doi: 10.2490/prm.20200030 Progress in Rehabilitation Medicine 2020; Vol. 5, 20200030

ORIGINAL ARTICLE

Translation, Inter-rater Reliability, Agreement, and Internal Consistency of the Japanese Version of the Cumulated Ambulation Score in Patients after Hip Fracture Surgery

Takahisa Ogawa, MD, MPH [a,b,c] Hiroto Hayashi, PT [c] Toshiki Kishimoto, PT [d] Shota Mashimo, PT [e] Yasuaki Kusumoto, PT, PhD [f] Keisuke Nakamura, PT [g] Takuya Aoki, MD, PhD, MMA [h,i] Janelle Moross, CNS [j] Morten Tange Kristensen, PT, PhD [k,l] and Hideaki Ishibashi, MD, PhD [m]

Objectives: The aim of this study was to translate the Cumulated Ambulation Score (CAS) from English into Japanese in cooperation with different types of healthcare providers and to investigate its inter-rater reliability and internal consistency. **Methods:** Two physical therapists at each of three general hospitals in Japan measured the mobility of 50 consecutive post-operative hip fracture patients on two occasions between 2 and 6 days after surgery using the Japanese version of the CAS (CAS-JP). We analyzed the inter-rater reliability and agreement using both the linear weighted kappa and the interclass correlation coefficient; we also analyzed the internal consistency using Cronbach's alpha coefficient. **Results:** The mean age of patients was 81 (SD: 11.6) years and 82% were women. Approximately half of the patients had severe cognitive impairment. Kappa was ≥ 0.93 for the three mobility activities and for the total CAS-JP score, the percentage agreement was ≥ 0.98, the ICC was ≥ 0.95, and Cronbach's alpha coefficient was 0.85. **Conclusions:** We found that the CAS-JP possessed good inter-rater reliability, agreement, and internal consistency. The CAS-JP is a reliable and easy-to-use evaluation tool suitable for daily clinical practice across different healthcare providers to monitor mobility in older hip fracture patients in Japan. We suggest that CAS-JP be evaluated in future studies for use in younger patients and in other patient groups with mobility problems.

Key Words: mobility score; rehabilitation; translation

INTRODUCTION

Post-operative hip fracture patients experience a loss of mobility.[1,2] To reduce morbidity, mortality, and improve physical function, early mobilization and rehabilitation after surgery is recommended.[3] Because a large majority of

Received: October 5, 2020, Accepted: November 16, 2020, Published online: December 2, 2020
[a] Harvard T.H. Chan School of Public Health, Boston, USA
[b] Department of Orthopedic Surgery, Tokyo Medical and Dental University, Tokyo, Japan
[c] Department of Public Health in Global Health, Graduate School of Medicine, Tokyo Medical and Dental University, Tokyo, Japan
[d] Department of Rehabilitation, Ina Hospital, Saitama, Japan
[e] Department of Rehabilitation, St. Luke's International Hospital, Tokyo, Japan
[f] Department of Physical Therapy, Tokyo University of Technology, Tokyo, Japan
[g] Department of Rehabilitation, Matsumoto City Hospital, Nagano, Japan
[h] Division of Clinical Epidemiology, The Jikei University School of Medicine, Tokyo, Japan
[i] Department of Community Medicine, Kyoto University Graduate School of Medicine, Kyoto, Japan
[j] Office for Global Education and Career Development, Institute of Global Affairs, Tokyo Medical and Dental University, Tokyo, Japan
[k] Physical Medicine and Rehabilitation Research − Copenhagen (PMR-C), Copenhagen, Denmark
[l] Departments of Physiotherapy and Orthopaedic Surgery, Copenhagen University Hospital, Copenhagen, Denmark
[m] Department of Orthopedic Surgery, Ina Hospital, Saitama, Japan
Correspondence: Takahisa Ogawa, MD, MPH, Department of Orthopaedic Surgery, Tokyo Medical and Dental University, 1-5-45 Yushima, Bunkyo-ku, Tokyo 113-8519, Japan, E-mail: takahisa.o@gmail.com

patients who undergo hip fracture surgery are elderly and less physically active in general, healthcare providers need valid and reliable measurement methods to monitor the level and improvement of mobility of individual patients. Not only patients with hip fracture,[4–7] but also geriatric patients,[8–9] patients with community-acquired pneumonia,[10] and patients who undergo acute high-risk abdominal surgery or knee-arthroplasty experience different levels of in-hospital mobility problems.[11,12] Therefore, by monitoring the early mobility function after admission or surgery, healthcare providers will be able to better plan and optimize patient care.

