

# Energy Intake at Admission for Improving Activities of Daily Living and Nutritional Status among Convalescent Stroke Patients

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## Abstract

**Our aim was to clarify the nutritional status and energy intake needed for activities of daily living (ADL) improvement among convalescent stroke patients. This retrospective cohort study of stroke patients used data from the Japan Rehabilitation Nutrition Database. Mean energy intake per ideal body weight was 26 kcal/kg/day at 1 week after hospitalization. Patients were divided into two groups according to energy intake:  $\geq 26$  kcal/kg/day (high) and  $< 26$  kcal/kg/day (low). ADL was evaluated using Functional Independence Measure (FIM), and nutritional status was evaluated using the mini nutritional assessment short form score. We created an inverse probability weighted (IPW) model using propensity scoring to control and adjust for patient characteristics and confounders at the time of admission. The analysis included 290 patients aged  $78.1 \pm 7.8$  years. There were 165 patients with high energy intake and 125 patients with low energy intake. FIM score was significantly higher in the high group compared with the low group (median 113 vs 71,  $P < 0.001$ ). FIM efficiency was also higher in the high group (median 0.31 vs 0.22,  $P < 0.001$ ). FIM efficiency was significantly higher in the high energy intake group than in the low energy intake group after adjustment by IPW (median 0.31 vs 0.25,  $P = 0.011$ ). Nutritional status improvement was also higher in the high energy intake group after adjustment by IPW (60.6% vs 45.2%,  $P < 0.001$ ). High energy intake was associated with higher FIM efficiency and nutritional status improvement at discharge among convalescent stroke patients.**

Key words: stroke, energy intake, nutrition improvement, activities of daily living improvement, convalescent rehabilitation ward

## Introduction

Malnutrition is common among stroke patients, and improvement of nutritional status is important to improve activities of daily living (ADL). ADL improvement is lower among underweight stroke

patients.<sup>1)</sup> If energy intake is low, malnutrition tends to occur and ADL improvement is reduced.<sup>2)</sup> In the convalescent rehabilitation ward, nutritional status and higher energy intake at admission are associated with greater ADL improvement among stroke patients,<sup>3)</sup> and improvement of nutritional status is related to Functional Independence Measure (FIM) efficiency.<sup>4)</sup> Malnutrition is observed in 6.1–62%<sup>5)</sup> of stroke patients, and may be caused by factors such as dysphagia, diabetes, and impaired consciousness.<sup>6)</sup> In addition, the prevalence of malnutrition among

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stroke patients is higher several weeks after stroke onset than during onset.<sup>7–9)</sup> In convalescent rehabilitation wards in Japan, up to nine units (one unit = 20 min) of rehabilitation by a physical therapist, occupational therapist, or speech therapist can be performed per day from the day of admission. If intensive rehabilitation is performed in patients with insufficient energy and protein intake, the effect of rehabilitation is lower, and malnutrition is likely to develop. In fact, weight loss has also been found to occur among stroke patients who had good nutrition before stroke onset.<sup>10)</sup> Therefore, management aimed at nutrition improvement from the beginning of admission is very important for stroke patients admitted to the convalescent rehabilitation ward who are malnourished or at risk of becoming malnourished.

The effect of energy intake on nutritional status and improvement of ADL among stroke inpatients is not clear. In acute care hospitals, management of nutrition to maintain intake of >22 kcal/kg/day has been shown to significantly improve swallowing function.<sup>11)</sup> However, in the convalescent rehabilitation ward, more energy intake is likely to be required because of longer rehabilitation training time and heavier training load. Nii et al.<sup>3)</sup> reported that ADL improvement was associated with energy intake at admission. However, the Nii et al. study did not examine the level of energy intake at admission that is needed for optimal improvement of ADL.

The purpose of this study was therefore to clarify the level of energy intake at admission that is required for greater improvement of nutritional status and ADL among stroke patients admitted to the convalescent rehabilitation ward.

