

Original Article

## Effects of Tongue and Oral Mucosa Cleaning on Oral *Candida* Species and Production of Volatile Sulfur Compounds in the Elderly in a Nursing Home

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The purpose of this study was to investigate the effects of oral care using simple tools and methods on the cleanliness of the oral cavity in the elderly. Enrolled were 84 elderly subjects with a mean ( $\pm$  S.D) age of  $85.1 \pm 7.0$  years in a nursing home. They were given tongue and oral mucosa cleaning (the oral care) after lunch every day or every other day for two consecutive weeks by the authors. The effect of the oral care was studied in terms of *Candida* scores in tongue coating, concentration of volatile sulfur compounds (VSC) which are the main causative substance of bad breath, and change in tongue coating scores. The above parameters were measured five times; just before the oral care program, weekly during, and at the end of the oral care program. The groups of patients, who were given the oral care, especially the group of patients cared with sponge brushes every day, showed a significant reduction in *Candida* scores but not in VSC concentration and tongue coating scores. The present method of oral care proved effective in cleaning the tongue and oral mucosa,

and the *Candida* scores appeared to be a reliable indicator for evaluation. It is suggested that this way of oral care is simple, easy and useful not only for the elderly at a nursing home but for the house-bound elder people who will rapidly increase in the near future in Japan.

**Key words:** the elderly in the nursing home, oral care, *Candida*

### Introduction

The importance of oral care has been suggested to improve not only oral functions but also the quality of life (QOL) of the elderly<sup>1-2</sup>. This is one of the basic daily life supports that nurses and caregivers could provide for enhanced cleanliness. It is sometimes difficult, however, to find a time for good oral cares because they are busy to take care of their meals and voiding<sup>3</sup>. The tongue could be a reservoir for bacteria in elderly subjects and those whose awareness levels are deteriorating, and automatic depuration was declined with reduced amount of saliva<sup>4</sup>. As a result, bacteria grow in the oral cavity and the subjects become susceptible to complications such as aspiration pneumonia<sup>5</sup>.

Nevertheless, tongue cleaning has not become common yet. Elderly subjects and disabled persons

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who are not independent in their oral care due to physical and mental dysfunction find it difficult to use toothbrushes. In Western countries, a disposable sponge with a handle (sponge brush) is widely used for its convenience<sup>6-7</sup>. The tool is not widely used in Japan partly because of unknown clinical effects<sup>8-10</sup>. There are no detailed studies that report the effects of tongue and oral mucosa cleaning in elderly subjects. The purpose of the present study was to compare simple tools and methods of oral care to obtain specific indications for elderly subjects, and to study the effects of tongue and oral mucosa cleaning (the oral care) in terms of *Candida* scores and physiological indices.

## Materials and Methods

### Subjects and study period

The subjects were those who were living in a skilled nursing home in J ward, Tokyo (150 beds) and satisfy the following inclusion criteria; 1) those over 65 years of age and who needed to be cared, 2) those who could take food orally, 3) those who were not under treatment of antibacterial, antifungal drugs, steroids or any drugs which affects saliva secretion, for one month before study and 4) those with stable systemic conditions without fever. Informed consent was obtained from 120 subjects and 100 out of them were participated in the research. The analysis was made on 84 subjects excluding 3 who had been hospitalized during the study period, 4 who had stayed home or who had been out, 3 who had refused to be included after entry and 6 whose samples were not sufficient (effective rate of 84.0%). The study period was between June and October 1998.

### Collection of Data

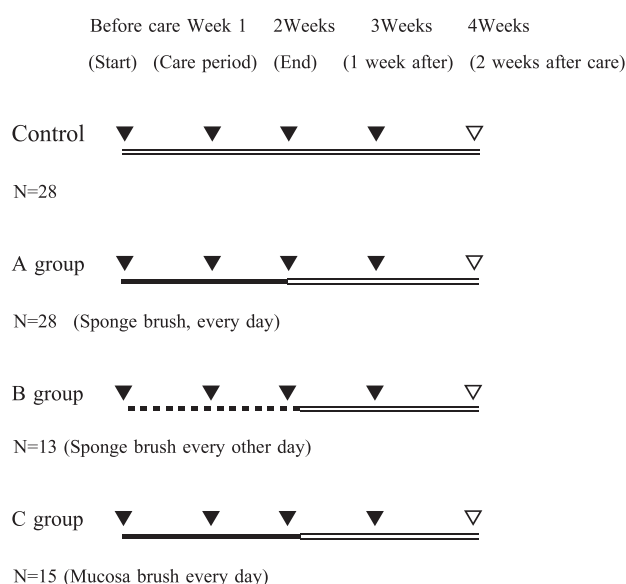
Information was collected from clinical charts, nursing charts and interview of staffs (nurses and certified care workers). Physiological indices (*Candida* scores, concentrations of volatile sulfur compounds (VSC) and tongue coating scores) were measured. Information items were sex, age, main diagnosis, activities of daily living (ADL), mental status, types of food intake, hydration, dysphagia, number of remaining teeth, denture, frequency and methods of oral cleaning etc. The N type activities of daily living scale for elderly people (N-ADL) developed by Kobayashi et al.<sup>11</sup> and the N type mental scale for elderly people (NM scale) devel-

