Alternating Motion Rate to Distinguish Elderly People With History of Pneumonia

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BACKGROUND: Under the hypothesis that elderly people in the community may have deficient oropharyngeal dysfunction, the purpose of this case-control study was to compare oral and physical characteristics in elderly people with and without a history of pneumonia and to identify factors distinguishing them. METHODS: In 2014, we examined 1,311 elderly people who agreed to participate in a longitudinal and intervention study for the community-dwelling elderly. We looked at such physical characteristics as body composition, grip power, gait, and balance and at oropharyngeal characteristics, such as alternating motion rate (AMR) in speech and the repetitive saliva-swallowing test (RSST). The subjects were also asked about past history of pneumonia and other morbid conditions. From that information, we extracted 24 subjects reporting to have had pneumonia within the previous 5 y as well as 172 other subjects who matched the pneumonia subjects with respect to age, sex, and number of other morbidities to form 2 groups for comparisons. We also subjected the data to a logistic regression analysis, with having or not having pneumonia as the dependent variable, oral and physical characteristics as independent variables, and age and sex as covariates. RESULTS: No significant differences were seen in physical characteristics between the 2 groups. Among the oropharyngeal characteristics, AMR was significantly lower in the pneumonia subjects ($P = .005$, effect size = 0.20), whereas RSST exhibited no significant difference between the 2 groups. Logistic regression revealed AMR to be the only factor related to pneumonia ($P = .002$, odds ratio 0.169, 95% CI 0.056–0.508). CONCLUSIONS: In community-dwelling elderly people, association of pneumonia with skilled tongue control (AMR) rather than with swallowing (RSST) prompts a reexamination of what constitutes being at risk for pneumonia. *Key words: pneumonia; community-dwelling elderly; repeated swallowing; repeated phonation; alternating motion rate.* [Respir Care 2016;61(12):1644–1650. © 2016 Daedalus Enterprises]

Introduction

For the past 10 years, lower respiratory tract infections, such as pneumonia, have been the fourth most prevalent cause of death in the world.[1] Pneumonia should be regarded as a threatening condition particularly in the elderly, since many in that age category die of pneumonia, and those who survive it are generally left debilitated. Since the turn of the century, lower respiratory tract infections have decreased in Europe for all age groups, and

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a similar situation can be found in the United States.[2,3] The prevalence of pneumonia continued to increase in Japan until 2011, the same year that it surpassed cerebral vascular disease to become the number 3 killer in that country.[4] However, mortality of both cerebral vascular disease and pneumonia began to decrease from 2011 onward, so the elevation in pneumonia ranking was really more of a relative change between 2 decreases in mortality than an actual upsurge of death by pneumonia. Nevertheless, 97% of deaths due to pneumonia in Japan have been of people ≥65 y old,[5] and so, as the population of the elderly continues to grow, preventing pneumonia remains an important problem.

According to a Japanese classification system of pneumonia, pneumonia is categorized into hospital-acquired pneumonia, nursing and health care-associated pneumonia, and community-acquired pneumonia (CAP),[6] the last of which is of great concern when considered from the standpoint of health promotion and life expectancy in the community-dwelling elderly. In the United States, 24.8 of every 10,000 people with CAP need to be hospitalized every year, and this figure jumps to 63.0 for people 65–79 y old and to 164.3 for those ≥80 y old.[7] Such an increase in CAP-related hospitalization with aging can be seen in Europe and Japan as well.[8,9] Risk factors associated with CAP are numerous, including pulmonary disorders, diabetes, cardiac insufficiency, malnutrition, pulmonary aspiration, use of tobacco, consumption of alcohol, and the environment.[10-12]

Pneumonia attributable to pulmonary aspiration is referred to as *aspiration* pneumonia. Aspiration pneumonia entails longer hospitalization and greater mortality than non-aspiration pneumonia, so it is a factor to consider when determining a patient's prognosis.[13,14] Incidence of aspiration pneumonia increases with age more than other forms of pneumonia,[15] and this is thought to be attributable to a decline in oropharyngeal function as one ages.[16] Oropharyngeal dysphagia has been found to be a strong risk factor associated with aspiration pneumonia in hospitalized CAP patients, operating independently of other risk factors,[17] so examining the possibility of a connection between oropharyngeal function and occurrence of pneumonia in the community-dwelling elderly would be meaningful.

