Multi-System pH Analysis: A Case Study Emphasizing the Relationship of Nasal, Urinary and Salivary pH to Diet and Physiological Factors

ABSTRACT

Acid/alkaline balance has assumed a prominent status among complementary and alternative medicine (CAM) approaches. Consistent with the current high level of interest in this subject, the Edgar Cayce readings encourage the measurement and regulation of internal pH, especially via diet. This paper reports the findings of a multi-system approach to endogenous pH levels while regulating diet in a case series approach. Generally speaking, the findings support a link between diet and endogenous pH as measured in urine, saliva, and nasal mucosa. The possible relevance of this finding to experimental rhinovirus infection studies is discussed in addition to historical views on the role of pH in health and illness.

BACKGROUND

Acid/alkaline balance has assumed a prominent status among complementary and alternative medicine (CAM) approaches. The increasing use of biological terrain assessment (BTA), the Heidelberg acid test, and functional medicine techniques attest to the emphasis placed on acid/alkaline by many CAM practitioners (Goldberg, 1998; Greenberg, 1996; The Institute for Functional Medicine, 1997). Claims for the efficacy of therapeutic interventions designed to maintain a slightly alkaline endogenous environment for the prevention and treatment of a wide variety of disorders have been reported (Young & Young, 2002; Barooty, 1991).

Commonly referred to as “pH” (potential for hydrogen), the acid/alkaline continuum ranges from 0 - 14 with 7 as neutral. The lower end of the scale (below 7) is acid and above 7 is alkaline.

Acid/alkaline balance is extremely important to normal physiology. For example, the blood will maintain a slightly alkaline range of 7.35 to 7.45. Other tissues show more variability in pH, which appears to be dependent on a wide range of factors including diet and stress. Extended pH imbalances of any kind are not well tolerated by the body. The management of the pH factor is so important that the body's primary regulatory systems (especially breathing, circulation, eliminations) closely regulate acid-alkaline balance in every cell and system.

Although the importance of acid/alkaline balance (both systemic and local) has been recognized by mainstream medicine for decades, recent advances in the utilization of nasal drug delivery has focused attention on nasal pH as a potential factor influencing the bioavailability of medicines administered via the nose (Washington et al, 2000). Interestingly, the concept of nasal pH as a significant factor in vulnerability to infectious disease and its treatment was proposed by Fabricant and others over sixty years ago (Fabricant, 1941). Fabricant’s work emphasized the correlation between the pH of diverse body systems and tissues which also correlate to emotional and disease states.

Fabricant's systems approach bears striking similarity to the model presented by Edgar Cayce. On numerous occasions Cayce discussed the connection between pH (local and systemic), mental/emotional states, and health status. Consistent with modern alternative medicine practitioners, Cayce insisted that diet and stress are important factors in health maintenance and the treatment of diseases with pH-related etiology.

Specifically, Cayce described an inherent correlation between cold and flu virus infection and acid/alkaline balance. The following quotes are indicative of Cayce's position:

> "Q-4. How can I overcome susceptibility to infections such as colds, influenza, etc.?
> A-4. As we have just indicated, by keeping the body alkaline. Only in acids do colds attack the body." (3248-1)

> "Q-15. What causes colds? Can you give me a formula or method of preventing them, or curing them?
> A-15. Keep the body alkaline! Cold germs do not live in an alkaline system! They do breed in any acid or excess of acids of any character left in the system." (1947-4)

Interestingly, many viruses (White & Wilson, 1987; Moore et al, 1988; Gong et al, 1990; Stubbs et al, 1991; Vorovitch et al, 1991; Lanzrein et al, 1993; Kreutz et al, 1996; Stiasny et al, 1996; Bui et al, 1996; Bishop & Anderson, 1997; Glomb-Reinmund & Kielian, 1998), including the rhinoviruses most often responsible for the common cold (Madshus et al, 1984) infect host cells by fusing with the cell membrane at low pH. Thus a mildly acidic environment is required for optimal infectivity of such pH-dependent viruses. Drugs that increase intracellular pH (alkalinity) have been shown to decrease infectivity of rhinovirus (Neubauer et al, 1987). Furthermore, the antimicrobial effects of many substances are pH-dependent. For example, Berberine sulfate, the most active antibacterial alkaloid in the herb goldenseal, is more effective in an alkaline than an acid environment. At a pH of 8.0 (alkaline), its antimicrobial activity in vitro is about 2 to 4 times greater than at 7.0 (neutral). At an acid pH of 6.0, the antimicrobial activity is only 1/4 as strong as at a neutral pH (Pizzorno, 1996). Similar patterns of pH-dependency have been noted for several antibiotics (Falagas et al, 1997) and antimicrobial dyes (Moats & Maddox, 1978).

Considering the current interest in acid/alkaline balance, Fabricant's historical findings on pH-related viral infections, and the Cayce material on pH as a crucial factor in viral infection, researchers at Meridian Institute decided to implement a preliminary study to determine the feasibility of further research in this area.

METHODS

This preliminary study was designed to explore the relation between endogenous pH levels in urine, saliva, and nasal mucosa, with each other and with specific dietary patterns. Simple, noninvasive, low cost equipment and methodology were given priority.

Subject

A fifty-three-year-old male in good health, not taking any medications, and without any medical diagnoses was the volunteer for this series of pH measurements. The participant was a clinical researcher with Meridian Institute at the time of this study.

The use of a single-subject series has been used by previous researchers in this field (Jackson & Turner, 1966) and provided several advantages including flexibility of schedule (to accommodate the frequent and precisely-timed data collection sessions) and procedural consistency (following the protocol).

Equipment

The pH of nasal mucosa, saliva, and urine was measured using an MI-508 flexible esophageal pH electrode (Microelectrodes, Inc., Bedford, NH, USA) connected to a Orion 230A portable pH/temperature meter. The meter was fitted with a reference electrode attached to the body on the cheek immediately beside the nose. The reported accuracy of the instrumentation is +/- .1pH.

The nasal pH measurements were obtained by inserting the microeletrode 2 cm ("front") or 4 cm ("back") into the nostril. Since mucosal pH typically varies over time and a period of a few seconds is usually necessary for a probe to obtain a stable measurement, the pH was recorded only after a factory-programmed audio signal was emitted from the meter indicating a stable measurement had been achieved. The nostril being measured was gently held closed by finger pressure after the probe had been inserted to prevent air flow from affecting the measurement. The data tables for each series of measurement records the sequence of the measurements (e.g., RF – right front, RB – right back, LF – left front, and LB – left back. The sequence was varied in some of the series to help eliminate sequence artifacts and to replicate findings from a previous experiment that found a sequence effect.

For all series that included saliva pH data, the saliva pH measurements were recorded by placing the microelectrode under the tongue (as with an oral thermometer). In one series (Series 2), an additional oral measurement was also recorded for comparison by placing the electrode midway along the inner cheek. As the tongue measurement seemed more comfortable and equally reliable, this technique was used exclusively in subsequent series that include saliva data.

A digital pH meter (pH Testr 2, Davis Instruments, Baltimore, MD) was used to measure urinary pH. This provided a sanitary precaution. As a check on reliability, one series (Series 5) also used the microelectrode to measure urine pH and found the two methods to be comparable. Standard 7.0 buffer solution was used to calibrate the digital pH meter at the beginning of each day. The digital pH meter consistently maintained calibration with this daily testing.

The microelectrode and ditigal pH meter were cleansed with distilled water and gently tamped dry with a paper towel after each measurement. All data were collected on log sheets and transferred to a spreadsheet for analysis. Dietary patterns were also recorded in Series 4 and 5 to see if the various pH measurements were related to diet.