oped by Kobayashi et al.<sup>11</sup> were used to evaluate ADL and mental status.

### Methods and the period of the oral care

To demonstrate the difference among care methods, the subjects were randomly assigned into four groups; control, A, B and C (Fig. 1). The control group received no special care at any point in time. The group A was given daily oral care using sponge brushes for two weeks. The group B was given the oral care using sponge brushes every other day for two weeks (total 7 days). The group C received continuous oral care using brushes for oral mucosa (mucosa brush) for two weeks. Kruskal-Wallis test was conducted on *Candida* scores, VSC and tongue coating scores to identify the difference among the four groups before oral care. Non-parametric test proved that no statistically significant difference was present in sex, age group, N-ADL and NM scales attributes among groups. Eleven items of types of food and oral functions (Table 1)<sup>12-14</sup> were also studied using non-parametric method since they were suspected to relate to oral indices. There were no significant differences either.

The care was given according to the preceding research by Tamamoto et al.<sup>4</sup> and the tongue and oral mucosa was cleaned using a sponge brush Toothette (Halbrand, U.S.A) or a mucosa brush Dentoerack



**Fig. 1.** Grouping and methods of care. ▼; Collection of samples and evaluation (*Candida*, VSC, Tongue coating Score); ▽; Collection of samples and evaluation (*Candida* and tongue coating score); — Care every day, - - - - Care every other day, ——— No care.

**Table 1.** Types of Food and Oral Functions

Item		Total	Group, number (%)			
			Control	A	B	C
Types of food (N=84)	Normal rice	22 (26.2)	7 (25.0)	9 (32.1)	2 (15.4)	4 (26.7)
	Gruel and chopped food	52 (61.9)	19 (67.9)	17 (60.7)	8 (61.5)	8 (53.3)
	Mashed with mixer	10 (11.9)	2 (7.1)	2 (7.1)	3 (23.1)	3 (20.0)
Hydration (N=84)	Each meal + Once in the morning and in the afternoon	42 (50.0)	16 (57.1)	10 (35.7)	7 (53.8)	9 (60.0)
	Above plus occasional hydration	42 (50.0)	12 (42.9)	18 (64.3)	6 (46.2)	6 (40.0)
Dysphagia (N=84)	Present	3 (3.6)	1 (3.6)	1 (3.6)	0 (0.0)	1 (0.0)
	Absent	81 (96.4)	27 (96.4)	27 (96.4)	13 (100.0)	15 (100.0)
No. of remaining teeth (N=84)	20 or more	9 (10.7)	3 (10.7)	3 (10.7)	1 (7.7)	2 (13.3)
	1~19	12 (14.3)	4 (14.3)	5 (17.9)	1 (7.7)	2 (13.3)
	None	63 (75.0)	21 (75.0)	20 (71.4)	11 (84.6)	11 (73.4)
Use of denture (N=84)	Full denture	29 (34.5)	13 (46.4)	11 (39.3)	3 (23.1)	2 (13.3)
	Partial denture	9 (10.7)	4 (46.4)	4 (46.4)	1 (7.7)	0 (0.0)
	None	46 (54.8)	11 (39.2)	13 (46.4)	9 (69.2)	13 (86.7)
Denture care (N=38)	Wearing all the time	24 (63.2)	10 (58.8)	9 (60.0)	4 (100.0)	1 (50.0)
	Wearing only during meals	2 (5.2)	1 (5.9)	1 (6.7)	0 (0.0)	0 (0.0)
	Remove during night	12 (31.6)	6 (35.3)	5 (33.3)	0 (0.0)	1 (50.0)
Independence in eating (N=84)	Independence	40 (47.6)	17 (60.7)	15 (60.0)	4 (30.8)	4 (26.7)
	Partial assistance	21 (25.0)	4 (14.3)	8 (6.7)	4 (30.8)	5 (33.3)
	Full assistance	23 (27.4)	7 (25.0)	5 (33.3)	5 (38.4)	6 (40.0)
Independence in transportation (N=84)	Independence	20 (23.8)	11 (39.3)	7 (25.0)	0 (0.0)	2 (13.3)
	Partial assistance	23 (27.4)	6 (21.4)	9 (32.1)	5 (38.5)	3 (20.0)
	Full assistance	41 (48.8)	11 (39.3)	12 (42.9)	8 (61.5)	10 (66.7)
Independence in oral care (N=84)	Independence	14 (16.7)	7 (25.0)	7 (25.0)	0 (0.0)	0 (0.0)
	Partial assistance	26 (31.0)	9 (32.1)	9 (32.1)	5 (38.5)	3 (20.0)
	Full assistance	44 (52.3)	12 (42.9)	12 (42.9)	8 (61.5)	12 (80.0)
Frequency of oral cleaning (N=84)	Every day	30 (35.7)	9 (32.1)	10 (35.7)	6 (46.2)	5 (33.3)
	Sometimes	9 (10.7)	4 (14.3)	1 (3.6)	2 (15.4)	2 (13.3)
	Rarely	45 (53.6)	15 (53.6)	17 (60.7)	5 (38.4)	8 (53.4)
Method of oral cleaning (N=39; Multiple answers)	With toothbrush	29 (67.4)	10	8	6	5
	Rinsing	11 (25.6)	3	3	3	2
	Tongue cleaning	0 (0.0)	0	0	0	0
	Others	3 (7.0)				
	Dental froth	(2)	1		1	
	Toothpick.	(1)				1

