

A Study of the pH Values of Discharges in Otolaryngology

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ABSTRACT

The authors examined 312 outpatients, including 100 with otorrhea, 144 with rhinorrhea and 68 with pharyngeal discharge. The pH of otorrhea was generally acid, except in 2 cases of diffuse otitis externa where the discharge was strongly alkalihe. Otorrhea in purulent otitis media was mucopurulent or purulent and was strongly acid. The pH of rhinorrhea ranged from 6.6 to 7.4, being generally weakly alkaline. In acute rhinitis, it was alkaline in half the cases; a tendency to greater alkalinity showed in cases of marked swelling of the inferior nasal conchae. In chronic paranasal sinusitis, the pH generally shifted to the acid side; in acute paranasal sinusitis and in nasal polyps, it was weakly alkaline in all cases; and in allergic rhinitis it was neutral with in a narrow range. the usual pH of oral and pharyngeal discharges ranged from 6.4 to 7.0, being generally weakly alkaline. The character of inflammatory discharges was serous or mucous in all cases, except for a case of peritonsillar abscess with mucopurulent discharge; the pH was weakly alkaline in 5 cases (7.4 per cent), neutral in 26 (38.2 per cent), and acid in 37 (54.4 per cent). When these discharges changed in character from seromucous to purulent, their pH was lowered.

INTRODUCTION

It is a well-known fact that the H-ion is indispensable to life, and there have been many reports

about the variability of its concentration in the inflammatory processes of a living organism. In other words, certain vital reactions are generally carried out at certain pH levels; prompt changes in pH are observed during inflammatory processes of a living body. The same is true in the field of otorhinolaryngology, and many studies about the relationship between pH and discharges in otolaryngology have been undertaken.

In the literature, one can find reports by Mittermair and Marchioni on the pH value of discharges in Otolaryngology (1928). Mittermair determined the pH of both the discharge and the mucous membrane of paranasal sinuses in chronic catarrhal rhinitis and in chronic maxillary sinusitis, using the Quinhydrone method (1930). Other reports include the determination of pH by the calorimetric method by Yamamoto and Hukue (1930); the pH values of the discharge of acute otitis media and of chronic maxillary sinusitis, as determined by Sato (1932); a study of the "relationship of pH to the state of the mucous membrane of sinuses in chronic maxillary sinusitis," as decribed by Yoshita (1932); the role of pH in diseases of the nose and asthma, especially in nasal polyps as reported by Griebel (1934); a precise report about the significance of pH in chronic rhinitis, chronic maxillary sinusitis, chronic laryngitis, and chronic faucial tonsillitis, as reported by Hukujima (1934), and the measurement of the pH of discharges, retained in the sinuses in paranasal sinusitis using the method of Okabe (1954).

As described above, almost all previous studies were directed to chronic paranasal sinusitis and to a few diseases of the nose, but in no study has there been reported a systematic investigation of the pH for all the diseases in the otolaryngological field. At the present time, the authors determined the pH of the discharges in the whole field of otolaryngology as a series of studies. The pH was determined both in normal Koreans and in those with various diseases in order to evaluate the changes of pH in various disease states.

MATERIALS AND METHOD

Material was obtained from 312 out-patients (190 male, and 122 female) of the E. N. T. Department, Yonsei University College of Medicine, Severance Hospital, and included 100 cases (56 male, and 44 female) of otorrhea, 144 cases (92 male, and 52 female) of rhinorrhea and 68 cases (42 male, and 26 female) of pharyngeal discharge.

For the determination of the pH of discharges in the field of E.N.T., both the Quinhydrone electrode method and the colorimetric method were used; the former utilized glass electrodes and proved accurate in the measurement of the pH of rhinorrhea. For the present study, the pH was determined by the

colorimetric method, which is simple in its procedure and easy to determine. Hydrion paper: B-T-B (pH 6.0—8.0), Micro Essential Laboratory, Brooklyn, New York, and an improved color chart were used.

