Fundamentals of Patch Design For Body Perspiration: An Approach In Health Promotion

Venus Jalali, Hassan Naeni, Sara Dindar, Newsha Kooshki and Azadeh Jahanbakhsh

Industrial Design Department,
Tehran University of Art,
Tehran, Iran

ABSTRACT

Nowadays, the significance of personal hygiene considering is inevitable for all. Axilla perspiration is the factor that causes some problems in terms of hygiene. The study's effort is the implicit film could lie on the body directly and invisibly. Data gathering was developed based on sampling, in depth observation, interviews, questioning and experimental studies. The anthropometic variables of samples` armpits were measured. Undoubtedly in this case the selection of related material has a critical role. Our findings were categorized into three parts of anthropometrics, questionings, and experimental. The related percentages were calculated on the anthropometry dimensions. A significant relationship was acquired between samples' feelings and perspiration level, also between peoples' inconveniences and the amount of sweating. Among the exiting materials, the hydrogels have high water absorption. Hydrogels based on partially hydrolyzed polyacrylamide were used in this case because of several advantages. Sodium Alginate is also used as a substrate for our gel,, which can link to it and have appropriate mechanical properties to hold it during usage. On the basis of the outcomes, the use of antiperspirant films in a way which doesn't have effects on naturally sweating of body could help control the inconveniences.

Keywords: Perspiration, Axilla, Product Design, Anthropometry, Hydrogels, Water Absorption

INTRODUCTION

Sweating is one of the physiological reactions, which occurs over the body surface. The average sweating in puberty is between 30-40gr/hour (Dehkhoda, 1337). This amount could exceed over a 12gr/hour in the axillary region in patients who suffer from severe axillary hyperhidrosis (Harry, 1996). Excessive sweating is the condition characterized by abnormally increased sweating (Green, 1978) in excess of that required for regulation of body temperature. When an excessive sweating is produced beyond a person`sphysiologic need in a part of body it is defined as Primary Focal Hyperhidrosis (Nyamekye, 2004). Excessive perspiration can cause extreme embarrassment that may lead to social and professional isolation (Nyamekye, 2004).In the axillary region, two different types of sweat glands exist, namely eccrine and aporcine sweat glands. Eccrine sweat glands secrete a watery fluid as their primary function is thermoregulation. In contrast, apocrine sweat glands occur only in the axillary, mammary, perineal and genital region of the human body. Apocrine glands in the axillary region secrete a variety of non-smelling odorant precursors that are transformed into volatile odoriferous substances by bacterial enzymes on the skin surface (Natsch et al., 2005), (Natsch et al., 2006), (Natsch et al., 2003).
The treatment options available for control of hyperhidrosis, non-surgical or surgical, differ in their invasiveness and efficacy (Nyamekye, 2004).The mechanisms of action of antiperspirants, iontophoresis, cholinergic inhibitor drugs, botulinum toxin, and surgical sympathectomy are reviewed.

Antiperspirants

Aluminium chloride is used in regular antiperspirants (Reisfeld and Berliner, 2008). Much of the population use mild aluminium-based antiperspirants in sprays and roll-on applications to inhibit normal sweating. In clinical hyperhidrosis, 20–25% aluminium chloride in 70% alcohol is a popular first line treatment especially for palms and axilla (Brandrup and Larsen, 1978), (Goh, 1990), (Glent-Madsen and Dahl, 1988)The effect is irritation of the skin (Reisfeld and Berliner, 2008).

Iontophoresis

Iontophoresis treatment involves immersion of the sweating area in a solution, and the use of low intensity electrical current from a D/C generator to drive charged ions in the skin (Hill et al., 1981), (Kreyden, 2004) The device can be painful (pain is usually limited to small wounds and over time the body adjusts to the procedure) and the process is time-consuming (Kreyden, 2004).

Cholinergic inhibitor (anticholinergic) therapy

Anticholinergic drugs may be administered orally and, among other effects, inhibit acetylcholine receptor sites on the sweat gland to stop sweat production (Mirakhur et al., 1978). Anticholinergics are the only systemic treatment in regular use and should be considered in patients with more generalised sweating (Klaber and Catterall, 2000).

Botulinum A toxin-haemagglutin complex

Injections of botulinum toxin type A, (Botox, Dysport) are used to block neural control of sweat glands (Reisfeld and Berliner, 2008), (Klaber and Catterall, 2000), (Heckmann et al., 2001) Transient burning sensation and compensatory hyperhidrosis in the surrounding skin are rare complications (Nyamekye, 2004), (Martin et al., 2011), (Edmondson et al., 1991).

