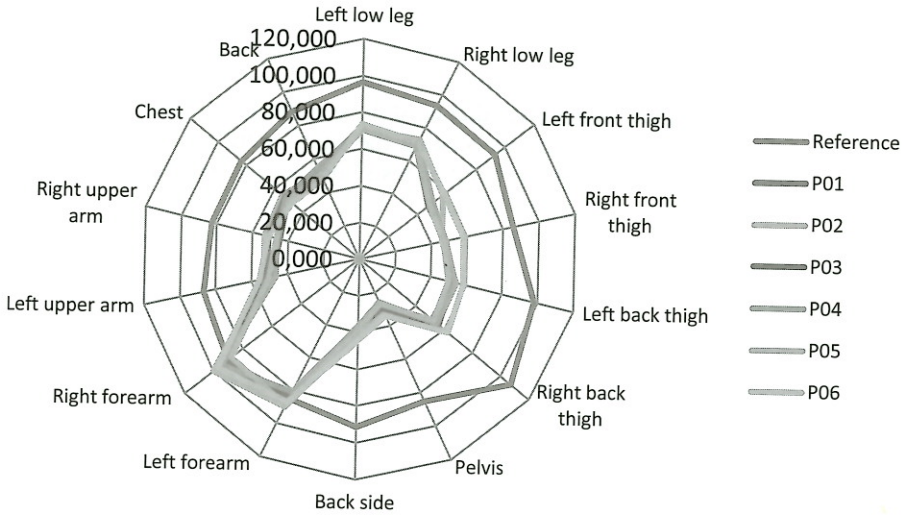

Figure 1 - Heat flux of the several segments of thermal manikins body (W/m^2) naked and using scrub suits P01, P02, P03, P04, P05 and P06.

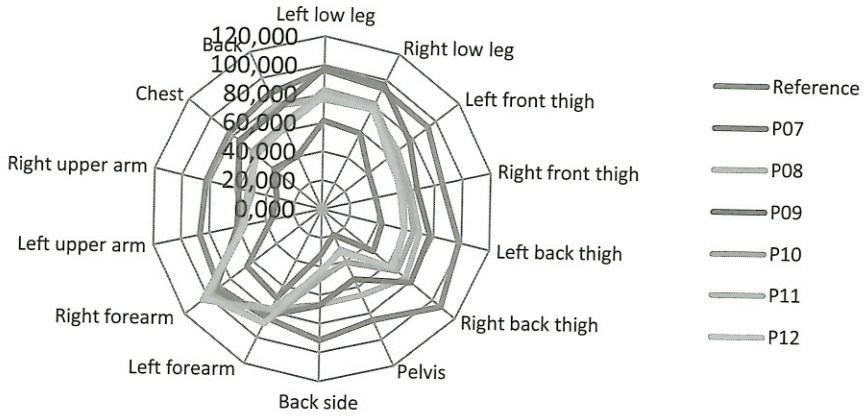

Figure 2- Heat flux of the several segments of thermal manikins body (W/m^2) naked and using scrub suits P07, P08, P09, P10, P11 and P12.

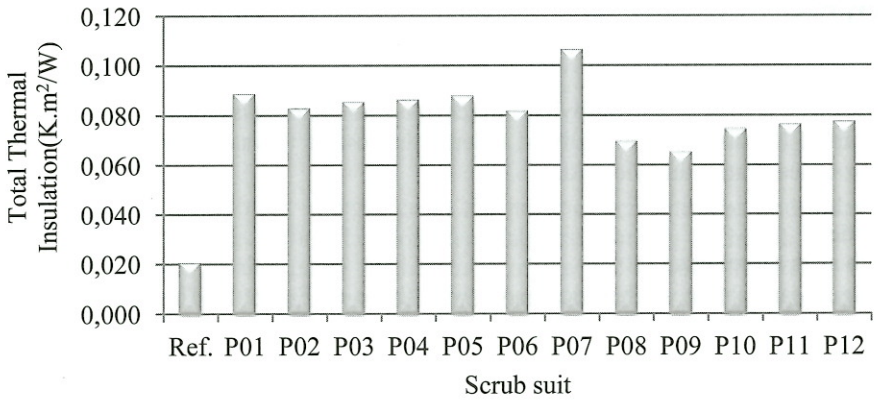

Figure 3 – Thermal insulation of scrub suits

4. CONCLUSIONS

For health care clothing it is important to study their behavior once its users deal with stress and daily routines, causing sweat and heat that makes users uncomfortable and may even influence performance in surgery. Each material that could absorb and conduct heat well will remove heat from the skin and give the sensation of being the "coolest" garment. The use of thermal manikins helps simulating some stress and heat situations and predict if a material is going to be too hot or too cool for its user. It's possible evaluate the textile barrier properties and retrieve some conclusions about the heat flux and the segment areas of the body that need to be cooled or warmed. This test allows the studying of medical clothing in three-dimensional measurements making the study more reliable once the manikin simulates the human body. Forward it is necessary to do other properties tests such as air and water permeability and water vapour permeability in order to evaluate all the comfort properties.

5. ACKNOWLEDGMENTS

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