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RESEARCH ARTICLE

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Validation of the cognitive performance scale of the interRAI-PAC and montreal cognitive assessment

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Abstract

Aims: The Cognitive Performance Scale (CPS), a minimum data set instrument of the interRAI, was initially designed to evaluate cognition in residential care and has demonstrated strong diagnostic accuracy. In this study, we evaluated the diagnostic accuracy and validity of the CPS in the post-acute care setting among post-stroke patients hospitalized in rehabilitation wards.

Design: Mixed methods.

Methods: The observational study was conducted in rehabilitation wards. Diagnostic accuracy was used to explore the level of agreement between CPS and Montreal Cognitive Assessment (MoCA) in 321 inpatients (62.12 years; 68.2% male).

Results: The diagnostic accuracy of the CPS was poor when MoCA was less than 24 as a gold standard, with an area under the curve of 0.69 (standard error 0.03, 95% confidence interval = 0.62–0.75). The CPS had a poor to moderate correlation with MoCA ($r_s = -.35$).

KEYWORDS
cognitive impairment, cognitive performance scale, interRAI post-acute care, stroke, validation studies

1 | INTRODUCTION

Stroke is an acute cerebrovascular disease characterized by focal neurological deficits. Ischemic stroke and haemorrhagic stroke are two general categories of stroke. About 60 to 80 per cent of stroke cases is due to ischemic stroke (Doberstein et al., 2017). Stroke is the second leading cause of death and adult disability around the world (Strong et al., 2007). In China, the incidence of new cases of stroke is 2.5 million/year (Wu et al., 2013). Due to the improvement in public health and medicine, the mortality caused by stroke is gradually decreasing (Kim et al., 2020). Following the decrease in death rate, the disabilities of stroke survivors were significantly increased (Krueger et al., 2015; Mar et al., 2008). Most of the survivors had hemiplegia, dysphagia, aphasia, depression, cognitive impairment (CI) and other sequelae (Feigin et al., 2014). Data from 4,212 patients with first-ever stroke in the South London Stroke Register suggested that the prevalence of CI 3 months after stroke was 24% according to the MMSE (Douiri et al., 2013). Zhou et al. (2005). conducted a 1-year follow-up study of 434 stroke patients and found that the incidence of CI 3 months after stroke was 37%. Post-stroke cognitive impairment (PSCI) has a statistically significant impact on independence and the potential to return to work after stroke (Fride et al., 2015). Systematic cognitive screening of all stroke inpatients, followed by a complete in-depth examination and recording of the cognitively damaged individual, may help to reduce the likelihood of negative outcomes and help the patients return to work (Arauz, 2013; Planton et al., 2012; van Dijk & de Leeuw, 2012).

The existing stroke-related scales are mainly used to evaluate the dysfunction in a single field. These scales usually have good

reliability and validity and have been widely used in the clinic, such as the Montreal Cognitive Assessment (MoCA) (Nasreddine et al., 2005), six-minute walk test (ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories, 2002) and modified Ashworth scale (MAS) (Ansari et al., 2008). Although these domain-specific scales can accurately evaluate the dysfunction of patients after stroke, they only reflect the dysfunction of stroke patients from a certain aspect. However each evaluator only focuses on a particular dysfunction of the patient, the evaluation results from various scales need to be integrated to reflect all the dysfunctions of the patient. This is not conducive to an early, rapid, comprehensive grasp of all the dysfunctions of patients. In addition, specific scales have higher requirements for evaluators, who need to go through systematic training, and these evaluation scales are always needed a long time to conduct. Therefore, a collective evaluation tool is of particular importance.

The International Resident Assessment Instrument (interRAI) is a collaborative network of researchers and practitioners in over 35 countries committed to improving care for people who are disabled or medically complex (The InterRAI Organization, 2021). There are several versions of the interRAI, including "Post-Acute Care". InterRAI-PAC (Fries et al., 2003; Gindin et al., 2007) is an evaluation tool for rehabilitation nursing in the post-stage of acute disease, which contains 18 items and can be used to evaluate the multi-dimensional functional status of patients in the post-stage of acute disease. A number of clinical measures are embedded in the interRAI-PAC, including the Cognitive Performance Scale (CPS), a scale for assessing cognitive function as a subdomain of overall functioning. It is based on a subset of five items of the interRAI/Minimum Data Set instruments and was originally developed to evaluate cognitive function of the residential population (Morris et al., 1994). Studies have shown that CPS and MMSE have good consistency in resident care (Morris et al., 1994; Paquay et al., 2007). Although satisfactory results have been achieved in resident care, the acute setting performance of CPS may be just moderate. A study on the cognition of interRAI Acute Care in hospitalized patients in acute geriatric ward showed that the diagnostic accuracy of CPS is moderate (area under curve 0.73) based on the gold standard of MMSE score below 24 (Wellens et al., 2013). Although MMSE is widely used, it has been reported that it is less sensitive to detecting CI after stroke (Blake et al., 2002; Nys et al., 2005). Montreal Cognitive Assessment scale (MoCA) as another screening scale for CI, which was reported to be particularly useful for identifying PSCI in patients whose cognitive dysfunction, was undetectable with the MMSE (Suda et al., 2020). At present, there are relatively few studies on interRAI-PAC, and we have not found any studies on CI of CPS after stroke. Therefore, we will explore the consistency of the CPS and MoCA in patients with stroke.