RESULTS

Series 1

The first series of data were collected from April 4 to May 19 (see Table 1A). This exploratory series was intended to provide an opportunity to become familiar with the equipment and get a sense of possible variability related to circadian rhythms. Only nasal mucosal pH was measured in this initial series following the sequence recorded in Table 1A (RF, RB, LF,LB).

Results of Series 1

With two exceptions, the pattern of data was generally what we had expected based on the literature. The data is documented in Table 1.

Slightly Acidic Nasal pH – The nasal pH measurements tended to fall between 6 and 7 (slightly acidic) with only a couple of measurements slightly over 7 (slightly alkaline).

Two Strongly Acidic Anomalies – The two exceptions were recorded on 4/29 (11:04 AM) and 5/8 (8:38 PM) when extremely strong acidic data were collected. No explanation is available for these anomalies. Interestingly, a preliminary case series with an adult female volunteer also included a comparably strong acidic data point when she was feeling emotionally distraught. No mental/emotional/physical stressors were noted by the male volunteer in this series during the timeframe of the strong acidic anomalies.

Correlations – Table 1B documents the significant and very strong correlations between front and back and side to side nasal pH measurements. (*NOTE: A two-tailed Pearson correlation coefficient was used to determine significance at the .05 level in this and successive series.***)**

Feasibility – This series of data established the feasibility of collecting nasal pH data using simple, noninvasive, inexpensive equipment and methodology.

Table 1A: Series 1 pH Data

Date	Time	RF	RB	LF	LB
4/4/2003	10:16 AM	6.67	6.85	6.79	6.56
	10:46 AM	7.17	6.73	6.69	6.50
4/5/2003	11:25 PM	6.55	6.48	6.61	6.49
4/6/2003	9:25 PM	6.67	6.44	6.43	6.48
	10:20 PM	6.55	6.44	6.62	6.49
4/7/2003	11:10 AM	6.74	6.34	6.59	6.36
	6:30 PM	6.33	6.42	6.87	6.59
4/19/2003	1:00 PM	6.51	6.63	6.99	6.97
	7:56 PM	6.60	6.49	6.63	6.40

4/21/2003	11:38 AM	6.53	6.24	6.42	6.39
	5:00 PM	6.67	6.39	6.52	6.41
	10:08 PM	6.70	6.50	7.00	6.72
4/22/2003	10:23 AM	6.91	6.61	6.63	6.59
4/25/2003	9:07 AM	6.67	6.45	6.59	6.52
	10:11 PM	6.48	6.51	6.51	6.61
4/26/2003	8:16 AM	6.50	6.17	6.37	5.98
	6:18 PM	6.72	6.16	7.11	6.65
4/27/2003	8:51 PM	6.66	6.61	6.99	6.70
4/29/2003	11:04 AM	3.17	3.05	3.01	3.09
	11:30 AM	6.80	6.49	6.57	6.61
	9:43 PM	6.52	6.25	6.47	6.54
5/1/2003	8:20 PM	6.59	6.35	6.44	6.23
5/3/2003	6:04 PM	6.55	6.31	6.75	6.59
5/4/2003	8:47 PM	6.72	6.63	6.77	6.82
5/5/2003	9:21 AM	6.37	6.27	6.18	6.44
	10:13 PM	6.69	6.42	6.53	6.77
5/6/2003	10:51 AM	6.48	6.24	6.63	6.21
	9:48 PM	6.57	6.49	6.79	7.04
5/8/2003	8:00 AM	6.56	6.22	6.42	6.63
	12:05 PM	6.61	6.58	6.79	6.36
	8:38 PM	3.57	3.36	3.44	3.35
	9:08 PM	6.73	6.50	6.88	6.85
5/9/2003	7:30 AM	6.65	6.50	6.32	6.49
	3:25 PM	6.56	6.32	6.53	6.30
	10:31 PM	6.74	6.57	6.47	6.44
5/10/2003	7:34 AM	6.79	6.29	6.40	6.48
5/11/2003	9:03 PM	6.28	5.71	6.57	6.52
	9:26 PM	6.42	6.61	6.88	6.55
5/12/2003	9:03 AM	6.36	6.34	6.45	6.40
	10:53 PM	6.95	6.38	6.96	7.14
5/14/2003	9:20 PM	6.92	6.72	6.82	6.78
5/15/2003	9:00 AM	6.52	6.34	6.74	6.58
	10:53 PM	6.21	6.01	5.69	6.01
5/16/2003	9:42 PM	6.90	6.80	7.11	6.87
5/17/2003	10:36 AM	7.02	6.87	6.83	6.74
	9:16 PM	6.93	6.49	6.59	6.58
5/18/2003	3:38 PM	6.78	6.45	6.46	6.34
	9:26 PM	6.55	6.32	6.44	6.44
5/19/2003	5:50 PM	6.53	6.46	6.72	6.61
	5:20 PM	6.94	7.04	7.15	6.89
MIN		3.17	3.05	3.01	3.09
MAX		7.02	7.04	7.15	7.14
MODE		6.67	6.49	6.79	6.49
MEDIAN		6.60	6.45	6.60	6.53
AVERAGE		6.49	6.32	6.50	6.42
STDEV		0.69	0.68	0.73	0.70

Table 1B: Series 1 Correlations (n=100)

Data Sources	r	p
RF/RB	0.965	<0.0001
LF/LB	0.966	<0.0001
RF/LF	0.939	<0.0001
RB/LB	0.945	<0.0001

Series 2

Series 2 consisted of data collected on four consecutive days (June 5 – June 8) every two hours from 7:00 AM to 9:00 PM. The four nasal positions were measured (RF, RB, LF, LB) and saliva pH was tested from two locations (under the tongue and along the inner cheek) as described in the Methods Section.

Results of Series 2

Nasal pH – A notable difference between the first two series is the absence of any strongly acidic anomalies that were recorded on two occasions in Series 1. This had a notable effect on differences in minimum pH levels and measures of central tendency and standard deviation. The front and back pH measurements for each side of the nose were comparable to Series 1 (significantly moderately correlated). In contrast to Series 1, the side to side pH measurements were not significantly correlated in Series 2 (see Table 2B).

Saliva pH – The two saliva pH measurement techniques (under the tongue and against the inner cheek) yielded similar results so the under the tongue technique was used exclusively in subsequent series (see Tables 2A and 2B).

Correlations – Neither set of saliva pH measurements (mouth or tongue) were significantly correlated with nasal pH see Table 2B).

Table 2A: Series 2 pH Data

Date	Time	Right Front	Right Back	Left Front	Left Back	Tongue	Mouth
6/5/2003	7:00 AM	6.40	6.15	6.37	6.34	5.85	5.93
	9:00 AM	6.47	6.53	6.50	6.66	6.19	6.08
	11:00 AM	6.35	6.44	6.51	6.44	5.61	5.87
	1:00 PM	6.32	5.69	6.53	6.37	6.47	6.06
	3:00 PM	6.14	6.23	6.44	6.41	5.53	6.01
	5:00 PM	6.24	6.46	6.23	6.18	5.20	5.17
	7:00 PM	6.12	6.39	6.40	6.49	4.83	5.12

