原著論文

Decrease in food intake and mortality risks of elderly individuals indicated by the reason for decreased food intake : A retrospective cohort study

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Abstract

Background：Elderly individuals who gradually reach their deaths due to dementia or senility pass away from decreased food intake. The objective of the present study was to analyze frequency of specific reasons for decreased food intake and the amount of decrease noted in electronic patient records in order to elucidate mortality risks.

Methods：This retrospective cohort study targeted 131 elderly people who were admitted to a nursing home for at least 6 months between 2011 and 2016 and passed away at the nursing home. We identified reasons for the decrease in food intake from their electronic patient records and statistically analyzed the correlation between the frequency of specific words and decrease in mean food intake (kcal) and the correlation between decreased food intake and mortality risk.

Results：Words related to the reasons for inability to eat were identified. Words such as "difficulty opening the mouth", "oversleeping", "phlegm", and "refusal" were used often and showed strong negative correlation with food intake ($r>-0.930$, $p<.0001$). Food intake significantly continued to decrease from nine months prior to death to the time of death. An ROC analysis detected significant difference in the amount of change between nine months prior to death and the nine months before that point (<0.001), where AUC was 0.929 and the odds ratio was 26.93.

Conclusions：It was verified that an increase in mortality risk of elderly individuals, who receive long-term care and pass away from dementia or senility, was certain, when food intake continues to decrease significantly due to reasons such as individuals not being fully awake during meals, inadequate swallowing and airway clearance, and refusal of meals.

key words：Long-Term Care, mortality, elderly, food intake, text mining

Background

When the death is near, cancer patients in the terminal stage and elderly individuals gradually weakening from dementia and senility begin to experience decreased food intake [1–3]. In case of terminal cancer patients, terminal symptoms, such as decreased physical functions, weight, awareness, and food intake, appear from two to three months prior to death [4–6]. Since these changes are concentrated in a relatively short time period, decreased food intake is considered a symptom of the terminal stage. On the other hand, in case of elderly individuals gradually weakening from dementia or senility under a long-term care at a nursing home (NH) and so on, changes such as decreased physical functions progress slowly over mid- to long-term period (several months to several years) [7,8]. Food intake also decreases in this process, but it can recover, or repeat a cycle of decrease and recovery ; thus, decreased food intake alone cannot be considered a sign of terminal stage of life [9,10].

Therefore, even experts of long-term care cannot present concrete evidence of impending death to family members. Family members might avoid the idea of impending death even when their elderly family's food

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intake begins to decrease[11, 12]. As a result, despite palliative care similar to that provided to terminal cancer patients being necessary for elderly individuals under a long-term care, ideal care might not be provided[13, 14].

Clinically, when food intake decreases under a long-term care, improving the nutritional state is the utmost priority[15, 16]. Stable food intake is the basic condition of life, and when food intake is ensured and nutritional state becomes stable, mortality risk may be reduced[17, 18]. Families and caregivers of elderly individuals consider ability to eat is important[19] and understand that elderly individuals must not be starved from decreased food intake.

However, elderly individuals who ultimately die under a long-term care gradually lose their ability to eat as their death nears[20]. Thus, it is necessary to objectively determine if decreased food intake can be recovered, or if the death is near, causing the inability to eat. If it can be clarified that a person is not dying from decreased food intake, but that food intake is decreasing in a process of death, palliative care can be provided for elderly individuals under a long-term care with their ultimate death in mind.

The objective of the present study was to clarify the relationship between decrease in food intake (kcal) and how often specific reasons for decreased food intake are noted in electronic patient records for elderly individuals who died under a long-term care at a NH. By analyzing the relationship between the amount of decrease in food intake and mortality risk, we aimed to clarify the state of decrease in food intake when death is near.

Methods

Study Design and Participants

The present study is a single-center and retrospective cohort study. Baseline data collection was conducted from May 1, 2011 to March 31, 2016. The subjects were all elderly individuals (aged ≥65) who died in a NH located in a typical Japanese Province during this period. They were officially recognized to be in a state requiring long-term care according to the Public Nursing Care Insurance Law. Residents of a facility covered by the Public Nursing Care Insurance, such as this NH, are required to be officially recognized as being at the care-need level 3 or above as per the Long-Term Care Insurance system.

