

# Stroke Patients with Nearly Independent Transfer Ability are at High Risk of Falling

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*Objectives:* To examine the relationship between patients' transfer ability and fall risk in stroke patients during hospitalization. *Materials and methods:* We retrospectively enrolled 237 stroke patients who were transferred to a convalescent rehabilitation ward from acute wards in the same hospital. Using incident reports, we investigated their fall rates and activity status at the falls according to their transfer abilities, which were assessed with Functional Independence Measure (FIM) transfer scores. The bi-weekly time trend of fall rates in all patients and in three subgroups based on FIM transfer scores of 1–3, 4–5, and 6–7, and activity status at the falls, were investigated. In addition, changes of patients' transfer ability on admission, at the first fall, and at discharge were investigated among falling patients. *Results:* The fall rate was the greatest in patients with a FIM transfer score of 4 (14.3 times/1000 person-days). The majority of falls for patients with a FIM transfer score of 1 occurred at the activity status of "on the bed" and "sitting", while three quarters of patients with a FIM score of 7 had falls during "standing" and "walking". No longitudinal trend in fall rates was found overall; however, the fall rate trends differed depending on the FIM transfer score. The majority of the patients who fell required full assistance for transfers upon admission but required no assistance at discharge. *Conclusions:* Fall risk differed among patients with various transfer abilities; the greatest risk was in those who needed minimal assistance for transfers.

**Key Words:** Accidental falls—Activities of daily living—Cerebrovascular disorders—Patient care—Patient safety—Rehabilitation—Transfer

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## Introduction

Stroke patients are at high risk of falling<sup>1–5</sup> due to various post-stroke symptoms including motor and/or cognitive impairments.<sup>6,7</sup> Falls can cause injuries such as fractures,<sup>2,4,8–10</sup> which can lead to further impairments and decreased participation in activities of daily living (ADLs). For this reason, the prevention of falls in stroke patients is important during hospitalization as well as in the community.

The risk factors for falls among stroke patients in hospitals have been studied extensively, and patients' motor and cognitive impairments and disability upon admission are associated with the subsequent occurrence of falls

during hospitalization.<sup>9–11</sup> Simply put, when a patient has increased severity of impairment/disability, his or her risk of falling may increase. However, the relationship between the degree of impairment/disability and the risk of falling is not simple. Some studies have reported on the non-linear relationship between mobility/disability and the risk of falling. One study reported that the risk of falling in stroke patients during inpatient rehabilitation was higher in those with moderate to severe disability upon admission than in those with mild or very severe disability.<sup>9</sup> Another cohort study reported that among older people (including stroke survivors) living in residential care facilities, fall rates were higher in those with fair standing balance than in those with the best or worst standing balance.<sup>12</sup> However, these studies investigated patients' abilities at different times relative to the occurrence of the falls. Therefore, the relationship between actual ability at the time of the fall and the risk of falling remains unclear. Since the abilities of stroke patients are continuously changing throughout the hospitalization with rehabilitative intervention, it is necessary to know the patients' abilities at the time of the falls in order to elucidate the true relationship between their abilities and their risk of falling.

Among the various abilities, transferring is the key ability in terms of both ADL participation and consideration of fall risk during hospitalization. In hospitals, patients with stroke are generally able to get out of bed and move around the ward independently when they are able to perform an independent transfer between their wheelchair and bed. Thus, transferring is an essential ability for patients to safely perform in order to increase their activity level. However, transferring is associated with a patient's potential risk of falling; it has been reported as the most common cause of falls in hospitalized patients with stroke.<sup>1,13–15</sup> It remains unclear at which level of transfer ability the patient is most likely to fall, and there is no standard indication to which patients should be given extra attention or precautions.

The purpose of this study was to examine the relationship between patients' transfer ability and risk of falling in stroke patients from stroke onset to discharge from the rehabilitation ward. Our hypothesis was that the degree of transfer ability and fall risk are closely related in stroke patients, and that the risk of falling was the highest when transfer ability was neither high nor low, but intermediate. We determined that the findings could provide valuable information for establishing fall prevention strategies to reduce falls and injuries in stroke patients.