	9:00 PM	6.42	6.39	6.02	6.64	5.26	5.23
6/6/2003	7:00 AM	6.24	6.33	6.37	6.59	5.55	6.52
	9:00 AM	6.81	6.57	6.74	6.66	5.93	5.79
	11:00 AM	6.37	6.24	6.28	6.02	5.16	6.33
	1:00 PM	6.30	6.54	6.84	6.51	5.90	5.65
	3:00 PM	6.15	6.24	6.35	6.37	5.79	5.70
	5:00 PM	6.08	6.18	6.27	6.37	5.37	5.68
	7:00 PM	6.26	6.50	6.26	6.03	5.66	5.57
	9:00 PM	6.59	6.65	5.95	6.31	6.30	5.95
6/7/2003	7:00 AM	6.31	6.36	6.05	6.24	5.42	5.87
	9:00 AM	6.99	6.67	6.21	6.45	5.71	5.44
	11:00 AM	6.57	6.19	6.36	6.22	5.54	4.94
	1:00 PM	5.99	6.27	6.23	6.33	6.41	6.45
	3:00 PM	6.89	6.73	6.53	6.48	5.83	5.72
	5:00 PM	6.14	6.71	6.80	6.27	5.81	6.10
	7:00 PM	6.04	6.05	6.25	6.36	5.34	5.36
	9:00 PM	5.97	6.39	6.15	6.50	5.82	4.97
6/8/2003	7:00 AM	6.44	6.69	6.38	6.33	5.19	5.52
	9:00 AM	6.75	6.61	5.83	6.06	5.23	5.31
	11:00 AM	6.60	6.45	6.00	5.98	5.71	5.74
	1:00 PM	6.70	6.66	6.59	6.55	5.72	6.17
	3:00 PM	6.87	6.78	6.67	6.79	5.61	5.96
	5:00 PM	6.89	6.55	6.27	6.72	5.70	5.24
	7:00 PM	6.22	6.36	6.42	6.71	5.24	5.71
	9:00 PM	6.89	6.80	6.79	6.63	5.39	5.40
MIN		5.97	5.69	5.83	5.98	4.83	4.94
MAX		6.99	6.80	6.84	6.79	6.47	6.52
MODE		6.89	6.39	6.37	6.37	5.61	5.87
MEDIAN		6.36	6.45	6.37	6.39	5.64	5.72
AVERAGE		6.42	6.43	6.36	6.41	5.63	5.71
STDEV		0.30	0.24	0.25	0.21	0.38	0.41

Table 2B: Series 2 Correlations (n=64)

Data Source	r	p
RF/RB	0.590	0.000
LF/LB	0.489	0.004
RF/LF	0.108	0.556
RB/LB	0.234	0.197
T/M	0.448	0.010
LF/M	0.250	0.167
RF/M	-0.106	0.565
LB/M	0.006	0.974
RB/M	-0.094	0.608
LF/T	0.170	0.352
RF/T	0.068	0.710

LB/T	0.099	0.588
RB/T	-0.107	0.561

Series 3

Data for the third series was collected on seven consecutive days (July 14 – July 20) at two-hour intervals between 7:00 AM and 9:00 PM. The entire pH data set and sequence of measurement for the nasal pH data are documented in Table 3A. Note that in addition to nasal and saliva pH, urine pH was also measured using the pH Testr 2 digital meter as described in the Methods Section.

Results of Series 3

Correlation of the Three pH Data Sources – There was a significantly moderate to strong correlation between the nasal pH measurements (see Table 3B). There was a weak to moderate correlation between nasal and saliva measurements with only the left back nasal pH and saliva correlation not reaching significance. Urine and saliva pH measurements did not correlate significantly. Urine and nasal pH measurements did not correlate significantly.

Circadian Rhythms – A circadian pattern was obvious, especially in the urine pH with a tendency toward acidity in the evening and overnight culminating in relatively acidic first morning measurements.

Table 3A: Series 3 pH Data

Date	Time	Right Front	Right Back	Left Front	Left Back	Saliva	Urine
7/14/2003	7:00 AM	6.29	6.63	6.51	6.13	5.10	6.20
	9:00 AM	6.55	6.44	6.50	6.44	5.54	6.30
	11:00 AM	6.72	6.66	6.61	6.36	5.19	7.30
	1:00 PM	6.85	6.75	6.90	6.68	5.40	7.30
	3:00 PM	6.25	6.55	6.48	6.92	6.05	7.60
	5:00 PM	6.65	6.43	6.45	6.21	5.21	7.40
	7:00 PM	6.96	6.72	6.99	6.45	6.36	5.80
	9:00 PM	6.69	6.84	6.78	6.68	6.04	6.90
7/15/2003	7:00 AM	6.08	6.39	6.60	6.66	4.99	5.70
	9:00 AM	6.51	6.68	6.85	6.52	5.49	7.10
	11:00 AM	6.94	6.71	6.79	6.73	5.82	8.00
	1:00 PM	6.55	6.50	6.81	6.44	5.52	7.00
	3:00 PM	6.85	6.51	6.61	6.53	5.67	7.70
	5:00 PM	6.91	6.48	6.60	6.01	6.30	7.10
	7:00 PM	6.74	6.77	6.72	6.58	6.18	7.90
	9:00 PM	6.88	6.83	6.52	6.53	5.78	7.60
7/16/2003	7:00 AM	6.22	6.40	6.52	6.64	5.37	6.90
	9:00 AM	6.88	6.63	6.59	6.63	5.63	6.60

	11:00 AM	5.93	6.14	6.50	6.42	5.29	7.80
	1:00 PM	6.30	6.66	7.04	6.16	5.32	7.40
	3:00 PM	6.32	6.12	6.68	6.56	5.43	7.80
	5:00 PM	6.74	6.99	6.87	6.77	5.34	6.60
	7:00 PM	6.40	6.54	6.48	6.44	5.40	6.90
	9:00 PM	6.45	6.51	6.41	6.77	5.67	7.00
7/17/2003	7:00 AM	6.20	6.36	6.56	6.49	5.45	6.10
	9:00 AM	6.28	6.29	6.60	6.36	5.55	5.60
	11:00 AM	6.27	6.39	6.49	6.44	5.42	7.60
	1:00 PM	6.74	6.59	7.36	6.83	5.13	6.70
	3:00 PM	6.50	6.72	6.72	6.63	4.71	7.60
	5:00 PM	6.76	6.66	7.03	6.93	6.08	7.30
	7:00 PM	6.94	6.92	6.65	6.74	5.53	6.30
	9:00 PM	6.52	6.57	6.65	6.57	5.88	6.40
7/18/2003	7:00 AM	6.28	6.30	6.68	6.54	5.73	5.50
	9:00 AM	6.54	6.42	6.56	6.74	5.75	6.60
	11:00 AM	6.30	6.03	6.42	6.44	5.38	8.00
	1:00 PM	6.60	6.34	6.52	6.35	5.88	6.90
	3:00 PM	6.41	6.31	6.68	6.13	5.09	7.20
	5:00 PM	6.27	6.55	6.78	6.58	5.13	6.40
	7:00 PM	6.64	6.37	6.62	6.56	6.30	6.90
	9:00 PM	6.98	6.67	6.83	6.61	5.92	7.30
7/19/2003	7:00 AM	6.48	5.88	6.10	6.36	4.82	6.10
	9:00 AM	6.19	6.24	6.38	6.66	5.43	7.10
	11:00 AM	6.38	6.29	6.63	6.11	5.72	7.80
	1:00 PM	6.51	6.44	6.83	6.92	5.62	6.80
	3:00 PM	6.39	6.52	6.45	6.62	5.30	7.80
	5:00 PM	6.14	6.32	6.57	6.40	5.58	7.80
	7:00 PM	6.55	6.50	6.41	6.53	5.33	7.20
	9:00 PM	6.49	6.35	6.71	6.65	4.93	6.60
7/20/2003	7:00 AM	6.27	6.36	6.33	6.58	5.14	5.20
	9:00 AM	6.26	6.36	6.37	6.43	5.40	5.90
	11:00 AM	6.14	6.36	6.41	6.40	5.19	6.80
	1:00 PM	6.43	6.50	6.93	6.65	5.85	6.40
	3:00 PM	6.65	6.50	6.76	6.67	5.26	6.60
	5:00 PM	6.02	6.36	6.23	6.36	5.55	6.30
	7:00 PM	5.98	6.35	6.29	6.02	4.51	6.70
	9:00 PM	6.31	6.25	6.20	6.24	5.38	6.90
MIN		5.93	5.88	6.10	6.01	4.51	5.20
MAX		6.98	6.99	7.36	6.93	6.36	8.00
MODE		6.55	6.36	6.60	6.44	5.40	6.90
MEDIAN		6.49	6.49	6.60	6.54	5.44	6.90
AVERAGE		6.48	6.48	6.62	6.51	5.50	6.90
STDEV		0.27	0.21	0.23	0.22	0.39	0.69

