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Prevalence and Determinants of Cognitive Complaints after Aneurysmal Subarachnoid Hemorrhage

P.E.C.A. Passier[a, c] J.M.A. Visser-Meily[a, c] M.J.E. van Zandvoort[b, d]
M.W.M. Post[a, c] G.J.E. Rinkel[b] C. van Heugten[e]

Departments of [a]Rehabilitation, Nursing Science and Sports, and [b]Neurology and Neurosurgery, Rudolf Magnus Institute for Neuroscience, University Medical Centre Utrecht, [c]Centre of Excellence for Rehabilitation Medicine, Rehabilitation Centre De Hoogstraat, [d]Psychological Laboratory, Helmholtz Institute, Utrecht University, Utrecht, and [e]School for Mental Health and Neuroscience and Department of Neuropsychology and Psychopharmacology, Maastricht University, Maastricht, The Netherlands

Key Words
Subarachnoid hemorrhage · Cognitive impairment · Mood · Disability

Abstract
Background: To investigate the prevalence of cognitive complaints after subarachnoid hemorrhage (SAH) and the relationships between cognitive complaints and cognitive impairments, disability and emotional problems. ***Methods:*** Cognitive complaints were assessed with the Checklist for Cognitive and Emotional Consequences following stroke (CLCE-24) in 111 persons who visited our outpatient clinic 3 months after SAH. Associations between cognitive complaints and cognitive functioning, demographic characteristics, disability and emotional problems were examined using Spearman correlations and linear regression analysis. ***Results:*** In this study group, 105 patients (94.6%) reported at least one cognitive or emotional complaint that hampered everyday functioning. The most frequently reported cognitive complaints were mental slowness, short-term memory problems and attention deficits. All cognitive domains, disability, depressive symptoms and feelings of anxiety were significantly associated with the CLCE-24 cognition score. In the final regression model, memory functioning (β value –0.21), disability (–0.28) and depressive symptoms (0.40) were significant determinants of cognitive complaints, together explaining 35.4% of the variance. ***Conclusion:*** Cognitive complaints are common after SAH and associated with memory deficits, disability and depressive symptoms. Rehabilitation programs should focus on these symptoms and deficits.

Introduction

Subarachnoid hemorrhage (SAH) from a ruptured intracranial aneurysm accounts for approximately 5% of all strokes [1], occurs at a relatively young age [2], and carries a poor prognosis for survival despite improvements in medical care for these patients [3]. Although a large proportion of the patients with SAH who resume living at home show functional independence, many of them have impairments in visual perception and construction, information processing speed, memory and executive functioning [4].

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Patricia Passier
Rehabilitation Centre De Hoogstraat
PO Box 85238
NL–3508 AE Utrecht (The Netherlands)
Tel. +31 30 256 1211, Fax +31 30 251 1344, E-Mail p.passier@dehoogstraat.nl

From a patient's perspective, not the cognitive impairments as assessed by neuropsychological tests, but their experience of cognitive and emotional dysfunction in everyday life matters most. Previous studies in patients with SAH on associations between cognitive impairments and cognitive complaints revealed only weak associations [5] or no significant associations at all [6]. Physical functioning and emotional problems such as depression and anxiety might influence the perceived cognitive dysfunction [7]. Psychological and social problems occur often in patients with SAH and reduce health-related quality of life [8], life satisfaction [9], returning to work [9, 10], and engagement in social activities [10]. The contribution of disability and emotional problems to the cognitive complaints in patients with SAH is however still unclear. Knowledge of the factors underlying cognitive complaints in patients with SAH is important to tailor rehabilitation programs with respect to the specific needs in this patient population.

We investigated the prevalence of cognitive complaints in patients living at home 3 months after SAH, and assessed whether cognitive impairments, demographic characteristics (age, sex, level of education), disability (Glasgow Outcome Scale, GOS) and emotional problems (depressive symptoms, anxiety) are related to the cognitive complaints of patients with SAH.