The Cumulated Ambulation Score (CAS) is a valid and reliable evaluation tool for assessing a patient's mobility by observing three basic activities[3]: (1) getting in and out of bed, (2) sitting and rising from a chair (with armrests), and (3) indoor walking (with or without a walking aid).[13] Each of these three CAS activities is scored from 0 (unable to perform) to 1 (assistance required) to 2 (independent) and the scores are summed to provide a one-day total CAS score of 0–6 points, with 6 points indicating an independent ambulatory status.[13] The CAS is routinely used in other countries for patients with hip fracture,[3–5] for those undergoing joint replacement,[14,15] and for other elderly health disorders.[11] CAS scores cumulated for postoperative days 1–3 (3-day CAS) has proven valid as a prediction of the short-term clinical outcome of patients after hip fracture surgery.[3] Moreover, the CAS shows a lower floor effect than the de Morton Mobility Index and the Chair Stand Test for physically frail populations, such as patients with hip fracture.[16] Therefore, the CAS can be used to monitor the trajectory of a patient's mobility function, especially in the crucial early stage after hip fracture surgery.

The CAS was developed in Denmark; it was subsequently translated into several languages including English, Italian, Spanish, and Turkish and is now used in many countries.[17–19] Approved versions are also available in Swedish, Norwegian, Indonesian-Bahasa, and French, and the CAS is used at the national level in the Danish and Irish multidisciplinary hip fracture database. In Japan, the mean age of patients with hip fracture has been increasing, as has also been seen in other countries.[20,21] Furthermore, the life expectancy of people in Japan is one of the highest worldwide. Consequently, healthcare providers in Japan need valid and reliable measurements to monitor and guide the rehabilitation needs of the aged population.

The CAS already has been used in Japan and has proven to be valid in reflecting the association of surgery within 24 h of hospital admission and the ambulatory status after hip fracture surgery.[4] However, although the CAS used in that study was in Japanese and was based on the first English version of the CAS,[3] that Japanese version was not translated according to international guidelines. Consequently, there is a need for an official Japanese version of the CAS. By translation and cross-cultural validation of the CAS into an official Japanese version, the CAS can be used in Japan as an easily applicable measurement of patients with basic mobility problems, thereby further promoting use of the CAS as an international multidisciplinary outcome measurement. The aim of this study was to translate and cross-culturally validate the English version of the CAS into Japanese and to investigate the inter-rater reliability, agreement, and internal consistency of the Japanese version of the CAS (CAS-JP).

METHODS

Translation Process

We followed the recommendations of Ramada-Rodilla et al.[22] to translate the English version of the CAS manual and score-sheet into Japanese.[23] Two Japanese physical therapists, one who is fluent in English (HH) and one who uses English in daily clinical practice in the U.S. (FI), independently translated the English version of the CAS manual and score-sheet into Japanese, taking the Japanese culture and language into consideration while maintaining the original intention of the test. A CAS-JP committee synthesized these two Japanese translations of CAS. A back translation of the synthesized version was conducted by a third person (JM) who is a native speaker of American English, holds a U.S. nursing license, and has experience in U.S. hospital wards, without knowledge of the original version of the CAS. This back translated English version was forwarded to Dr. Kristensen, who is one of the original developers of CAS, to ensure that the core concepts of the score remained intact.[3,13] We subsequently modified the Japanese CAS with some word corrections to retain the original CAS scoring procedure. Two physical therapists from each institution conducted pilot measurements with the provisional Japanese CAS; one of these physical therapists communicated with Dr. Kristensen, and the other was a novice CAS user. First, these two raters preliminarily measured CAS-JP to confirm all measurements. If additional comments were presented during this process, they were shared and described on the CAS-JP score manual with Dr. Kristensen's agreement. Once the modification process was complete, the final version of the Japanese CAS (CAS-JP) was approved by CAS-JP committee members. CAS-JP is available as a supplement

(**Appendix 1**).

The Cumulated Ambulation Scores

The CAS is a composite measurement that consists of the following three basic mobility activities: (i) getting in and out of bed with the sequence of events as follows: the patient starts in the supine position on the bed, moves to sitting, stands or transfers to a chair next to the bed, then returns to sitting on the bed, and then to the supine position on the bed (with or without assistance or aids); (ii) sit to stand to sit from a chair with armrests (with or without assistance or aids), and (iii) walking indoors (with or without walking aids).[13,23] These three basic activities are each allocated 0–2 points and the three scores are combined for a total one-day CAS score ranging from 0 (minimum) to the maximum of 6 points. A CAS score of 0 indicates total dependence, whereas 6 points indicates complete independence in mobility activities. A score of 2 was given to patients who could perform the activity without verbal or physical assistance, a score of 1 was given to those who required verbal or physical assistance by one or more persons, and a score of 0 was given for patients who were unable to do the activity despite human assistance.[13,23]

