Short Communication

A review on Normal human skin flora: Exploring the microbial flora of the skin

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ABSTRACT: Humans and their microbial associates collectively called the human microbiome have co-evolved for centuries. The normal flora of the human skin has been an issue of intrigue for a long time, yet it is hard to locate an agreeable description of the bacterial population of human skin. This review covers what is meant by normal skin flora, types of flora residing on human skin, and the factors that affects microbial flora of the skin. It collectively reveals a remarkable diversity of studies of microbiota present in normal human skin, in terms of kinds of bacteria present. This review furthermore focuses on the factors that modify the type and number of the resident microbial organism.

Keywords: Normal human skin flora, Microbiome, Microbiota

INTRODUCTION

The skin is a complex human organ functioning to prevent loss of moisture and confine the entry of pathogens. It also provides an environment for part of the human flora [19]. There are approximately 1 million resident bacteria per square centimeter of skin, for a total of about 1010 skin microorganisms covering the average adult [19]. Normal human skin is colonized by huge quantities of microbiota that live on its surface. The normal flora of the skin, composed primarily of gram-positive cocci and diphtheroid, may represent a selective barrier against the proliferation of potentially pathogenic organisms [1]. Moreover, small numbers of gram-negative bacteria or yeasts may also include in the normal human skin flora. Skin sets a good example of microenvironments of the varying temperature, pH, moisture, and sebum content. The organization of the microflora varies from site to site as indicated by the character of the microenvironment [8]. One particular set of microenvironments includes moist skin areas such as toe webs, the armpit, and the axilla which harbor more microorganisms than the dry microenvironment areas such as forehead, skin, arms. Besides, the third microenvironment consists of areas with high concentrations of sebaceous glands such as those by the side of the nose, the back of the scalp, and the upper chest and back [19].

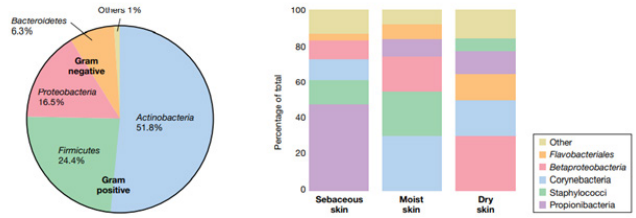

Figure 1: *Normal human flora of the skin. Data are adapted from Grice et al., 2009, Science 324: 1190*

The number of bacteria on an individual's skin remains relatively constant; bacterial survival and the extent of colonization probably depend partly on the exposure of skin to a particular environment and partly on the innate and species-specific bactericidal activity in the skin [8]. Also, a high degree of specificity is involved in the adherence of bacteria to epithelial surfaces but not all bacteria attach to the skin [8].

The purpose of this review was to study some information about the type and number of microbiota populations in each site of human skin and the factors that are responsible for discouraging skin colonization.

Types of microbial organism

The resident organisms live as small microcolonies on the surface of the stratum corneum and within the outermost layers of the epidermis of the skin [4]. The peripheral layer of the epidermis comprises a layer of dead, anucleated, horny cells, and is constantly in contact with bacteria from the surrounding environment. The organisms that are considered as resident flora of skin are listed and described accordingly.

Staphylococci

Staphylococci, excluding Staphylococcus aureus, belong to the normal human skin flora, and together with the Diphtheroids constitute the main part of the indigenous flora [7]. Staphylococci is a major inhabitant of the skin, and in some areas, it makes up more than 90 percent of the resident aerobic flora [8]. Staphylococci are categorized into the coagulase-positive Staphylococcus aureus and the coagulase-negative species. Humans have a high degree of natural resistance to skin colonization by S. aureus [3]. In most body sites the skin is usually not colonized with S. aureus, but it can be found in intertriginous areas, particularly the perineum, of up to 20% of persons [5,3]. Also, persistent nasal carriage of the organism is present in 20% to 40% of normal adults [10] where its occurrence in the nasal canal varies with age, being greater in the newborn and less in adults [8].

Coryneforms (Diphtheroids)

The term diphtheroid indicates a wide range of bacteria belonging to the genus Corynebacterium [8]. Coryneforms organisms are gram-positive pleomorphic rods, which require lipid supplements for growth in artificial media, and nonlipophilic organisms [3]. Classification of diphtheroids remains unsatisfactory so for convenience, cutaneous diphtheroids have been categorized into the following four groups: lipophilic or nonlipophilic diphtheroids; anaerobic diphtheroids; diphtheroids producing porphyrins (coral red fluorescence when viewed under ultraviolet light); and those that possess some keratinolytic enzymes and are associated with trichomycosis axillaris (infection of axillary hair) [8]. Furthermore, Lipophilic diphtheroids are very normal in the axilla, though nonlipophilic strains are discovered all the more generally on glabrous skin.