## Materials and Methods

This retrospective cohort study of stroke patients used registration data from the Japan Rehabilitation Nutrition Database (JRND), which was founded by the Japan Association of Rehabilitation Nutrition (JARN) and was built using Research Electronic Data Capture in March 2016. The focus is on clinical research on rehabilitation nutrition that can contribute to the improvement of patient care, and thus, the JRND contains many rehabilitation nutrition-related variables. Patients aged 20 years or older with stroke or hip fracture in convalescent rehabilitation wards and those aged 65 years or older with pneumonia in acute care hospitals were eligible for registration in the database. Participating facilities were recruited from the JARN and ultimately included 11 facilities and 1105 patients as of the end of March 2018. For stroke patients, information included in the registry

is as follows: (a) basic information and admission data, including age, sex, dates of onset and admission, diagnosis, Charlson comorbidity index (CCI) score, consciousness, modified Rankin Scale score, pre-stroke certification of public long-term care insurance (LTCI), FIM score on admission, medication, implementation of physical/occupational/speech-language–hearing therapy, height and weight, Mini Nutritional Assessment Short-Form (MNA-SF) score, energy intake, and food type and route of feeding; and (b) discharge data, including discharge date and destination, FIM score, MNA-SF score, and total units of rehabilitation therapy provided (one unit = 20 min based on the national healthcare insurance policy). Energy intake was evaluated as the mean for the first week after hospitalization. The estimation method of energy intake was not specified when registering in the database. Most hospitals in Japan plan menus with commercially available software incorporating the Standard Tables of Food Composition in Japan—2015 (seventh revised edition).<sup>12)</sup> The amount of each item consumed by the patient is visually observed by the nursing staff or a registered dietitian and is recorded as a percentage. These data are then converted to energy intake by a registered dietitian using the standard tables. LTCI is a public long-term care system in Japan, and it is mandatory that all citizens are covered to manage the care of senior citizens as a whole.

This study was approved by the ethical committee of the Jikei University School of Medicine. Because only anonymous clinical data are registered in the JRND, participating facilities supplied information regarding the JRND to all patients and explained the opt-out option, which allowed patients to withdraw from the registry at any time.

The aim of convalescent rehabilitation wards, which are covered by public healthcare insurance in Japan, is to maximize ADL recovery for patients with disabilities and allow them to return to their own homes.<sup>13)</sup> In these wards, comprehensive rehabilitation for improving everyday meals, walking, excretion, bathing and other actions is provided by a multidisciplinary team. For stroke patients within 60 days from onset, individualized rehabilitation by a physical therapist, occupational therapist, and speech therapist for nine units (180 min) per day for up to 180 days is covered by public insurance.

## Evaluation of nutritional status

Nutritional status was evaluated with the MNA-SF, a nutritional screening tool for older people that consists of six low-order items, including dietary intake reduction (0–2 points), weight loss (0–3 points), mobility (0–2 points), stress/acute disease (0 or 2 points), neuropsychological problems (0–2

points), and body mass index (BMI) (0–3 points).<sup>14)</sup> The total score of the MNA-SF can be used to infer nutritional status, which is classified into three categories: malnutrition (0–7 points), at risk of malnutrition (8–11 points), and normal nutritional status (12–14 points). MNA-SF scores at the time of admission and discharge were compared, and cases where the score was improved were regarded as having nutritional status improvement.

### Activities of daily living

Activities of daily living was evaluated using the FIM, a scale that assesses patients' ability to perform certain activities taking into account the amount of assistance required. The FIM can be used for any disease and its reliability and validity have been verified.<sup>15,16)</sup> The FIM consists of 13 physical activity-related items, including transfer to and from bed/chair/wheelchair, toileting, transfer to and from bath/shower, walking/wheelchair use, and use of stairs; and five cognitive items, including understanding, expression, social interaction, problem solving, and memory. Each item is scored on a scale from 1 (total assistance) to 7 (complete independence); therefore, total FIM scores range from 18 to 126. FIM gain is the value obtained by subtracting the total FIM score at the time of admission from the total FIM score at discharge, and the higher the numerical value, the higher the effect of rehabilitation and care. FIM efficiency is a value obtained by dividing the FIM gain by the number of hospital days; here too the higher the numerical value, the higher the efficiency of rehabilitation and care.

### Participants

This study included stroke patients aged 65 years and older who were admitted to the rehabilitation ward. Patients who were transferred to acute care hospitals (suggesting a worsening of clinical condition) and those with missing data for energy intake, MNA-SF, or FIM at hospital admission and discharge were excluded. Patients who were hospitalized with a recovery period of more than 180 days after stroke onset were also excluded, because they did not undergo comprehensive rehabilitation targeted for public health insurance. Finally, rehabilitation wards in Japan usually start rehabilitation within the day following admission, so patients for whom more than 3 days elapsed from admission to the start of rehabilitation were also excluded.