We thus hypothesized that dysphagia would be associated with occurrence of pneumonia in elderly people living in the community. The purpose of this study was to see whether oropharyngeal function differed between community-dwelling elderly people with histories of pneumonia and those without such histories and to explore possible associations between pneumonia and oropharyngeal function.

QUICK LOOK

Current knowledge

Although mortality due to pneumonia has been decreasing in advanced industrialized countries, pneumonia is the fourth highest cause of death in the world and the third highest in Japan. Because this mortality increases exponentially with age, pneumonia is a considerable threat in advanced countries that have aging populations. The risk of aspiration pneumonia, in particular, is high among patients with vascular or degenerative diseases of the central nervous system because many of them have substandard swallowing function, and even a slight decrease in oropharyngeal function due to aging can precipitate aspiration pneumonia.

What this paper contributes to our knowledge

Community-dwelling elderly with a history of pneumonia within the previous 5 years cannot enunciate the syllable "ta" as rapidly for 5 s as their compatriots with no such previous history of pneumonia. The possibility of this subtle and simple test of skilled tongue control, called alternating motion rate, being more sensitive in detecting risk of pneumonia in the community-dwelling elderly than current tests of swallowing function might merit further study.

Methods

Subjects

The volunteer participants in this case-control study were recruited from 2 community programs run by the Tokyo Metropolitan Geriatric Hospital and Institute of Gerontology. In one, we invited 6,699 men and women 65–84 y old in the Itabashi Ward of Tokyo who were not living in geriatric facilities, were not former patients of our hospital, and had not hitherto been in the institute's cohort programs, to participate in a program that we dubbed "Otassha Kenshin" ("Health Examination for the Healthy"). Of them, 762 agreed to participate in our survey in 2014. For the other program, called "Toshima Senior Health Investigation of Mind and Activity," we invited all 6,158 people 65–84 y old on November 1, 2014, who were living in a section of the neighboring Toshima Ward of Tokyo but not residing in institutions, and 549 of them participated in the survey. Combining the data from these 2 sources, we had an overall sample of 1,311 elderly people for analysis.

We explained to all of these subjects the advantages and disadvantages of being in this study and obtained their

written consent to participate in it. This study was approved by the ethics committee at our institution (approval number 48 in 2011 and number 32 in 2014).

Morbidity Survey

Using a form as a guideline, we asked each subject about being under treatment for hypertension, cerebral vascular disease, heart disease, diabetes, hyperlipidemia, anemia, COPD, or cancer. If a response was positive, it was counted as a morbidity. The subject was also asked about having ever contracted pneumonia in the past and, if so, at what age, and whether he or she was currently under treatment for it. For analysis, we assigned people who reported having had pneumonia within the previous 5 y to a pneumonia group.

Of the 1,311 participants in the study, 24 of them reported having had pneumonia within the previous 5 y, so they were assigned to the pneumonia group. To make a group of similar subjects for the non-pneumonia group, 172 of the remaining subjects were found who matched one or another of the pneumonia subjects with respect to age, sex, and number of morbidities. Two of the subjects with pneumonia had no matching subject in the overall sample, whereas 3 subjects with pneumonia had as many as 23 matches each.

Physical and Cognitive Function Assessment

The subject's fat-free mass, body-fat mass, percent body fat, and skeletal muscle mass were measured by multifrequency bioelectrical impedance analysis[18] with an InBody 770 analyzer (Biospace, Seoul, Korea). Body mass index was calculated by dividing weight (kg) by the square of height (m). Bone density, measured with an ultrasound bone densitometer (model CM-200, Furuno Electric Co., Ltd., Nishinomiya, Japan), was indicated in terms of bone conduction velocity (m/s). Grip power was measured with a Smedley-type hand dynamometer (Yagami, Nagoya, Japan) as an indicator of overall body strength. Time to walk 5 m, both at the subject's usual pace and as fast as possible, the timed up-and-go test,[19] and time standing on the preferred foot were measured with a stopwatch to assess mobility and balance. For cognitive assessment, a number of psychologists examined the subjects on a one-to-one basis using the mini-mental state examination.[20]

