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Skin Surface and Open Comedone pH in Acne Patients

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Received July 8, 1982

Abstract. To assess the variability of surface and comedone pH in one and the same individual and between individuals, pH measurements were made on extracted single comedone material and on the adjacent skin surface, at face and back sites on 56 acne patients. The pH values were normally distributed. The mean values were: comedone pH 5.52 and surface pH, 5.26. The pH ranges were similar: comedones 4.01 to 6.85 and surface, 4.10 to 6.81. There was no correlation between comedone pH and adjacent skin surface pH.On each person and at one site there was variability of surface pH and comedone pH. Variability of pH from person to person was greater than within an individual at the same site.

Key words: pH measurement; Skin surface; Open comedone

Acne is a pathological condition of the pilosebaceous system and it has been suggested (1) that if environmental changes occur within individual follicles this will lead to a change in the physiology of the resident microflora which would be the initial step in triggering the production of non-inflamed and inflamed lesions. The pH of a follicle is a variable which would affect the physiology of the bacteria.

The contributory factors influencing the pH of both the skin surface and follicles are water-soluble components from transepidermal water loss, cellular excretions and sebum. Such components would be lactic acid, glutamic and aspartic acids, other amino acids, proteins and free fatty acids. The variation in pH from site to site on the same person and from follicle to follicle at the same site will be influenced by the proportions of these components.

The aim of this investigation was firstly to determine the pH of individual extracted open comedone material and to assess the variability, if any, from comedone to comedone on the same individual and from person to person. Secondly, to compare the pH of comedones with the pH of normal surface skin either adjacent to or in the close vicinity of the open comedones.

MATERIALS AND METHODS

Subjects. Fifty-six acne patients were studied, 29 females and 27 males. Their ages ranged from 13 to 32 years (mean 18.5 years).

Oral and topical treatment for acne had been stopped at least 6 weeks before the investigation commenced. The patient's skin was free of cosmetics and had not been washed for at least 3 hours before sampling.

Measurements were made on the back and face of each individual before mid-day, in a non air conditioned room. The patient had rested for 15–30 min before measurements were made.

Assessment of pH. A Beckman 3500 digital pH meter was used in conjunction with a Beckman pH flat-head combined reference and glass electrode. The electrode/meter was calibrated using two standard Beckman buffers, pH 4.01 and pH 6.88, and the pH was measured in a manner identical with the comedone material.

Table 1. *Synopsis of comedone and skin surface pH values*

Site	Number of readings	pH range	Mean pH	Standard error
Comedone				
Female face	38	4.22–6.39	5.66	0.09
Female back	51	4.01–6.85	5.28	0.08
Male face	47	4.72–6.59	5.73	0.06
Male back	63	4.06–6.58	5.39	0.07
Surface				
Female face	45	4.42–5.93	5.20	0.06
Female back	80	4.10–5.86	5.07	0.04
Male face	42	4.22–6.80	5.58	0.08
Male back	104	4.16–6.81	5.20	0.04

Mean pH contactant = 5.75.

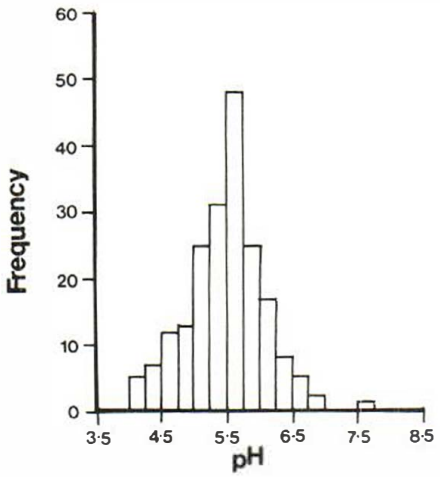

Fig. 1. Comedone pH measurements obtained from males and females on both faces and backs. Values ranged from pH 4.01 to 6.85, with a mean at pH 5.52.

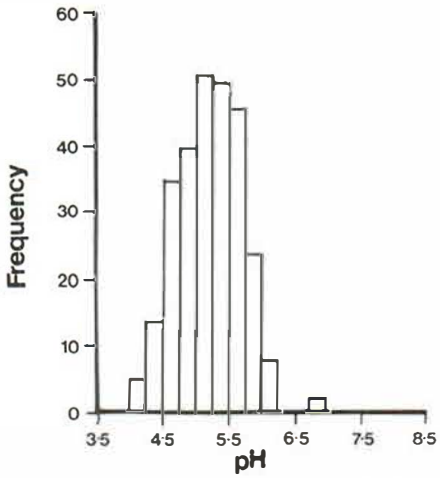

Fig. 2. Surface pH measurements obtained from males and females, on both faces and backs. Values ranged from pH 4.10 to 6.81, with a mean at pH 5.26.