### Outcomes

The primary outcome was total FIM score at discharge and the secondary outcome was nutritional status improvement.

### Statistical approach

The mean energy intake per ideal body weight at 1 week after hospitalization was  $26 \pm 4.8$  kcal/kg/day in this study. Ideal weight was calculated by multiplying the square of height by a BMI of 22. Patients were divided into two groups according to energy intake (high:  $\geq 26$  kcal/kg/day; low:  $< 26$  kcal/kg/day) and compared. Data were analyzed with EZR statistical software.<sup>17)</sup> The mean  $\pm$  SD was reported for normally distributed variables; medians and interquartile ranges were reported for skewed data. We used the independent sample *t*-test, Mann–Whitney *U*-test, and chi-square test as appropriate to compare values between the two groups. We created an inverse probability weighted (IPW) model using propensity scoring to control and adjust for patient characteristics and confounders at the time of admission.<sup>18)</sup> In this method, patients in the high energy intake group were weighted for the reciprocal of the propensity score, and those who in the low energy intake group were weighted for the reciprocal of 1 minus propensity score. As the result of weighting, number of patients increases in most cases. The propensity score was the predictive probability for grouping calculated in each case by logistic regression modeling including eight independent variables determined at admission (age, sex, stroke classification, presence of long-term care before hospitalization, CCI, MNA-SF score at hospitalization, FIM score at hospitalization and total rehabilitation units). Descriptive statistics for all patients were compared before and after IPW adjustment to check for covariate balance and the effect of weighting on the estimate. A *P*-value  $< 0.05$  was considered statistically significant.

## Results

Of the 1105 patients in the JRND, 369 patients met our inclusion criteria. From these, we excluded patients with more than 60 days from stroke onset to rehabilitation ward hospitalization ( $n = 20$ ), patients whose length of hospital stay was 180 days or more ( $n = 10$ ), patients who had been transferred to acute care hospitals ( $n = 34$ ), and patients for whom more than 3 days had elapsed from hospitalization to the start of rehabilitation ( $n = 4$ ). In addition, three patients with missing energy intake data at admission and six patients with missing FIM scores and MNA-SF scores at admission and discharge were excluded. In total, 290 patients were included in the analysis. Each person is weighted by each person's propensity score, resulting in an increase in the number of people. As a result, it became 699 people in this case.

Patient demographic data are shown in Table 1. Study participants were divided into two groups based on energy intake; above (high energy intake group) or below (low energy intake group) 26 kcal/kg/day. There were 165 patients with high energy intake and 125 patients with low energy intake. Unadjusted analysis showed that compared with the low energy intake group, the high energy intake group was younger, had a higher proportion residing at home before stroke onset, and had a higher total FIM score, BMI, and MNA-SF score. After adjustment by IPW, baseline characteristics were found to be closely matched between the two groups.

Table 2 shows the comparison between outcome and discharge destination at the time of discharge from the rehabilitation ward. FIM efficiency was significantly higher in the high energy intake group than in the low energy intake group (median 0.31 vs 0.22,  $P < 0.001$ ). Nutritional status improvement was also higher in the high energy intake group (63.6% vs 48.0%,  $P = 0.011$ ). In the high energy intake group, the length stay in the rehabilitation ward was shorter (median 91 vs 112 days,  $P = 0.003$ ); the proportion of patients discharged to home was also higher (83.0% vs 58.4%,  $P < 0.001$ ), which was consistent with the results after IPW adjustment. FIM efficiency was significantly higher in the high energy intake group than in the low energy intake group at after adjustment by IPW (median 0.31 vs 0.25,  $P = 0.011$ ). Nutritional status improvement was also higher in the high energy intake group after adjustment by IPW (60.6% vs 45.2%,  $P < 0.001$ ).

## Discussion

This study had two important clinical findings. First, geriatric stroke patients with high energy intake during admission in the rehabilitation ward had significantly higher FIM efficiency and nutritional status improvement. Second, an energy intake  $\geq 26$  kcal/kg/day per ideal body weight is required to increase ADL status at discharge as well as nutritional status improvement.