Swallowing and Oral Function Assessment

We measured swallowing function by using a repetitive saliva-swallowing test (RSST).[21,22] For the RSST, the examiner palpated the area of the subject's laryngeal prominence and hyoid with one hand, asked the subject to repeatedly swallow his or her own saliva for 30 s, and with the other hand started a stopwatch when commanding the subject to start swallowing. Lap time was used to indicate when the first swallow occurred ($RSST_{first}$), and the examiner counted swallows over 30 s ($RSST_{30}$). A swallow was counted when the thyroid cartilage moved up and down, but only if the laryngeal prominence completely passed across the palpating finger. Based on comparison with video fluorography, an $RSST_{30}$ of <3 swallows over 30 s has been deemed a cutoff for screening abnormal swallowing.[23]

To assess oral function, we looked at rapid monosyllable repetition (alternating motion rate [AMR]),[24] number of functioning teeth (including dentures and dental implants), number of actual remaining teeth, dental plaque, and tongue coating. The AMR is a kind of oral diadochokinesis test. In the AMR, a single syllable ("ta" in this study) is repeatedly enunciated as rapidly as possible. Another test of oral diadochokinesis, known as sequential motion rate, involves rapid polysyllable repetition as, for example, saying "pa/ta/ka" over and over again.[25]

The AMR assessment was done with a specialized device (Kenko-kun, Takei Scientific Instruments, Niigata, Japan), equipped with a microphone programmed to distinguish and count instances of sounds like "pa," "ta," or "ka" over 5 s. Concurrent validity checked against audio recordings has been established, with a coefficient of determination at $R^2 = 0.96$ for the "ta" sound.[26] In this study, we had the subject enunciate the "ta" syllable as frequently as possible for 5 s. In a study on AMR,[27] 88 people 65–74 y old could repeat "ta" a median of 6.2 times/s with 2 SD values below the mean at 4.1 times/s. The corresponding values for 82 people $\geq$75 y old were 6.0 and 3.3 times/s, respectively. We thus regarded 4.1 and 3.3 as borderline values between normal and subnormal for the 2 age groups. A dental hygienist counted functioning teeth (including missing teeth treated by prosthesis, such as dentures and dental implants) and remaining teeth and classified dental plaque and tongue coating as absent, moderate, or considerable.

Statistical Analysis

First we assigned those subjects who had contracted pneumonia within the previous 5 y to a pneumonia group. We then gleaned, from the remainder of the overall sample, subjects who matched members of the pneumonia group with respect to sex, age, and number of morbidities, assigning them to a non-pneumonia group of similar subjects. In comparing the 2 groups, a 2-tailed *t* test for unpaired data was used when the distribution could be regarded as normal. Otherwise, the Mann-Whitney *U* test was used. Categorical variables were examined in chi-square contingency tables.

To search for factors associated with pneumonia, a logistic regression analysis was conducted using data from

Table 1. Age, Body Composition, and Physical and Cognitive Function of the Subjects

Characteristics	All Subjects Except Pneumonia (n = 1,287)	Pneumonia (n = 24)	Non-Pneumonia (n = 172)	P
Age, y	73.8 ± 5.7	74.8 ± 5.5	73.6 ± 5.5	.29
Height, cm	155.6 ± 8.5	156.1 ± 8.7	153.0 ± 6.8	.10
Weight, kg	55.4 ± 10.1	54.5 ± 9.8	52.9 ± 8.9	.40
BMI, kg/m^2	22.8 ± 3.2	22.3 ± 3.0	22.6 ± 3.2	.75
Fat free mass, kg	39.1 ± 7.5	38.3 ± 8.6	36.9 ± 6.1	.70
Body fat mass, kg	16.3 ± 5.6	16.2 ± 5.0	16.1 ± 5.7	.73
Body fat percentage, %*	29.1 ± 7.5	29.8 ± 7.7	29.9 ± 7.6	.86
Skeletal muscle mass, kg	20.9 ± 4.5	20.4 ± 5.2	19.5 ± 3.7	.76
Bone density, cm/s	1483.2 ± 24.4	1473.8 ± 21.7	1478.5 ± 20.4	.41
Grip power, kg	26.4 ± 8.2	23.9 ± 9.4	24.6 ± 6.7	.83
5-m walk (usual pace), s	3.8 ± 1.0	4.4 ± 2.3	3.8 ± 0.8	.23
5-m walk (maximum speed), s	2.6 ± 0.7	2.9 ± 0.9	2.6 ± 0.6	.19
Timed up-and-go test, s	5.9 ± 1.8	6.2 ± 1.6	5.8 ± 1.2	.19
Time standing on one foot, s	44.3 ± 21.7	38.6 ± 24.7	47.8 ± 19.5	.09
MMSE (30 possible points)	28.2 ± 2.3	28.8 ± 1.4	28.3 ± 2.4	.42