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Micrococci

Micrococci are not as basic as staphylococci and diphtheroids; nonetheless, they are regularly present on normal human skin. Although less frequently present than staphylococci, at least eight different Micrococcus species have been identified from human skin [11]. By order of prevalence, these are M. luteus, M. varians, 211. lylae, M. nishinomiyacnsis, M. kristinae, M. roseus, M. sedentarius, and M. agieis [3]. Micrococcus luteus, the predominant species, usually accounts for 20 to 80 percent of the micrococci isolated from the skin [8] and is the most common in children.

Propionibacteria

Propionibacterium species are non-spore forming, non-motile, anaerobic, gram-positive bacteria. In the deep sebaceous glands are found lipophilic anaerobic bacteria such as P. acnes. The latter organism is a normal skin inhabitant and is usually harmless; however, it has been associated with a skin disease known as acne vulgaris [2]. Propionibacterium acnes are most numerous on the skin of the scalp, forehead, and back and is the predominant species by far, present in almost 100% of adults [12].

Gram-negative bacilli

Gram-negative bacteria make up a small proportion of the skin flora, because of skin's desiccation [8]. They are seen in moist intertriginous areas, such as the toe webs and axilla, and not on dry skin [8]. Enterobacter, Klebsiella, Escherichia coli, and Proteus spp. are the Gram-negative organisms found predominantly on the skin.

Candida

Candida species are mostly found on the human skin; normally on oral mucous membranes. When present, C. albicans is the most common species found, existing in the blastospore form [3]. Increased colonization of the skin by Candida species is seen in immunosuppressed and diabetic patients and in patients with psoriasis or atopic dermatitis [13].

Factors modifying the normal flora

The normal human skin surface is hostile to the endurance and growth of many kinds of bacteria. Although resident flora remains relatively constant, several factors are responsible discouraging for skin colonization.

Dryness

The relatively dry surface of the skin inhibits microbial growth. Increased temperature and humidity increase the density of bacterial colonization leading to the alteration of the relative ratio of the bacteria. Normally, microbiota survives longer on wet skin than dry skin as some regions of the skin are moist than others. For instance, the axillary, toe webs, and the skin at the lower end of the trunk between the thighs. These regions have higher numbers of normal flora organisms than the drier areas of skin [3].

pH

The skin has a normal pH between 3 and 5 (higher in moist regions), which is due in part to lactic or other organic acids produced by normal skin microorganisms such as staphylococci [2]. This low pH can inhibit the growth of many kinds of microorganisms.

Age

The age of the individual has a significant impact on the microflora. Colonization of skin begins at birth. Newborn babies are sterile inside the womb of the mother and later on becomes colonized on the first contact with the outside world. The organisms that are found at birth are usually present in small numbers, except for S. epidermidis, which is the predominantly found organism in the vaginal just prior to birth. The flora is most varied in young children, who carry micrococci, coryneform bacteria, and gram-negative organisms more frequently and in larger numbers than older children and adults [14]. Furthermore, infants additionally convey a higher extent of microorganisms or possible microbes on their skin. On the other hand, P. acnes are predominantly found at much lower levels before pubescence.

Soaps and Detergents

The skin's surface is normally a dry environment in spite of the fact that sweat and sebum serve to soak the skin with salts, lipids, lysozyme, and different proteins in water. These emissions are inhibitory to numerous microorganisms yet they are additionally nutritive and development advancing for a significant number of the normal flora. These organisms are exceptionally adjusted to this environment, holding tight persistently, colonizing the deep layers and spaces between the cells of the layer corneum as well as numerous hair follicles, sebaceous organ pipes, and sweat organ pores. Forcefully washing with soaps and detergents may quickly diminish their numbers. Also, repeated washing with soap makes the skin more alkaline than washing with medicated disinfectants [17]. Neither of these products significantly altered the count of coagulase-negative staphylococci, but propionibacteria were markedly increased when soap was used and depressed with a medicated disinfectant [3]. In a related observation Price [18] also found that scrubbing the hands with water alone decreased the numbers of bacteria faster than when non-medicated soap was used [3].

Ultraviolet light

Although no statistically significant change was seen in the normal flora after PUVA therapy for psoriasis [15,3], UVB has been shown to inhibit the growth of certain organisms [16,3]. It was also seen that Candida species were more sensitive than the abundantly found Staphylococci.

Conclusion

The benefits of knowing an individual's skin microbiota appear to be encouraging and incorporate the advancement of biomarkers for predicting liability to specific diseases, the plan of treatments focusing on chosen microbial species in particular body sites. It ought to be emphasized that we are just at the beginning stages of resolving the many associations between our body and the microorganisms we host. Microbial studies to date have uncovered a mind-boggling variety of microbial life in and on the human body. However, sorting out the nature and activities of the human microbiome is an extremely complex problem because not only is a person affected by his or her microbiota but that microbiota is also affected by the person's activities, health, and diet [19]. Subsequently, circumstances and effect relationships are often not immediately obvious and can at times be hard to figure out.

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