Surgical therapies

Excision of affected skin

Local skin excision was formerly used in axillary hyperhidrosis. This radical approach is limited by poor cosmesis, abscess and sinus formation, and hypertrophic and constrictive scarring and is now seldom used (Breach, 1979), (Kim et al., 1999), (Payne and Doe, 1998)

Open surgical sympathectomy

Open sympathectomy interrupts the sympathetic chain to abolish sweating. Conventional open sympathectomy is now rarely used due to the extensive and traumatic dissection required to gain access to the sympathetic chain, with its increased rates of unacceptable side effects (Moran and Brady, 1991), (Adar, 1994), (Hashmonai et al., 1994)

Transthoracic endoscopic sympathectomy (TES)

TES has gained in popularity over the last decade as the surgical treatment of choice for palmar and facial hyperhidrosis (Shachor et al., 1994), (Ahn et al., 1994), (Fox et al., 1999), (Drott et al., 1995), (Siah and Hampton, 2013).This minimally-invasive procedure, via one or two chest portals per hemithorax, is safe in experienced hands and is associated with negligible scarring.

Other therapies

Many unproven therapies have been tried for hyperhidrosis. Dusting powders are unhelpful as profuse sweating washes the powder away. Other alternative therapies including homoeopathy, massage, acupuncture, hypnosis and phytotherapeutic drugs have not been found to be helpful. Hypnosis, psychotherapy and psychopharmacologic therapies have not cured hyperhidrosis but may help some patients to accept living with their symptom (Nyamekye, 2004) Sweatpads are an alternative to antiperspirants. The liners are applied directly to clothing. Underarm liners can eliminate armpit stains sometimes caused by antiperspirants. They are also designed to protect clothes in a way

that have no effect on the amount of perspiration (Cobb, 2002), (Vadoud-Seyedi and Simonart, 2007).

Purpose

The main purpose of this study is to relieve the apparent sweating inconveniences in the axilla region. Also functional purpose is to design a product that could help the user feel relax during their daily activity without interfering in their bodies natural perspiration. To reach this target sweat absorbing products are designed to be settled on the axilla. Not only does their thickness have to must be appropriate, in order not to have any effects on the appearance of the clothes, but also they are to absorb sweating and avoid from penetrating in to clothing. Regarding to produce this patch considering factors such as water absorptions, flexibility, elasticity, no sensitivity, inconspicuous and stickiness to the skin, a few tests were conducted in a laboratory. It's worthy of mention that controlling the hygienic inconveniences of sweating through designing an appropriate product could obtain beneficial hygienic effects.

METHODS

Development of the Patch Model

In this study, data gatherings were developed based on voluntarily sampling. Data gathering consists of, observation, interviews, questioning, experimental studies, and biblical research. To define, ten designers requirements aged (20-30 years) discussed the topic, so that a Likert questionnaire was formatted. Thirty healthy adults (15 female/ 15 male subjects; aged 20-30 years) were recruited attending the research. The gathering data was analyzed by SPSS-Win18. In order to design the related product, the anthropometric variables of samples armpits including thickness, anthropometric dimensions and convenient usage.

These regions comprise: 1- shoulder curve arc (sagittal plane). 2- The circumference of the arm round. 3- The expanse of the axilla region 4- The circumference of the chest. 5- The circumference of the armpit to neck.

The dimension of these region were measured by, meter, caliper, and flexible ruler.