510S (Lion, Tokyo). Brushing it from back to front 10 times (approx. for 15 sec) cleaned the tongue. Rubbing lingual and labial side of upper and lower gums as well as the palate at certain light pressure for

5 sec each cleaned oral mucosa. Neither water nor toothpaste was used. The same researchers visited the same subjects every day including weekend, and gave the oral care. The control group was also visited

and given oral instruction only. Besides, the staffs and the elderly subjects were asked to continue their usual oral care. The room was air conditioned at 25–28 °C in this nursing home. The care was given after lunch for two consecutive weeks between 3rd and 16th of August 1998. The orders of subjects cared were changed each time.

### Collection of samples and evaluation

*Candida* scores of the tongue: Stomastat (Sankin Kogyo, Tokyo) was used. Samples of tongue coating were collected from the right of central groove of the tongue using a sterilized swab. They were then cultured at 37 °C for 24 hours. The samples were compared with the color samples provided by the manufacturer and determined as negative (–) < 10<sup>2</sup> /ml of saliva, false positive (±), about 7 × 10<sup>2</sup> /ml of saliva, positive (+) > 7 × 10<sup>5</sup>.<sup>13</sup> For the analysis, scores of 1, 2 and 3 were given for negative, false positive and positive, respectively.

Oral malodor test: Using sterile microspatula, one scrape of tongue coating was collected from the right of central groove of the tongue. The sample was immediately suspended in 2.5 ml of Todd Hewitt Broth (DIFCO) with L-methionine in a sterile centrifugal tube. The tube was then sealed and stored at 4 °C. The tongue coating sample was displaced with mixed gas (N<sub>2</sub>: CO<sub>2</sub>: H<sub>2</sub> = 8: 1: 1) for 48 hours and cultured at 37 °C under anaerobic condition for 24 hours. After culture, the samples were agitated for 10 sec using a mixer and 0.5 ml of gas phase samples were applied to a gas chromatography (detector FDP) to measure produced CH<sub>3</sub>SH and H<sub>2</sub>S concentrations. The sum of CH<sub>3</sub>SH and H<sub>2</sub>S was defined as VSC concentration<sup>13,16</sup>.

Tongue coating scores: The visual scores developed by Kojima et al.<sup>17</sup> was used to study the coat of the tongue. It is four steps. The score 1 is about 1/3 of the thin tongue coating. The score 2 is about 2/3 of the thin tongue coating or about 1/3 of the thick tongue coating. The score 3 classifies about 2/3 and more of the thin tongue coating or about 2/3 of the thick tongue coating, the score 4 in about 2/3 and more of the thick tongue coating.