2 | METHODS

2.1 | Study setting and participants

In this observational study, samples from 9 hospital rehabilitation departments were collected from September 2019 to August 2020. Participants will be identified according to the "Cerebrovascular Disease Classification" formulated at the 4th Chinese Conference of Cerebrovascular Disease in 1995 (Li, 1996). All patients were evaluated in 72 hr of admission and all evaluators received consistent training.

The inclusion criteria of this study were as follows:

1. Patients with stroke (recurrence stroke were included) diagnosed by cranial CT or magnetic resonance imaging (MRI);
2. 20–90 years old;
3. Informed consent of patients and their families to participate in this study.

While the exclusion criteria were as follows:

1. Those who were impaired in listening comprehension or expression
2. Those who were unable to complete the evaluation

The interRAI scale used in this study was transformed into Chinese by the Public Health Research Center of Tsinghua University. Assessors used face-to-face structured assessment to collect interRAI data. Research Ethics Committee approval was obtained from the human research and ethics committees of REDACTED medical research ethics committee. Personal consent was obtained in writing before participation.

2.2 | Sample size

The sample size was estimated based on test of one ROC curve using a PASS 15.0 software, at significance level of 5% and power of 90%. According to the previous study, the diagnostic accuracy of CPS was moderate and the AUC = 0.73 (Wellens et al., 2013). The ROC curve (AUC)|H0 0.5 and AUC|H1 0.73. In the end, we came to the conclusion that at least 62 samples were needed in this study.

2.3 | Measures

1. Background variables: Age, gender, type of stroke, height, weight, living arrangement, etc. were collected using the interRAI-PAC
2. The interRAI-PAC evaluation, CPS: The CPS score is determined by the patient's level of consciousness and performance in the following areas: the ability to make decisions in daily life, short and long-term memory, memory recall or orientation, the ability to make oneself understood and communication skills (Morris et al., 1994). Instead of summing the item scores, a computer-based algorithm is used. The CPS has a dual role. It seeks to detect patients with cognitive impairment on the one hand. The typical threshold of 2 points or more was used to determine the existence of cognitive impairment in the current study (Hartmaier et al., 1995). On the other hand, it aims to map cognitive functional

variations and severity by computing scores ranging from 0 to 6, with higher values indicating greater cognitive impairment. The decision rules for scoring the CPS are shown in Figure S1.

3. The MoCA-Beijing (Wen et al., 2008) was used in our study. The MoCA-Beijing version is translated from the original English version literally, but has been revised in the following aspects (Yu et al., 2012):
   a. Visuospatial/executive function domain: Chinese characters (甲/乙/丙/丁/戊) that have the same sequential meanings as the English letters "A/B/C/D/E" are used in place of the alphabet letters.
   b. Attention domain: In the auditory vigilance task, numbers are used instead of letters from the English alphabet.
   c. Language domain: The semantic fluency task, which asks participants to produce as many animals as they can in 60 s, replaces the phonemic fluency task, which asks participants to produce words beginning with the letter F, in the verbal fluency task. You can access the exact test forms and instructions for the MoCA-Beijing version at https://www.mocatest.org/, the MoCA's official website. MoCA scores range from 0–30, with higher scores indicating better cognition. According to the MoCA score, the patients were subdivided into normal (MoCA ≥26), mild cognitive impairment (18 ≤ MoCA < 26) and dementia (MoCA ≤ 17) (Feng et al., 2021). For those with less than 12 years of education, one point was added to the total score (Nasreddine et al., 2005).