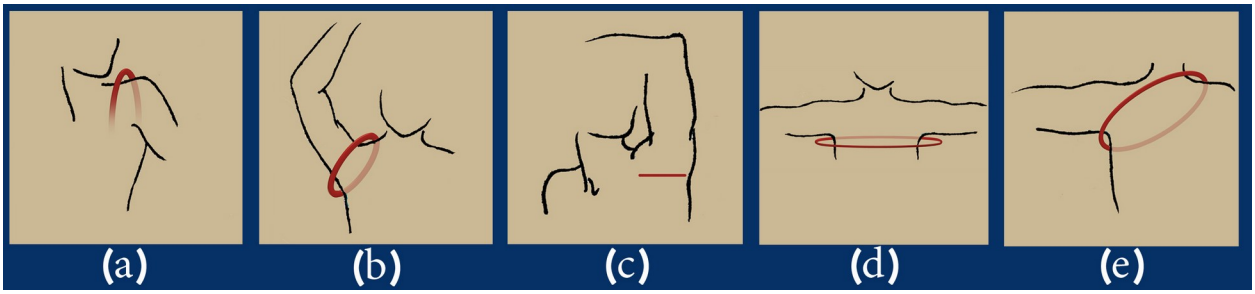

Figure 1

Experimental

Some polymers such as Alginate, polyurethane, polyvinyl alcohol and polyacrylamide were studied for the mentioned product design. According to the fact that hydrogels are composed of hydrophilic polymer chains, which are either synthetic or natural in origin, they have high water absorption. As a result, these hydrogels can be appropriate for our goal in this study; hence, hydrogels based on polyacrylamide used in this case because of several advantages involve low cost, good biocompatibility, high flexibility, high water absorption, good transparency and desirable adhesion to human's skin. In the present work, attempts have been made to prepare hydrogels by crosslinking the polyacrylamide aqueous solutions with low percentages of chromium (III). We used low amount of chromium (III). Gelation time as well as variation of viscoelastic parameters such as storage modulus (G) of the gel network during gelation process at 70°C was studied and followed by Rheomechanical Spectroscopy (RMS). In addition, the effect of crosslink density on swelling ratio was measured. The hydrogels which had lower crosslink agents showed higher flexibility, higher swelling ratio and higher adhesion.

In order to measure degree of swelling, hydrogel samples (0.5 ml) prepared in vials were accurately weighted out of the vials (Wi) and then incubated in 5 ml of distilled water at 37℃. Subsequently, water was taken off from the

samples at regular time intervals, and the hydrogels were weighed (Ws) until reaching to the constant value. The degree of swelling was defined as (Ws-Wd)/Wd.

$$\text{Degree of swelling} = (Ws - Wd)/ Wd \times 100$$

A substrate is needed for our absorbable polymer which can link to it and have appropriate mechanical properties to hold the gel during usage. Sodium Alginate has the good film-forming properties. The Alginate Film was prepared by casting/Solvent evaporation. Film solution contains 1.2 g Alginate powder, which was added in a constantly stirred mixture of 100 ml of distilled water with 0.87 g of NaCl powder. When the solution was completely solved, 10 ml of Alginate Solution was casted into a Petri dish and let it to evaporate and get us thin layer of dry polymer. After all 120mM Calcium chloride solution were prepared and added to the polymer layer for 15 minutes to completely crosslink. The Alginate film prepared after washing it by NaCl solution.

RESULT AND DISCUSSION

Considering to distinct implicit features in this study our findings were categorized into three subsets of anthropometric, questioning and experimental.

a) **Anthropometric results**: according to the obtained measurements and calculated percentages table (1) was reached.

Percentile	The circumference of the armpit to neck	The circumference of the chest	The expanse of the axilla region	The circumference of the arm round	Shoulder curve arc
5%	62.80	75.50	6.20	23.30	3.02
50%	76.70	93.50	9.20	31.90	4.20
95%	90.75	111.60	12.20	40.48	5.37
sd	8.47	10.95	1.80	2.20	0.71

Table 1: Anthropometric Data

The dimensions were measured to help the designer to decide whether or not to use the straps. In the end under arm dimensions were used to design the patch.

b) **Questioning result**: regarded as questioner's result and statistic analysis based on chi square test, related results were obtained. This study expensed that a significant relationship was acquired between sample's feelings and perspiration level. But no relationship (p: 0.01) was found between the amount of perspiration and the ways of preventing the caused problems including using dress shields.

There is a significant association between the individual`s problems and perspiration level (p: 0.00). Between the unpleasant feeling of sweating and sexually there were no significant meaning ($p < 0.05$). It's worthy of mention that the unpleasant feeling caused by exercises sweating and the inconvenient were discussed differently by samples.

Among the propounded 32.25%, mentioned tow cases of bad odor, and stained clothing together, 35.48% mentionedstains as the only problem, (figure 1). The way of preventing the problem was different between samples. Deodorant and anti-perspirant were suggested in 90% of the solutions. 80.25% used two choices of cleaning and slim clothes together. Furthermore the most efficient ways of preventing inconvenience, caused by excessive sweating were cleaning and using deodorants. Required samples in Iran weren't familiar with sweat pads in 70.96% (figure 1) and case who used available pads faced problems such as their dimensions, color and materials.