Data are mean ± SD. There were no statistically significant differences between pneumonia and non-pneumonia groups.
* t test for unpaired data (Mann-Whitney U test for all other comparisons).
BMI = body mass index
MMSE = mini-mental state examination

Table 2. Oral Function Among the Subjects

Characteristics	All Subjects Except Pneumonia (n = 1,287)	Pneumonia (n = 24)	Non-Pneumonia (n = 172)	P (ES)
Number of functionally normal teeth, mean ± SD	26.9 ± 3.3	27.5 ± 1.5	27.0 ± 3.5	.52
Number of remaining teeth, mean ± SD	20.3 ± 8.7	19.6 ± 9.8	20.1 ± 8.6	.78
Dental plaque, mean ± SD	1.2 ± 0.4	1.2 ± 0.5	1.2 ± 0.4	.94
Tongue coating, mean ± SD	1.4 ± 0.5	1.4 ± 0.5	1.4 ± 0.5	.78
AMR using "ta", mean ± SD enunciations/s	6.0 ± 1.0*	5.5 ± 1.0	6.0 ± 1.0	.005 (0.20)
Incidence of AMR, n (%)				
<4.1 times/s (≤75 y old) <3.3 times/s (>75 y old)	45 (3.5)*	1 (4.2)	5 (2.9)	.55†
RSST$_{first}$ (time to first swallow), mean ± SD s	3.0 ± 3.6‡	3.8 ± 5.1	3.4 ± 4.6	.68
RSST$_{30}$, mean ± SD times/30 s	4.0 ± 1.8‡	4.5 ± 2.3	4.1 ± 1.9	.34
Incidence of RSST$_{30}$ at <3 times/30 s, n (%)	229 (17.8)‡	3 (12.5)	33 (19.2)	.58†

* 8 data missing from the overall sample but not from the compared groups.
† Chi-square tests (Mann-Whitney U test for all other comparisons).
‡ 10 data missing from the overall sample but not from the compared groups.
AMR = alternating motion rate in rapidly enunciating "ta" over 5 s
ES = effect size (Pearson product moment correlation coefficient r)
RSST = repetitive saliva-swallowing test

the overall sample. The dependent variable was contraction of pneumonia within the last 5 y, and the independent variables were the physical characteristics described above and listed in Table 1 and the oral characteristics described above and listed in Table 2. Sex and age were added into the analysis as covariates. For this regression analysis, the AMR results were transformed into categories of faster versus slower than the median number of enunciations/s. Measurements are expressed as number of subjects or as mean ± SD, and the level of confidence for statistical testing was set at $P < .05$.

Results

The pneumonia group had significantly higher relative incidences of cerebral vascular disease, heart disease, and

Table 3. Incidence of Morbidity in Pneumonia Versus Similar Subjects

Condition	Pneumonia (n = 24)	Non-Pneumonia (n = 172)	P (ES)
Hypertension	11 (45.8)	73 (42.4)	.83
CVD	3 (12.5)	4 (2.3)	.04 (0.18)
Heart disease	8 (33.3)	21 (12.2)	.01 (0.20)
Diabetes	0 (0.0)	13 (7.6)	.38
Hyperlipidemia	11 (45.8)	66 (38.4)	.51
Anemia	1 (4.2)	5 (2.9)	.55
CRF	0 (0.0)	0 (0.0)	
COPD	0 (0.0)	2 (1.2)	>.99
Cancer	6 (25.0)	16 (9.3)	.035 (0.16)