## Methods

### *Study design and setting*

This study was a single-center retrospective cohort study. The study setting was a 1435-bed university hospital in Japan, which has both acute care wards and a 60-

bed convalescent rehabilitation ward. In Japan, the convalescent rehabilitation ward is the main provider for sub-acute rehabilitation covered by Japan's medical insurance system, and patients can stay up to six months after hospitalization.<sup>16</sup> The protocol for this study was approved by the appropriate ethics committee (Approval Number: HM18–314 CI18–379).

In the hospital, the safety measures and permitted activity range is determined based on periodic fall risk assessments completed by medical staff; generally, the patients performed the activities within their allowed range. When patients performed activities outside of their permitted range, they were asked to call the medical staff for assistance or supervision.

### *Participants*

We enrolled 237 stroke patients who were transferred to the convalescent rehabilitation ward from the acute wards of the same hospital between January 2018 and August 2019. The participants' characteristics are shown in [Table 1](#).

### *Data collection*

The data of falls were extracted from incident reports recorded in the hospital's electronic medical records. Incident reports were written by medical staff who first discovered the patient's fall, including medical doctors, nurses, care workers, physical therapists, occupational therapists, and speech-language-hearing therapists. We collected the data about the patients' level of transferring ability using the Functional Independence Measure (FIM) "transfer to bed/chair/wheelchair"<sup>17,18</sup> within two weeks before or after the falls. The FIM score was evaluated by the physical or occupational therapists in charge of the patients. All therapists in our hospital were trained for FIM scoring. Linear interpolation was applied for the missing FIM scores in each patient.

## Analysis

We counted all falls, including the repeated falls of a patient. Fall rates were calculated by dividing the number of falls by the observed 1000 person-days. First, to clarify the relationship between the patients' transfer ability and falls, we calculated the fall rates in each patient's transfer ability level as the total number of falls divided by the total observed patient-days for each FIM transfer score. Secondly, we investigated the relationship between the patients' transfer ability and the activity status at the falls. Using the description of falls in incident reports, we defined activity status at the falls into the following categories: "on the bed" included when the patient lying on the bed fell to the floor; "sitting" included when the patient fell while sitting on a raised surface (e.g., bed, chair, wheelchair, toilet seat); "standing" included when the patient fell while standing (including those that

**Table 1.** Participants' characteristics (N = 237).

Sex, male/female, <i>n</i>	132/105
Age, years, mean (SD)	68.9 (13.5)
Type of stroke, ischemic/intracranial hemorrhage/subarachnoid hemorrhage, <i>n</i>	114/98/25
Lesion site, right hemisphere/left hemisphere/bilateral hemisphere/brainstem/cerebellum, <i>n</i>	93/99/16/21/8
Length of stay, days, mean (SD)	
Acute wards	26.6 (16.2)
Convalescent rehabilitation ward	67.5 (37.9)
FIM at admission of acute wards, median (IQR)	
Total score	40 (21)
Motor score	17 (13)
Cognitive score	20 (8)
FIM at discharge from convalescent rehabilitation ward, median (IQR)	
Total score	112 (92)
Motor score	82 (70)
Cognitive score	30 (21)
Number of falls, single/multiple, <i>n</i>	
Acute wards	27/6
Convalescent rehabilitation ward	41/28
Fall rate, rate per 1000 patient-days	
Acute wards	6.51
Convalescent rehabilitation ward	7.56

SD: standard deviation; IQR: interquartile range; FIM: Functional Independence Measure.

happened during transfers); and "walking" included when the patient fell while walking. We calculated the percentages of activity status at the falls in each FIM score.

Thirdly, the longitudinal changes in fall rates were determined by calculating the fall rates every two weeks from stroke onset to discharge from the convalescent rehabilitation ward. In addition, to examine the effects of environmental change when patients were transferred from the acute wards to the convalescent rehabilitation ward, we also calculated the fall rates in a timeline realigned based on the admission date to the convalescent rehabilitation ward. Furthermore, to examine the effects of the phases of hospitalization, i.e., early, middle, late phase of hospitalization, for each individual, we calculated the fall rates in a timeline normalized to 0–100% from stroke onset to discharge from the convalescent rehabilitation ward. Since the fall rates differed depending on the FIM transfer scores, we investigated the longitudinal changes in the fall rates of three subgroups with different transfer abilities (FIM transfer scores of 1–3, 4–5, and 6–7) every two weeks from stroke onset to discharge from the convalescent rehabilitation ward. We also calculated the percentage of activity status at the falls in each time period.