50 μl of de-ionized water was used as a contactant between skin surface and electrode, since without a contactant it was impossible to obtain steady pH readings. The pH of the contactant was recorded before use.

The temperature at which pH readings were recorded was that of the contactant, i.e. 25°C.

pH of comedone material. Individual open comedone material was expressed using a comedone extractor and homogenized in 100 μl of de-ionized water in a micro tissue homogenizer. 50 μl of this emulsion was assayed for pH on a clean glass slide.

pH of skin surface. 50 μl of de-ionized water was pipetted onto the skin, removed, and replaced onto the same area in order to produce rapid mixing and equilibration of contactant and aqueous phase of the skin surface emulsion. The pH electrode was positioned on the contactant and a reading taken when the meter stabilized, which was in approximately 60 sec.

Table II. *Analysis of variance of comedone and skin surface pH values*

Site	F	n_1	n_2	p
Comedone pH				
Female face	5.27	6	28	0.01
Female back	4.07	12	36	0.01
Male face	5.12	10	35	0.01
Male back	10.53	15	46	0.01
Surface pH				
Female face	13.90	8	36	0.01
Female back	12.28	13	66	0.01
Male face	54.78	5	36	0.01
Male back	8.08	14	89	0.01

RESULTS

At the four sites examined, for both comedone and surface pH, the distribution of pH values was normal about their means. A summary of these values is given in Table I and the normal distributions of total comedone and total surface pH values are given in Figs. 1 and 2.

There were differences between the means from 8 sites but when analysed by Student's t-test these differences were not significant ($p>0.9$).

The variability of pH values among individuals was compared with those values from an individual by analysis of variance. It was found that at each of the 8 sites the differences in pH were significantly greater between individuals than within an individual ($p<0.01$).

However, there was variation in one and the same individual at the same site, the recordings being made from an average of 5 positions at each anatomical site, and this is shown by the mean

Table III. *Mean variation in comedone and skin surface pH values per individual at one site*

Site	Surface pH units	Comedone pH units
Female face	0.44	1.01
Female back	0.50	0.76
Male face	0.53	0.62
Male back	0.62	0.56

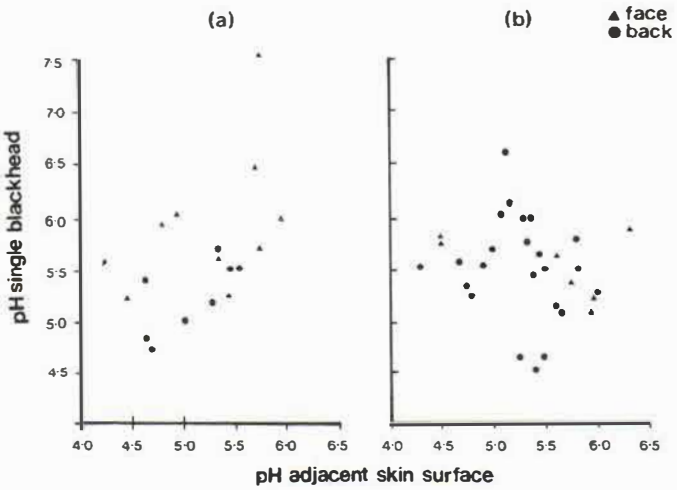

Fig. 3. Correlation between the pH of individual comedones and the adjacent skin surface pH. (*a*) Female: correlation coefficient 0.5839. (*b*) Male: correlation coefficient −0.2776.

variations (Table III), with a total mean variation for surface pH readings of 0.52 units and a greater variation for comedone pH of 0.74 units.

Although some people had consistently higher or lower pH values on the surface or in their comedones, the pH value of the surface did not relate to the pH of the comedone. There was only a poor correlation between pH values of the individual comedones with the pH value of the adjacent skin surface; for females the correlation coefficient was 0.5839 and for males, −0.2776 (Fig. 3*a* and *b*).

DISCUSSION

This investigation has shown that the ranges of pH of comedones and skin surface on the face and back of males and females are similar. However, the pH of the skin varies between individuals and the variation in pH of comedones and skin surface on the same individual at the same site is of considerable interest.