Data are n (%).
ES = effect size (r)
CVD = cerebral vascular disease
CRF = chronic renal failure

Table 4. Logistic Regression for Predicting History of Pneumonia

Characteristic	OR	P	95% CI
Age (y)	1.007	.86	0.936–1.083
Female sex	1.383	.46	0.584–3.278
AMR (>6.2 times/s)	0.169	.002	0.056–0.508

N = 1,311 people; model chi-square: P = .002. Hosmer-Lemeshow goodness of fit statistic = 0.893. With the effects of age and sex accounted for, alternating motion rate was the only physical or oropharyngeal characteristic to predict having a history of pneumonia within the past 5 y.
OR = odds ratio
AMR = alternating motion rate in rapidly enunciating "ta" over 5 s

cancer (Table 3). The 2 groups were similar in terms of body type, body composition, muscular strength, mobility, and cognitive function (see Table 1). Intraoral features, such as number of teeth, dental plaque, and coating of the tongue, were likewise similar between the 2 groups (see Table 2). In the screening test for swallowing dysfunction, no significant difference between the 2 groups was found for $RSST_{first}$, $RSST_{30}$, or screen-positive incidence of <3 swallows/s (see Table 2 and Fig. 1).

Incidence of abnormally slow AMR was low and not significantly different between the 2 groups (see Table 2 and Fig. 1). Nevertheless, the pneumonia subjects did perform significantly slower on the AMR test than did the members of the non-pneumonia group, by about half an enunciation/s on average (see Table 2).

In the logistic regression analysis, based on data of the overall sample, the median AMR turned out to be 6.2 enunciations/s. Using that as a borderline, AMR was transformed into a dichotomous categorical variable. It was the only independent variable among the physical and oropharyngeal functions assessed in this study to have predictive power concerning the presence or absence of pneumonia within the previous 5 y (Table 4).

Discussion

Although we anticipated seeing decreased ability to swallow to be related to history of pneumonia in the previous 5 y, given that aspiration pneumonia is the dominant form of pneumonia in the elderly, neither $RSST_{first}$ nor $RSST_{30}$ differed between the pneumonia and non-pneumonia groups. The AMR test was a convenient addendum in data collection because it required only 5 s. Surprisingly, the AMR outperformed the RSST in distinguishing people who had recent bouts of pneumonia from those who had not.

The RSST is quite useful for screening patients with cerebral vascular disease or neuromuscular disease to see whether they have dysphagia.[23] Among the factors regulating swallowing function, the RSST is associated with sensitivity of the swallowing reflex.[21] We thus anticipated RSST to exhibit a relation with a past history of pneumo-

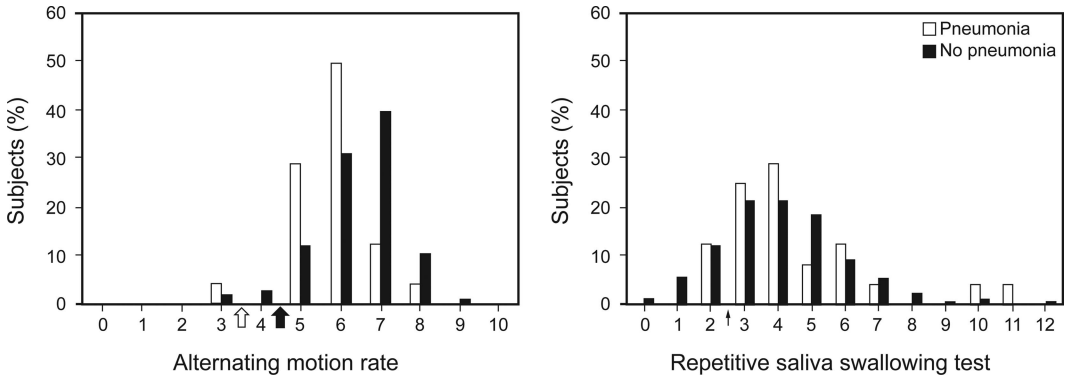

Fig. 1. Performance in alternating motion rate (AMR) and 30-s repetitive saliva swallowing tests (RSST) by subjects with and without pneumonia. AMR is the rate of repeating the syllable "ta" as rapidly as possible for 5 s. $RSST_{30}$ is the number of swallows performed as rapidly as possible over 30 s. Thick black and white arrows indicate borderlines of abnormal AMR for ages 65–74 and ≥75 y, respectively.[27] The thin black arrow indicates the screening borderline for $RSST_{30}$.[23]