Study Population

A total of 50 consecutive hip fracture patients who underwent reparative surgery and were admitted between January and June 2020 to three general hospitals (one urban, one suburban, and one rural hospital: 18, 12, and 20 patients, respectively) in Japan were analyzed. We included patients with hip fracture (trochanteric fracture or femoral neck fracture) aged 65 years and older. Patients with multiple trauma, loss of consciousness, or immobility before injury were excluded. The following descriptive information was extracted from each patient's medical chart: weight, height, type of fracture, and type of surgery. Additionally, the following baseline demographics were evaluated at hospital admission: age, sex, body mass index (BMI), walking ability before injury, walking aid use before injury, the affected side, the type of fracture, the surgical procedure, and the results of the Pfeiffer short portable mental state questionnaire (SPMSQ, 0–10 points[24]). The patient's walking ability and walking aid use was obtained from the patient or from the patient's family if the patient had cognitive impairment. Walking ability was then classified into one of four categories: able to walk outside for 15 min or more, able to walk outside for less than 15 min, able to walk only inside, or unable to walk. Walking aid was categorized as: no aid use, use of a cane or walker outside only, or use of a cane or walker both inside and outside. The fracture type was assessed as a femoral neck fracture or a trochanteric fracture according to the fracture site. The surgical procedure was categorized as open reduction with internal fixation or hemiarthroplasty. With respect to cognitive function, we assessed the SPMSQ score between 7 and 14 days post-surgery to avoid possible acute delirium that would have influenced the evaluation. SPMSQ scores were categorized as follows: 0–2 points as no cognitive impairment, 3–4 points as mild cognitive impairment, 5–7 points as moderate cognitive impairment, and >8 points as severe cognitive impairment.[13,23,24]

Inter-rater Reliability

Inter-rater reliability for the CAS-JP was evaluated according to the Guidelines for Reporting Reliability and Agreement.[25] The inter-rater reliability of the CAS-JP was assessed between two physical therapy raters at each of the three general hospitals (six physical therapists in total); each therapist did the first measurement of half of the consecutive hip fracture patients who had undergone surgery at their respective hospital. The first assessment of each patient by a rater from physical therapist group A was made as part of clinical practice before rehabilitation within postoperative days 2–6 and was followed by assessment by the other rater (physical therapist group B) on the same day. To reduce possible bias resulting from fluctuations in patients' daily mobility function, the second rater measured the same patient 2 h after the first rater; the raters performed the measurements independently. No discussion of the ratings was allowed until the end of the study.[26] Two days after the first assessment, all patients were evaluated again using the same procedure. Consequently, each patient was evaluated twice by each rater, which sums to a total of 200 CAS assessments conducted by the six raters. Therefore, reliability estimates were based on comparison of 100 CAS evaluations by rater group A and 100 by rater group B. If the planned day of assessment was a national holiday or an out-of-service day, the measurement day was adjusted accordingly.

Statistical Analysis

Continuous variables are presented as means with standard deviations (SDs) or as medians with interquartile ranges according to their distributions; categorical variables are described as numbers with percentages. We estimated linear weighted kappa values to assess the inter-rater reliability for the three mobility activities and the total CAS-JP score.[27] A kappa value less than 0.2 was considered as slight agree-

ment, between 0.21 and 0.40 as fair agreement, between 0.41 and 0.60 as moderate agreement, between 0.61 and 0.80 as substantial agreement, and more than 0.80 as almost perfect agreement.[28] The percentage agreement between the two raters and the prevalence of CAS-JP scores for the three mobility activities and the total CAS-JP scores were described. To evaluate the measurement error for the three mobility activities and the total CAS-JP score, we also calculated the interclass correlation coefficient (ICC) with a two-way mixed model based on consistency measurement.[29] The ICC ranges from 0 to 1, and cut off values were assessed as follows: poor agreement for ICC lower than 0.40, fair agreement for ICC ranging from 0.40 to 0.59, good agreement for ICC ranging from 0.60 and 0.74, and excellent agreement for more than 0.75.[30] ICC values were used to calculate the standard error of measurement [SEM=SD × √(1-ICC)] and the smallest real difference (SRD=SEM × √2 × 1.96) to allow comparison of the measurement error with previous original CAS research performed in English.[13,27,31] The score differentiation between the two raters was also visualized using a Bland-Altman plot. To test for internal consistency, Cronbach's alpha coefficient was estimated.[32] Cronbach's alpha coefficient ranges from 0 to 1, and values lower than 0.70 were regarded as unacceptable, values between 0.70 and 0.80 as acceptable, and values higher than 0.80 as good.[33,34] The sample size was calculated according to the criteria of Nunnally and Hoskins et al. A total of 45 to 50 study patients were planned.[35,36] Written informed consent was obtained from patients or their relatives. Study approval was obtained from the institutional review board (E19HS-010, 19-R097). The type I error probability was set to 0.05 for all analyses. All statistical analyses were performed using Stata version 16.1 (Stata Corp, College Station, TX, USA).

RESULTS

During the translation process, there were two major considerations: one was the difference of language use and the other was the discrepancy in bedside settings across hospitals. First, when we translated the original English version of CAS into Japanese (CAS-JP), the phrase "get in/out of bed" was freely translated into Japanese, resulting in the implication of different mobility actions. Therefore, we prioritized the original meaning rather than the technical term used in the physical therapeutic field, *rishou,* which mainly means getting out of bed but does not include getting into bed. The second challenging point was the concept of independence when it comes to putting on footwear. Different hospitals used different types of footwear, such as slippers or shoes. The original version of the CAS did not include any variance in footwear such as room shoes or slippers for the measurement of independence. Therefore, to maintain consistency across hospitals, we did not include putting on footwear in evaluating independence and added this point to the manual.