The clinical picture of care-need level 3 individuals is as follows : difficulty in rising, moving, and transferring to and from a vehicle on their own, understanding the routine schedule[21], and remembering what they were doing prior to an interview. At the highest level, care-need level 5, in addition to the abovementioned conditions, includes dysphagia, disorientation, limited range of motion in the joints, motor paralysis, and other problems[22, 23]. In NH targeted for this research, approximately 90% of the reasons for discharge was death.

All subjects received professional care assistance under the same living conditions from the time of admission. They consumed three main meals (breakfast, lunch, and dinner) that were managed as nutrient requirements by registered dieticians of the facility at a given time. If they had difficulty in eating or swallowing, they received support.

The subjects included elderly individuals who continuously resided in the NH for at least 6 months and who died during their stay without receiving artificial nutrition and hydration (ANH).

Among the 151 individuals who died at the NH during the survey period, 131 of them met the inclusion criteria and were included in the present study. The baseline for the initiation of measurements was defined as the time point when the patients entered the facility. Of the 131 patients, 34 were hospitalized for ≥60 months, and the mean duration of hospitalization was approximately 40 months.

Clinical Measurements

Upon completion of each meal, nurses and trained caregivers observed and recorded the proportion of meals consumed on a scale of 1–10. The energy intake (kcal) was calculated daily by multiplying the proportion of the meal consumed by the nutritional value of each meal. Nurses and caregivers input observations of intake of meals provided to subjects and reasons for any inability to completely finish the meals in an electronic patient record as texts. Whenever the subjects could not eat all the food given, nurses and caregivers were required to record the reasons by the facility standards.

Statistical Analysis

We calculated the mean value of mean food intake up to 60 months immediately before death. We also identified words that were associated with food intake and inability to eat from the text data input in the electronic patient record which was automatically categorized as “meals” when nurses and caregivers input observations of intake of meals. From these words, we

identified words that describe reasons for decreased food intake and separated into four categories : (1) related to swallowing, (2) related to wakefulness, (3) related to airway clearance, and (4) related to meal refusal. We requested the number of times words under these categories were noted for each elderly individual per month up to 60 months immediately before death. Subsequently, we obtained a correlation between the number of times words of each category were used and actual food intake.

Next, we compared the result to the food intake six months prior and obtained the first month when significant and continuous decrease until immediately before death began using a paired t-test. Then we went back the same number of months from the first month of the significant decrease, as the number of months from the first month of significant decrease to immediately before death, and calculated the predictive ability and cutoff values of food intake for both periods using an ROC analysis to determine the change that occurs as death approaches. Youden's index was used to determine the cutoff values. Using a logistic regression analysis, we examined the strength of the relationship between the amount of change in food intake and death.

A P-value of <0.05 was considered statistically significant. Words were identified with the aid of Trend Search 2015 (Social Survey Research Information Co., Ltd.) and EK Words (DJ SOFT Co., Ltd.). All statistical analyses were performed using JMP Pro 16.0 (for Windows 10) (SAS Institute Inc., Cary, NC, USA).

Results

The baseline characteristics of the 131 elderly people are presented in Table 1. Mean age at the time of death was 89 years. There were 27 men and 104 women. Mean food intake 60 months prior to death was 1,312 kcal. Mean food intake immediately before death was 449 kcal, showing about 67% decrease.

Table 1. Baseline clinical characteristics of the 131 elderly people

ITEM	N=131
Age at death (years)	89 ± 8
Women (%)	79
Food intake 60 months before death (kcal/day)	1,312 ± 173
Food intake prior to death (kcal/day)	439 ± 366

Data are the mean ± standard deviation or n (%)

Next, from 39,546 text data categorized under "meals", we identified words that were related to food intake and inability to eat and arranged them in the order of the highest number of mention (Table2). "Good opening of the mouth", "missing meals", and "swallowing well" were the most commonly mentioned in that order.

We divided the words associated with decrease in food intake into four categories : (1) "difficulty opening the mouth", "choking", and "holding mouthful of food" as words related to swallowing, (2) "oversleeping", "daytime sleepiness", and "drowsiness" as words related to wakefulness, (3) "phlegm" and "wheezing" as words related to airway clearance, and (4) "refusal" and "missing meals" as words related to refusal of meals. Figure 1 shows the number of times these words were used per person in each month up to 60 months immediately before death along with the mean food intake. As the death neared, the number of times each category was mentioned increased along with decrease in food intake.