In determining the pH of discharge, one should prevent the release of CO₂ gas into the air, but otorrhea, rhinorrhea and laryngeal discharge are always exposed to air, so that such prevention is impossible. Moreover, the pH tends to be alkaline on cooling, to be acid more at night than during the daytime, and shows acid trends on prolonged rest and sleeping. Therefore, we took care to determine it accurately under constant conditions. The test paper was tested before hand by the Beckmann Model G.S. pH Meter and various test solutions to determine its accuracy and variation. Measurement was made by comparing the test paper with the abovementioned improved color chart, after placing a piece of test paper (about 1.0 cm in length) with forceps on the discharge for about 5 seconds.

RESULTS

1) pH of Otorrhea

1) Age and sex incidence of 100 patients whose otorrhea was studied: 56 were male, 44 were female. Most of them were 11 to 30 years of age.

Table 1. The pH of Otorrhea in several ear diseases

Diseases	Diffuse otitis externa		Otomycosis		Dermatitis of external auditory canal		Acute serous otitis media		Acute purulent otitis media		Chronic serous otitis media		Chronic purulent otitis media		Total		
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	Total
6.0	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	2	2
6.2	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	6	6
6.4	—	4	—	—	2	—	—	—	—	—	—	—	4	4	8	4	12
6.6	2	—	—	—	—	—	—	—	—	—	—	—	5	4	5	4	9
6.8	—	—	—	—	—	—	—	—	—	—	—	—	15	8	17	10	27
7.0	2	2	—	—	—	—	—	—	—	—	—	—	10	10	10	12	22
7.2	—	2	—	—	—	2	—	—	—	—	—	—	12	2	14	6	20
7.4	2	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8.0	2	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	2
Total	8	10	—	—	2	2	—	—	—	—	—	—	46	32	56	44	100

2) The pH of the otorrhea is shown in Table 1. Of those cases studied, 78 had chronic purulent otitis media, 28 diffuse otitis externa, and 4 dermatitis of the external auditory canal, including eczema. The lowest pH value of 6.0 was observed in chronic purulent otitis media, while the highest of 8.0 was seen in diffuse otitis externa. The pH was acid in 44 of 78 cases of chronic purulent otitis media (56 per cent) and in 10 of 18 cases of diffuse otitis externa (55 per cent). Of the four cases of dermatitis of the external auditory canal, two were acid and the other two alkaline. The discharge from the external auditory canals was acid more often than alkaline; no high alkaline value was observed.

3) The pH in 78 cases of chronic otitis media (the disease with the highest incidence in the present series). In all 78 cases, the discharge was purulent; in 44 (56 per cent) it was acid, in 20 (25 per cent) neutral, and in 14 (19 per cent) alkaline.

4) The relationship of the pH to the character of the otorrhea is shown in Table 2. Generally speaking, serous or mucous discharge was weakly alkaline, neutral or weakly acid, while mucopurulent and purulent discharge tended to be more acid. As the character changed from sero-mucous to purulent, the pH became more acid.

Table 2. The pH and the character of otorrhea

pH	Character		Serous		Mucous		Mucopurulent		Purulent		Total			
	Sex		M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	Total	
6.0			—	—	—	—	—	—	—	—	2	—	2	2
6.2			—	—	—	—	—	—	4	—	2	—	6	6
6.4			—	—	—	—	6	2	2	2	8	4	12	
6.6			—	—	1	1	3	2	1	1	5	4	9	
6.8			2	—	—	1	11	6	4	3	17	10	27	
7.0			—	2	—	—	10	5	—	5	10	12	22	
7.2			—	—	—	2	11	2	3	2	14	6	20	
7.4			—	—	—	—	—	—	—	—	—	—	—	
7.6			—	—	—	—	—	—	—	—	—	—	—	
7.8			—	—	—	—	—	—	—	—	—	—	—	
8.0			—	—	—	—	—	—	—	2	—	2	—	2
Total			2	2	1	4	41	21	12	17	56	44	100	

The relationship of the pH to the character of the otorrhea from chronic otitis media exhibits the same tendency as shown above in Table 2.