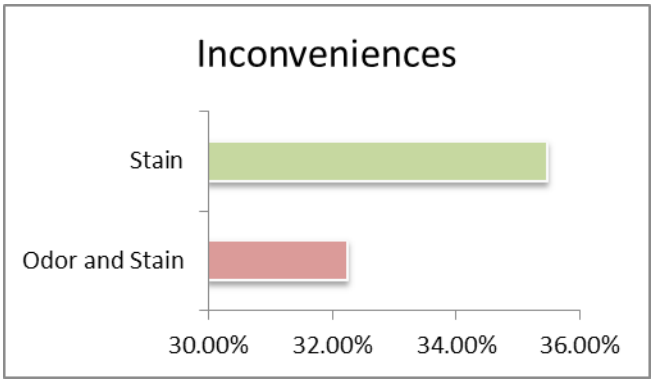

Figure 2

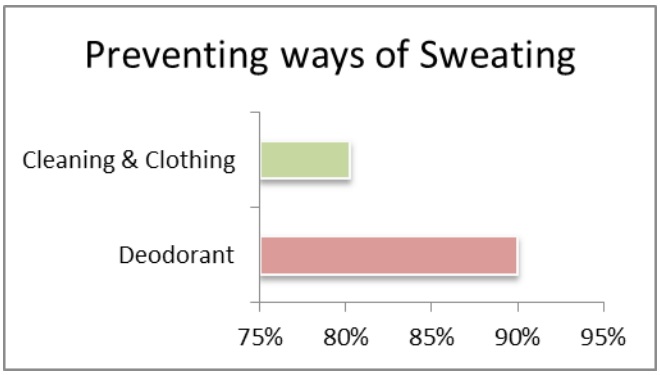

Figure 3

c) **Experimental results**: The results of swelling ratio of the investigated hydrogel indicated high water uptake capability due to the high hydrophilicity of partially hydrolyzed polyacrylamide (Fig 3). As it has been observed in Fig 3, partially hydrolyzed polyacrylamide hydrogel showed 80% swelling ratio after 1 hour and, more than 90 % after 18 hrs, which has made it appropriate for this application.

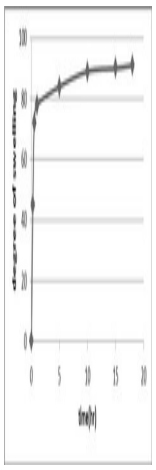

Figure 4

CONCLUSION

On the basis of the research outcomes, the use of anti perspiration films in a way that doesn't have effect on naturally sweating of body could help control the inconveniences resulting perspiration. According to the result more perspiration cause more inconvenience, so in environment with high heat stress these films can have an efficient role. In addition, this issue is more significant in conditions when the heat stress factor such as the factors (WBGT), are above standard. It is worthy of mention that the heat stress in the industrial regions is not measured in this study, and undoubtedly this matter can be discussed in future studies. In view of designing underarm films , and on the basis of anthropometric dimensions, we can obtain an extended coverage for different samples with limited dimension varieties.

REFERENCES

Adar, R.. (1994), "Surgical treatment of palmar hyperhidrosis before thoracoscopy: experience with 475 patients." Eur J Surg. pp. (572) 9–11.

Ahn, SS. Machleder, HI. Concepcion, B. Moore, WS. (1994), "Thoracoscopic cervicodorsal sympathectomy: preliminary results", J Vasc Surg. pp. 20:511–517.

Brandrup, F. Larsen PO. (1978), "Axillary hyperhidrosis: local treatment with aluminum chloride hexahydrate 25% in absolute ethanol", Acta Derm Venereol. pp. 58:461–465.

Breach, NM. (1997), "Axillary hyperhidrosis: surgical cure with aesthetic scars", Ann R Coll Surg Engl. pp. 61:295–297.

Cobb, Linda., (2002), "How the Queen Cleans Everything", SImon and Schuster., pp. 289.

Dehkhoda, A. (1337), "Dehkhoda Encyclopedia of Persian. Tehran : Cyrus Printing", pp. 760.

Drott, C. Gothberg, G. Claes, G. (1995), "Endoscopic transthoracic sympathectomy: an efficient and safe method for the treatment of hyperhidrosis", J Am Acad Dermatol. pp. 33:78–81.

Edmondson, RA. Banerjee, AK. Rennie, JA. (1991), "Endoscopic Transthoracic Sympathectomy in the Treatment of Hyperhidrosis", Advances in Surgical Technique. pp. 3: 289-293.