Finally, to investigate the changes in the patients' transfer ability among patients who experienced a fall(s), we examined the distribution of their FIM transfer scores upon admission, at their first fall, and at discharge.

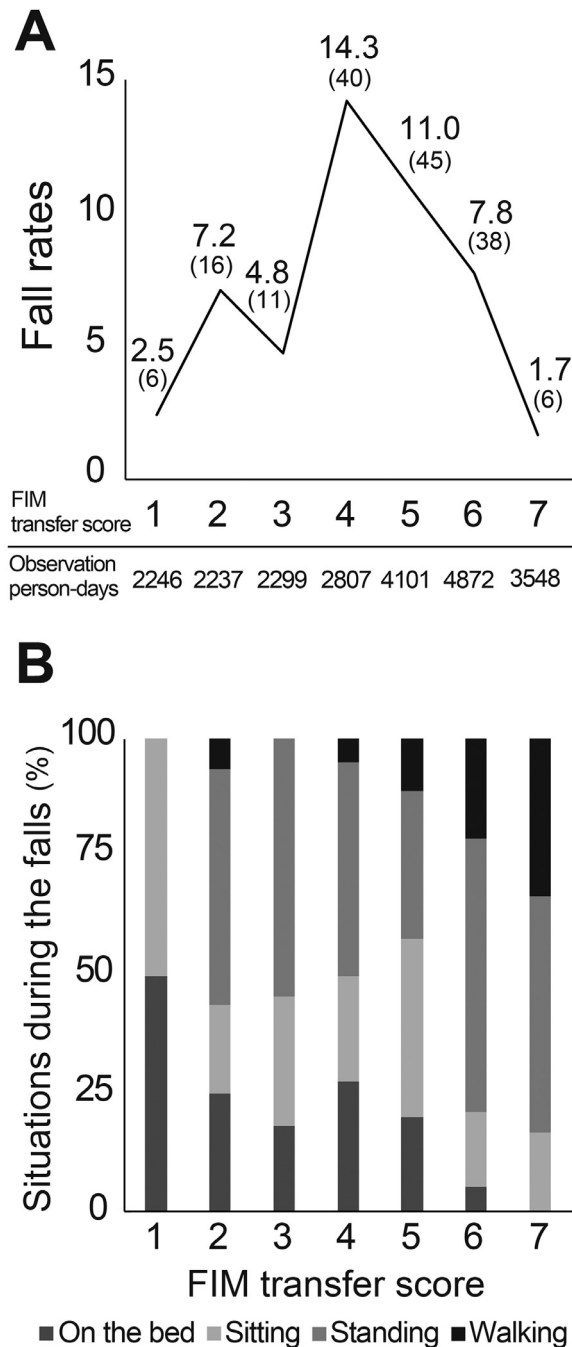
## Results

A total of 162 falls were reported in 93 (39.2%) patients during the observation period. Fifty-six patients

experienced only one fall, and 37 patients had two or more falls. The FIM scores were missing in 14.6% of all FIM data and interpolated. The fall rates for each FIM score are shown in Fig. 1A. The highest fall rate (per 1000 person-days) was 14.3 for patients with a FIM score of 4, followed by 11.0 for those with a score of 5, and 7.8 for those with a score of 6. The total number of falls occurred in patients with FIM scores ranging from 4 to 6 accounted for more than three quarters of all falls. The smallest fall rate was 1.7 for patients with a FIM score of 7, followed by 2.5 for those with a FIM score of 1.

For each FIM score, the activity status at falls, "transfer to bed/chair/wheelchair", are shown in Fig. 1B. Only "on the bed" and "sitting" accounted for the activity status at falls among the patients with a FIM score of 1. In contrast, "standing" and "walking" accounted for more than three quarters of falls among patients with a FIM score of 7. As FIM score increased from 5 to 7, the percentage of activity status including "on the bed" and "sitting" decreased, and that of "standing" and "walking" increased.