2) pH of Rhinorrhea

1) Age and sex incidence in 144 patients with rhinorrhea; 92 were male, 52 were female. Most of these were 11 to 30 years of age.

Table 3. The pH of rhinorrhea in nasal diseases (I)

Diseases	Acute rhinitis		Chronic simple rhinitis		Chronic atrophic rhinitis		Chronic hypertrophic rhinitis		Allergic rhinitis		Nasal polyp		Acute paranasal sinusitis		Chronic paranasal sinusitis		Total			
	Sex		M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	Total	
6.0			—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6.2			—	—	—	—	—	—	—	—	—	—	—	—	4	—	4	—	—	4
6.4			—	—	—	4	—	—	—	—	—	—	—	—	—	2	—	—	6	6
6.6			—	—	—	—	2	—	—	—	—	—	—	—	3	2	5	2	—	7
6.8			8	—	12	2	—	6	4	2	—	—	—	—	12	10	36	20	—	56
7.0			2	2	2	—	—	—	4	2	—	2	—	—	12	10	20	16	—	36
7.2			6	—	2	—	—	2	1	2	1	—	2	1	10	2	24	7	—	31
7.4			2	—	—	—	—	—	—	—	—	—	1	1	—	—	3	1	—	4
7.6			—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7.8			—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8.0			—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total			18	2	16	6	2	8	9	6	1	2	2	—	3	2	41	26	—	144

2) For control, the nasal discharge from 30 healthy subjects was studied. The pH was 6.6 in 2 cases, 6.8 in 4, 7.0 in 7, 7.2 in 11 and 7.4 in 6 cases, most of them being weakly alkaline.

3) The pH of rhinorrhea in various diseases was shown in table 3: the pH was determined in 67 cases of chronic paranasal sinusitis, in 22 of chronic simple rhinitis, 20 acute rhinitis, 15 chronic hypertrophic rhinitis, 10 chronic atrophic rhinitis, 5 acute paranasal sinusitis, 3 allergic rhinitis, and 2 cases of nasal polyps. The lowest pH was 6.2 in chronic paranasal sinusitis, the highest 7.4 in acute rhinitis and acute paranssal sinusitis.

Among these, an acid trend was noted in 33 (49 per cent) of 67 cases of chronic paranasal sinusitis, 18 (82 per cent) of 22 chronic simple rhinitis, 6 (40 per cent) of 15 chronic hypertrophic rhinitis, and 8 (80 per cent) of 10 chronic atrophic rhinitis; a neutral trend was noted in 2 (67 per cent) of 3 cases of allergic rhinitis; and an alkaline trend was noted in both cases (100 per cent) of 2 nasal polyps. Among 20 cases of acute rhinitis, 8 (40 per cent) were acid, 4 (20 per cent) neutral, and 8 (40 per cent) alkaline, the pH range being 6.8 to 7.4. In all 5 cases of acute paranasal sinusitis, the pH was weakly alkaline.

Table 4. The pH and the character of rhinorrhea (I)

pH	Sex	Serous		Mucous		Muco-purulent		Puru-lent		Total		
		M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	Total
6.0												
6.2						2		2		4		4
6.4			4					2			6	6
6.6		2				1		2	2	5	2	7
6.8		4	4	8	4	14	10		2	26	20	46
7.0		2	4	6		10	12	2		20	16	36
7.2		12	2	2	1	14	2	6	2	34	7	41
7.4		2		1	1					3	1	4
7.6												
7.8												
8.0												
Total		22	14	17	6	41	26	12	6	92	52	144
		36		23		67		18		92		144

4) The pH of rhinorrhea in chronic paranasal sinusitis was found to be scattered around neutral; the pH is lowered or becomes more acid progressively from the atrophic type to the simple type, the polyp type and the hypertrophic and granular type.