A total of 50 consecutive hip fracture patients were evaluated twice (with an interval of 2 h) on two separate occasions (200 measurements in total) using the CAS-JP. Evaluations were carried out by six physical therapists independently in three general hospitals in Japan (**Table 1**). All patients were evaluated between 2 and 10 days post-surgery.

The mean age of patients was 81 (SD, 11.6) years and the majority were women (n=41, 82%). In terms of the pre-fracture mobility, 62% of patients were able to walk outside before injury, and more than a two-thirds of patients either required no use of a walking aid or use of a walking aid outside only. With respect to hip fracture, 68% of patients had femoral neck fracture and half of the patients underwent hemiarthroplasty. Approximately half of the patients had severe cognitive impairment (**Table 1**).

Tables 2 and 3 show the results for inter-rater reliability. The weighted kappa for the three mobility activities (getting in and out of bed, sit-to-stand-to-sit from an armchair, walking indoors with or without an aid) and the total CAS-JP were excellent (0.96, 0.93, 0.97, and 0.97, respectively). The corresponding percentage agreement also was excellent (≥98%) (**Table 2**).

The ICC showed an excellent result (≥0.94) for the three mobility activities and the one-day CAS-JP **(Table 3)**. The SEM and the SRD for the one-day CAS-JP were 0.17 and 0.47. The largest difference in scores between the two raters was 1 point, and the Bland-Altman plot indicated that there was no systematic between-rater bias over the three mobility activities or for the total CAS-JP scores (**Figure 1**). Cronbach's alpha coefficient for the CAS-JP was 0.85.

DISCUSSION

In this study, the English version of the CAS was translated and cross-culturally validated into Japanese based on the guideline used in previous research in which the CAS was translated.[22] CAS-JP showed excellent inter-rater reliability, high agreement, and excellent internal consistency in our research patients. In our analysis, a total of 50 patients were enrolled and 200 measurements in total were carried out by the two physical therapist rater groups (groups A and B). The patients were evaluated in three hospitals located in urban

Table 1. Patient demographics (n=50) and observed scores of the Japanese version of the Cumulated Ambulation Score

	Total (N=50)
Age (years)	80.68 (11.55)
Sex	
Female	41 (82)
Male	9 (18)
Body mass index (kg/m^2)	20.44 (3.19)
Pre-fracture walking ability	
Able to walk outside for 15 min or more	20 (40)
Able to walk outside less than 15 min	11 (22)
Able to walk inside only	19 (38)
Unable to walk	0 (0)
Pre-fracture use of walking aid	
No use	18 (36)
Use only outside (cane or walker)	19 (38)
Use both inside and outside (cane or walker)	13 (26)
Fracture side	
Right	23 (46)
Left	27 (54)
Fracture type	
Femoral neck	34 (68)
Trochanteric	16 (32)
Surgical procedure	
Open reduction with internal fixation	25 (50)
Hemiarthroplasty	25 (50)
Short portable mental state questionnaire	
No cognitive impairment	6 (12)
Mild cognitive impairment	6 (12)
Moderate cognitive impairment	11 (22)
Severe cognitive impairment	27 (54)
Cumulated Ambulation Score (CAS)	
Getting in and out of bed (0–2)	1.10 (0.48)
Sit-to-stand-to-sit from chair with armrests (0–2)	1.30 (0.56)
Walking indoors with or without an aid (0–2)	0.63 (0.72)
Total one-day CAS (0–6)	3.02 (1.50)

Values are given as the number of patients with the percentage of the cohort in parentheses, with the exception of age, body mass index (BMI), short portable mental state questionnaire (SPMSQ), and cumulated ambulation score (CAS) which are given as the mean and standard deviation. The total number of CAS observations was 200 because measurement by raters from groups A and B were taken on two occasions.

(Tokyo), suburban (Saitama), and rural (Nagano) areas. The baseline characteristics of our data represent the general hip fracture population in Japan.[21)]

As the age of patients with hip fracture increases in Japan along with the aging of the population, CAS-JP as applied to the hip fracture population can contribute to geriatric clinical research. Also, because life expectancy and the incidence of hip fracture are increasing around the world, the results of clinical research on patients with hip fracture in Japan can contribute to health care in other countries where there are predictions of a future increase in the number of hip fractures. Although our patients were slightly older than those in previous studies in Denmark, Spain, and Turkey, the reliability and consistency of the translated CAS-JP were consistent with previous studies.[17–19)]

Because the CAS can be used with high reliability by dif-

Table 2. Inter-rater reliability and agreement of the Japanese version of the Cumulated Ambulation Score between scores taken by two different physical therapists (1)

Activity	Linear weighted Kappa value (95%CI)	Observed agreement, n (%)	CAS score 0 to 2, n (%)		
			0	1	2
Getting in and out of bed (0–2)	0.96 (0.81–1.0)	99 (99)	15 (7.5)	144 (72.0)	41 (20.5)
Sit-to-stand-to-sit from chair with armrests (0–2)	0.93 (0.77 − 1.0)	98 (98)	12 (6.0)	114 (57.0)	74 (37.0)
Walking indoors with or without an aid (0–2)	0.97 (0.82 − 1.0)	99 (99)	102 (51.0)	68 (34.0)	30 (15.0)
Total CAS (0–6)	0.97 (0.84 − 1.0)	99 (99)	n/a	n/a	n/a

CI, confidence interval.