Methods

SAH Patients and Procedure

Patients who visited the SAH outpatient clinic of the University Medical Centre Utrecht (UMCU) between November 2006 and September 2008 were included if they had had an SAH from a ruptured aneurysm, and were living at home at the time of their visit. At our multidisciplinary SAH outpatient clinic, patients are seen by a neuropsychologist for a brief neuropsychological examination (45 min), a specialized SAH nurse who interviews the patient and assesses the Checklist for Cognitive and Emotional consequences following stroke (CLCE-24), and, finally, patients are seen by a rehabilitation physician who performs a physical examination and evaluates the necessity of any form of therapy. All patients were approached by mail and asked to complete a questionnaire before their visit to the clinic. All patients gave informed consent. The study was approved by the Medical Ethics Committee of the UMCU.

Outcome Measurement

The CLCE-24 [11] is assessed by an interviewer asking the patient whether he/she has cognitive and/or emotional complaints since the SAH and consists of 13 cognitive items (for instance problems with 'doing two things at once' or 'attending to things') and 9 emotional items (for instance being 'depressed' or 'faster or more often tired') and 2 open-ended questions which allow addition of other problems but which are not included in the scores. The interviewer scores a '0' for absence and a '1' for presence of complaints; the sum score indicates the number of experienced complaints. The CLCE-24 was validated [11] using the Mini Mental State Examination and the Dutch CAMCOG, part of the Cambridge Examination of Mental Disorders in the elderly, as reference instruments.

Possible Determinants

Demographic data, the clinical condition on admission (Prognosis on Admission of Aneurysmal Subarachnoid Hemorrhage scale [12]), location of the ruptured aneurysm and complications were obtained from the database of the Department of Neurology and Neurosurgery of the UMCU. The level of disability 3 months after SAH was assessed by means of the GOS [13], obtained either from the neurology database or the outpatient clinic.

The concise neuropsychological examination covered four major cognitive domains. *Memory* included verbal working memory as assessed by the Backward Digit Span of the Wechsler Adult Intelligence Scale III (WAIS-III) and Category Fluency (semantic memory) using animal naming [14]. The Rey Auditory Verbal Learning Task was used to measure verbal learning, revealing scores for immediate and delayed recall and recognition [14]. Non-verbal recall, incidental, was evaluated using the delayed Rey-Osterrieth Complex Figure Test (Rey-CFT) [14]. *Executive functioning* was measured with the Brixton Spatial Anticipation Test for strategic thinking and with phonological fluency ('N' and 'A') for concept generation [14]. *Attention* was measured by Forward Digit Span of the WAIS-III and the Stroop Color Word Test [14]. To obtain an indication of *visuospatial functioning*, the copy score of the Rey-CFT was used [14]. A control group, containing 62 subjects with a mean age of 57.8 years and 58.1% women, was studied to obtain reference data for the neuropsychological examination [15].

To study depressive symptoms, we administered the Beck Depression Inventory-II-NL (BDI), a 21-item screening instrument for depression. The total score ranges between 0 and 63. A high score indicates the severity of depressive symptoms [16], and we accepted a score of 10 or higher as suggestive of possible depression [17]. We measured anxiety with the state part of the State-Trait Anxiety Inventory (STAI-DY-1), with a sum score between 20 and 80 [18]. A higher sum score implicates a higher level of anxiety, with different cutoff points based on sex and educational level.

Statistical Analyses

Descriptive statistics were used to describe the SAH population, the cognitive and emotional complaints, cognitive impairments and emotional problems. We recorded the patients' level of education using the Dutch classification system ranging from 1 (did not finish primary school) to 7 (university education), which was dichotomized as low (0–5) and high (6–7) [19]. GOS was dichotomized as 'disability' (GOS <V) and 'no disability' (GOS V). The CLCE-24 cognition score was computed, which showed satisfactory internal consistency in the present study (Cronbach's α 0.7).

Raw neuropsychological test scores of patients on all individual tests were transformed into z scores based on the means and standard deviations of the control group. Subsequently, z scores were averaged per cognitive domain. Based on the z scores, pa-

tients could be stratified into 'normal' (within 1.5 standard deviations from the control mean), 'mildly impaired' (between 1.5 and 2 standard deviations from the control mean) or 'severely impaired' (more than 2 standard deviations from the control mean) [14].