nia in this study, but no difference was found between the groups. Given that the RSST was developed to screen patients clearly at risk of developing dysphagia, the test may not be very well oriented toward picking up subtler degrees of dysfunction in community-dwelling elderly people. The recommendation of <3 swallows over 30 s to trigger a videofluoroscopic examination[23] is rather conservative. In developing the $RSST_{30}$, Oguchi et al[21] obtained a mean of 5.9 swallows/30 s in 30 healthy people 59–82 y old, considerably higher than the means of the 2 groups in our study (see Table 2), but based on results with a bimodal distribution (black bars in Fig. 4a of their paper).[21] This raises questions about inter-rater reliability as well as about the behavioral nature of the $RSST_{30}$ in a geriatric population.

The RSST is a simple test developed in Japan and apparently not used elsewhere. The AMR is used in languages other than Japanese, such as English,[28] Dutch,[29] and Thai,[30] for problems related to dysarthria. In speakers of English 74–86 y old, Pierce et al[28] found normal AMR of "ta" to be 6.4 ± 1.08 times/s in men and 5.9 ± 0.87 times/s in women. Hara et al[27] found normal AMR of "ta" in Japanese people ≥75 y old to be slightly lower, at 6.0 ± 1.2 times/s in men and 5.4 ± 1.2 times/s in women. The AMR for enunciating "ta" has previously been shown to decrease with age in healthy Japanese people,[27] and in our study, the incidence of subnormal performance of the AMR was very low, unlike the $RSST_{30}$ (see Table 2).

So how is it that the AMR was significantly slower in elderly people who had suffered from pneumonia in the previous 5 y? As a test of articulation, the AMR has principally been used to assess functional skill and speed of tongue movement in patients with neuromuscular disorders or ataxia.[24,31,32] Low performance in the AMR has been shown to be associated with dysphagia in patients who have disorders of phonation or speech production.[33] No link between AMR and swallowing function has hitherto been the focus of investigation, as far as we know, so it is hard to posit a physiological explanation between AMR performance and pneumonia. It is tempting, nevertheless, to make a conjecture considering the tongue movement required to rapidly repeat "ta." The tongue plays an important role in swallowing by propelling the content to be ingested with a push into the hard palate, a function shown to be impaired in frail elderly people.[32] Enunciation of "ta" resembles the tongue thrust used in swallowing, so performance on the AMR may have some mechanistic relation with the ability to swallow properly. One may question whether our AMR findings may fortuitously have been due to a type-1 error, the answer to which can only be found if further work on this subject is pursued.

This study is not without its limitations. The presence or absence of pneumonia was judged entirely from self-reports by the participants, with no validation or confirmation from medical records. The elderly people in the survey were physically and mentally active enough to go out to a gathering place to participate, so the sample may have had a lower incidence of community-dwelling elderly vulnerable to catching pneumonia than the population it was intended to represent. Looking at pneumonia retrospectively in this study, not only may we have missed weaker pneumonia subjects, but also we did not account for elderly people in the community who may have died of pneumonia in the previous 5 y. Thus, a prospective study with medical documentation might yield results different from what we have found.

The scope of what we examined was also limited, not including measures of immunocompetence, information on swallowing difficulties during meals, detailed examination of swallowing, or a check for pathogens related to pneumonia. Although we were concerned with accidental aspiration during swallowing as a risk factor, not all cases of pneumonia are due to aspiration. Aspiration itself is not a sufficient condition to bring on pneumonia, since the ability to cough out the aspired material, the bacterial content of the aspired material, immunocompetence, and yet other factors play their respective roles in determining whether pneumonia sets in.