High energy intake among geriatric stroke patients admitted to a rehabilitation ward is associated with significantly higher FIM efficiency and higher nutritional status improvement. According to a study by Nishioka et al.<sup>4)</sup> improvement of nutrition status, especially maintenance of body weight, correlates with recovery of ADL among malnourished geriatric convalescent stroke patients. Nii et al.<sup>3)</sup> have also noted that recovery of ADL after stroke is related to nutritional improvement and energy intake at admission. In our study, based on mean energy intake per ideal body weight, FIM efficiency and nutritional

status improvement were significantly higher in the group with higher energy intake. Therefore, energy intake at hospitalization should be set higher for geriatric convalescent stroke patients.

The level of energy intake that enables geriatric convalescent stroke patients to achieve a greater increase in FIM efficiency and nutritional status improvement is  $\geq 26$  kcal/kg/day per ideal body weight. To our knowledge, this is the first study to report the energy intake required to improve ADL. Stroke patients are prone to malnourishment mainly due to dysphagia, impaired consciousness, perception deficits, and cognitive dysfunction.<sup>19)</sup> Being malnourished or at risk of malnutrition on admission leads to increased risk of mortality and poor clinical outcomes.<sup>19)</sup> According to a study that used the MNA-SF to evaluate nutritional status among acute stroke patients, nutritional status significantly declined in the first 10 days of hospitalization.<sup>20)</sup> Early nutritional intervention including an energy supply of 26 kcal/kg/day or more per ideal body weight should be performed to promote increase independence in ADL at discharge among convalescent stroke patients in rehabilitation.

Stroke patients require nutritional management for various reasons: for example, nutritional enhancement to treat undernutrition or low body weight; or on the other hand, energy restriction to address obesity and metabolic abnormalities. Among stroke patients admitted to a rehabilitation ward, FIM efficiency was found to be lowest in the low body-weight group.<sup>21)</sup> Maeda et al.<sup>22)</sup> suggested that energy intake should be increased to 27 kcal/kg/day in the case of malnutrition, based on their study investigating the relationship between energy intake and ADL. In light of these findings, energy requirements should be calculated using ideal body weight [height (m)  $\times$  height (m)  $\times$  ideal weight (kg)], not current body weight, for patients with malnutrition or low body weight. Aggressive nutrition management that takes into account the addition of accumulated energy to increase body weight can induce greater improvement of ADL. Our findings may help enable appropriate nutritional management immediately after rehabilitation hospital admission for geriatric convalescent stroke patients.

There are some limitations to this study. First, the change in energy intake during hospitalization was not taken into account; rather, we used the mean energy intake for the first week after hospitalization. Since hospitals registered in the JRND were institutions that practice rehabilitation nutrition,<sup>23)</sup> it is possible that nutritional intervention was changed during hospitalization. Also, after stroke, malnutrition is likely to occur due to sequelae