Sample collection and determination of tongue coating scores was performed at 3 o'clock in the afternoon for all subjects. The VSC concentration was measured 3 times and *Candida* scores and tongue coating scores were measured 5 times as shown in Fig. 1.

### Analytical methods

Statistical analysis package SPSS was used for analyzing the data. Friedman test, Kruskal-Wallis test or Mann-Whitney U-test was performed. Multiple comparison was performed using Bonferroni. The value shown here indicates average ± standard deviation.

## Results

### Subjects characteristics

Basic attributes: As shown in Table 2, there were more female than male with the ratio of 8:2. Seventy-five (89.3%) subjects were over 75 years of age. N-ADL score were 20.1 ± 13.6 and many needed care in all of ADL. NM scale was 25.3 ± 15.4 and more than half (55.9%) of the subjects were moderate to severe.

Types of food and oral function: Table 1 summarizes the types of food they took and their oral functions. Fifty-two (61.9%) had gruel or chopped meals. Sixty-three subjects (75.0%) had no remaining teeth of their own. Thirty-eight subjects (45.2%) used denture and 24 of them (63.2%) wore the denture at night as well. For oral cleaning frequency, 30 (35.7%) cleaned every day (once or more) and 45 (53.6%) cleaned rarely. Of those who cleaned their mouth everyday or sometimes, 29 used toothbrushes and 11 only rinsed their mouth.

### Physiological indices

The oral conditions were evaluated for three parameters before beginning of oral care. For *Candida* scores, 22 were positive (26.2%), 41 were false positive (48.8%) and 21 were negative (25%). The VSC concentration was 68.2 ± 13.5 ng/ml. The tongue coating score was 2 in 29 subjects (34.5%), and 4 in only 5 (6.0%). The relationship between these and other scores were studied using Kruskal-Wallis test, showing no relation of *Candida* scores, VSC concentration and tongue coating scores with other parameters. There was also no strong relationship observed among the three physiological indices.

### Change in physiological indices by difference of oral care

Change over time by difference of oral care: Friedman test was conducted for *Candida* scores. No difference in *Candida* scores was observed in the control group and groups B and C, while significant difference was noticed in the group. Multiple comparison showed that the group A presented significant differ-

**Table 2.** Basic Attributes of Elderly subjects

Items	Total	Group, number (%)				
		Control	A group	B group	C group	
Sex	Male	18 (21.4)	3 (10.7)	8 (28.6)	3 (23.1)	4 (26.7)
	Female	66 (78.6)	25 (89.3)	20 (71.4)	10 (76.9)	11 (73.3)
Age	65~74	9 (10.7)	2 (7.1)	3 (12.0)	2 (15.4)	2 (13.3)
	75~84	24 (28.6)	7 (25.0)	11 (44.0)	2 (15.4)	4 (26.7)
	≥85	51 (60.7)	19 (67.9)	14 (50.0)	9 (69.2)	9 (60.0)
N-ADL*		20.1 ± 13.6	23.3 ± 14.6	22.7 ± 15.0	15.6 ± 8.0	13.1 ± 9.7
NM scale*		25.3 ± 15.4	27.1 ± 14.4	26.9 ± 15.8	26.8 ± 14.2	25.8 ± 12.4

\*Mean ± SD

**Table 3.** *Candida* scores by time

Care	N	<i>Candida</i> score				
		Before care	1 week	2 weeks	1 week after care	2 weeks after care
A (sponge daily)	28	1.96 ± 0.79	1.61 ± 0.74	1.39 ± 0.63	1.50 ± 0.69	1.61 ± 0.74
B (sponge every other day)	15	2.00 ± 0.81	1.46 ± 0.51	1.31 ± 0.63	1.54 ± 0.77	1.85 ± 0.69
C (mucosa brush daily)	13	1.93 ± 0.79	1.73 ± 0.70	1.27 ± 0.46	1.60 ± 0.74	1.60 ± 0.74
Control	28	2.11 ± 0.63	2.21 ± 0.62	2.25 ± 0.52	2.29 ± 0.53	2.25 ± 0.52
χ <sup>2</sup>		0.77	14.59	33.95	20.72	14.91
significance		ns	**	***	***	**

All values are average ± standard deviation. \*: P<0.05, \*\*: P<0.01, \*\*\*: P<0.001, ns: not significant,

ence in week 2 and 1 week after the oral care as compared to the precare condition. In the groups B and C, the *Candida* scores tended to be lower at any point than the precare scores, however, they were significant. Four groups were compared at each timepoint (Table 3). After 1 week, a significant difference was observed between the control and the group A as well as the control and the group B. After 2 weeks, the groups A and C showed significant difference from the control. The VSC concentration (Table 4) and the tongue coating scores (Table 5) showed no significant difference between each group.