5) The relationship of the pH to the character of

Table 5. The pH of discharge in oral and pharyngeal diseases

Diseases	pH	Sex	Glossitis		Diseases of salivary gland		Stomatitis		Periton-sillar abscess		Lingual tons-illitis		Acute faucial tons-illitis		Chronic faucial tons-illitis		Acute phar-nyngitis		Chronic phar-nyngitis		Syp-hilis		Tuber-culosis		Diphth-eria		Total		
			M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	Total
6.0																1											1	1	
6.2									1				1		1												3	3	
6.4									1	1			1			1											2	2	4
6.6				1				1							2	1											3	2	5
6.8			1	2				2	1			2		1		6	4			2	1			2			16	8	24
7.0								1				1	1	5	2	2	4	4	2		2					2	14	12	26
7.2															1	2	2										3	2	5
7.4																													
7.6																													
7.8																													
8.0																													
Total			4	3			3	2	2	1	3	1	8	2	13	12	6	2	2	3				2		2	42	26	68

the rhinorrhea is shown in Table 4. In general, serous discharge was alkaline, while mucopurulent or purulent discharge was acid. As the character of the discharge changed from serous or mucous to purulent, the pH became more acid.

3) pH of pharyngeal discharge

1) Age and sex incidence in 68 patients with pharyngeal discharge: 42 were male and 26 were female. Most of them were 11 to 30 years of age.

2) For control, pharyngeal discharge was obtained from 50 healthy students in medical college and studied. Its pH was 6.4 in 7 cases, 6.6 in 8, 6.8 in 25, and 7.0 in 10 cases. The pH of pharyngeal discharge in healthy Koreans is around 6.4 to 7.0, or weakly acid.

3) The pH of oral and pharyngeal discharge in various diseases is shown in table 5; determinations were made in 25 cases of chronic faucial tonsillitis, 10 of acute faucial tonsillitis, 8 of acute pharyngitis, 5 each of chronic pharyngitis and stomatitis, 4 each of lingual tonsillitis and glossitis, 3 of peritonsillar abscess, and 2 cases each of pharyngeal tuberculosis and diphtheria. Both the lowest and the highest pH values were observed in chronic faucial tonsillitis, being 6.0 and 7.2, respectively.

Among these, the pH was acid in 16 (64 per cent) of 25 cases of chronic faucial tonsillitis, in all 3 cases of peritonsillar abscesses, in 3 (30 per cent) of 10 cases of acute faucial tonsillitis (the remaining 7 were neutral); it was weakly acid in all 4 cases of glossitis, in 4 (80 per cent) of 5 cases of stomatitis, in both cases of pharyngeal tuberculosis, and in 2 each (50 per cent) of 4 cases of lingual tonsillitis and chronic pharyngitis; it was neutral in 7 (70 per cent) of 10 cases of acute faucial tonsillitis, in 6 (75 per cent) of 8 cases of acute pharyngitis, and in both cases of pharyngeal diphtheria. It was alkaline in no cases.

4) The pH of discharges in chronic faucial tonsillitis, which is one of the most frequently observed pharyngeal diseases, was around 6.8, being weakly acid, although it tends to become higher as the character of the inflammation changes from follicular to simple or proliferative.

5) The relationship of pH to the character of the

Table 6. The pH and the character of pharyngeal discharge

Character	Serous		Mucous		Mucopurulent		Purulent		Total		
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	
6.0	—	—	1	—	1	—	—	—	1	—	1
6.2	2	—	—	—	—	—	—	—	3	—	3
6.4	1	1	1	1	—	—	—	—	2	2	4
6.6	1	1	2	1	—	—	—	—	3	2	5
6.8	10	5	6	3	—	—	—	—	16	8	24
7.0	9	8	5	4	—	—	—	—	14	12	26
7.2	1	2	2	—	—	—	—	—	3	2	5
7.4	—	—	—	—	—	—	—	—	—	—	—
7.6	—	—	—	—	—	—	—	—	—	—	—
7.8	—	—	—	—	—	—	—	—	—	—	—
8.0	—	—	—	—	—	—	—	—	—	—	—
Total	24	17	17	9	1	—	—	—	42	26	68

pharyngeal discharge was shown in Table 6; the pH values generally tended to be acid.