**Table 1 Demographic data of 290 patients after stroke in the rehabilitation wards**

| Characteristic  | Unadjusted data (n = 290)  |                   |                   | Data adjusted by inverse probability weighting (n = 699) |                   |                   |         |
|---|----------------------------|-------------------|-------------------|--|-------------------|-------------------|---------|
|   | Energy intake at admission |                   |                   | Energy intake at admission                               |                   |                   |         |
|   | Overall                    | ≥26 kcal/IBW (kg) | <26 kcal/IBW (kg) | P-value  | ≥26 kcal/IBW (kg) | <26 kcal/IBW (kg) | P-value |
| Number of participants                                | 290                        | 165               | 125               |  | 343               | 356               |         |
| Age, year, mean ± SD                                  | 78.1 ± 7.8                 | 76.5 ± 7.5        | 80.2 ± 7.8        | <0.001 <sup>c</sup>                                      | 78.8 ± 8.0        | 78.5 ± 7.4        | 0.559   |
| Female, N (%)   | 145 (50.0)                 | 90 (54.5)         | 55 (44.0)         | 0.096 <sup>d</sup>                                       | 178 (51.9)        | 194 (54.5)        | 0.491   |
| Stroke type, N (%) <sup>a</sup>                       |                            |                   |                   | 0.719 <sup>d</sup>                                       |                   |                   | 0.743   |
| Cerebral infarction                                   | 200 (69.2)                 | 116 (70.3)        | 84 (67.7)         |  | 241 (70.3)        | 256 (71.9)        |         |
| Intracerebral hemorrhage                              | 73 (25.3)                  | 39 (23.6)         | 34 (27.4)         |  | 84 (24.5)         | 79 (22.2)         |         |
| Subarachnoid hemorrhage                               | 16 (5.5)                   | 10 (6.1)          | 6 (4.8)           |  | 18 (5.2)          | 21 (5.9)          |         |
| Neurosurgery procedure, N (%) <sup>a</sup>            |                            |                   |                   | 0.688 <sup>d</sup>                                       |                   |                   | 0.980   |
| Conservative treatment                                | 239 (83.6)                 | 136 (84.5)        | 103 (82.4)        |  | 288 (84.0)        | 299 (84.0)        |         |
| Craniotomy  | 23 (8.0)                   | 11 (6.8)          | 12 (9.6)          |  | 25 (7.3)          | 27 (7.6)          |         |
| Other neurosurgical operations                        | 24 (8.4)                   | 14 (8.7)          | 10 (8.0)          |  | 30 (8.7)          | 30 (8.4)          |         |
| Onset-admission duration, days, median (IQR)          | 22 (15–33)                 | 22 (15–33)        | 22 (14–33)        | 0.542 <sup>e</sup>                                       | 25 (18–37)        | 24 (14–34)        | 0.642   |
| CCI, median (IQR)                                     | 1 (0–2)                    | 1 (0–2)           | 1 (1–2)           | 0.050 <sup>e</sup>                                       | 1 (0–2)           | 1 (0–2)           | 0.614   |
| Pre-stroke incontinence, N (%)                        |                            |                   |                   | <0.001 <sup>f</sup>                                      |                   |                   | 0.959   |
| Home  | 270 (93.1)                 | 163 (98.8)        | 107 (85.6)        |  | 321 (93.6)        | 335 (94.1)        |         |
| Care facilities                                       | 17 (5.9)                   | 1 (0.6)           | 16 (12.8)         |  | 19 (5.5)          | 18 (5.1)          |         |
| Hospital  | 3 (1.0)                    | 1 (0.6)           | 2 (1.6)           |  | 3 (0.9)           | 3 (0.8)           |         |
| Pre-stroke certification for LTCL, N (%) <sup>b</sup> | 103 (35.9)                 | 53 (32.3)         | 50 (40.7)         | 0.183 <sup>d</sup>                                       | 110 (32.2)        | 133 (37.4)        | 0.150   |
| FIM, median (IQR)                                     | 67 (34–89)                 | 77 (53–99)        | 40 (25–70)        | <0.001 <sup>e</sup>                                      | 61 (34–84)        | 62 (32–84)        | 0.615   |
| BMI, kg/m <sup>2</sup> , mean ± SD                    | 21.4 ± 3.5                 | 22.0 ± 3.6        | 20.7 ± 3.3        | 0.002 <sup>c</sup>                                       | 21.4 ± 3.4        | 21.1 ± 3.7        | 0.394   |
| MNA-SF, score, median (IQR)                           | 6 (4–8)                    | 7 (5–8)           | 5 (3–7)           | <0.001 <sup>e</sup>                                      | 6 (4–8)           | 6 (4–8)           | 0.771   |
| Intake energy/IBW, mean ± SD                          | 26.4 ± 4.8                 | 29.5 ± 2.8        | 22.2 ± 3.5        | <0.001 <sup>c</sup>                                      | 29.3 ± 2.7        | 22.4 ± 3.3        | 0.002   |

<sup>a</sup>Data analyzed from 239 participants (one missing data), <sup>b</sup>237 participants (three missing data), <sup>c</sup>Unpaired t-test, <sup>d</sup>Mann-Whitney U-test, <sup>e</sup>Fisher's exact test, BMI: body mass index, CCI: Charlson comorbidity index, FIM: Functional Independence Measure, IBW: ideal body weight, IQR: interquartile range, LTCL: public long-term care insurance, MNA-SF: Mini Nutritional Assessment Short-Form, SD: standard deviation.

