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**PHYSICAL PROPERTY OF COMMERCIALLY AVAILABLE CONTACT LENS SOLUTIONS IN GHANA**

BY

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**CHAPTER 1**

INTRODUCTION

Contact lens care solutions are composed of several important components, including viscosity increasing agents, buffering agents, preservatives, pH, tonicity, and surface tension. The combination and concentration of these agents will have a significant impact on the physical properties of the solution and this could potentially influence patient comfort. Surface tension of a solution refers to the difference in surface energies between solvent molecules and polymer membrane surface (Ginn, Noyees, & Jungermann, 1968). The surface tension of human tears is in the range 40 to 46mN/m. In a contact lens care solution, the presence/absence and type/number of surfactants will have a substantial impact on the surface tension of the solution. A study that investigated the surface tension of various care solutions showed that most multipurpose solutions have surface tension values that ranged between 29 and 70mN/m (Dalton, Lakshman, Ronan, & Lyndon, 2008). Contact lens care solutions differ in certain physical properties and by design, most care solutions fall within acceptable limits of ocular physiological tolerance. When properties of these solutions do not fall within the acceptable limits, clinically, this could result in burning, stinging, and epithelial cell damage. Minor shift in the values may have the potential to influence patient comfort naturally and/or at the end of the day. To date, very little has been published directly investigating the physical properties of lens care solutions and this warrants further investigation. The purpose of the present study is to investigate the surface tension of commercially available contact lens care solutions in Ghana.

PURPOSE:

To investigate the surface tension of commercially available contact lens solutions in Ghana.

STATEMENT OF PROBLEM

Many contact lens Multi-Purpose Solutions (MPS) and accessories are used in the fitting, wearing, and maintenance of contact lens. An in depth understanding of these solutions which include; Freshlook solution, Opti-Free solution, Gp fresh solution, Trufresh solution, Avizor solution, and Refresh solution commercially available in Ghana is required by eye care practitioners if they are to be used to their fullest advantage.

Problems from mild discomfort to severe ocular damage can occur if the solutions are not compatible with the lens, the eye, and other solutions, and this can lead to contact lens dropouts. Most studies have shown that surface tension may have the potential to influence patient comfort, either initially upon lens insertion or at the end of the day, through interactions between the solution, the lens, and the patient’s tear film (Tiffany, 1998; Pandit, Nagyova, Bron, & Tiffany, 1999).

Dalton et al (2008) conducted a study on the physical property of various contact lens solutions in Canada. The study reported on the effect of surface tension of various contact lens solutions including Opti-Free solution (Dalton, Lakshman, Ronan, & Lyndon, 2008). However, little is known about surface tension of commercially available solutions in Africa. Therefore, this study is conducted to investigate the surface tension of the contact lens solutions listed above which are commercially available in Ghana.

HYPOTHESIS

HO: There is no significant difference in the surface tension among the various contact lens solutions.

HA: There is a significant difference in the surface tension among the various contact lens solutions.

RESEARCH QUESTIONS

* What is the average surface tension value of the various commercially available contact lens solutions?
* Does the surface tension value vary significantly among the soft contact lens solutions?
* Is there any effect of temperature on surface tension value of a contact lens solution?
* Which of the commercially available solutions have surface tension value that falls within the reported tolerable range for the ocular surface?

OBJECTIVES

* To determine the average surface tension value of the various commercially available contact lens solutions.
* To determine if the surface tension value vary significantly among the soft contact lens solutions.
* To ascertain whether each of the commercially available solutions have surface tension value that falls within the reported tolerable range for the ocular surface?

SIGNIFICANCE OF THE STUDY

* Results in this study will help in creating awareness to the contact lens community with respect to the care solutions in Ghana which fall within the acceptable limits of ocular physiological tolerance.
* It will also help inform the contact lens practitioner on the lens care products in Ghana that may improve subjective comfort in the contact lens patients.
* The results will form the basis for future studies.

LITERATURE REVIEW

Because of the benefits of contact lenses over spectacles, such as, improved optical quality for vision correction and a higher quality of life, the number of people who wear them has steadily increased over time. Contact lenses are primarily used to address refractive problems, as well as for cosmetic and therapeutic reasons. Other reasons to wear contact lenses include the prevention of ocular surface disorders and vocational reasons, such as for athletes. Any of these can be used in combination. The ability of contact lens to perform its functions is dependent on the contact lens solution. Contact lens solution moisturize the lens material giving the contact lens its adherent property. The solutions also help to remove sediments without scratching the surface of the lenses. Again, the use of contact lens care products following the labeling instructions of the manufacturers may provide increased assurance that viable populations of contaminating microorganisms will be reduced. Despite the advantages of contact lenses and their solutions, some individuals experience ocular discomfort. Many contact lens wearers have stopped wearing them temporarily or permanently due to the discomfort they experience while wearing them (Dumbleton K, 2013).

According to a report published by the Tear Film and Ocular Surface Contact Lens Discomfort Workshop, contact lens discomfort is defined as a condition characterized by episodic or persistent adverse ocular sensations related to lens wear, either with or without visual disturbance, resulting from decreased compatibility between the contact lens and the ocular environment, which can lead to decreased wearing time and discontinuation (Nichols, Redfern, & Jacob, 2013). According to the report, contact lens discomfort can be caused by a variety of factors, including the contact lens itself or the surrounding environment (Nichols, Redfern, & Jacob, 2013). This discomfort could be caused by a variety of factors including medications, food, hydration, alcohol consumption, smoking, physiological/fatigue, and the physical qualities of contact lens solution. (Dumbleton K, 2013). Contact lens–related causes include the material, design, and care of the contact lens. Environmental related causes include patient-specific factors, compliance, and ocular surface conditions (Nichols, Redfern, & Jacob, 2013).