Bivariate associations of cognitive domains (memory, attention, executive and visuospatial functioning), demographic characteristics (age, sex, education), disability (GOS) and emotional problems (BDI and STAI) with the CLCE-24 cognition score were tested using Spearman correlations. Differences in the number of cognitive complaints (range 0–13) and emotional complaints (range 0–9) between groups of persons with SAH were tested using Mann-Whitney test. After that, backward multiple regression analyses were performed to examine associations between joint predictors and cognitive complaints. We first used only the cognitive domain scores as independent variables to study the amount of variance of cognitive complaints explained by the cognitive impairments alone. Subsequently, we added the demographic characteristics, disability and emotional problems to the regression models in cumulative steps. We considered $p < 0.05$ as statistically significant.

Results

SAH Population

From September 2006 until August 2008, 268 patients with SAH were admitted to the Department of Neurology and Neurosurgery of the UMCU. Within this group, 68 died, 27 were discharged to a nursing home, 38 to a rehabilitation center, and 136 were discharged home. At a mean time of 3 months after SAH 150 patients were living at home, of whom 129 visited the outpatient clinic. Eighteen of these 129 patients (14%) were excluded because of missing CLCE-24 cognition scores (n = 8), no neuropsychological examination (n = 4) or incomplete BDI and/or STAI (n = 6). The 111 patients with SAH who were included in this study did not differ substantially from the 39 patients who did not visit the outpatient clinic (n = 21) or were excluded from the study (n = 18) in terms of age, sex, education, clinical condition on admission, complications or GOS score at discharge. The characteristics of the 111 included patients are displayed in table 1. Besides the lesions based on the SAH itself and the complications of the SAH, no other cerebral lesions were found.

Cognitive and Emotional Complaints

In this study group, 105 patients (94.6%) reported at least one cognitive or emotional complaint that hampered everyday functioning as assessed by the CLCE-24. In 89 patients (80.2%) this concerned at least one cognitive complaint and in 103 (92.8%) at least one emotional

Table 1. Characteristics of SAH patients (n = 111)

	n	%
Demographic characteristics		
Sex, number of women	91	82.0
Mean age, years	52.8 ± 13.0	
Education level		
Low	9	8.1
Intermediate	82	73.8
High	20	18.0
SAH characteristics		
Mean follow-up time after SAH, weeks	11.2 ± 4.0	
PAASH		
I, GCS 15	73	65.8
II, GCS 11–14	29	26.1
III, GCS 8–10	2	1.8
IV, GCS 4–7	3	2.7
V, GCS 3	3	2.7
Missing	1	0.9
Aneurysm location		
Anterior cerebral and anterior communicating	48	43.2
Middle cerebral	24	21.6
Internal carotid	26	23.4
Posterior circulation	13	11.7
Treatment received		
Coiling	70	63.1
Surgery	41	36.9
Complications, yes	45	40.5
Rebleeding	5	4.5
Secondary ischemia	23	20.7
Hydrocephalus	14	12.6
Hydrocephalus and ischemia	3	2.7
GOS 3 months after SAH		
III = Dependent on others	4	3.6
IV = Disabled but independent	26	23.4
V = Good recovery	81	73.0
Emotional characteristics		
STAI-DY-1		
Anxious	58	52.3
BDI-II-NL		
Mean	8.6 ± 6.9	
No depressive symptoms (score 0–9)	67	60.4
Minor–moderate depression (score 10–18)	35	31.5
Moderate–severe depression (score 19–30)	7	6.3
Severe depression (score >30)	2	1.8

SAH = Subarachnoid hemorrhage; PAASH = Prognosis on Admission of Aneurysmal Subarachnoid Hemorrhage; GCS = Glasgow Coma Scale; GOS = Glasgow Outcome Scale. STAI-DY-1 = State Trait Anxiety Inventory; BDI-II-NL = Beck Depression Inventory.

Table 2. Cognitive and emotional complaints in patients (n = 111) with SAH, as assessed with the CLCE-24

Complaints since SAH	n	%
Cognitive complaints		
Keeping up; has become slower	67	60.4
Remembering new information	54	48.6
Attending to things	49	44.1
Doing two things at once	41	36.9
Taking initiative	26	23.4
Planning and organizing things	25	22.5
Remembering old information	23	20.7
Performing daily activities	23	20.7
Speaking or writing	9	8.1
Perceiving time	6	5.4
Orientating to places or persons	3	2.7
Social aspects of language	2	1.8
Attending to a part of the body or space	2	1.8
Emotional complaints		
Faster and more often tired	100	90.1
Fear of things to come	47	42.3
Emotional, crying faster	41	36.9
Irritable	36	32.4
Depressed	34	30.6
Less oriented socially	31	27.9
Indifference	18	16.2
Not realistic about things	8	7.2
Less in control of his own behavior	7	6.3