Table 3B: Series 3 Correlations (n=112)

Data Sources	r	P
RF/RB	0.628	<0.0001
LF/LB	0.376	0.004
RF/LF	0.480	0.000
RB/LB	0.351	0.008
S/U	0.129	0.343
RF/S	0.472	0.000
LF/S	0.267	0.047
RB/S	0.285	0.033
LB/S	0.220	0.103
RF/U	0.158	0.243
LF/U	0.086	0.531
RB/U	0.082	0.550
LB/U	0.010	0.941

Series 4

As with the previous series urine, saliva, and nasal pH were measured every two hours from 7 AM to 9 PM for a period of six days (July 24 – July 29).

- The urine was tested using the pH Testr 2 device.
- The saliva was measured with the microelectrode placed under the tongue.
- The nasal pH was measured front and back (2 cm and 4 cm) proceeding from front left to back left; then to front right to back right. This is opposite of the pattern used in a previous 7-day consecutive series (Series 3).

For the first three days (July 24-26) of this series, the participant ate a relatively acid diet as described by Edgar Cayce. For the last three days he ate a relatively alkaline diet as described by Cayce. Here are the specifics:

Day 1 (relatively acidic diet)
- Breakfast – large bowl of Kashi cereal topped with frozen blueberries and milk
- Lunch – large bowl of lentil soup (from can) and a piece of whole wheat garlic toast
- Dinner – peanut butter and jelly sandwich on whole wheat bread

Day 2 (relatively acidic diet)
- Breakfast – large bowl of Kashi cereal topped with frozen blueberries and milk
- Lunch – large bowl of lentil soup (from can) and a piece of whole wheat garlic toast
- Dinner – peanut butter and jelly sandwich on whole wheat bread

Day 3 (relatively acidic diet)
- Breakfast – large bowl of Kashi cereal topped with frozen blueberries and milk
- Lunch – meatless BLT sandwich
- Dinner – peanut butter and jelly sandwich on whole wheat bread

Day 4 (relatively alkaline diet)
- Breakfast – 2 glasses of orange juice
- Lunch – vegetable salad and piece of whole wheat toast
- Dinner – watermelon

Day 5 (relatively alkaline diet)
- Breakfast – 2 glasses of orange juice
- Lunch – 2 meatless BLT sandwiches on whole wheat bread
- Snack – dried fruit
- Dinner – corn and tomatoes

Day 6 (relatively alkaline diet)
- Breakfast – 2 glasses of orange juice
- Lunch – salad and whole wheat toast
- Snack – baklava
- Dinner – 1 meatless BLT sandwich on whole wheat bread

Results of Series 4

Table 4 contains the data for this series. Here are some observations about the results of this series.

Alkalizing Trend – All three pH data sources showed a trend toward alkalinity during the last three days (relatively alkaline diet). Here are the *average* pH findings for each series:

	Nasal	Saliva	Urine
First 3 days (acid diet)	6.28	5.48	5.69
Last 3 days (alkaline diet)	6.40	5.55	6.82

Analysis with a Two-Tailed Student's T-Test for Paired Samples yielded the following results:
- Nasal pH change was significant (0.008).
- Saliva pH change was not significant (0.515).
- Urinary pH was significant (<0.0001).

Urinary pH Shows Strongest Results – The urine pH showed the strongest finding with regard to variance between acid/alkaline diet series. See Graph 4 for a visual representation of this dramatic change.

Circadian Rhythms – Consistent with previous series, there does appear to be a circadian rhythm in all data sets with a tendency toward acidity overnight culminating in relatively acidic first morning measurements. With regard to urine pH, there appears to be another rhythmic pattern toward alkalinity in the mid to late morning, a dip just after lunch (1 PM), and another alkalizing trend mid afternoon. The trend is most obvious with the alkaline diet, but also is there to some extent with the acid diet (see Table 4 and Graph 4).

Measurement Sequence – Reversing the pattern of first nasal measurement from the previous series also reversed the data. In the previous series (July 14-19) where the right side was always measured first there was a slight tendency toward higher alkalinity on the left side. In this series with the reversed pattern of measurement (left side first), there was a slight tendency toward the right side being more alkaline. This is consistent with findings of other researchers, although not as strong as the .3 shift toward alkalinity reported in the literature (Jackson & Turner, 1966).

Right First Series Averages (July 14-19)	Right side = 6.48	Left side = 6.57
Left First Series Averages (July 24-29)	Left side = 6.27	Right side = 6.41

Correlations – The right back to left back correlation was very weak and not significant. The other three nasal pH measurements displayed a significantly weak to moderate correlation. The urine and saliva pH measurements were not correlated. Only the left front nasal was correlated with urine and saliva measurements. All other nasal measurements did not correlate significantly with urine or saliva (see Table 4B).