When the relationship between the character and the pH of discharge in chronic faucial tonsillitis, which is frequently observed in practice, was studied, there was no significant difference from other pharyngeal discharges.

SUMMARY AND COMMENT

1) The pH of discharges in various disease states

1) The pH of otorrhea in various diseases:

We did not determine the pH of the skin surface of the external auditory canal in healthy subjects; but according to the literature, in 1939, Blank determined the pH of the skin surface of the external auditory canal in 100 healthy males and females whose ages ranged from 19 to 27, and reached the conclusion that it is definitely acid; and in 1938, Marchioni and Hausknecht reported that cornified, horny-cell parts had an acid mantle, while seborrheic areas were more alkaline. In 1949, Fabricant determined the pH of the healthy external auditory canal (membrano-cartilaginous portion) with a Coleman electrometer (Silver-Silver chloride glass electrode) and reported that it was acid, though slightly higher pH values were obtained than those

given in Blank's report.

In these studies, Blank reported that the average pH was slightly higher in females, while Fabricant's studies showed higher values in males. But they reached the same conclusion that the skin surface of the auditory canal was acid, acting as an acid mantle.

The pH of otorrhea in disease was generally acid, except that it was strongly alkaline in 2 cases of diffuse otitis externa, as shown in Table 1. Particularly was it strongly acid (pH 6.0 to 6.8) in the otorrhea of chronic purulent otitis media.

On the other hand, Machionini reported that the pH shifted to alkaline in vesicular eczema. Bernstein and Herrmann said that the pH of discharges in eczema is alkaline, and it shows stronger alkalinity in the dry forms of eczema associated with fissure. Fabricant reported that the pH of discharge in otitis externa was 7.1 to 7.8 and 7.1 to 7.4 in males and females, respectively, being alkaline. In our series, strong alkalinity was observed in 2 cases of diffuse otitis externa, exhibiting the same trend as mentioned above, though we cannot make strong conclusions, in view of the too few cases studied.

2) The pH of rhinorrhea in various diseases:

The pH of rhinorrhea in healthy subjects is variable according to the different reporters, but our results showed it to range between 6.6 and 7.4, being generally weakly alkaline.

According to the literature, the pH in rhinorrhea differs in various reports, except in cases of allergic rhinitis, where the pH is neutral or weakly alkaline, as shown in Table 7. In our series, as shown in Table 3, it was generally acid in chronic rhinitis and in chronic paranasal sinusitis, neutral in allergic rhinitis, and weakly alkaline in all cases of nasal polyps and acute paranasal sinusitis. In acute rhinitis, a half are acid and the other half are alkaline, and especially, the more marked the swelling of the inferior nasal conchae, the more alkaline was the pH of discharge, while it was generally acid in chronic paranasal sinusitis.

3) The pH of pharyngeal discharges in various diseases: The pH of pharyngeal discharge in healthy subjects is generally acid, being 6.4 to 7.0, as shown before, while in disease states it was acid or neutral. Among 25 cases of chronic faucial tonsillitis and 8 cases of acute pharyngitis, a weakly alkaline discharge was observed in only 3 cases. In no oral or pharyngeal disease was it alkaline.