Next, we examined a correlation between the number of times words of each category were used and food intake between 24 months prior to death and immediately before death, when decrease in food intake was observed in Figure 1. (Figure.2). There was strong negative

Table 2. Words that were mentioned frequently in relation to food intake and inability to eat

	Words	# of mention
1	Good opening of the mouth	3,251
2	Missing meals	3,073
3	Swallowing well	2,537
4	Choking	2,233
5	Phlegm	2,179
6	Oversleeping	1,927
7	Difficulty opening the mouth	1,823
8	Refusal	1,756
9	Smooth	1,621
10	Drowsiness	1,486
11	Daytime sleepiness	1,370
12	Delayed meals	1,361
13	Holding mouthful of food	1,047
14	Poor swallowing	686
15	Nausea	505
16	Smile	465
17	Cough	317
18	Fatigue	306
19	Wheezing	264
20	Vomiting	164

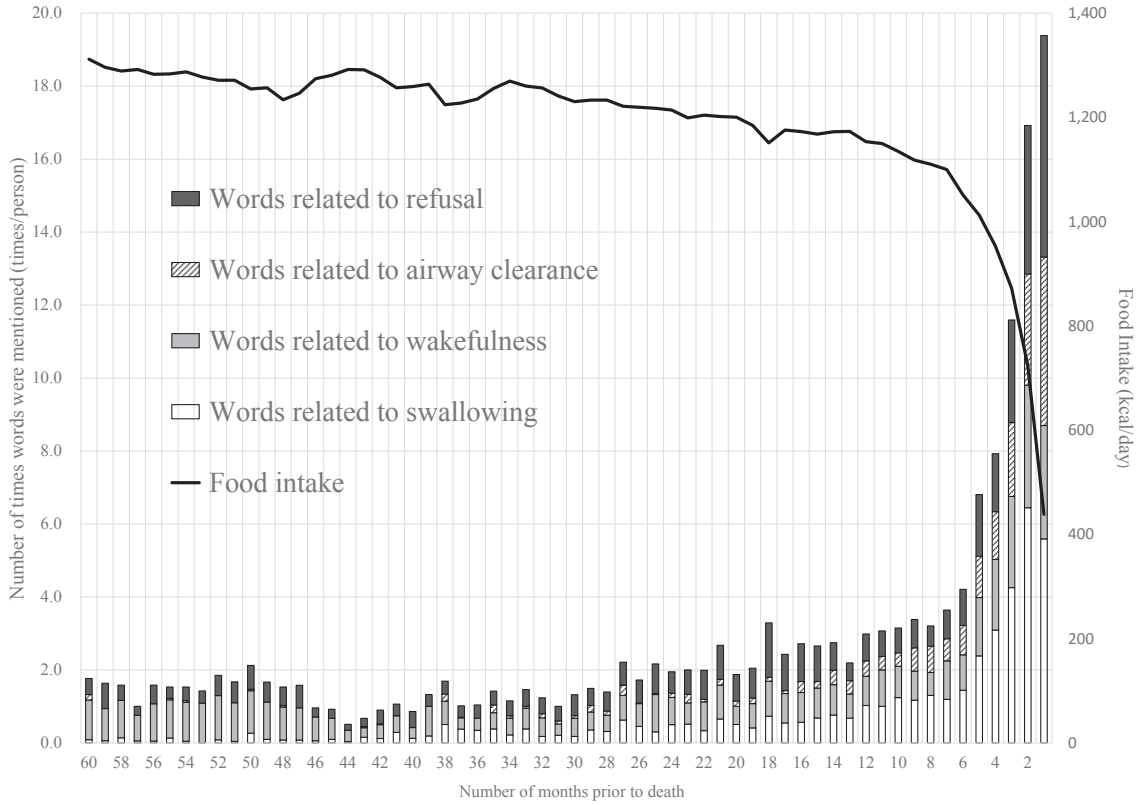

Figure 1. Changes in the number of times words related to the cause of decreased food intake were used along with the mean food intake