2.4 | Statistical analysis

SPSS (version 22.0) was used to analyse the collected data. For nominal variables, descriptive statistics were expressed in percentages, while for continuous variables, means and standard deviations (or medians and quartiles in case of skewed distributions) were calculated. The area under the receiving operational characteristic (ROC) was used to measure the overall diagnostic accuracy of the CPS and MoCA. The Spearman correlation coefficient was used to investigate the relationship between CPS and MoCA. One-way ANOVA analysis was used to compare the mean MoCA scores in the various CPS groups. All of the tests were two-tailed, with a significance level of $p < .05$.

3 | RESULTS

3.1 | Sample characteristics

This study included 321 individuals, the majority of whom were male (219, 68.2%), with a mean age ± standard deviation of 60.12 ± 12.24. Cerebral infraction accounted for 68.2% of the participants. Of the 321 participants, 170 (53%) lived with their spouse/partner and others. At the time of admission, there were a total of 5 drugs (interquartile range Q1–Q3: 4–7). According to the activities of daily living (ADL) hierarchy scale, 32.1% of the participants were independent. On demographic, type of stroke, living arrangement, total number of medications at admission and ADL hierarchy scale, participants with cognitive impairment as measured by MoCA (MoCA ≤ 24) did not vary from those without cognitive impairment (Table 1).

3.2 | Descriptive analyses and ANOVA

As shown in Table 2, the higher the CPS level, the lower the mean MoCA score. However, the mean MoCA scores for CPS levels 0, 1 and 2 were similar (21.29 ± 3.87, 20.20 ± 4.98, 19.59 ± 4.77, respectively), the mean MoCA scores 3 and 4 were similar (16.67 ± 5.76, 16.33 ± 5.01, respectively), and the mean MoCA scores 5 and 6 were similar (14.59 ± 4.50, 14.08 ± 4.15, respectively). These findings, according to descriptive analysis, were validated by ANOVA, which revealed a statistically significant difference in mean MoCA score on levels of CPS score, ($F = 12.10$, $p < .0001$). According to the post hoc analysis, the mean of the group with CPS score 0 was not significantly different from the mean of the group with a CPS score 1 and 2, but statistically significant differences in means were observed with the groups with CPS score of 3–6. Additionally, the mean of the group with CPS score 1 was not significantly different from the group with CPS score 2–4, but it was significantly different from the group with CPS score 5 and 6. The mean of the CPS score 2 group was not significantly different from the CPS score 0–4 groups, but it was significantly different from the CPS score 5 and 6 groups. The mean of the group with CPS score 3 and 4 was not significantly different from the groups with CPS score 1, 2 and 5, 6 but only significantly different from the group with CPS score 0. The means of the groups of the CPS score 5 and 6 were significantly different from the means of the groups 0, 1 and 2.

3.3 | Relationship with cognitive impairment diagnosis

The correlation between CPS and MoCA was poor to moderate ($r_s = -.35$, $p < .0001$). The sensitivity and specificity of the CPS for post-stroke cognitive impairment were tested using a ROC curve. The CPS had poor diagnostic accuracy for PSCI diagnosis with an AUC of 0.69 (95% confidence interval (CI) = 0.62–0.75, standard error (*SE*) 0.03; see Figure 1). The derived optimal cut-off in this study was 2.5. Using this cut-off, the sensitivity of the CPS was poor at 0.34 and specificity was excellent at 0.98.

4 | DISCUSSION

To the best of our knowledge, this is the first study to examine the performance of the CPS against PSCI compared with MoCA. The aim of this study was to determine whether cognitive assessment by CPS and MoCA is in sufficient agreement to be used interchangeably

TABLE 1 Characteristics of the study participants ($N = 321$)