**Table 2 Rehabilitation outcome and discharge destination of 290 patients after stroke in rehabilitation ward**

| Characteristic                                  | Unadjusted data (n = 290) |   |   | Data adjusted by inverse probability weighting (n = 699) |   |   |         |
|---|---------------------------|---|---|--|---|---|---------|
|   | Overall                   | Energy intake at admission<br>≥26 kcal/IBW (kg) | Energy intake at admission<br><26 kcal/IBW (kg) | P-value  | Energy intake at admission<br>≥26 kcal/IBW (kg) | Energy intake at admission<br><26 kcal/IBW (kg) | P-value |
| Number of participants                          | 290                       | 165   | 125   |  | 343   | 356   |         |
| Length of hospital stay, days, median (IQR)     | 99 (63–139)               | 91 (58–128)                                     | 112 (78–145)                                    | 0.003 <sup>a</sup>                                       | 88 (62–130)                                     | 98 (79–135)                                     | 0.017   |
| Rehabilitation time per day (min), median (IQR) | 156 (135–166)             | 155 (135–166)                                   | 156 (135–167)                                   | 0.749 <sup>a</sup>                                       | 158 (139–167)                                   | 155 (135–164)                                   | 0.583   |
| Home return, N (%)                              | 245 (84.4)                | 149 (90.2)                                      | 96 (76.7)                                       | <0.001 <sup>b</sup>                                      | 293 (85.7)                                      | 283 (79.5)                                      | 0.032   |
| FIM, median (IQR)                               |                           |   |   |  |   |   |         |
| Discharge score                                 | 102 (65–118)              | 113 (98–121)                                    | 71 (47–104)                                     | <0.001 <sup>a</sup>                                      | 102 (70–117)                                    | 94 (55–112)                                     | 0.001   |
| Gain  | 25 (13–38)                | 25 (15–39)                                      | 24 (10–35)                                      | 0.156 <sup>a</sup>                                       | 26 (13–45)                                      | 19 (10–33)                                      | <0.001  |
| Efficiency                                      | 0.28 (0.14–0.43)          | 0.31 (0.18–0.47)                                | 0.22 (0.10–0.38)                                | <0.001 <sup>a</sup>                                      | 0.31 (0.17–0.49)                                | 0.25 (0.12–0.47)                                | 0.011   |
| Improvement of nutritional status, N (%)        |                           |   |   | 0.011 <sup>b</sup>                                       |   |   | <0.001  |
| Yes   | 165 (56.9)                | 105 (63.6)                                      | 60 (48.0)                                       |  | 208 (60.6)                                      | 161 (45.2)                                      |         |
| No  | 125 (43.1)                | 60 (36.4)                                       | 65 (52.0)                                       |  | 135 (39.4)                                      | 195 (54.8)                                      |         |

<sup>a</sup>Mann–Whitney *U*-test, <sup>b</sup>Chi-squared test, FIM: Functional Independence Measure, IQR: interquartile range, SD: standard deviation.

such as paralysis and dysphagia, but because the optimal amount is not known at the beginning of hospitalization, it tends to be less identified. Therefore, in order not to impair nutritional status and ADL, at the very least at the time of discharge, it is considered necessary to set an initial optimal amount of required energy intake. Second, as data were collected at rehabilitation hospitals, this study did not include patients with mild stroke who do not need continued rehabilitation, or those with severe stroke who are not subject to rehabilitation. Such patients may be discharged from acute care hospitals to their homes or to nursing homes, and it is assumed that the influence of nutritional status on their rehabilitation is relatively small.

In conclusion, geriatric stroke patients with high energy intake admitted to rehabilitation wards had significantly higher FIM efficiency as well as nutritional status improvement. Energy intake  $\geq 26$  kcal/kg/day per ideal body weight is required to promote a greater increase in efficient improvement of ADL and nutritional status improvement. Additional research to evaluate energy intake throughout hospitalization is necessary to further elucidate the relationship between improvement of nutritional status and functional outcome.

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### Conflicts of Interest Disclosure

Momosaki reports grants from Japan Society for the Promotion of Science, during the course of the study. Wakabayashi reports grants from The Ministry of Education, Science, Culture, Sports, Science, and Technology of Japan, outside the submitted work. Nishiyama, Nishioka, and Nagano declare no conflicts of interest.

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