Table 3. Inter-rater reliability and agreement of the Japanese version of the Cumulated Ambulation Score between scores taken by two different physical therapists (2)

Activity	ICC (95%CI)	SEM	SRD
Getting in and out of bed (0–2)	0.96 (0.95–0.97)	0.10	0.28
Sit-to-stand-to-sit from chair with armrests (0–2)	0.94 (0.92–0.96)	0.14	0.39
Walking indoors with or without an aid (0–2)	0.98 (0.97–0.99)	0.10	0.28
Total CAS (0–6)	0.99 (0.98–0.99)	0.17	0.47

ICC, intraclass correlation coefficients; SEM, standard error of measurement; SRD, smallest real difference.

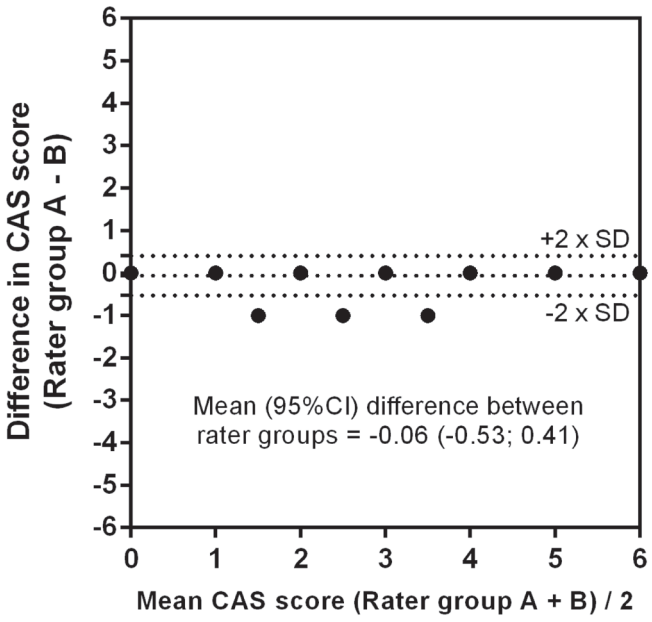

Fig. 1. A Bland-Altman plot of two physical therapist raters for the Japanese version of the Cumulated Ambulation Score.

ferent healthcare providers, including physical therapists, occupational therapists, and physicians,[13,17–19] we also included a nurse in the translation process to expand knowledge of the CAS across healthcare providers. The use of the CAS to monitor the progress of early recovery after hip fracture surgery and of other patient groups by different healthcare providers has been demonstrated. There is scope for further application of the CAS to a wider range of age groups with or without comorbidities across a broad range of countries.

Strength and Limitations

One strength of this study is that the excellent reliability estimates were based on evaluations by six physical therapists: two at each of the three hospitals forming rater groups A and B. Nonetheless, our research also had some limitations. First, we did not externally validate the CAS-JP, although the original version of the CAS was validated in previous studies.[16,18] Therefore, further study is needed to confirm the validity of the CAS-JP and to compare results with previous studies. Second, our study was restricted to general hospitals in Japan, although we achieved some diversification by selecting study sites in urban, suburban, and rural hospitals. Even so, these study sites may not represent all hospital settings across Japan. Finally, the number of patients with a CAS score of 0 was relatively small, whereas patients with a CAS score of 1 or 2 were sufficiently covered. Our data collection started from post-operative day 2, which explains the low number of patients with a CAS score of 0. However, a CAS score of 0, which means the inability to perform any mobility activity (e.g., a completely bedridden patient), should be relatively easy to evaluate and we assumed it to be

reasonable to draw conclusions without a larger number of patients with a CAS score of 0.

We translated the original English version of the CAS into Japanese and demonstrated its excellent inter-rater reliability and consistency based on robust methods. The CAS is reliable and easy to use in daily clinical practice to monitor mobility by different healthcare providers. We therefore suggest that the CAS-JP be measured broadly for older patients with hip fracture in Japan and that it be evaluated throughout hospitals in Japan for use in younger patients and in other patient groups with mobility problems.