Graph 4: Series 4 Urine and Saliva pH

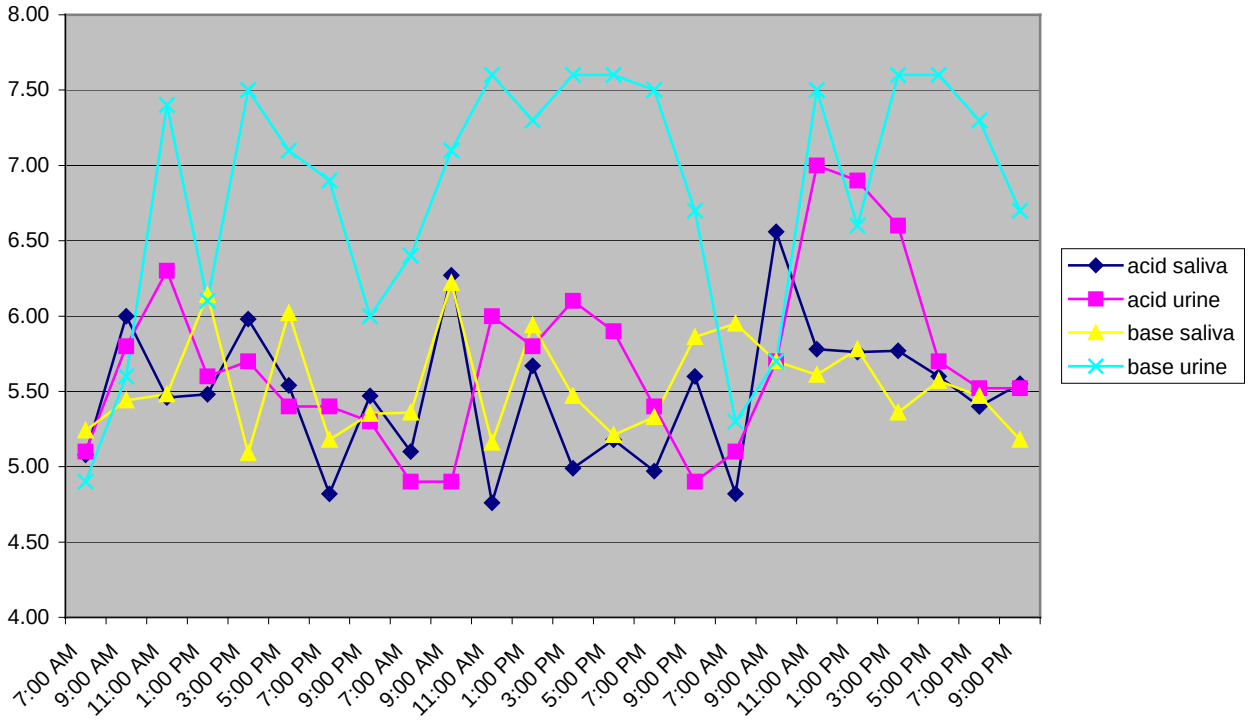

Table 4A: Series 4 pH Data

Date	Time	Left Front	Left Back	Right Front	Right Back	Saliva	Urine
7/24/03	7:00 AM	6.32	6.30	6.37	6.28	5.08	5.10
	9:00 AM	6.39	6.36	6.53	6.48	6.00	5.80
	11:00 AM	6.33	6.24	6.27	6.23	5.46	6.30
	1:00 PM	6.15	5.99	6.50	6.10	5.48	5.60
	3:00 PM	6.37	6.09	6.35	6.10	5.98	5.70
	5:00 PM	6.07	5.94	6.39	6.35	5.54	5.40
	7:00 PM	6.08	6.20	6.36	6.06	4.82	5.40
	9:00 PM	5.98	6.43	6.25	6.41	5.47	5.30
7/25/03	7:00 AM	5.85	5.90	6.59	6.46	5.10	4.90
	9:00 AM	6.64	6.67	6.67	6.60	6.27	4.90
	11:00 AM	6.48	6.30	6.31	6.08	4.76	6.00
	1:00 PM	6.11	6.30	6.25	6.41	5.67	5.80
	3:00 PM	6.42	6.45	6.43	6.64	4.99	6.10
	5:00 PM	6.22	6.35	6.31	6.36	5.18	5.90
	7:00 PM	5.91	6.43	6.20	6.25	4.97	5.40
	9:00 PM	6.08	6.05	6.31	6.08	5.60	4.90
7/26/03	7:00 AM	5.86	5.89	6.48	6.61	4.82	5.10
	9:00 AM	6.10	5.50	6.65	6.59	6.56	5.70
	11:00 AM	6.36	6.32	6.47	6.70	5.78	7.00

	1:00 PM	6.23	6.39	6.39	6.13	5.76	6.90
	3:00 PM	5.94	6.17	6.42	5.91	5.77	6.60
	5:00 PM	6.76	6.13	6.75	6.74	5.60	5.70
	7:00 PM	6.11	6.21	6.11	6.11	5.40	5.52
	9:00 PM	5.85	5.97	6.14	6.11	5.55	5.52
7/27/03	7:00 AM	5.99	5.92	6.61	6.54	5.24	4.90
	9:00 AM	6.35	6.26	6.35	6.13	5.44	5.60
	11:00 AM	6.52	6.20	6.00	6.67	5.48	7.40
	1:00 PM	6.78	6.62	6.61	6.42	6.14	6.10
	3:00 PM	6.40	6.13	6.57	6.70	5.09	7.50
	5:00 PM	6.24	6.05	6.41	6.15	6.02	7.10
	7:00 PM	6.30	5.95	6.07	6.51	5.18	6.90
	9:00 PM	5.94	6.29	6.30	6.28	5.35	6.00
7/28/03	7:00 AM	5.83	5.82	6.39	6.40	5.36	6.40
	9:00 AM	6.61	6.77	6.59	6.50	6.22	7.10
	11:00 AM	6.27	6.20	6.57	6.32	5.16	7.60
	1:00 PM	6.41	6.42	6.54	6.45	5.94	7.30
	3:00 PM	6.49	6.24	6.48	6.30	5.47	7.60
	5:00 PM	6.30	6.52	6.36	6.55	5.21	7.60
	7:00 PM	6.38	6.52	6.45	6.56	5.33	7.50
	9:00 PM	6.50	6.45	6.15	6.90	5.86	6.70
7/29/03	7:00 AM	6.17	6.83	5.86	6.72	5.95	5.30
	9:00 AM	6.49	6.41	6.67	6.82	5.70	5.70
	11:00 AM	6.32	6.25	6.13	6.40	5.61	7.50
	1:00 PM	6.41	6.39	6.71	6.43	5.78	6.60
	3:00 PM	6.63	6.44	7.01	7.01	5.36	7.60
	5:00 PM	6.76	6.57	6.86	6.51	5.57	7.60
	7:00 PM	6.39	6.40	6.28	6.14	5.47	7.30
	9:00 PM	6.28	6.22	5.97	6.15	5.18	6.70
AVERAGE		6.28	6.26	6.41	6.40	5.52	6.25
STDEV		0.25	0.26	0.23	0.25	0.40	0.91

Table 4B: Series 4 Correlations (n=96)

Data Sources	r	p
RF/RB	0.337	0.019
LF/LB	0.549	<0.0001
RF/LF	0.378	0.008
RB/LB	0.232	0.113
S/U	0.054	0.718
RF/U	0.105	0.479
RB/U	0.184	0.211
LF/U	0.457	0.001
LB/U	0.253	0.083
RF/S	0.187	0.204
RB/S	0.145	0.326
LF/S	0.308	0.033
LB/S	0.163	0.268

Series 5

Series 5 was designed to explore a specific hypothesis from the Cayce material with regards to the supposed alkalizing effects of a "citrus diet." Cayce stated that citrus fruit has an alkalizing effect on the body that can be measured in saliva and urine pH. The participant ate only citrus fruit between August 1 – August 3. Nasal pH, saliva (under the tongue) and two types of urinary pH measurements (as described in the Methods Section) were recorded as documented in Table 5A.

Results of Series 5

Alkalizing Diet – The citrus diet did tend to have an alkalizing effect when compared to the first three days (acid diet) of Series 4 (nasal, <0.001; saliva, 0.020; urine, <0.001).

Urine pH Data Collection – The two instruments (microelectrode and pH Testr 2 demonstrated comparable pH data with average variation of less than .1 pH (.08). Given the ease of use and sanitary considerations involved, the pH Testr 2 is a reasonable choice for measuring urine pH.

Table 5A: Series 5 pH Data

Date	Time	LF	LB	RF	RB	Saliva	Urine 1	Urine 2	Note: "Urine 1" is microelectrode; "Urine 2" is pH Tester 2
8/1/2003	7:00 AM	6.50	6.10	6.46	6.06	5.42	5.33	5.00	
	9:00 AM	6.61	5.64	6.55	6.48	5.55	5.63	5.50	8AM - 2 large glasses of orange juice with 1 lemon each
	11:00 AM	6.29	6.31	6.37	6.39	5.89	7.04	7.00	
	1:00 PM	6.33	6.16	6.21	6.37	5.62	6.61	6.60	10PM - 1 large glass of orange juice with 1 lemon
	3:00 PM	6.05	6.26	6.16	6.27	5.83	6.76	6.60	2PM - 1 large glass of orange juice with 1 lemon
	5:00 PM	6.42	6.51	6.45	6.17	5.62	7.19	7.20	4 PM - 2 grapefruit
	7:00 PM	6.20	6.19	6.27	6.14	5.63	6.87	7.20	6PM - 1 large glass of orange juice with 1 lemon
	9:00 PM	6.39	6.41	6.86	6.60	6.05	6.13	5.90	
8/2/2003	7:00 AM	6.30	6.21	6.43	6.11	5.05	5.85	5.60	8AM - 2 large glasses of orange juice with 1 lemon each
	9:00 AM	6.12	6.56	6.33	6.62	5.67	6.61	6.40	
	11:00 AM	6.26	6.19	6.19	6.42	5.44	7.67	7.60	12:30PM - 1 large glass of orange juice with 1 lemon
	1:00 PM	6.36	6.36	6.56	6.43	5.58	7.54	7.50	
	3:00 PM	6.99	6.16	6.71	6.70	5.88	6.77	6.60	4PM - 1 grapefruit
	5:00 PM	6.44	6.32	5.82	6.41	6.37	7.53	7.40	6PM - 1 grapefruit
	7:00 PM	6.42	6.45	6.38	6.30	5.66	7.40	7.40	8PM - 1 large glass of orange juice with 1 lemon
	9:00 PM	6.97	6.84	6.79	6.67	6.30	7.38	7.30	
8/3/2003	7:00 AM	6.47	6.04	6.45	6.41	5.12	6.13	6.00	8AM - 1 large glass of orange juice with 1 lemon
	9:00 AM	6.16	6.06	6.11	6.15	5.66	7.37	7.30	10AM - 1 large glass of orange juice with 1 lemon
	11:00 AM	6.19	6.22	6.49	6.54	5.51	6.91	7.20	12AM - 1 large glass of orange juice with 1 lemon
	1:00 PM	5.93	6.43	6.57	6.37	6.10	6.86	7.10	2PM - 1 grapefruit
	3:00 PM	6.20	6.32	6.38	6.49	5.80	7.16	7.30	4PM - 2 grapefruit
	5:00 PM	6.80	6.58	6.24	6.76	5.85	7.06	6.90	