Global.The prevalence of current CLs’ users was 40.5%. Most of the wearers (80.2%) used soft lenses. The yearly type of lenses, followed by each of the daily and monthly types were the commonest used lenses (Ibrahim, Seraj, Khan, Baabdullah, & Reda, 2018). Using the population-based survey, an estimated 40.9 million persons in the United States aged ≥18 years wear contact lenses (16.7% of U.S. adults)§; 93.0% of contact lens wearers reported wearing soft contact lenses (lenses made of soft, flexible plastics that allow oxygen to pass through to the cornea) (Cope, et al., 2015).

Out of 321 contact lens wearers in Abuja (Nigeria), most contact lens wearers were females (91%) and only 9% were males (Ezinne, Austin, Ilechie, & Mashige, 2019). Similar findings were recorded in reviews of contact lens prescribing habits in 27 countries including: Australia, Canada, United Kingdom, United States of America, Germany, Greece, Italy, Japan, Netherland, New Zealand, Sweden, Singapore and Norway except Spain where there was 48% female contact lens wearers and 52% male (Morgan, et al., 2015). Thite et al9 also showed that 67% of contact lens wearers in India were females (Thite, Noushad, & Kunjeer, 2013). Moreover, the use of contact lenses has always remained high in females than males since the inception of the international prescribing trends project which began in 1996 (Ezinne, Austin, Ilechie, & Mashige, 2019). In a previous study within an academic population in Ghana, the proportion of spectacle wearers reporting a history of contact lens wear was 3.3% (Abokyi, Manuh, & Otchere, 2017).

Contact lens solutions have been in the system since the 70’s, although they were specifically to be used for rigid gas permeable lenses. Since this time, the development and optimisation of contact lens solutions, as well as testing and evaluation guidelines, have rapidly evolved to keep pace with the development of novel contact lens materials and our ever-growing appreciation of the role that contact lens care regimes play in contact lens success. The ideal characteristics of a contact lens solution are; effective disinfection against a wide variety of pathogenic organisms, non-toxic to ocular tissues, compatible with all contact lens materials, simple to use, rapid disinfection capability, condition lens surface to enhance wettability and in-eye comfort, minimise deposition of tear film components, and inexpensive to purchase (Lyndon & Senchyna, 2007).

The ability of contact lens solution to posse the above characteristics depends on the component of the solution. One important component is the surfactant. Surfactants are wetting agents that lower the surface tension of a liquid and lower the interfacial tension between two liquids. Surface tension is defined as the difference in surface energies between solvent molecules and polymer membrane surface (Ginn, Noyees, & Jungermann, 1968). Surfactants are usually organic compounds that are amphiphilic, meaning they contain both hydrophobic groups (their tails) and hydrophilic groups (their heads). Surfactants reduce the surface tension of water by adsorbing at the liquid–air interface. The surfactant in the contact lens care solution gives the solution an average surface tension making it possible to perform its function as a detergent or cleaner in removing loose debris and deposits (including microorganisms). It has been found that for a substance to wet another another substance, its surface tension must be lower than the target. studies provide scanning electron microscopic evidence to suggest that methods used in the previous studies cause severe damage to the corneal epithelium and may be flawed on a theoretical basis as well.13 More recent evidence suggests that the surface tension of the cornea is much higher (67.5–72 dynes/cm) than previously determined, with minimal change after reatment with mucolytic agentsThe ST of human tears falls within the range of 40 to 46 mN/m (Tiffany, 1998)**,** (Pandit, Nagyova, Bron, & Tiffany, 1999)**.**

It has been reported that clean and dry human skin has a surface tension of 27-28 mN/m (Ginn, Noyees, & Jungermann, 1968). The surface energy of any substrate must be equal to or less than that of human skin in order for it to stick to the skin's surface. This means that the surface energy of a contact lens solution must be less or identical to the that of the human tears in order for it to stick to the lens' surface. The surfactant then combine with these deposits to form micelles which are more easily suspended in the surrounding liquid. The micelles are then removed during the rinsing procedure. The surfactants both soften the deposits, preventing them from becoming irreversibly adherent to the lens surface (Phillips, 1980). The second function relates to their ability to enhance the wettability of hydrophobic substrates (Ketelson, Meadows, & Stone, 2005; Tonge, Jones, & Goodall, 2001), which is becoming of increasing importance with the development of silicone hydrogel lenses, that are generally more hydrophobic than conventional hydrogel materials (Bruinsma, van der Mei, & Busscher, 2001; Cheng, Muller, & Radke, 2004). As the growth in the numbers of patients wearing silicone hydrogels continues, the importance of surfactants for both their cleaning and enhanced wetting roles is likely to increase.

The most common surfactants found in lens care solutions are sourced from BASF and consist of two distinct groups –poloxamines sold under the trade name Tetronic and poloxamers sold under the trade name Pluronic. Every company that deals in contact lens solution have a specific surfactant and specific level of that surfactant that they use in their products. Specific examples include Pluronic F87 (poloxamer 237), Pluronic F127 (poloxamer 407), Pluronic 17R4, Tetronic 1107 (ReNu MultiPlus), Tetronic 1304 (Alcon OptiFree products) and Tetronic 1307. Other surfactants include isopropyl alcohol (isopropananol) found in CIBA Vision’s Miraflow, Tyloxapol (a viscous polymer of the alkyl aryl polyether alcohol type) found in AMO’s Complete MoisturePlus, and Cremophor RH40 (Aqualube) in CIBA Vision’s Focus Aqua (Lyndon & Senchyna, 2007).

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