ACKNOWLEDGMENTS

We thank Yasuhiro Yamamoto, Junya Kubo, and Yuya Nagasawa for help with participant recruitment and the measurement of the CAS-JP. We also thank Fumiaki Isshiki for help with the translation process of the CAS-JP.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

REFERENCE

1. Ariza-Vega P, Jiménez-Moleón JJ, Kristensen MT: Change of residence and functional status within three months and one year following hip fracture surgery. Disabil Rehabil 2014;36:685–690. DOI:10.3109/09638288.2013.813081, PMID:23919643
2. Bower ES, Wetherell JL, Petkus AJ, Rawson KS, Lenze EJ: Fear of falling after hip fracture: prevalence, course, and relationship with one-year functional recovery. Am J Geriatr Psychiatry 2016;24:1228–1236. DOI:10.1016/j.jagp.2016.08.006, PMID:27726939
3. Foss NB, Kristensen MT, Kehlet H: Prediction of postoperative morbidity, mortality and rehabilitation in hip fracture patients: the cumulated ambulation score. Clin Rehabil 2006;20:701–708. DOI:10.1191/0269215506cre987oa, PMID:16944827
4. Ogawa T, Aoki T, Shirasawa S: Effect of hip fracture surgery within 24 hours on short-term mobility. J Orthop Sci 2019;24:469–473. DOI:10.1016/j.jos.2018.11.001, PMID:30502228
5. Kristensen MT, Öztürk B, Röck ND, Ingeman A, Palm H, Pedersen AB: Regaining pre-fracture basic mobility status after hip fracture and association with post-discharge mortality and readmission – a nationwide register study in Denmark. Age Ageing 2019;48:278–284. DOI:10.1093/ageing/afy185, PMID:30615060
6. Fitzgerald M, Blake C, Askin D, Quinlan J, Coughlan T, Cunningham C: Mobility one week after a hip fracture – can it be predicted? Int J Orthop Trauma Nurs 2018;29:3–9. DOI:10.1016/j.ijotn.2017.11.001, PMID:29602677
7. Hulsbæk S, Larsen RF, Troelsen A: Predictors of not regaining basic mobility after hip fracture surgery. Disabil Rehabil 2015;37:1739–1744. DOI:10.3109/09638288.2014.974836, PMID:25350664
8. Aagesen M, Kristensen MT, Vinther A: The cumulated ambulation score is superior to the new mobility score and the de Morton Mobility Index in predicting discharge destination of patients admitted to an acute geriatric ward; a 1-year cohort study of 491 patients. Disabil Rehabil 2020;1–8. DOI:10.1080/09638288.2020.1802522, PMID:32757865
9. Kristensen MT, Jakobsen TL, Nielsen JW, Jørgensen LM, Nienhuis RJ, Jønsson LR: Cumulated Ambulation Score to evaluate mobility is feasible in geriatric patients and in patients with hip fracture. Dan Med J 2012;59:A4464. PMID:22759844
10. Melgaard D, Baandrup U, Bøgsted M, Bendtsen MD, Kristensen MT: Early mobilisation of patients with community-acquired pneumonia reduce length of hospitalisation – a pilot study. J Phys Ther Sci 2018;30:926–932. DOI:10.1589/jpts.30.926, PMID:30034100
11. Jønsson LR, Ingelsrud LH, Tengberg LT, Bandholm T, Foss NB, Kristensen MT: Physical performance following acute high-risk abdominal surgery: a prospective cohort study. Can J Surg 2018;61:42–49. DOI:10.1503/cjs.012616, PMID:29368676
12. Gkagkalis G, Pereira LC, Fleury N, Luthi F, Lécureux E, Jolles BM: Are the Cumulated Ambulation Score and Risk Assessment and Prediction Tool useful for predicting discharge destination and length of stay following total knee arthroplasty? Eur J Phys Rehabil Med 2019;55:816–823. PMID:31334623