CLCE = Checklist for Cognitive and Emotional consequences following stroke; SAH = subarachnoid hemorrhage.

complaint. The proportions of patients with cognitive and emotional complaints are shown in table 2. The most reported cognitive complaints were mental slowness, short-term memory problems and attention problems, whereas the most reported emotional complaints were fatigue, feelings of anxiety and being emotionally less stable. The number of cognitive complaints showed a median of 3 (IQR from 1 to 5) and the number of emotional complaints showed a median of 3 (IQR from 1 to 4).

Cognitive Functioning and Emotional Problems

Fifty-two patients (46.8%) showed mild and 28 (25.2%) severe cognitive impairments on one or more neuropsychological tests. Results of the separate cognitive tests are shown in table 3.

On the whole, 44 patients (39.6%) had depressive symptoms; most of whom (n = 35) had scores in the minor to moderate depression range (score 10–18). Based on the STAI sum score, feelings of anxiety were present in 58 patients (52.3%).

Relationships with Cognitive Complaints

Table 4 shows bivariate and multivariate relationships with the CLCE-24 cognition score. All cognitive domains, disability (GOS), depressive symptoms (BDI) and feelings of anxiety (STAI) were significantly associated with the CLCE-24 cognition score. There were no differences in the amount of cognitive complaints ($p = 0.90$) or emotional complaints ($p = 0.14$) between persons with SAH due to an aneurysm at the anterior circulation compared to those having an aneurysm at the posterior circulation. Furthermore, there were no differences in the amount of cognitive ($p = 0.35$) and emotional complaints ($p = 0.67$) between persons with SAH without complications compared to those having complications.

In the regression analyses, step 1 (cognitive domains only) explained 6.9% of the variance of the CLCE-24 cognition score. Adding demographic characteristics in step 2 did not increase the percentage of variance. Step 3, adding the level of disability (GOS), increased the explained variance to 22.8%. In the final regression model, memory, disability (GOS), and depressive symptoms (BDI) were significant independent determinants, together explaining 35.4% of the variance in the CLCE-24 cognition score. The presence of depressive symptoms was the strongest predictor.

Discussion

Our study showed that most patients who are living at home after SAH have one or more cognitive or emotional complaints 3 months after SAH, and half of these patients showed mild or severe cognitive impairments, predominantly in memory and visuospatial functioning. In addition, more than half of the patients had feelings of anxiety and one third of the patients had depressive symptoms. Cognitive impairments were significantly related to cognitive complaints in the bivariate analysis, whereas in combination with other determinants only memory was a significant predictor in the regression analyses. The presence of depressive symptoms was the strongest predictor of cognitive complaints.

All patients in our study group were living at home at the time of the assessment and had a moderate to good physical recovery. Nevertheless, the prevalence of cognitive complaints, cognitive impairments, and emotional problems was high. Only one third of the cognitive com-

Table 3. Neuropsychological screening in patients with SAH (n = 111)

Domain task	n	Mildly impaired		Severely impaired		Impaired total, %
		n	%	n	%	
Memory						
RAVLT – immediate recall	111	7	6.3	6	5.4	11.7
RAVLT – delayed recall	110	14	12.7	10	9.1	21.8
RAVLT – recognition	104	9	8.7	9	8.7	17.4
Digit span backward	111	0	0	0	0	0
Semantic fluency	110	8	7.3	4	3.6	10.9
Rey-CFT – delayed recall	102	12	11.8	3	2.9	14.7
Attention						
Digit span forward	111	8	7.2	0	0	7.2
Stroop	96	1	1.0	3	3.1	4.1
Executive functioning						
Brixton	107	5	4.7	2	1.9	6.6
Letter fluency	110	15	13.6	2	1.8	15.4
Visuospatial functioning						
Rey-CFT – copy	107	9	8.4	11	10.3	18.7

SAH = Subarachnoid hemorrhage; RAVLT = Rey Auditory Verbal Learning Task; Rey-CFT = Rey-Osterrieth Complex Figure Test. Some patients were not able to complete one or more tests predominantly due to problems finding words or visual problems.