Fox, AD. Hands, L. Collin, J. (1999), "The results of thoracoscopic sympthatetic trunk transection for palmar and sumpathetic ganglionectomy for axillary hyperhidrosis", Eur J Vasc Endovasc Surg. pp. 17:343–346.

Glent Madsen, L. Dahl, JC. (1988), "Axillary hyperhidrosis. Local treatment with aluminium-chloride hexahydrate 25% in absolute ethanol with and without supplementary treatment with triethanolamine", Acta Derm Venereol. pp. 68:87–89.

Goh, CL. (1990), "Aluminum chloride hexahydrate versus palmar hyperhidrosis. Evaporimeter assessment", Int J Dermatol. pp. 29:368–370.

Hashmonai, M. Kopelman, D. Schein, M. (1994), 'Thoracoscopic versus open supraclavicular upper dorsal sympathectomy: a prospective randomised trial", Eur J Surg. pp. 572:13–16.

Harry, RG. Wilkinson, JB. Moore, Rj. (1996), Harry`s Cosmeticology. 7th edition. England; Amazon.co.uk. pp. 125.

Heckmann, M. Ceballos Baumann, AO. Plewig, G. (2001), "Hyperhidrosis Study Group. Botulinum toxin A for axillary hyperhidrosis (excessive sweating)", N Engl J Med. pp. 344:488–493.

Hill, AC. Baker, GF. Jansen, TG. (1981), "Mechanism of action of iontophoresis in the treatment of palmar hyperhidrosis Cutis", pp. 28:69–71.

I. K. Nyamekye. Current Therapeutic Options for Treating Primary Hyperhidrosis.

Kim, IH. Seo SL, Oh CH. (1999), "Minimally invasive surgery for axillary osmidrosis: combined operation with CO2 laser and subcutaneous tissue remover",Dermatol Surg. pp. 25:875–879.

Klaber, M. Catterall, M. (2000), "Treating hyperhidrosis. Anticholinergicdrugs were not mentioned", BMJ. pp. 321:703.

Kreyden, Oliver P. (2004), "Iontophoresis for palmoplantar hyperhidrosis", Journal of Cosmetic Dermatology 3. pp. 4: 211–4.

Martin, A. Hellhammer, J. Hero, T. Max, H. Schult, J. Terstegen, L. (2011), " Effective prevention of etress-induced sweating and axillary malodour formation in teenagers", International Journal of Cosmetic Science. pp. 33: 90 – 97.

Mirakhur, RK. Dundee, JW. Jones, CJ. (1978), " Evaluation of the anticholinergic actions of glycopyrronium bromide", Br J Clin Pharmacol. pp. 5:77–84.

Moran, KT. Brady, MP. (1991), "Surgical management of primary hyperhidrosis", Br J Surg. pp. 78:279–283.

Natsch, A. Derrer, S. Flachsmann, F. and Schmid, J. (2006), "A broad diversity of volatile carboxylic acids, released by a bacterial aminoacylase from axilla secretions, as candidate molecules for the determination of human-body odor type", Chem. Biodivers. pp.3: 1-20.

Natsch, A. Gfeller, H. Gygax, P. and Schmid, J. (2005), "Isolation of a bacterial enzyme releasing axillary malodour and its use as a screening target for novel deodorant formulations", Int. J. Cosmet. Sci. pp. 27:115-122.

Natsch, A. Gfeller, H. Gygax, P. and Schmid, J and Acuna, G. A. (2003), "specific bacterial aminoacylase cleaves odorant precursors secreted in the human axilla", J. Biol. Chem. pp. 278, 5718-5722.

Payne CM, Doe PT. (1998), "Liposuction for axillary hyperhidrosis", Clin Exp Dermatol. pp. 23:9–10.

Reisfeld, Rafael. Berliner Karen, I. (2008), "Evidence-Based Review of the Nonsurgical Management of Hyperhidrosis", Thoracic Surgery Clinics. 18 (2) pp. 157–66.

Sex, Hormones and Behaviour. London., (1978), CIBA Foundation Symposium. pp 196-197.

Siah, TW. Hampton, PJ. (2013), "The effectiveness of tap water iontophoresis for palmoplantar hyperhidrosis using a Monday, Wednesday, and Friday treatment regime", Dermotology Online Journal. (pubmed) 19(3):14.

Shachor, D. Jedeikin, R. Olsfanger, D. Bendahan, J. Sivak, G. Freund, U. (1994), "Endoscopic transthoracic sympathectomy in the treatment of primary hyperhidrosis. A review of 290 sympathectomies", Arch Surg. pp. 129:241–244.