**Comparisons of oral care effects**

The *Candida* scores, VSC concentrations, tongue-coating scores were compared before and after the oral

care. A decrease in the scores was considered ‘improvement’, no change as ‘no change’ and an increase in scores as ‘deterioration’. Consolidated results of the groups A, B and C were compared with the control. *Candida* scores improved more among the oral care group at weeks 1 and 2 as shown in Fig 2. U test between the oral care group and control showed significance at week 1 (Z= -5.2, p < 0.001) and week 2 (Z= -4.2, p < 0.001). As for the VSC concentration and the tongue coating scores, more subjects tended to improve at weeks 1 and 2 in the oral care groups than the control, but it was not significant.

**Table 4.** VSC concentration by time

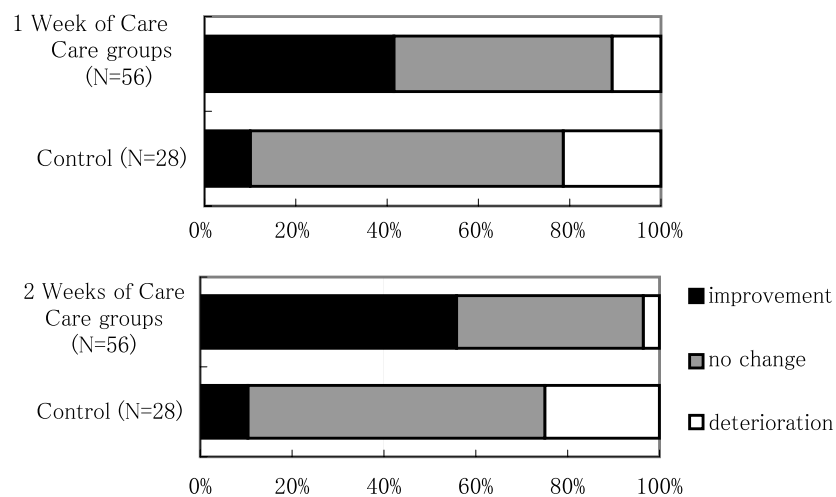
Care	N	VSC concentration (ng/ml)			
		Before care	1 week	2 weeks	1 week after care
A (sponge daily)	28	84.99 ± 161.99	51.24 ± 128.17	36.63 ± 102.00	14.48 ± 20.12
B (sponge every other day)	15	18.71 ± 35.88	81.29 ± 255.97	30.22 ± 60.51	9.53 ± 11.55
C (mucosa brush daily)	13	31.91 ± 74.63	44.09 ± 60.21	23.55 ± 47.76	11.66 ± 19.09
Control	28	93.71 ± 154.38	46.38 ± 76.43	103.11 ± 157.40	30.96 ± 46.97
$\chi^2$		9.54	1.89	9.74	7.92
significance		ns	ns	ns	ns

All values are average ± standard deviation.

**Table 5.** Tongue coating scores by time

Care	N	Tongue coating score									
		Before care		1 week		2 weeks		1 week after care		2 weeks after care	
A (sponge daily)	28	2.32	± 0.94	1.86	± 0.77	1.93	± 1.05	2.04	± 0.69	2.44	± 0.92
B (sponge every other day)	15	1.89	± 0.74	1.62	± 0.96	1.31	± 0.63	2.00	± 0.91	1.73	± 0.79
C (mucosa brush daily)	13	2.13	± 0.90	1.53	± 0.83	1.80	± 1.08	2.13	± 1.13	2.14	± 0.77
Control	28	2.07	± 1.13	2.17	± 0.77	2.10	± 0.92	2.03	± 0.90	2.48	± 1.05
$\chi^2$		3.93		8.72		7.15		0.04		5.79	
significance		ns		ns		ns		ns		ns	

All values are average ± standard deviation.