We further have difficulty asserting that performance in AMR has a definitive relationship with occurrence of dysphagia, because no such relationship appears to have been investigated thus far on an a priori basis. We do, of course, encourage such investigative work as a potentially worthwhile endeavor. Use of the monosyllable "ta" in the AMR by Japanese subjects in our study might not quite be equivalent to speakers of other languages attempting the same task, so criterion values for the elderly used in this study may not necessarily apply to native speakers of other languages.

Conclusions

Community-dwelling elderly people who had suffered pneumonia within the previous 5 y appeared to have no more difficulty with gross swallowing mechanics than other people. They did, however, have slightly greater difficulty than others in repeating the syllable "ta" as rapidly as possible over 5 s. Linking this curious finding to history of pneumonia is a matter of conjecture at this point, but it does suggest something novel to investigate in considering what constitutes being at risk for pneumonia.

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REFERENCES

1. World Health Organization (WHO). The top 10 causes of death 2012. http://www.who.int/mediacentre/factsheets/fs310/en/. *Accessed February 17, 2016.*
2. World Health Organization (WHO). Global Health Observatory data repository. http://apps.who.int/gho/data/view.main.RCODREG6EURV?lang=en. *Accessed February 17, 2016.*
3. Centers for Disease Control and Prevention. Number of deaths for leading causes of death. http://www.cdc.gov/nchs/fastats/deaths.htm. *Accessed February 23, 2016.*
4. General Portal to Government Statistics (e-Stat). [Demographics surveys: ranking of cause of death year by year.] http://www.e-stat.go.jp/SG1/estat/Csvdl.do?sinfid=000031288449. *Accessed February 17, 2016.*
5. Ide S, Imamura Y, Kouno S. [Management of pneumonia in patients over 65.] Nihon Kyobu Rinsho 2014;73(8):925-937.
6. Kohno S, Imamura Y, Shindo Y, Seki M, Ishida T, Teramoto S, et al. Clinical practice guidelines for nursing- and healthcare-associated pneumonia (NHCAP) [complete translation]. Respir Investig 2013; 51(2):103-126.
7. Jain S, Self WH, Wunderink RG, Fakhran S, Balk R, Bramley AM, et al. Community-acquired pneumonia requiring hospitalization among U.S. adults. N Engl J Med 2015;373(5):415-427.
8. Welte T, Torres A, Nathwani D. Clinical and economic burden of community-acquired pneumonia among adults in Europe. Thorax 2012;67(1):71-79.
9. Morimoto K, Suzuki M, Ishifuji T, Yaegashi M, Asoh N, Hamashige N, et al. The burden and etiology of community-onset pneumonia in the aging Japanese population: a multicenter prospective study. PLoS One 2015;10(3):e0122247.
10. Jackson ML, Neuzil KM, Thompson WW, Shay DK, Yu O, Hanson CA, Jackson LA. The burden of community-acquired pneumonia in seniors: results of a population-based study. Clin Infect Dis 2004; 39(11):1642-1650.
11. Jackson ML, Nelson JC, Jackson LA. Risk factors for community-acquired pneumonia in immunocompetent seniors. J Am Geriatr Soc 2009;57(5):882-888.
12. Loeb M, Neupane B, Walter SD, Hanning R, Carusone SC, Lewis D, et al. Environmental risk factors for community-acquired pneumonia hospitalization in older adults. J Am Geriatr Soc 2009;57(6):1036-1040.
13. Taylor JK, Fleming GB, Singanayagam A, Hill AT, Chalmers JD. Risk factors for aspiration in community-acquired pneumonia: analysis of a hospitalized UK cohort. Am J Med 2013;126(11):995-1001.
14. Hayashi M, Iwasaki T, Yamazaki Y, Takayasu H, Tateno H, Tazawa S, et al. Clinical features and outcomes of aspiration pneumonia compared with non-aspiration pneumonia: a retrospective cohort study. J Infect Chemother 2014;20(7):436-442.