13. Kristensen MT, Andersen L, Bech-Jensen R, Moos M, Hovmand B, Ekdahl C, Kehlet H: High inter-tester reliability of the Cumulated Ambulation Score for the evaluation of basic mobility in patients with hip fracture. Clin Rehabil 2009;23:1116–1123. DOI:10.1177/0269215509342330, PMID:19923208
14. Andersen KV, Bak M, Christensen BV, Harazuk J, Pedersen NA, Søballe K: A randomized, controlled trial comparing local infiltration analgesia with epidural infusion for total knee arthroplasty. Acta Orthop 2010;81:606–610. DOI:10.3109/17453674.2010.519165, PMID:20860447
15. Holm B, Kristensen MT, Myhrmann L, Husted H, Andersen LØ, Kristensen B, Kehlet H: The role of pain for early rehabilitation in fast track total knee arthroplasty. Disabil Rehabil 2010;32:300–306. DOI:10.3109/09638280903095965, PMID:20055568
16. Hulsbæk S, Larsen RF, Rosthøj S, Kristensen MT: The Barthel Index and the Cumulated Ambulation Score are superior to the de Morton Mobility Index for the early assessment of outcome in patients with a hip fracture admitted to an acute geriatric ward. Disabil Rehabil 2019;41:1351–1359. DOI:10.1080/09638288.2018.1424951, PMID:29334273
17. Ariza-Vega P, Mora-Traverso M, Ortiz-Piña M, Ashe MC, Kristensen MT: Translation, inter-rater reliability, agreement, and internal consistency of the Spanish version of the cumulated ambulation score in patients after hip fracture. Disabil Rehabil 2019;1–6. DOI:10.1080/09638288.2019.1577499, PMID:30907173
18. Çolak İ, Mete E, Kristensen MT, Kuru Çolak T: Translation, reliability, agreement and validity of the Turkish version of Cumulated Ambulation Score in patients with hip fracture. Eklem Hastalik Cerrahisi 2020;31:346–352. DOI:10.5606/ehc.2020.75526, PMID:32584736
19. Grana E, Verzellotti S, Grassi FA, Ferriero G, Kristensen MT, Cisari C, Invernizzi M: Cross-cultural validation of the Italian version of the Cumulated Ambulation Score. Int J Rehabil Res 2016;39:160–164. DOI:10.1097/MRR.0000000000000165, PMID:27028288
20. Brauer CA, Coca-Perraillon M, Cutler DM, Rosen AB: Incidence and mortality of hip fractures in the United States. JAMA 2009;302:1573–1579. DOI:10.1001/jama.2009.1462, PMID:19826027
21. Hagino H, Endo N, Harada A, Iwamoto J, Mashiba T, Mori S, Ohtori S, Sakai A, Takada J, Yamamoto T: Survey of hip fractures in Japan: recent trends in prevalence and treatment. J Orthop Sci 2017;22:909–914. DOI:10.1016/j.jos.2017.06.003, PMID:28728988
22. Ramada-Rodilla JM, Serra-Pujadas C, Delclós-Clanchet GL: [Cross-cultural adaptation and health questionnaires validation: revision and methodological recommendations]. Salud Publica Mex 2013;55:57–66. DOI:10.1590/S0036-36342013000100009, PMID:23370259
23. Kristensen MT, Curtis DJ: Cumulated Ambulation Score (CAS), English version, manual and score-sheet. 2015. https://www.researchgate.net/publication/270888051_Cumulated_Ambulation_Score_CAS_English_version_manual_and_score-sheet. Accessed 30 Nov 2020.
24. Pfeiffer E: A short portable mental status questionnaire for the assessment of organic brain deficit in elderly patients. J Am Geriatr Soc 1975;23:433–441. DOI:10.1111/j.1532-5415.1975.tb00927.x, PMID:1159263
25. Kottner J, Audigé L, Brorson S, Donner A, Gajewski BJ, Hróbjartsson A, Roberts C, Shoukri M, Streiner DL: Guidelines for reporting reliability and agreement studies (GRRAS) were proposed. Int J Nurs Stud 2011;48:661–671. DOI:10.1016/j.ijnurstu.2011.01.016, PMID:21514934
26. Kristensen MT, Nielsen AØ, Topp UM, Holmehave-Brandt J, Petterson CF, Gebuhr P: Development and psychometric properties of the Basic Amputee Mobility Score for use in patients with a major lower extremity amputation. Geriatr Gerontol Int 2018;18:138–145. DOI:10.1111/ggi.13156, PMID:28858422
27. Weir JP: Quantifying test-retest reliability using the intraclass correlation coefficient and the SEM. J Strength Cond Res 2005;19:231–240. PMID:15705040
28. Landis JR, Koch GG. The measurement of observer agreement for categorical data. biometrics. Biometrics 1977;33:159–174. DOI:10.2307/2529310, PMID:843571
29. Farhi D, Falissard B, Dupuy A: Global assessment of psoriasis severity and change from photographs: a valid and consistent method. J Invest Dermatol 2008;128:2198–2203. DOI:10.1038/jid.2008.68, PMID:18418412
30. Cicchetti DV: Guidelines, criteria, and rules of thumb for evaluating normed and standardized assessment instruments in psychology. Psychol Assess 1994;6:284–290. DOI:10.1037/1040-3590.6.4.284

31. Beckerman H, Roebroeck ME, Lankhorst GJ, Becher JG, Bezemer PD, Verbeek AL: Smallest real difference, a link between reproducibility and responsiveness. Qual Life Res 2001;10:571–578. DOI:10.1023/A:1013138911638, PMID:11822790
32. Bland JM, Altman DG: Statistics notes: Cronbach's alpha. BMJ 1997;314:572. DOI:10.1136/bmj.314.7080.572, PMID:9055718
33. Tavakol M, Dennick R: Making sense of Cronbach's alpha. Int J Med Educ 2011;2:53–55. DOI:10.5116/ijme.4dfb.8dfd, PMID:28029643
34. Streiner DL: Starting at the beginning: an introduction to coefficient alpha and internal consistency. J Pers Assess 2003;80:99–103. DOI:10.1207/S15327752JPA8001_18, PMID:12584072
35. Nunnally JC: Psychometric Theory, 2nd edn. McGraw-Hill, New York, 1978.
36. Hopkins WG: Measures of reliability in sports medicine and science. Sports Med 2000;30:1–15. DOI:10.2165/00007256-200030010-00001, PMID:10907753

APPENDIX

APPENDIX 1 CAS-JP score sheet [in Japanese]

氏名：	入院病名：

累積移動能力スコア(CAS)の評価方法

CAS スコア(0-2 点)-詳細はマニュアルを参照。
(2 点)介助もしくは口頭指示が無くても、安全に実行できる。
(1 点)一人以上の介助者による介助または口頭指示があれば、実行できる。
(0 点)介助や口頭指示があっても、実行できない。