Overall, no obvious longitudinal change was found in the fall rates in any timelines (Fig. 2). The longitudinal change in the fall rate for each group divided based on patients' transfer ability is shown in Fig. 3. The fall rates in groups with FIM scores of 4 and 5 were the highest immediately after the stroke onset and decreased thereafter. In contrast, the groups with FIM scores of 6 and 7 showed a gradual increase in fall rate, and at 14 weeks, they had the highest fall rate among the three groups. The longitudinal change in the percentage of activity status at the falls is shown in Fig. 3. While the percentages of activity status of "walking" gradually increased, the



**Fig. 1.** Fall rates and activity status at the falls depending on patients' transfer ability

A: Fall rates in each Functional Independence Measure (FIM) transfer score, B: Activity status at the falls in each FIM transfer score. Fall rates are presented as falls per 1000 person-days. Values are presented as fall rate (number of falls) in each FIM transfer score.

percentages of "on the bed" were high from the stroke onset to eight weeks, and then decreased thereafter.

The distribution of FIM transfer scores for patients who fell during their hospitalization is shown in Fig. 4. Most patients who fell required full assistance for transferring upon admission, and those with a FIM score of 1

accounted for approximately 70% of all fallers. Patients tended to experience the first fall when they needed minimal assistance or supervision for transferring. Most of them were independent in transferring at discharge from the convalescent rehabilitation ward, and those with FIM scores of 6 and 7 accounted for more than 70%.

## Discussion

This study examined the relationship between the patients' transfer ability and the risk of falling from stroke onset to discharge from the convalescent rehabilitation ward. The results of this study showed that, as we hypothesized, patients were at higher risk of falling when they had neither high nor low transfer ability, but rather when they had an intermediate ability. In addition, the activity status at the falls also differed among those with different transfer ability.

The analysis of the fall rates of patients based on their transfer ability showed that those with FIM transfer scores of 4 to 6 had high fall incidence rates, whereas those with FIM scores of 1 or 7 had low rates. These findings were consistent with previous studies that showed the patients are at highest risk of falling when they have intermediate abilities.<sup>9,12</sup> Previous studies assessed the baseline abilities of patients, namely at admission to a rehabilitation ward<sup>9</sup> and in a certain time of commencement of the investigation,<sup>12</sup> and examined their relationship to subsequent falls. Their studies could not establish a relationship between the mobility/disability at the time of the falls and the risk of falls. To the best of our knowledge, this is the first study to clearly elucidate the close relationship between the patients' mobility at the time of falls and the risk of falls, showing that stroke patients are at higher risk of falling when they have intermediate transfer ability. Based on the results, it is considered that those with the ability to transfer almost independently have a high risk of falling.

The results of this study also showed that the patients' activity status at falls differed depending on the FIM transfer score. The rate of activity status of "walking" increased with the FIM transfer score, while the rate of "on the bed" decreased as the FIM transfer score increased. In other words, those with low transfer ability had fallen when performing low activity movements, and those with high transfer ability had fallen when performing high activity movements. In addition, the analysis of the distribution of FIM transfer scores for patients who fell showed that a majority of patients had significantly improved transfer abilities from full assistance to independence during hospitalization, indicating that the falls occurred during the process of dynamic changes in patients' transfer ability. This suggests that the risk factor for falls may not only be the ability level itself (to be mostly independent) at the fall, but also the status when the patient is becoming able to perform increased activity

