Preoperative cognitive assessment: development of a self-administered screening tool and normative data for an elderly population

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Background: Pre-existing cognitive impairment in surgical patients is one of the leading risk factors for adverse cognitive outcomes such as postoperative delirium and postoperative cognitive dysfunction. We developed a self-administered tablet computer application to assess the individual risk for adverse postoperative cognitive outcomes. This prospective observational cross-sectional study aimed to establish normative data for this test tool.

Setting: Swiss University hospital.

Methods: Healthy volunteers aged ≥65 years were administered the Mini-Mental State Examination (MMSE), Geriatric Depression Scale (GDS), and Consortium to Establish a Registry for Alzheimer’s Disease-Neuropsychological Assessment Battery (CERAD-NAB) to assess cognitive health. All subjects completed the tablet computer application CogCheck consisting of a test battery assessing six cognitive domains. The primary outcome measure was the test performance. Regression models were built for each cognitive domain score with the covariates age, gender, and education in cognitively healthy subjects. Demographically-adjusted standard scores (z-scores) were computed for each subtest.

Figure 1 Translated screenshots of the CogCheck application.

	Description of question or task	Cognitive domain
Demographic and medical data		
Vision	Use of vision aids	Self-reporting
Hearing	Presence of hearing impairment or use of hearing aids	Self-reporting
Medication	Entry of the number of daily drugs	Self-reporting
Age	Entry of the age in years	Orientation
Education	Entry of the education in years	Self-reporting
Language	German indicated as native language	Self-reporting
	If the native language is not German: rating of the German language skills	Self-reporting
Cognitive self-assessment		
	Answering five questions about the ability to cope with daily situations compared to two years ago: (1) Memorising new things; (2) Remembering names; (3) Multiple simultaneous tasks; (4) Financial issues; (5) Remembering appointments	Self-reporting
Temporal orientation		
Weekday	Entry of the weekday (Monday to Sunday)	Orientation
Date	Entry of the day, month and year	Orientation
Automated subtests of cognitive functions		
Visual recognition	15-item multiple-choice version of the Benton Visual Retention Test.	Visual memory
Picture learning and recognition	Recognition of 10 hand-drawings that were shown for three seconds each among 30 pictures at the end of the test.	Episodic memory
Digit span	Repetition of an extending series of randomly presented digits	Attention span
Spatial span	Repetition of an extending series of blinking blocks	Visuospatial attention
Reaction time and attention*	Tapping on the screen as fast as possible if a star appears (15 stars out of 15 other geometric forms)	Reaction time and attention
Trail Making Test A	Electronic version of the Trail Making Test A, limited in time (45 sec)	Psychomotor speed
Trail Making Test B	Electronic version of the Trail Making Test B, limited in time (60 sec)	Flexibility

Table 1 Content and structure of the CogCheck application. *The reaction time and attention task was discarded from CogCheck.

Results: 283 participants were included in the final analysis. Participants’ mean (SD) age was 73.8 (5.2) years, and their average level of education was 13.6 (2.9) years. Mean (SD) MMSE score was 29.2 (0.9) points, GDS score was 0.4 (0.7) points, and CERAD-NAB total score was 98.7 (5.7) points. Older age was associated with poorer performance in the visual recognition task and in Trail Making Test B ($P<0.05$ after Bonferroni-Holm adjustments).

	All participants (n=283)	65–69 years (n=68)	70–74 years (n=102)	75–79 years (n=68)	> 79 years (n=45)
Demographics					
Age; years	73.8 ± 5.2	67.6 ± 1.4	72.2 ± 1.3	76.5 ± 1.4	82.6 ± 2.4
Female gender	155 (55)	42 (62)	58 (57)	34 (50)	21 (47)
Education; years	13.6 ± 2.9	13.2 ± 2.7	14.0 ± 2.8	13.7 ± 3.1	13.3 ± 2.8
Medical comorbidities					
Heart disease	54 (19)	5 (7)	13 (13)	17 (25)	19 (42)
Arterial hypertension	112 (40)	20 (29)	36 (35)	31 (46)	25 (56)
Hypercholesterolemia	60 (21)	14 (21)	14 (14)	18 (26)	14 (31)
Diabetes type II	14 (5)	4 (6)	6 (6)	1 (1)	3 (7)
Chronic lung disease	14 (5)	1 (1)	3 (3)	8 (12)	2 (4)
Gastrointestinal disease	23 (8)	4 (6)	11 (11)	2 (3)	6 (13)
Urologic disease	27 (10)	3 (4)	8 (8)	9 (13)	7 (16)
Thyroid diseasee	30 (11)	8 (12)	12 (12)	7 (10)	3 (7)
Arthrosis	35 (12)	8 (12)	11 (11)	13 (19)	3 (7)
Osteoporosis	34 (12)	4 (6)	14 (14)	10 (15)	6 (13)
Chronic pain	27 (10)	5 (7)	9 (9)	9 (13)	4 (9)
History of head trauma	25 (9)	5 (7)	11 (11)	5 (7)	4 (9)
Prior general anesthesia	239 (84)	59 (87)	85 (83)	56 (82)	39 (87)
Regular alcohol consumption	181 (64)	45 (66)	61 (60)	49 (72)	26 (58)
Neuropsychological tests					
MMSE score	29.2 ± 0.9	29.4 ± 0.7	29.3 ± 0.9	29.0 ± 0.9	28.9 ± 1.0
GDS score	0.4 ± 0.7	0.3 ± 0.8	0.4 ± 0.7	0.3 ± 0.6	0.4 ± 0.7
CERAD-NAB total score	98.7 ± 5.7	97.9 ± 5.5	98.6 ± 5.2	99.5 ± 5.9	99.0 ± 6.5

Table 2 Demographic characteristics according to age category.

Figure 2 Predicted Trail Making Test B (TMT-B) score with 95% confidence interval. The ratio of correct line connections per minute was calculated to measure the accuracy of performance. In this model, older age and lower education were associated with a lower TMT-B score.

Figure 3 Examples of individual risk profiles originating from RAPACO. The risk for adverse postoperative cognitive outcome is stratified according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) criteria of mild and major neurocognitive disorders. Demographically-adjusted (age, gender and education) standard scores (z-scores) in six cognitive domains (visual memory, episodic memory, visuospatial attention, attention span, psychomotor speed and flexibility) are used to describe presumed low risk (green; z-scores ≥1), presumed intermediate risk (yellow; z-scores <−1.0 and ≥−2.0) and presumed high risk (red; z-scores <−2.0). The blue line represents the individual performance in the RAPACO application. (A) shows the risk profile of a 67-year-old woman with presumed low risk, (B) shows the risk profile of a 74-year-old woman with presumed intermediate risk, and (C) shows the risk profile of an 88-year-old woman with presumed high risk.

Conclusions: This study provides demographically-adjusted normative data for a novel self-administered tablet computer application designed to measure the individual risk for adverse postoperative cognitive outcomes in elderly patients.