入院前のｽｺｱ	日付	/	/	/	/	/	/	/	退院日
	ベッドへの/ベッドからの移乗動作								
	肘掛け付き椅子/車椅子からの立ち座り								
	屋内歩行								
	4 輪歩行器（ｻｰｸﾙ歩行器など）								
	固定歩行器（ﾋﾟｯｸｱｯﾌﾟ ｳｫｰｶｰなど）								
	ｼﾙﾊﾞｰｶｰ								
	杖/松葉杖								
	独歩 （補助具なしでの歩行）								
	Daily CAS スコア(0-6 点)								
	階段昇降								

1-day CAS スコア(0-6 点)は、3 つの基本動作の合計スコアである；ベッドへの／ベッドからの移乗(0-2 点)、椅子/アームレスト付き車いすからの立ち座り(0-2 点)、屋内歩行(0-2 点：必要な歩行補助具の利用可)。
靴の着脱は介助に含まない。階段昇降は追加評価項目であるが、総合スコアには含まれない。

3-day CAS スコア(0-18 点) = 術後 1+2+3 日目の 1-day CAS スコア合計点 =

APPENDIX 2 CAS-JP user's manual [in Japanese]

移動能力スコア(Cumulated Ambulation Score：CAS)-日本語版マニュアル
概要と評価方法：CAS[1]は患者が自立に至るまで日々の移動能力の変化を評価できるスコアである。以下の様に定義される。

評価項目
1. ベッドへの／からの移乗動作
2. 肘掛け付き椅子座位からの立ち座り
3. 屋内歩行
各 3 つの動作は 0-2 点で得点され、同日の 3 つの動作のスコアを組み合わせた 0-6 点（ワンデイ CAS）[2-4]の合計スコアが付けられる。

CAS は早期の在院日数やリハビリテーション予後予測が得られる、信頼性のある有用な評価方法として実証されている。予後の予測には、手術後の最初の 3 日間の CAS 合計スコア（0-18 点）である 3-day CAS が用いられる。[1]

手術後 3 日間の合計 CAS（3-day CAS）スコアが 9 点を超える場合、14 日以内の退院、直接の自宅退院、大きな合併症がないこと、30 日間生存率、との関連が先行研究で実証されている。[1]

CAS のスコアリングは信頼性試験の付録の記載に準ずる。[2]

1. ベッドサイドへの/からの移乗動作：
手順：①ベッド上背臥位から端座位へ、②端坐位から起立しながら、もしくは直接ベッド横の椅子への移乗、③再び開始姿位（ベッド上背臥位）まで戻る一連の動作を含む。

2 点：動作が自立して実施可能な場合。
自立とは、口頭指示や介助がなくても安全に動作が実施できることを指す。歩行補助具を使用してもよい。

1 点：動作が介助を要する場合。
介助とは、一人以上の介助者による口頭指示、軽介助から全介助までをも含む。補助具を使用しても良い。

0 点：離床できない場合。
離床できないとは、一人以上の介助者による全介助や補助具があっても、起立や座位保持ができない状態を指す。

2. 肘掛けのある椅子座位からの立ち座り：
（肘掛けがある椅子または車椅子の座位からの立ち座り）

2 点：動作が自立して実施可能の場合。
自立とは、口頭指示や介助なくても安全に実施できることを指す。

1 点：動作が介助を要する場合。
介助とは、一人以上の介助者による口頭指示、軽介助から全介助までをも含む。補助具を使用しても良い。

0 点：椅子の座位保持ができない場合。
座位保持ができないとは、一人以上の介助者による全介助や補助具があっても座位保持ができない状態を指す。

3. 屋内歩行：

2 点：屋内自立歩行が可能な場合。
自立とは、口頭指示や介助なく安全に歩行できることを指す。歩行補助具は使用しても可。

1 点：屋内歩行に介助を要する場合。
介助とは、一人以上の介助者による口頭指示、何らかの介助または全介助を含む。補助具を使用しても良い。

0 点：屋内歩行が不能な場合。
歩行不能とは、一人以上の介助者による何らかの介助または全介助があっても歩行ができない状態を指す。

参考文献

1. Foss NB, Kristensen MT, Kehlet H. Prediction of postoperative morbidity, mortality and rehabilitation in hip fracture patients: the cumulated ambulation score. Clin.Rehabil. 2006; 20: 701-8.
2. Kristensen MT, Andersen L, Bech-Jensen R et al. High intertester reliability of the cumulated ambulation score for the evaluation of basic mobility in patients with hip fracture. Clin.Rehabil. 2009;23: 1116-23.
3. Kristensen MT, Jakobsen TL, Nielsen JW, Jorgensen LM, Nienhuis RJ, Jonsson LR. Cumulated Ambulation Score to evaluate mobility is feasible in geriatric patients and in patients with hip fracture. Dan Med J 2012; 59: A4464.
4. Kristensen MT, Kehlet H. Most patients regain prefracture basic mobility after hip fracture surgery in a fast-track programme. Dan.Med.J. 2012; 59: A4447.