	7:00 PM	6.51	6.67	6.57	7.11	5.93	7.55	7.40	
	9:00 PM	6.56	6.65	6.49	6.57	6.34	6.49	6.00	
AVERAGE		6.39	6.32	6.41	6.44	5.74	6.83	6.75	
STDEV		0.26	0.25	0.23	0.24	0.34	0.64	0.73	

Table 5B: Series 5 Correlations (n=48)

Data Sources	r	p
RF/RB	0.367	0.078
LF/LB	0.177	0.409
RF/LF	0.385	0.063
RB/LB	0.212	0.320
U1/U2	0.971	<0.0001
U1/S	0.379	0.067
U2/S	0.304	0.148
RF/U1	-0.286	0.176
RB/U1	0.281	0.184
LF/U1	-0.054	0.803
LB/U1	0.480	0.018
RF/U2	-0.272	0.198
RB/U2	0.202	0.345
LF/U2	-0.156	0.466
LB/U2	0.389	0.060
RF/S	0.067	0.756
RB/S	0.446	0.029
LF/S	0.231	0.276
LB/S	0.576	0.003

DISCUSSION

The five series of pH data collection presented above were intended to provide (1) feasibility information for future studies and (2) comparison with previous findings by other researchers. The feasibility question was answered positively with regard to instrumentation, practicality, and reliability. With a couple of exceptions as discussed below, we were generally able to replicate outcomes of previous studies.

As noted in the Background section, one of our primary interests in researching physiological pH in humans is to explore hypotheses generated from the Edgar Cayce health information that consistently affirmed a relationship between various physiological pH parameters (particularly urine and saliva), the role of diet and lifestyle as an important influence on diverse pH levels, and a close correlation between pH levels and vulnerability to viral infection (e.g., colds and influenza). An earlier preliminary study had suggested a correlation between diet and urinary pH (McMillin, 2001). The current study sought to expand on these preliminary findings by simultaneously measuring urine, saliva and nasal pH with the idea that such data would be helpful in designing a study to see if these parameters are related to vulnerability to viral infection.

Specifically, numerous rhinovirus infectivity studies have been conducted to explore the pathophysiology and treatment effects with regard to rhinovirus infection (e.g., Dowling et al, 1957; Hendley & Gwaltney, 2004; Turner et al, 2004). In these studies small amounts of rhinovirus are placed in the nasal passages of volunteers to produce cold infection. Interestingly, even with this direct method of infection some individuals do not become infected. Based on the Cayce model, perhaps this subgroup has increased resistance to infection due to pH factors (either locally within the nasal cavities or more systemically). Another research question based on the Cayce approach is whether diet could be measured and/or controlled to influence pH in a manner to influence the infectivity rate.

As a preliminary step in developing a rhinovirus infectivity research design to explore these pH-related hypotheses, we decided to conduct the feasibility study described in this paper to ensure that we could obtain the proper instrumentation and design a practical protocol that would yield reliable results. Our findings in this study suggest that the pH measurement process can be adapted to the experimental design routinely used in rhinovirus infectivity studies.

The second broad goal of our study is to compare our findings with previous studies. Although we did not precisely replicate any particular previous study, certain aspects of our method and outcomes should provide meaningful comparisons, particularly with regard to factors that may be relevant for future studies. The following four areas of comparative study appear most useful for our purposes:

Cyclical Variability of pH

Fabricant's early findings of cyclical variability in nasal pH documented that "nasal pH varies with sleep, with rest, with the ingestion of food and diurnally and nocturnally and can be changed not only by infection but by alterations in a person's emotions." (1941, p. 153). Fabricant conducted minute-to-minute readings of nasal pH values in situ in a group of patients on a daily basis for more than a year, concluding that "the futility of relying on only one pH reading is amply illustrated by the frequent numerical changes in pH values that occur when readings are recorded over one hour." (p.163)

Fabricant's observations of nasal pH variability were widely accepted until a small study in 1999 (Hehar et al) reported contradictory findings. The Hehar et al study utilized techniques and equipment designed for twenty-four hour ambulatory esophageal pH monitoring. Instead of a single pH probe being inserted via the nostril into the stomach that is typically used with acid reflux patients, the researchers positioned two probes at 1cm and 4 cm behind the anterior end of the inferior turbinate. The apparatus included a monitor and recording device that took pH measurements every six seconds by the posterior electrode and every thirty seconds by the anterior electrode over a twenty-four hour period. Four participants each had two sessions recorded, for a total of eight sessions.

The researchers concluded that nasal pH "appears not to vary with daily activities and there are no diurnal changes" (p. 25). The only data presented with the article is a table containing the mean pH for each electrode for each session and a graph of a single twenty-four hour session for

one participant. No statistical analysis of the data is provided. Strangely, the graph does appear to show a notable dip in the pH measured by the posterior electrode over a period of several hours. The graph does not include clock time (only an x axis marked 0-24), so it is not possible to determine if the dip (indicating increased acidity) occurred over the night and early morning hours as we consistently noted in our study. Some of the potential shortcomings of the method used by Hehar et al are discussed below under "placement of electrodes.

Our findings are more consonant with Fabricant's interpretation. We noted that nasal pH does tend to vary constantly and that there does appear to be patterns over a twenty-four hour period.

Recognizing the variability issue (which may possibly be increased due to the irritation of a nasal probe), Ireson et al (2001) required that the nasal pH measurement be stable for at least ten seconds before recording the data. In our study, we used the built-in detection feature of the Orion 230A portable meter to signal when a stable measurement was achieved. This usually took at least several seconds and some drift was usually noted after a stable measurement was taken, suggesting that nasal pH does constantly change.

The Fabricant and Hehar et al studies are the only instances of time series design that we have found in the literature. Other researchers have apparently accepted Fabricant's findings and scheduled repeated sessions at the same time of day to reduce noise from physiological or activity-related cycles. For example, England et al found that taking nasal pH measurements at the same time of day (between 12:00 and 14:00) yielded reliable and repeatable data.

Possible variations in nasal pH associated with circadian/physiological or activity-related cycles could be an important factor in future research such as a rhinovirus infectivity study. If nasal pH is a vulnerability factor for infection and nasal pH consistently varies during a twenty-four hour period, this should be taken into consideration when scheduling inoculation sessions. Based on our preliminary data, inoculation early in the early morning would be more likely to be in a relatively acidic nasal pH compared to mid-morning or early afternoon.