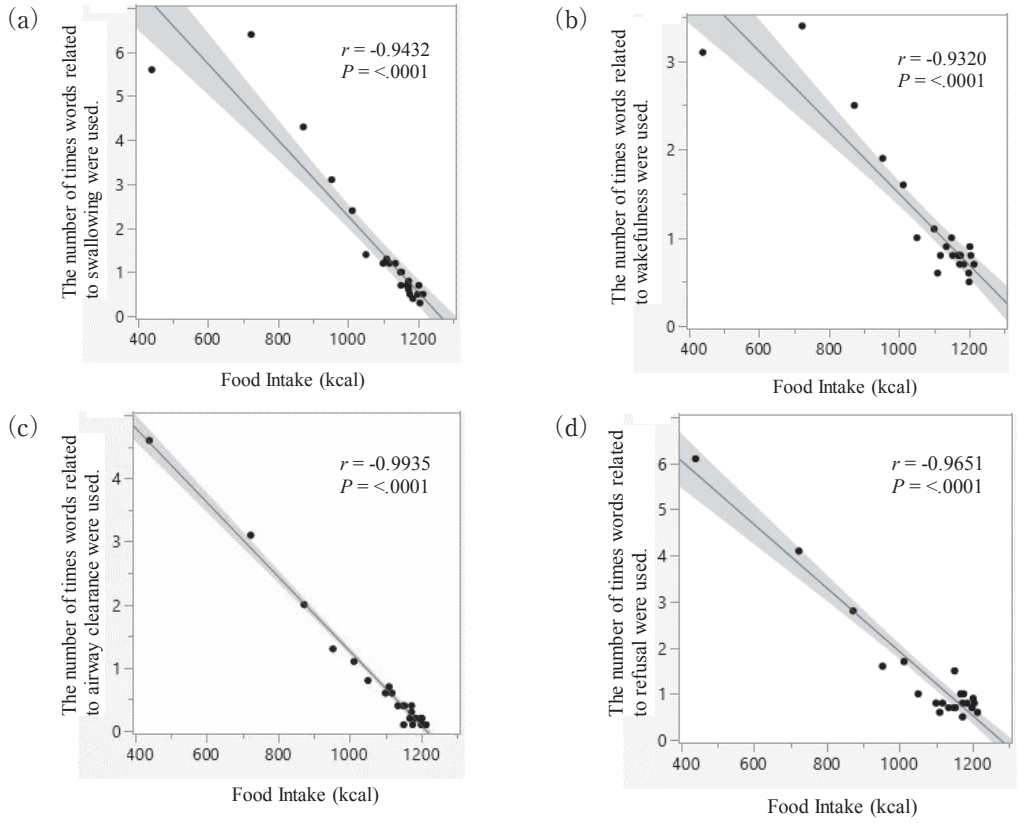

Figure 2. Correlation between the number of times words of each category were used and food intake between 24 months prior to death and immediately before death.

correlation between the number of times words of each category were used, which were reasons for decrease in food intake, and food intake. There were significant differences in test of no correlation.

When we compared monthly food intake of each month within the 24-month period prior to death, when food intake showed the decrease, to six months before, it was shown that the decrease was significant at 19 months prior to death, and then significant decrease was continuous from nine months prior to death (Table.3).

Compared to the food intake six months prior, the first month a continuous and significant decrease until immediately before death was observed was nine months prior to death. We calculated the predictive ability forimpending death and cutoff value of the amount of change for two periods — "nine months until immediately before death" and "nine months from 18 months to 10 months prior to death" — through an ROC analysis. The ROC curve is presented in Figure 3.

AUC was 0.929 with a significant difference observed for food intake. The cutoff values measured using Youden's index (Table 4) were 218 (Table 4). A decrease in food intake of 218 kcal over 9 months can be considered to be associated with a higher mortality risk. Using the logistic regression analysis, the odds ratios per standard deviation were 26.93.