15. Teramoto S, Fukuchi Y, Sasaki H, Sato K, Sekizawa K, Matsuse T. High incidence of aspiration pneumonia in community- and hospital-acquired pneumonia in hospitalized patients: a multicenter, prospective study in Japan. J Am Geriatr Soc 2008;56(3):577-579.
16. Cabré M, Serra-Prat M, Force L, Almirall J, Palomera E, Clavé P. Oropharyngeal dysphagia is a risk factor for readmission for pneumonia in the very elderly persons: observational prospective study. J Gerontol A Biol Sci Med Sci 2014;69(3):330-337.
17. Almirall J, Rofes L, Serra-Prat M, Icart R, Palomera E, Arreola V, Clavé P. Oropharyngeal dysphagia is a risk factor for community-acquired pneumonia in the elderly. Eur Respir J 2013;41(4):923-928.
18. Cha K, Chertow GM, Gonzalez J, Lazarus JM, Wilmore DW. Multifrequency bioelectrical impedance estimates the distribution of body water. J Appl Physiol 1995;79(4):1316-1319.
19. Shimada H, Furuna T, Obuchi S, Sugiura M, Yoshida H, Kim H, et al. [Timed up & go test is a useful assessment tool for community health in elderly people.] Rigaku Ryoho Gaku 2006;33(3):105-111.
20. Ideno Y, Takayama M, Hayashi K, Takagi H, Sugai Y. Evaluation of a Japanese version of the Mini-Mental State Examination in elderly persons. Geriatr Gerontol Int 2012;12(2):310-316.
21. Oguchi K, Saitoh E, Mizuno M, Baba M, Okui M, Suzuki M. [The repetitive saliva swallowing test (RSST) as a screening test of functional dysphagia: (1) normal values of RSST.] Rehabilitation Igaku 2000;37(6):375-382.
22. Baba Y, Teramoto S, Hasegawa H, Machida A, Akishita M, Toba K. [Characteristics and limitation of portable bedside swallowing test in elderly with dementia: comparison between the repetitive saliva swallowing test and the simple swallowing provocation test.] Nihon Ronen Igakkai Zasshi 2005;42(3):323-327.
23. Oguchi K, Saitoh E, Kusudo S, Baba M, Tanaka T, Onogi K. [The repetitive saliva swallowing test (RSST) as a screening test of functional dysphagia: (2) validity of RSST.] Rehabilitation Igaku Jpn J Rehabil Med 2000;37(6):383-388.
24. Nishio M, Niimi S. Comparison of speaking rate, articulation rate and alternating motion rate in dysarthric speakers. Folia Phoniatr Logop 2006;58(2):114-131.
25. Duffy JR. Motor Speech Disorders: Substrates, Differential Diagnosis, and Management, 3rd edition. St Louis: Mosby/Elsevier;2012: 80-81.
26. Ito K, Yoshihara A, Takano N, Ishigami K, Seida Y, Inoue M, et al. [A comparison of methods for the measurement of oral diadochokinesis.] Ronen Shika Igaku 2009;24(1):48-54.
27. Hara S, Miura H, Yamasaki K. [Oral diadochokinesis among Japanese aged over 55 years: analysis of standard values.] Nihon Ronen Igakkai Zasshi 2013;50(2):258-263.
28. Pierce JE, Cotton S, Perry A. Alternating and sequential motion rates in older adults. Int J Lang Commun Disord 2013;48(3):257-264.
29. Hakkesteegt MM, Brocaar MP, Wieringa MH, Feenstra L. Influence of age and gender on the dysphonia severity index: a study of normative values. Folia Phoniatr Logop 2006;58(4):264-273.
30. Prathanee B. Oral diadochokinetic rate in adults. J Med Assoc Thai 1998;81(10):784-788.
31. Wang YT, Kent RD, Duffy JR, Thomas JE. Analysis of diadochokinesis in ataxic dysarthria using the motor speech profile program. Folia Phoniatr Logop 2009;61(1):1-11.
32. Sugimoto T, Yoshihara A, Ito K, Miyazaki H. [The relationship between articulation function evaluated by oral diadochokinesis and speech mechanism disorder.] J Dent Hlth 2012;62(5):445-453.
33. Rofes L, Arreola V, Romea M, Palomera E, Almirall J, Cabré M, et al. Pathophysiology of oropharyngeal dysphagia in the frail elderly. Neurogastroenterol Motil 2010;22(8):851-858, e230.