Cognitive impairment according to MoCA					
Characteristics	**Total sample ($N = 321$)**	**No ($n = 59$)**	**Yes ($n = 262$)**	**Test value**	***p***
Age, years (mean ± *SD*)	60.12 ± 12.24	57.69 ± 12.64	60.66 (12.11)	U = 6,984.5	.25[a]
Gender, *n* (%)					
Male	219 (68.2)	41 (69.5)	178 (67.9)	$\chi^2 = 0.54$	.82[b]
Female	102 (31.8)	18 (30.5)	84 (32.1)		
Type of stroke, *n* (%)					
Cerebral infarction	219 (68.2)	45 (76.3)	174 (66.4)	$\chi^2 = 2.16$	.14[b]
Cerebral haemorrhage	102 (31.8)	18 (23.7)	88 (33.6)		
Height (mean ± *SD*)	1.62 ± 0.08	1.62 ± 0.07	1.62 ± 0.09	U = 7,460	.68[a]
Weight (mean ± *SD*)	62.2 ± 12.61	63.54 ± 13.21	61.9 ± 12.47	U = 7,256.5	.46[a]
BMI (mean ± *SD*)	23.57 ± 4.03	24.25 ± 4.35	23.42 ± 3.94	U = 6,730	.12[a]
Living arrangement, *n* (%)					
Alone	12 (3.7)	3 (5.1)	9 (3.4)	$\chi^2 = 0.41$	.94[b]
With spouse or partner	97 (30.2)	17 (28.8)	80 (30.5)		
With spouse or partner and others	170 (53)	31 (52.5)	139 (53.1)		
With others	42 (13.1)	8 (13.6)	34 (13.0)		
Total numbers of medications at admission, median (Q1; Q3)	5 (4; 7)	6 (4; 7)	5 (4; 7)	U = 7,228.5	.43[a]
ADL Hierarchy Scale (range 0–6), *n* (%)					
Independent	103 (32.1)	25 (42.4)	78 (32.1)	$\chi^2 = 7.95$	.24[b]
Supervision	17 (5.3)	5 (8.5)	12 (4.6)		
Limited	27 (8.4)	5 (8.5)	22 (8.4)		
Extensive	14 (4.4)	2 (3.4)	12 (4.6)		
Maximal	79 (24.6)	9 (15.3)	70 (24.6)		
Dependent	51 (15.9)	10 (16.9)	41 (15.6)		
Total Dependent	30 (9.3)	3 (5.1)	30 (9.3)		

Abbreviations: Q1, first quartile; Q3, third quartile.

[a]Mann–Whitney U-test.

[b]χ^2 tests.

in post-acute care. In medical inpatients, we were unable to replicate the good agreement previously shown between both methods in a nursing home population. Previous studies in nursing home setting (Gruber-Baldini et al., 2000; Hartmaier et al., 1995; Paquay et al., 2007) found that CPS had high reliability when MMSE was used as the gold standard for the diagnosis of cognitive impairment, the sensitivity levels between 0.81 and 0.94, specificity between 0.80 and 1.00. While studies (Hartmaier et al., 1995; Wellens et al., 2013) in acute care setting found that the diagnosis accuracy of CPS was moderate, the sensitivities levels were between 0.51 and 0.56 and the specificity was between 0.93 and 0.95. However, in our study, the diagnostic accuracy of CPS was poor (AUC = 0.68), with low sensitivity (0.34) but an excellent specificity (0.98) using the recommended cut-off. Furthermore, CPS was poor to moderate negatively correlated with MoCA.

As a screening tool, CPS did not demonstrate an adequate screening ability for cognitive impairment in this study. Even if the diagnostic standard of MOCA was reduced to 18, its diagnostic accuracy (AUC = 0.59) did not improve, and it still showed lower sensitivity and better specificity at the optimal cut-off value. CPS can only differentiate between patients with normal cognitive function and those with severe cognitive function, but it is not possible to further subdivide the severity of cognitive impairment, which was consistent with Wellens's et al. study (Wellens et al., 2013).

In our study, the low diagnostic ability of CPS may be due to the following reasons: Firstly, a large number of studies have come from nursing home setting (Gruber-Baldini et al., 2000; Hartmaier et al., 1995; Paquay et al., 2007) or community setting (Gee et al., 2021), where CPS has shown good diagnostic accuracy, which may be related to the different subjects according to studies. Participants in this study had various types of dysfunctions (e.g. aphasia, hemiplegia, depression and dysphagia) caused by stroke, which may make them less cooperative. In addition, the participants were assessed in 3 days of admission, and they may not have

TABLE 2 Average MoCA score and 95% confidence interval according to CPS

Cognitive status according to CPS			Average MoCA score				MoCA ≤ 23	MoCA ≤ 17
Score	Label	*n*	Mean	*SD*	95% CI	Tukey HSD[a]	*n* (%)[b]	*n* (%)[c]
0	Intact	72	21.29	3.87	20.38–22.30	A	52 (72.2)	9 (12.5)
1	Borderline intact	85	20.20	4.98	19.13–21.27	AB	63 (74.1)	23 (27.1)
2	Mild impairment	73	19.59	4.77	18.48–20.70	AB	57 (78.1)	24 (32.9)
3	Moderate impairment	46	16.67	5.76	14.96–18.38	BC	45 (97.8)	20 (43.5)
4	Moderate severe impairment	15	16.33	5.01	13.56–19.11	BC	15 (100)	7 (46.7)
5	Severe impairment	17	14.59	4.50	12.27–16.90	C	17 (100)	17 (100)
6	Very severe impairment	13	14.08	4.15	11.57–16.59	C	13 (100)	13 (100)

[a]A, B, C refer to statistically significant differences of the means between the groups for each level of CPS ($p < .05$). Groups with equal letters have average MoCA values, which are not significantly different from one another.