Broadening the discussion to cyclical variations in urine pH, our findings were consistent with Fabricant's observation that "The urine passed a short time after rising in the morning is less acid than that formed during sleep, and this change in urinary reaction is spoken of as the 'morning alkaline tide.'" (1944, p. 404)

Placement of Electrodes

The placement of the electrode(s) in previous studies of nasal pH has varied:

- Fabricant (1940) inserted a single glass electrode into the patient's naris where it was left resting on the floor of the nasal passageway in contact with the inferior turbinate.
- Jackson and Turner (1966) placed a single electrode against the nasal septum opposite the anterior tip of the inferior turbinate.
- Hehar et al (1999) utilized a dual electrode method in which the nasal pH was recorded continuously over a 24 hour period using two miniature electrodes in the anterior and posterior parts of the nasal cavity.

- England et al (1999) also recorded two pH measurements per nostril at 1 cm along the medial aspect of both inferior turbinates and 1cm posteriorly away from the maxillary spine on both sides of the nasal septum.
- Washington et al (2000) positioned a dual electrode device with the anterior electrode sited immediately inside the nasal cavity and the posterior electrode 3 cm further into the cavity so that they were in contact with the nasal floor mucosa.
- Ireson et al (2001) placed a single electrode under the inferior turbinate of the right nostril. If the right nostril could not be cannulated because of septal deviation, the left nostril was used. pH was recorded at a depth of 4 cm from the anterior nares until readings were stable for 10 seconds.

We chose to use the dual measurement of each nostril method because Hehar et al (1999) reported a variation in nasal pH with a mean nasal pH of 7.1 at the anterior probe and 6.6 at the posterior probe. Washington el al (2000) also reported that the anterior probe in their study recorded significantly higher alkalinity than the posterior probe.

If the pH does vary from anterior to posterior, this could be a crucial factor in determining nasal pH in a rhinovirus infectivity study where the placement of the virus inoculation would need to coincide precisely with the pH measurement. If nasal pH does not vary significantly from anterior to posterior, the pH measurement could be taken anteriorly which is less invasive – the deeper measurement can be unpleasant if roughly done.

As described in the Methods section, we placed the probes at a depth of 2 cm and 4 cm, which seemed reasonable based on the previous studies and our own preliminary calibrations with the equipment. Except for the left front/left back measurements in the fifth series, all other front and back measurements for each side were moderately to strongly correlated. In six out of ten anterior-posterior measurements the anterior probe pH was more alkaline. Thus, our findings are consistent with those of England et al. (1999) who reported no significant difference between anterior and posterior measurements.

The Hehar et al. (1999) finding of variation between anterior and posterior measurements may have been due to their use of different electrodes for the two locations. The anterior measurement was taken with a glass electrode; the posterior was antimony. The antimony was chosen for the posterior (deeper) position because it was smaller than the glass electrode and would be less likely to obstruct the nasal passage. It was not used for the anterior measurement because its small size would not make consistent contact with the nasal mucosa required for the twenty-four hour ambulatory procedure.

We had tried a larger diameter glass electrode earlier in our preliminary investigations and found that it tended to give suspiciously high (alkaline) readings. We eventually chose the smaller diameter probe which made consistent contact with nasal mucosa in both the anterior and posterior positions when the nostril being measured was gently held shut with a finger during the measurement cycle. Perhaps the difference in probes in the Hehar et al study could have produced the variation in anterior/posterior pH measurements, although they claimed that previous *in vitro* studies with the two devices over the required pH ranges were not significantly

different (see the discussion of the Washington et al method below for more information on this topic).

Another potential source of noise in the Hehar et al study is contact with air during respiration. As Fabricant has noted, "nasal secretions, when collected, are susceptible to changes in pH almost instantly when they are exposed to air …" (1941, p. 163). Jackson and Turner (1966) observed that "Oscillations in pH coincident with respiration precluded the use of the expanded scale of the pH meter. Even on the normal scale, the subject had to hold his breath to prevent small oscillations" (p. 446).

In our study we prevented air flow over the electrode (and ensured constant mucosal contact with the probe) by gently closing the targeted nostril with a finger during measurement. With the design used by Hehar et al, it is not clear what (if any) precautions were taken to prevent respiration (even to a limited degree) over the electrodes. Perhaps the dual measuring setup entirely blocked the nasal cavity and prevented air flow (although they explicitly stated that the purpose of using the small electrode for the posterior measurement was that it would "not obstruct the nasal passage" (p. 24). If the anterior probe was more exposed to air, this might explain the constancy of pH (over a twenty-four hour period) and relatively increased (alkaline) pH compared to the posterior probe. Clearly, there are numerous questions surrounding the methods and results of the Hehar et al study.

The Washington et al study (2000) also utilized a dual electrode method that resulted in findings similar to Hehar et al. Like the Hehar et al study, there was no attempt to restrict or eliminate air flow to the probes. Washington et al used the same type of probe for both anterior and posterior measurements, suggesting that this variation in the Hehar et al study may not have been a significant factor in the outcome as discussed above. The possibility that pH may vary significantly within a 3 cm distance within the nasal cavity has important implications for any attempts at a future experimental rhinovirus infection study, as noted above. More studies should be done to resolve this issue. Based on current data, it would be prudent to ensure that nasal pH measurements be taken as close as possible to the site of infection in any experimental rhinovirus infection study.

Systems Analysis

Fabricant recognized a correlation between the pH of various tissues and systems within the body. In particular, "The nasal pH can be said to mirror a whole series of functional as well as chemical changes which may be of clinical significance in the inadequate organ [i.e., nose and respiratory tract] or for the organism as a whole." (1941, p. 153) "Studies were made of the pH of the buccal mucosa, the lips and various portions of the tongue and gingiva at intervals of one and two minutes. The same variation which is observed in the pH of nasal mucosa is also observed in the pH of the buccal mucosa, the lips, the tongue, the gingiva and the skin. It is reasonable to assume that a similar variation may be found for the pH of vaginal mucosa or of rectal mucosa – in fact, for that of any surface of the body that readily lends itself to study in situ by means of the glass electrode." (p. 154)

This type of systemic perspective (which recognizes the connectedness of diverse organs and processes) was the basis for the physiology and pathophysiology of Cayce's approach to health and healing. Like Fabricant, the Cayce readings asserted a correlation between the pH of various physiological systems and processes. Specifically, Cayce encouraged individuals to measure the pH of urine and saliva as a marker for systemic pH which he linked to vulnerability for viral infection. Thus, the multi-system pH model we used in our study is consistent with both Fabricant and Cayce. However, our findings are less clear.

Four of the five series in our studies included nasal pH data and other organs. In Series 2 there was no significant correlation between any of the nasal pH measurements and the pH of the tongue or mouth (inner cheek). In Series 3 three out of four nasal pH measurements correlated significantly with saliva pH (as measured under the tongue), but none of the nasal pH measurements correlated with urine pH. In Series 4, for both urine and saliva only one of four pH measurements for each parameter correlated significantly with nasal pH. Series 5 was similar with only one urine and two saliva measurements that correlated significantly with nasal pH.

Based on the concepts presented by both Fabricant and Cayce, we expected a stronger correlation between nasal, urine, and saliva pH. Furthermore, in no series was urine and saliva significantly correlated.

Diet and pH

Both Fabricant and Cayce asserted that pH can be influenced by diet. Although Fabricant did not elaborate details on this topic, Cayce provided dietary guidelines that we attempted to follow in Series 4 and 5.

Series 4 provides the best comparison (first three days "acid diet" and last three days "alkaline diet"). As we had noticed in a previous study (McMillin, 2001), using Cayce's approach to "alkalizing" the diet did have a very significant alkalizing effect on urine pH (<0.0001). The current study also showed a significant alkalizing effect on nasal pH (0.008). There was also a slight alkalizing effect on saliva pH that was not statistically significant (See the Results sections for Series 4 for details).