Table 3. Months where decrease was significant compared to food intake six months prior

Months prior to death	Food Intake (kcal)		
	Mean	Standard Deviation (SD)	*p*-Valure (Comparative Value before 6 month)
1	439	366	< 0.001 *
2	723	375	< 0.001 *
3	872	348	< 0.001 *
4	953	310	< 0.001 *
5	1,012	294	< 0.001 *
6	1,051	281	< 0.001 *
7	1,100	251	< 0.001 *
8	1,110	270	< 0.001 *
9	1,118	275	0.0213 *
10	1,135	243	0.0672
11	1,150	229	0.0508
12	1,153	237	0.6808
13	1,173	237	0.1554
14	1,173	235	0.0358 *
15	1,168	260	0.1027
16	1,173	246	0.1057
17	1,176	245	0.0194 *
18	1,151	263	0.0015 *
19	1,185	220	0.0093 *
20	1,200	224	0.0798
21	1,202	235	0.1315
22	1,205	223	0.0888
23	1,199	226	0.0622
24	1,214	213	0.3393

the paired t-test ; *at p<0.05, mean value < comparative value before 6 month

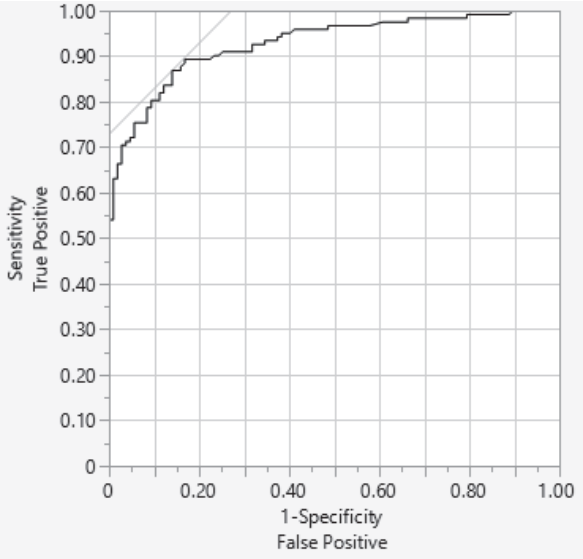

Figure 3. ROC curves for the amount of change from the period 9months to immediately before death and the period from 18months to 10 months prior to death.
Explanatory variable: the amount of change of food intake
Objective variables : Survival / Death

Table 4. AUC, cutoff value, and odds ratio of food intake

	AUC	95% Confidence Interval		*p*-value	Sensitivity	Specificity	Cutoff Value	Odds Ratio with 1SD
		Lower Limit	Upper Limit					
Food Intake (kcal)	0.929	0.896	0.961	<.0001	86%	85%	218	26.93

Discussion

To my knowledge, this is the first study that showed the reason for decrease in food intake and actual amount of decrease in elderly individuals who passed away.

The most notable finding in this study was that it identified the reasons for decreased food intake observed in elderly individuals, who gradually weakened and passed away under a long-term care for dementia or senility, in clinical settings. We verified that there was a strong correlation between the frequency of these reasons being mentioned and decreased food intake.

As for decrease in food intake among elderly individuals, physiological causes, such as impaired taste and smell reducing appetite[24], and decline in number of physiological functions and basal metabolic rate, are considered to be the reasons[25, 26]. In the present study, we examined reasons for decreased food intake in actual scenes of elderly individuals eating their meals and found that there was a strong correlation between increased frequency of these reasons being mentioned and decreased food intake. Thus, these reasons are likely direct causes that reduce food intake.

These reasons were mentioned before nine months prior to death, when food intake began to significantly decrease until immediately before death. But their frequency did not increase. Yet, when the death neared, their frequency steadily increased. Thus, this trend is not transient but increased in the process of dying.

Details of four categories are related to each other. When wakefulness is inadequate — "oversleeping", "daytime sleepiness", and "drowsiness" — swallowing functions is impaired ("difficulty opening the mouth", "choking", and "holding mouthful of food"), which causes "phlegm" and "wheezing". These issues lead to individuals refusing their meals, leading to missed meals. Resolving each of the reasons does not necessarily improve food intake, as decreased food intake is a result of overall frailty[27].

The second important finding was that at nine months prior to death, when food intake began to show continuous and significant decrease until immediately before death, food intake was significantly lower compared to the previous nine months. It not only clarified that food intake continues to decrease as death approaches for elderly individuals under a long-term care, but also characterized that decrease in food intake does not stop its continuous decrease after a certain point when death is imminent. Energy expenditure for Japanese women living in a facility is said to be 1,112 ± 231 kcal/day[28], but mean food intake for nine months prior to death is 1,118 kcal ± 275 kcal. From this period, individuals become unable to eat enough food to meet the necessary nutritional values, and it dramatically decreased 439 ± 366 kcal immediately before death, which is below the basal metabolic rate.