Table 7. The pH of rhinorrhea in nasal diseases (II)

Reporters	Acute rhinitis	Chronic simple rhinitis	Chronic atrophic rhinitis	Chronic hypertrophic rhinitis	Allergic rhinitis	Acute paranasal sinusitis	Chronic paranasal sinusitis					
							Simple	Atrophic	Hypertrophic, granular	Polyp	Mixed	
Fabricant	Alkaline					Alkaline						
Coates, Schenck												
Lederer												
Griebel					7.35~ 7.45							
Hildung	Acid											
Sato												
Mittermair												
Ichihara, Sakuma	6.4~7.8 Acid	6.8~7.6 Alkaline	6.4~7.6 Acid		7.0~7.4 Neutral	6.2~7.4 Acid	6.4~7.8	6.2~7.0	6.6~7.6	7.4~7.8		
Fukushima		7.69~ 8.10	6.79~ 7.35				7.8~ 8.09		6.19~ 7.02	7.39~ 7.45	7.09~ 7.78	
Yoshida								6.40~ 7.20		7.93~ 8.03		
Kim, Kim, Park.	6.8~7.2	6.4~7.2	6.6~7.2	6.8~7.2	7.0~7.2	7.2~7.4	6.6~7.0	6.8	6.2~7.2	6.2~7.2		

2) **The relationship between the character and the pH of the discharge.**

1) **The relationship of character to pH in otorrhea:** As shown in Table 2, most otorrhea was purulent and strongly acid. Generally speaking, the pH of otorrhea tended to become more acid as its character changed from serous or mucous to purulent.

2) **The relationship of character to pH in rhinorrhoea:** As shown in Table 8, there are many reports indicating that the character of rhinorrhoea has a definite relationship to its pH. Generally, serous discharge is neutral or weakly alkaline, mucous discharge is weakly acid, and mucopurulent and purulent discharge is strongly acid. The more purulent its character, the more acid is its pH.

Table 8. The pH and the character of rhinorrhoea (II)

Character. Reporter	Serous	Mucous	Muco- purulent	Purulent
Mittermair		7.995~ 8.830		6.345~ 7.640
Ichihara, Sakuma	6.4~7.8	7.2~7.8	6.4~7.8	6.2~7.0
Kim, Kim, Park	6.4~7.4	6.8~7.4	6.2~7.2	6.2~7.2

3) **The relationship of character to pH in pharyngeal discharge:** Pharyngeal discharge in healthy subjects is weakly acid, as shown before. The relationship of the character and the pH of discharges is shown in Table 6; the discharge was serous or mucous in 67 (98.5 per cent) of 68 cases and mucopurulent in one case of peritonsillar abscess. The pH was 7.2 in 5 cases (7.4 per cent), neutral in 26 (38.2 per cent), and acid in 37 cases (54.4 per cent).

CONCLUSION

1) The pH of otorrhea was generally acid except in a case of diffuse otitis externa in which it was strongly alkaline. Particularly was it strongly acid in chronic purulent otitis media.

2) In chronic purulent otitis media, the otorrhea was mucopurulent or purulent in character and was always acid. As the character of the otorrhea changed from seromucous to purulent, the pH of it was lowered.

3) In healthy subjects, the pH of rhinorrhoea ranged from 6.6 to 7.4, being generally weakly alkaline.

4) In acute rhinitis, the discharge was acid in a half of the cases and alkaline in the other half; and the more marked the swelling of the inferior nasal conchae, the more alkaline was the pH. In chronic paranasal sinusitis, the pH was generally shifted to the acid side.

5) In acute paranasal sinusitis and in nasal polyps, the pH was weakly alkaline in all cases; in allergic rhinitis it was neutral, the range of its distribution being narrow.

6) As the rhinorrhoea changed in character from seromucous to purulent, its pH became lowered.

7) In healthy subjects, the pH of the pharyngeal discharge ranged from 6.4 to 7.0, being generally weakly alkaline.

8) In diseases of the oral cavity and pharynx, the character of the discharge was serous or mucous in all cases except in a case of peritonsillar abscess where the discharge was muco-purulent. The pH was weakly alkaline in 5 cases (7.4 per cent), neutral in 26 (38.2 per cent), and acid in 37 (54.4 per cent), showing 2 general tendency toward acidity.

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