[b]Proportion of the number of persons with MoCA ≤ 23 and the total number of persons for each level of CPS score.

[c]Proportion of the number of persons with MoCA ≤ 17 and the total number of persons for each level of CPS score.

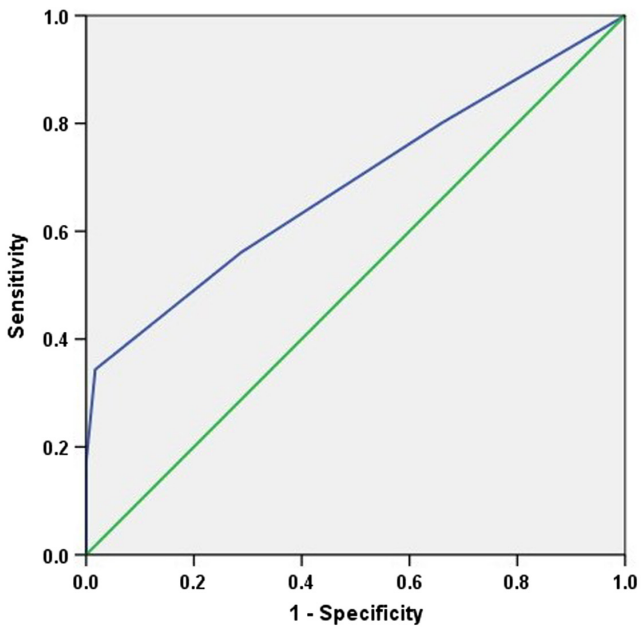

FIGURE 1 Receiver operating characteristic curve for CPS at admission (area under the ROC curve (AUC) 0.69, standard error 0.03, 95% confidence interval = 0.62–0.75, $p < 0.001$).

adapted to the new environment and population around them, which may have some adverse impact on the assessment. Secondly, in previous studies, MMSE was used as the gold standard to measure the diagnostic ability of CSP, but MMSE itself had limitations in the diagnosis of cognitive impairment. Compared with MOCA, it has lower sensitivity and ceiling effect (Dong et al., 2010; Pendlebury et al., 2010; Toglia et al., 2011). In this study, MoCA was used as the gold standard. However, MoCA is a more rigorous test and focuses more on language and execution functioning skills, which require higher cognitive abilities than MMSE (Sakurai et al., 2020), which may be one of the reasons for the decline in the diagnostic ability of CPS. Furthermore, in this study, sampling errors may have affected the diagnostic ability of CPS. A 81.6% of the participants had CI, and statistically significant differences existed in age, sex and other factors. Previous studies have shown that older age and a lower level of education are the risk factors for cognitive impairment (Lo et al., 2019). The average age of patients in this study is 60.12 years, and the education level of the elder population in China is 5.89 years (Zhang, 2016). Unfortunately, in our study, we do not have data on the level of education of the participants. Therefore, ageing and low level of education may also be one of the reasons for the decline in the diagnostic ability of CPS.

5 | CONCLUSION

In summary, in terms of the current results, we do not recommend CPS as a routine screening tool for cognitive function in stroke. For interRAI-PAC, further optimizing the project content of CPS may contribute to the screening role of CPS, but this still needs to be verified by a large number of clinical trials to obtain a wide range of evidence.

5.1 | Limitations

In this study, traumatic brain injury and other diseases that may lead to cognitive impairment were excluded. Only stroke participants were included, which is not conducive to judging the diagnostic accuracy of CPS from a holistic perspective. At present, there is no means to directly evaluate cognitive impairment. The evaluation of the scale is affected by the mental state and emotional behaviour of patients. These two assessment methods attempt to indirectly quantify cognitive impairment and cannot solve the potential problems in the assessment.

AUTHOR CONTRIBUTIONS

All authors have agreed on the final version and meet at least one of the following criteria [recommended by the ICMJE (http://www.icmje.org/recommendations/)]:

- substantial contributions to conception and design, acquisition of data or analysis and interpretation of data;
- drafting the article or revising it critically for important intellectual content.

ETHICAL APPROVAL

This study was approved by The Second Affiliated Hospital of Kuming Medical University research ethics committee, China (No: PJ-2019-04).

DATA AVAILABILITY STATEMENT

Data available on request from the authors.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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