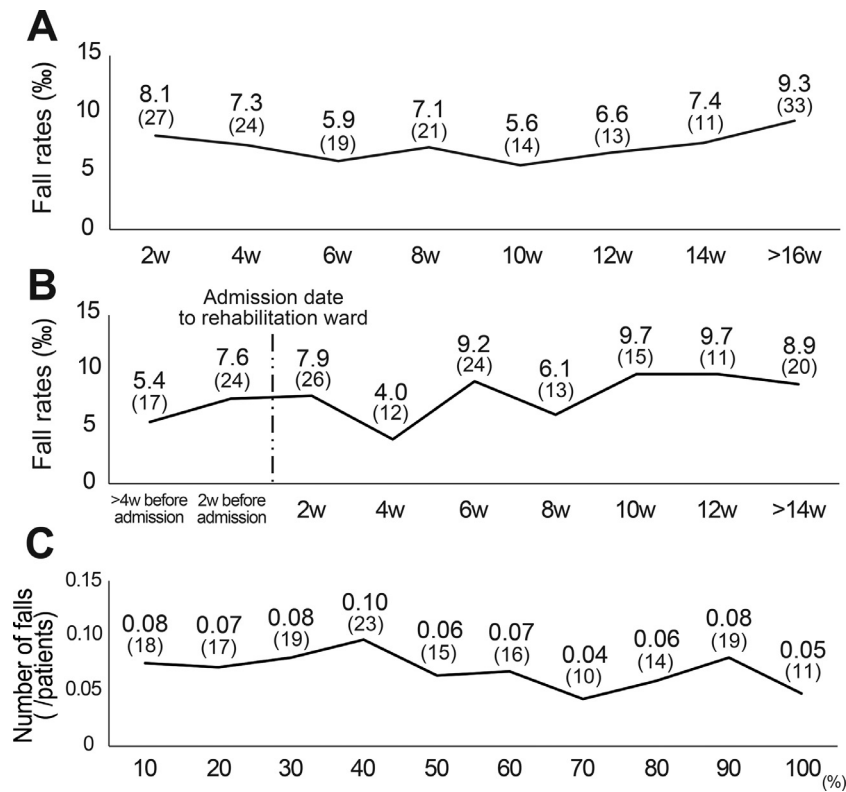


Fig. 2. Fall rates during hospitalization

A: From the stroke onset to discharge from the convalescent rehabilitation ward, B: Timeline realigned based on the admission date to convalescent rehabilitation ward, C: Normalized length of stay in hospital for each individual.

Fall rates in A and B are presented as falls per 1000 person-days. In C, the numbers of falls per patients in each 10% normalized period of total inpatient period are shown. Values in parenthesis indicate the number of falls in each time-interval.

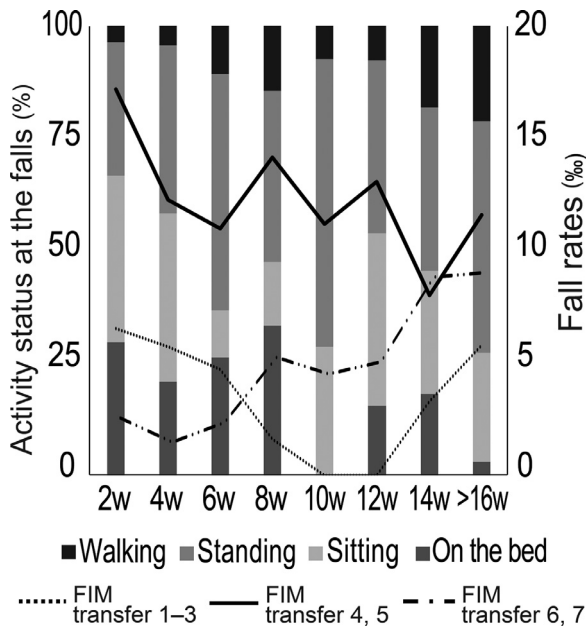


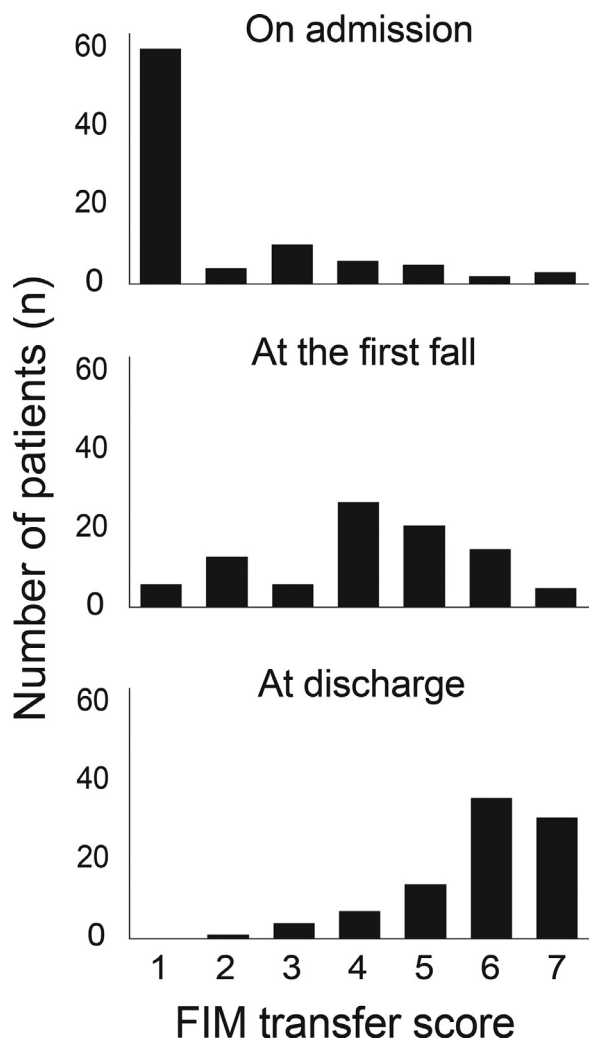
Fig. 3. Longitudinal changes in fall characteristics