It is difficult to compare this study with the limited published data because of the differences in age groups, body site, size of site, methods of measurement, body temperature and humidity that have been used.

Seasonal variations have been shown to be important factors affecting skin pH (2). Fore-arm skin surface pH was significantly lowered by sweat secretions stimulated by increasing skin temperature. The mean skin pH in July was 4.6 and in January was 5.0. Our investigation was carried out over a period of 6 months, November to April, when skin temperature and evaporative water loss are low in comparison with the summer months.

It is impossible to compare the techniques of skin surface pH estimation, but this is a factor which might introduce discrepancies between investigations. In this study the equilibration and stabilization of pH readings was brief, as the contactant mixed with the skin surface emulsion. The pH value of the skin surface—and not that of contactant—would be observed, as deionized water has no buffering capacity.

Significant differences in skin pH from one body site to another have been reported (3) even though the differences in mean pH values were small. However, in this study no significant differences between skin surface body site on face and back were found, as the distribution of the pH values for these sites overlapped considerably.

This investigation has shown that there is variability in the pH of individual comedones at the same site and on the same patient and that the comedone pH can differ from that of an adjacent skin surface site. This supports the theory of environmental changes such as pH affecting the follicles' fate, to normality or disease by influencing the physiology of resident follicular microflora. *Propionibacterium acnes* (*P. acnes*) is thought to play a role in acne and this organism's highest potential for growth and production of exocellular biologically active substances is between pH 5.2 and 6.0 and the rapid loss of production occurs with small changes of pH either side of the optimum (1). Mean variations of comedone pH on the same site of the same indi-

vidual were 0.56 to 1.01 pH units. This variation would produce large changes in the physiology of *P. acnes*. Furthermore, since the comedonal pH and adjacent skin surface pH had a low correlation coefficient, this would imply that the physiology of the resident microflora on the surface and in the follicle ought to differ.

The method for measuring follicular pH in this investigation is suitable only for open comedones. However, it is important to compare the pH of normal and acne-affected follicles and the microelectrode would seem to be the only method left available for this type of investigation.

ACKNOWLEDGEMENT

We wish to thank Vick International for financial support for this study.

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Bacteria and Fungi in Severe Foot Infection

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Received July 22, 1982

Abstract. In a study of severe foot infection in 21 miners, an attempt was made to match nine clinical parameters with both bacteriological and mycological findings. Erythema was significantly more pronounced in the presence of dermatophytes but less pronounced in the presence of Gram-negative bacilli. No other clinical parameter differed in relation to the presence of particular microorganisms.

In 1957, Marples and Bailey (3) drew attention to the apparent discrepancy, that, although many of the persons they examined had some abnormality of the skin of the toewebs, only a varying proportion yielded fungus from the lesions. Marples and Bailey proposed that bacterial infection might account for some of the symptoms. With a few exceptions bacteriologists and mycologists have ignored this work and, whilst papers on bacterial infection and on fungal infection can be found, it is rare to find both groups considered together. This paper describes clinical, bacteriological and mycological investigations on a small group of miners with severely infected feet.

METHODS

Men attending a clinic with severe foot infection were studied. A clinical assessment was made, scoring separately for each of the following factors; pruritis, maceration, malodour, burning, erythema, weeping, bleeding, peeling and fissuring, using a scale of 0 = absent, 1 = very mild, 2 = mild, 3 = moderate, 4 = severe, 5 = very severe.

Scrapings were collected for mycological examination and a swab for bacteriological examination (transport medium). All organisms were identified to at least the generic level, using conventional tests.

RESULTS

The results described here are for the first occasion only on which each of the 21 men was seen. The data are analysed in two ways. The total score for all factors for each man was set against the presence or absence of each specific organism in turn (Table I). There was no significant difference between mean scores of those with vs. without a specific organism.

Each factor was then considered in turn against each specific organism (Table II). The only diagnostic feature to emerge was erythema: in the presence of dermatophytes, erythema was significantly more severe than in the absence of dermatophytes, while in the presence of Gram-negative bacilli the trend was reversed.

The species isolated in this study were diverse. The eight dermatophytes were *T. mentagrophytes var. interdigitale* (2), *T. rubrum* (4), *Epidermophyton floccosum* (1) and positive microscopy only (1). No *Candida albicans* was grown, but 6 men yielded other *Candida* species. Amongst the Gram-negative bacilli were *Escherichia coli, Citrobacter*