**Fig. 2.** Comparison of care effects (Candida scores)

## Discussion

In this study, the authors performed tongue and oral mucosa cleaning to find the simplest and most effective oral care for elderly subjects. The effects of oral care were studied using physiological parameters and the reactions and opinions of the subjects.

### Oral care tools and effects for elderly subjects

*Candida* scores were decreased by any of the methods and the percentage of *Candida* positive subjects was also declined. This result agrees with the other report<sup>4</sup> showing that one tongue cleaning effectively reduced *Candida* scores on the tongue. Cleaning of the tongue, which serves as a reservoir of microorganisms, helped reduce *Candida* scores in tongue coating. *Candida* is one of the normal flora in the mouth. Immunocompromised resistance of host may acquire opportunistic infection, leading to oral candidiasis<sup>18</sup>. Prevention and treatment of oral candidiasis requires antifungal agents and cleaning in the mouth. It is important to clean the tongue and oral mucosa because they are reservoirs of microorganisms.

Concerning the tools, multiple comparisons showed a significant difference between week 2 and precare in the group cared with sponge brushes every day for two weeks. No significant difference, however, was observed in the group using mucosa brushes. The results were similar to those of Suzuki *et al.*<sup>8</sup> who reported that sponge brushes have special cleaning effects avoiding reattachment of microorganisms on the tongue and oral mucosa and that tooth brush may help reattachment of microorganisms. There is a low risk of aspiration because sponge brushes need not to be wet. It is the minimum tool to be used in the mouth. It is also an advantage that few infectious materials can be transported because of disposable nature. A sponge brush is easier to use for non-professional caregivers and its short handle keeps them from injuring pharynx. As reported, a sponge brush provides relatively stable cleaning effects<sup>8,19</sup> and it removes oral residue. Though it does not need to water the sponge, subjects sometimes complain dryness of the mouth. It is because of lowered saliva secretion of elderly subjects<sup>20</sup>. To improve the dryness and strange feeling in the mouth, the sponge could be moisturized if the subjects have a low risk of aspiration and advise them to rinse their mouth.

### Frequency and effects of oral care

The subjects who received the oral care with a sponge brush every day and every other day were compared. Daily oral care group maintained the effects of oral care at week 2 and one week after the oral care. The group cared every other day showed a decreased number of *Candida*. The difference, however, was not statistically significant in multiple comparison with the precare data. It was found that daily oral care with sponge brushes was most effective in this study.

### Indices to measure oral care effects

Before oral care, 63 (74.0%) of the subjects were false positive or positive in *Candida* scores. The figure was close to the figure for elderly subjects<sup>1</sup>. The study revealed that *Candida* is a good and stable index to evaluate effectiveness of oral care because its culture media is easy to operate. *Candida* scores revealed oral care effects but VSC concentrations and tongue coating scores did not. Oral malodor is shown to be affected with time and eating habits<sup>11</sup>, and is related to the coat of the tongue and saliva<sup>21</sup>. In the present study, detailed evaluation of periodontal diseases and saliva measurement was not performed because they were difficult for elderly subjects who need to be cared. The evaluation was limited to simple observation and subjective complaint of dryness. It is necessary to develop some easy but accurate methods of saliva measurement of its quality and quantity. It is also considered necessary to study intrinsic self-cleaning mechanism of mouth through mastication and conversation. Determination of *Candida* attachment on the tongue coating was made using visual scores since it gave least burden to the subjects. There is a report, however, which suggests that it is difficult to accurately determine quantitative change of tongue coating through non-dyeing macroscopic procedure<sup>4</sup>. It is more desirable to perform culture of tongue coating microorganisms, as used in this study.

### Limit of the study and future outlook

Cleaning of the tongue and oral mucosa was performed for two weeks and effects after the oral care was evaluated. It may be too short, however, to make comprehensive evaluation, taking into consideration of daily living and QOL of the elderly subjects<sup>4,22</sup>. It is, therefore, necessary to verify long term oral care effects.

In conclusion, 1) *Candida* scores were significantly decreased in any of the oral care groups as compared

to precare data. 2) Daily cleaning groups, especially that using sponge brush showed decrease in *Candida* scores with statistical significance. 3) Continued effects of the oral care were observed even 1 week after oral care completion among those who were cleaned every day with a sponge brush. *Candida* scores of them were much lower than precare level. 4) No significant difference was observed in VSC concentrations and tongue coating scores. These results suggest that it is important for elderly subjects to clean the tongue and the oral cavity every day as a part of daily cleaning.

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