Fall rates are shown in the line graph, and the activity status at the falls is shown the bar graphs for each two-week period from the stroke onset to discharge from convalescent rehabilitation ward. Fall rates are presented as falls per 1000 person-days.

with changing ability. Previous studies have discussed that the incidence of falls in stroke patients during inpatient rehabilitation tends to increase several weeks after admission due to the increased ability of the patient.<sup>15,19</sup> We believe that the results of the present study provide evidence to support these previous findings.

There was no obvious trend in the fall rates among patients based on the date of stroke onset or based on the date of admission to the convalescent rehabilitation ward. It has been reported that the cumulative number of stroke patients who fell increased throughout the first year after stroke.<sup>20</sup> The patients in this study also fell at various times during their hospitalizations, indicating that stroke patients have a constant risk of falls. In previous reports from the subacute wards, including the convalescent rehabilitation ward, the number of falls immediately after the transfer of patients from an acute ward to a subacute ward has been high,<sup>21-24</sup> and the trend has been especially consistent in stroke patients.<sup>5</sup> However, in the present study, there was no increase in the fall rates immediately after transfer to the convalescent rehabilitation ward. One explanation for this result may be that the patients in this study were transferred from the acute wards to the convalescent rehabilitation ward in the same hospital. It was considered that safety measures were





**Fig. 4.** Changes in Functional Independence Measure (FIM) transfer score of the patients who experienced a fall(s)

Distributions of FIM transfer scores at the time of admission to the acute wards (On admission), falling occurrence (At the first fall), and discharge from the convalescent rehabilitation ward (At discharge) among patients who experienced a fall(s) during the hospitalization ( $n = 93$ ) are shown.

exchanged well between the wards, and there were few changes in the patients' environment. The result of the present study suggests that the high fall rates immediately after admission to rehabilitation wards observed in the previous studies may have been influenced by environmental factors (i.e., changing the hospital is a drastic environmental change for stroke patients).

There was no obvious time trend overall. However, there was a time trend in the fall rate depending on the status of transfer ability. The fall rate in those with high transfer ability (FIM score of 6 and 7) gradually increased. Accordingly, the percentage of activity status including "on the bed" decreased, while the percentage of "walking" increased. The result of the present study indicated that a longer length of hospital stay related to patients having an increased risk of falling during higher-level activities

due to the increased mobility during hospitalization. We believed that it was also necessary to consider the duration after the hospitalization when estimating the risk of falling for patients.

The present study gives valuable clinical implications. For patients with nearly independent transfer ability, interventions, such as fall risk assessment, exercise programs, sharing information of fall risk, and patient education, are necessary.<sup>25–27</sup> In addition, it became clear that the priority is for a patient to be independent as soon as possible, and it was considered that effective rehabilitation training to acquire safe transferring is important for patient safety.

This study had some limitations. Our study was conducted in a single facility with a unique setting, which has both acute wards and the convalescent rehabilitation ward. Therefore, the generalization of the results to other settings such as rehabilitation hospitals with only convalescent rehabilitation wards or community settings after discharge from acute wards should be done with caution. A further multi-center prospective study with a large sample size is required to confirm our findings.

In conclusion, the present study clearly elucidated the relationship between the patients' transfer ability and the risk of falling in stroke patients during hospitalization. The results show that the risk of falling was prominent in those with nearly independent transfer ability. Further studies will develop interventions to prevent falls while ensuring improvement in the patients' activity level.

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None.

#### Declaration of Competing Interest

None.

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