Nutritional status is significantly related to mortality risks. Yet there is a report that it was not related to medical diagnosis, which is the main cause[29, 30]. It is known to be significantly or independently related to mortality, similar to factors such as morbidity, frequency of hospital admissions, and immune dysfunctions[31－33].

Institutionalized elderly individuals, such as those in NHs, and elderly individuals under a homecare setting, are not medically examined unless there are acute onset or change in symptoms. This means that necessary data for medical diagnosis may not be collected[34]. Therefore, observation of food intake, which is easy to achieve, over a time span of several months or even several years, and analysis of the trajectory of decreased food intake along with the frequency of the reasons being mentioned, may clarify the mortality risk for impending death, making it extremely useful.

An interesting point of the present study is the relationship between decrease in food intake and the reasons. Reasons for decrease in food intake included not being awake during a mealtime, impairment in swallowing functions and airway clearance in elderly individuals, and refusal of meals. In order to maintain food intake in elderly individuals in this state, it is necessary to promote wakefulness, intervene to improve airway clearance, and improve swallowing functions. On the other hand, our study showed that weight or body mass index (BMI) is not maintained even if the number of meals was maintained constantly in elderly individuals who pass away under a long-term care[20] ; thus, effects that increase food intake may be limited.

An observation study of discomfort that used the Discomfort Scale–Dementia of Alzheimer Type (DS-DAT) argued that it is important for elderly individuals that they experience no discomfort from obstructed breathing, such as wheezing. They found that patients who slept most of the time experienced much less discomfort. Thus, they state that ability to sleep is a condition for "peace"[35]. Nurses and trained caregivers at the NH in the present study determined oversleeping and daytime sleepiness as a "peaceful state" where elderly individuals were able to spend

their time sleeping, prioritizing maintenance of "peace" over food intake.

Elderly individuals who pass away do not reach their terminal state due to decreased nutritional intake and hydration. Instead, their eating and drinking become less because they are in the terminal state[36, 37]. It is important to objectively determine the "watershed moment" and "critical point" between the survival effect of maintaining food intake and discomfort/pain brought on by such act, and provide ideal palliative care for elderly individuals under a long-term care.

The present study has certain limitations. First, the sample size was limited to Japanese people from a single NH. We also excluded elderly people who died within 6 months of being admitted to the NH ; thus, the results of this study cannot be applied to elderly people with acute diseases requiring continuous medical care or acute symptoms that the NH could not provide the care. About 80% of elderly individuals examined in this study was women, which might have led to a bias toward women in the analytical result.

Also, information on the food intake and reasons for inability to eat entered in the electronic patient record may not be for every single meal ; thus, number of mentions may be less than the actual frequency of these reasons being mentioned. In addition, the text entered in the electronic patient records may have affected the observation ability of nurses and caregivers and the duration of observation of the patients.

Conclusion

Elderly individuals who passed away under a long-term care in a NH experienced decrease in food intake due to impaired swallowing functions, poor airway clearance, refusal of meals, and not being awake during mealtimes. Food intake continued to decrease after a point : nine months prior to death. Decrease in food intake and reasons for such decrease show a strong correlation, demonstrating that the analysis of their relationship allows us to objectively indicate mortality risks.

Declarations

Ethics approval and consent to participate

The study was planned in accordance with the principles of the Declaration of Helsinki, and the study protocol was approved by the Ethical Review Board of Tokyo Ariake University of Medical and Health Sciences (Project identification code : 48 ; date of approval : July 24, 2012, Project identification code : 67 ; date of approval : July 4, 2013, Project identification code : 134 ; date of approval : July 21, 2015, Project identification code : 256 ; date of approval : July 26, 2018). The informed consent was waived due to the retrospective nature of the analysis and not required for research that relies exclusively on secondary use of anonymous human biological materials and text data, so long as the process of data recording or dissemination of results does not generate identifiable information.

Competing interests

There are no relevant financial or non-financial competing interests to report.

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