Table 4. Bivariate and multivariate analyses of independent variables and CLCE-24 cognition score after SAH (n = 111)

Determinant	Bivariate analysis		Multivariate analysis, β value (p value)			
	Spearman	p value	step 1	step 2	step 3	step 4
Cognitive functions						
Memory	–0.323	0.001	–0.279 (0.004)	–0.279 (0.004)	–0.338 (0.001)	–0.213 (0.009)
Executive functioning	–0.190	0.047	–	–	–	–
Attention	–0.222	0.019	–	–	–	–
Visuospatial functioning	–0.333	0.000	–	–	–	–
Demographic characteristics						
Gender	0.061	0.527	Not entered	–	–	–
Age	0.001	0.996	Not entered	–	–0.156 (0.099)	–
Education level	0.008	0.929	Not entered	–	–	–
SAH characteristics						
GOS at 3 months	–0.361	0.000	Not entered	Not entered	–0.385 (0.000)	–0.277 (0.001)
Emotional problems						
STAI-DY-1	0.484	0.000	Not entered	Not entered	Not entered	–
BDI-II-NL	0.589	0.000	Not entered	Not entered	Not entered	0.399 (0.000)
Explained variance			6.9	6.9	22.8	35.4

SAH = Subarachnoid hemorrhage; CLCE-24 = Checklist for Cognitive and Emotional consequences following stroke; GOS = Glasgow Outcome Scale; STAI-DY-1 = State Trait Anxiety Inventory; BDI-II-NL = Beck Depression Inventory.

plaints found in our study could be explained by underlying cognitive impairments, the presence of depressive symptoms, and the level of (physical) disability. Other factors, such as social support, personality characteristics, physical function, and fatigue might also be considered as predictors of these cognitive complaints in future studies [6, 7].

Mental slowness, memory problems for new information and attention problems were the most reported cognitive complaints in our study. Similarly, cognitive impairments most often concerned memory, and less often executive and visuospatial functioning [20, 21], and rarely attention, which is in line with previous findings in SAH [6, 20–22].

In this study only weak associations between cognitive complaints and potentially underlying cognitive impairments were found, which has been described earlier for SAH [5, 6], ischemic stroke [23], and patients with traumatic brain injury [7]. The discrepancy between cognitive complaints and impairments might be due to different factors. First, our concise neuropsychological examination did not cover the complete spectrum of cognitive functioning. Second, neuropsychological examinations in general are aimed to detect cognitive impairments and, as such, are less sensitive to subtle cognitive changes. Third, subtle cognitive changes might force patients, with good functional outcome, to use additional cognitive resources in order to perform within normal limits, which may lead to the experience of cognitive failure and, as such, give rise to cognitive complaints [7]. Fourth, an overestimation of cognitive complaints might be due to attribution, which means patients are more observant after their SAH and attribute cognitive problems related to normal aging or stress to the SAH [24]. Finally, an overrating of cognitive complaints might be caused by depressive symptoms, which were frequent in our study sample.

Although this is a large-scale study on cognitive complaints and impairments in patients with SAH and good neurological recovery, some limitations should be mentioned. The neuropsychological data set did not cover all relevant domains and was not completed by all patients, and some selection bias might have taken place. However, when all available data were put into the regression analyses the significant predictors of cognitive complaints did not change (data not reported). Furthermore, the CLCE-24 was not compared to an age-matched control group. However, with a mean age of 52.8 (SD 13.0) years in our patient group, a substantial age-related cognitive decline is not to be expected.

Our study shows that, in patients who recovered enough after SAH to live at home, structured screening at an outpatient clinic will often reveal emotional and cognitive problems that are otherwise easily overlooked. The rehabilitation program for patients with SAH should focus on these problems and include cognitive therapy or psychological education dependent on whether cognitive impairment or emotional problems are most prominent. Additionally, anti-depressive treatment should be considered when depressive symptoms are present. Furthermore, physiotherapy and occupational therapy can be of some importance in patients with persisting disability. When making the rehabilitation program, the weak relationships between the cognitive problems as experienced by the patients and the cognitive impairments should be taken into account. Personality characteristics and fatigue might also be important determinants of cognitive complaints which need to be examined in future.

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