Analyzing the pH data from Series 5 (3-day alkalizing citrus diet) is not as direct as the previous series since there was no 3-day "acid diet" for comparison. When the data from Series 5 (3-day alkalizing citrus diet) is compared to the first three days of Series 4 ("acid diet"), all three pH measures showed significant change toward alkalinity (nasal, <0.001; saliva, 0.020; urine, <0.001).

The pH data from the Series 1-3 is not really useful for this type of comparison since there was no systematic attempt at regulating the pH of the diet. The volunteer tended to eat a Cayce "alkalizing diet" so it is not surprising that the data from those series is relatively alkaline compared to the later series.

SUMMARY AND CONCLUSION

Generally speaking, our study confirmed the findings of previous research suggesting that nasal pH is a reliable and repeatable measure. As per Fabricant and others, we did observe cyclical variability and activity-related (diet) pH patterns that were consistent with the models of Fabricant and Cayce.

Based on previous studies, it seems appropriate that further studies focusing on nasal pH and viral infectivity be undertaken. As England et al have noted, "the next step is to study mucosal pH in rhinitis and its alteration after medical treatment." (1999, p. 68) Attention should be given to the question of whether the previously observed alkalization of nasal mucosa during the early stages of infection is a *cause* or *effect* of the infection and whether cyclical variations or lifestyle-related activities (i.e., diet, sleep patterns, etc.) are involved in pH changes and vulnerability to infection. Hopefully, the discussion of some of the technical and methodological issues provided in this paper will be helpful to this end.

REFERENCES

Baroody T. *Alkalize or Die*. Waynesville, NC: Eclectic Press; 1991.

Bishop NE, Anderson DA. Early interactions of hepatitis A virus with cultured cells: viral elution and the effect of pH and calcium ions. *Arch. Virol.* 1997;142(11):2161-78.

Bui M, Whittaker G, Helenius A. Effect of M1 protein and low pH on nuclear transport of influenza virus ribonucleoproteins. *J Virol* 1996;70(12):8391-401.

Dowling HF, Jackson GG, Inouye T. Transmission of the experimental common cold in volunteers. *J. Lab. Clin. Med.* 1957;50(4):516-525.

Englad RJA, Homer JJ, Knight LC, Ell SR. Nasal pH measurement: A reliable and repeatable parameter. *Clin. Otolaryngol.* 1999;24:67-68.

Fabricant ND. Significance of the pH of nasal secretions in situ. *Arch. Otolaryng*. 1941;34:150-163.

Fabricant ND. Effect of emotions on the hydrogen ion concentration of nasal secretion in situ. *Arch. Otolaryng.* 1946;43:402-408.

Falagas ME, McDermott L, Snydman DR. Effect of pH on in vitro antimicrobial susceptibility of the Bacteroides fragilis group. *Antimicrobial Agents and Chemotherapy*. 1997;41(9):2047-2049.

Glomb-Reinmund S, Kielian M. The role of low pH and disulfide shuffling in the entry and fusion of Semliki Forest virus and Sindbis virus. *Virology* 1998;248(2):372-81.

Goldberg B (Ed.). *Alternative medicine guide to chronic fatigue, fibromyalgia & environmental illness*. Tiburon, CA: Future Medicine Publishing, 1998.

Gong SC, Lai CF, Esteban M. Vaccinia virus induces cell fusion at acid pH and this activity is mediated by the N-terminus of the 14-kDa virus envelope protein. *Virology*. 1990 Sep;178(1):81-91.

Greenberg RC. *Access the core of all illness through biological terrain: Module 2*. Payson, AZ: RCG Enterprises, 1996.

Hehar SS, Mason JDT, Stephen AB, Washington N, Jones NS, Jackson SJ, Bush D. Twenty-four hour ambulatory nasal pH monitoring. *Clin. Otolarygol* 1999;24:24-25.

Hendley JO, Gwaltney JM Jr. Viral titers in nasal lining fluid compared to viral titers in nasal washes during experimental rhinovirus infection. *J Clin Virol.* 2004 Aug;30(4):326-8.

Ireson NJ, Tait JS, MacGregor GA, Baker EH. Comparison of nasal pH values in black and white individuals with normal and high blood pressure. *Clinical Science* 2001;100:327-333.

Jackson RT, Turner JS. Some observations on nasal pH. *Arch. Otolaryng.* 1966;84:110-114.

Kreutz LC, Ackermann MR. Porcine reproductive and respiratory syndrome virus enters cells through a low pH-dependent endocytic pathway. *Virus Res*. 1996 Jun;42(1-2):137-47.

Lanzrein M, Weingart R, Kempf C. pH-dependent pore formation in Semliki forest virus-infected Aedes albopictus cells. *Virology*. 1993 Mar;193(1):296-302.

Madshus IH, Olsnes S, Sandvig K. Different pH requirements for entry of the two picornaviruses, human rhinovirus 2 and murine encephalomyocarditis virus. Virology. 1984;139:346-357.

McMillin D. Diet and urinary ph: A preliminary study and brief discussion of relevance to infectious disease. Paper presented at the 6*th Annual Cayce Health Professionals Symposium,* September 15, 2001:Virginia Beach, VA. (http://www.meridianinstitute.com/ceu/ceu21ph.html)

Moats WA, Maddox SE. Effect of pH on the antimicrobial activity of some riphenylmethane dyes. *Can J Microbiol*. 1978;24:658-661.

Moore LL, Bostick DA, Garry RF. Sindbis virus infection decreases intracellular pH: alkaline medium inhibits processing of Sindbis virus polyproteins. *Virology* 1988;166(1):1-9.

Neubauer C, Frasel L, Kuechler E, Blaas D. Mechanism of entry of human rhinovirus 2 into HeLa cells. *Virology* 1987;158:255-58.

Pizzorno J. *Total Wellness.* Rocklin, CA: Prima Publishing; 1996.

The Institute for Functional Medicine. *Essentials of functional medicine*. Gig Harbor, WA: HealthComm International, Inc. 1997.

Shusterman D, Avila PC. Real-time monitoring of nasal mucosal pH during carbon dioxide stimulation: Implications for stimulus dynamics. *Chem. Senses* 2003;28:595-601.

Stiasny K, Allison SL, Marchler-Bauer A, Kunz, C. Structural requirements for low-pH-induced rearrangements in the envelope glycoprotein of tick-borne encephalitis virus. *J Virol.* 1996;70(11):8142-7.

Stubbs MJ, Miller A, Sizer PJ, Stephenson JR. X-ray solution scattering of Sindbis virus. Changes in conformation induced at low pH. *J Mol Biol.* 1991 Sep 5;221(1):39-42.

Turner RB, Bauer R, Woelkart K, Hulsey TC, Gangemi JD. An evaluation of Echinacea angustifolia in experimental rhinovirus infections. *J Clin Virol.* 2004 Aug;30(4):326-8.

Vorovitch MF, Timofeev AV, Atanadze SN, Tugizov SM, Kushch AA, Elbert LB. pH-dependent fusion of tick-borne encephalitis virus with artificial membranes. *Arch Virol* 1991;118(1-2):133-8.

Washington N, Steele RJC, Jackson SJ, Bush D, Mason J, Gill DA, Pitt K, Rawlins DA. Determination of baseline human nasal pH and the effect of intranasally administered buffers. *Int J Pharm*. 2000 Apr 5;198(2):139-46.

White JM, Wilson IA. Anti-peptide antibodies detect steps in a protein conformational change: low-pH activation of the influenza virus hemagglutinin. *J Cell Biol.* 1987;105:2887-96.

Young RO, Young SR. *The pH Miracle*. New York, NY: Warner Books; 2002.