Adherence of stroke patients with an online brain training programme: the role of health professionals' support.

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Abstract

Background. Computer-based cognitive rehabilitation (CBCR) is used to improve cognitive functioning after stroke. However knowledge on adherence rates of stroke patients is limited.

Objective. To describe stroke patients' adherence with a brain training programme using two frequencies of health professionals' supervision.

Methods. This study is part of a randomized controlled trial comparing the effect of the brain training programme (600 minutes playtime with weekly supervision) with a passive intervention in patients with self-perceived cognitive impairments after stroke. Patients randomized to the control condition were offered the brain training after the trial and received supervision twice (vs weekly in intervention group). Adherence was determined using data from the study website. Logistic regression analyses were used to examine the impact of supervision on adherence.

Results. 53 patients allocated to the intervention group (group S8; 64% male, mean age 59) and 52 patients who were offered the intervention after the trial (group S2; 59% male, mean age 59) started the brain training. The median playtime was 562 minutes (range 63-1264) in group S8 vs. 193 minutes (range 27-2162) in group S2 (p<0.001, Mann Whitney U).

Conclusions. The overall adherence of stroke patients with a brain training was low and there are some implications that systematic, regular interaction with a supervisor can increase training adherence of stroke patients with a restitution-focused intervention performed at home.

Keywords: stroke, adherence, cognitive rehabilitation, supervision, support, brain training.

This work was supported by the Fonds Nuts Ohra under Grant [number 1202-006] and Revalidatiefonds under Grant [number 2011184].

Introduction

Although stroke mortality rates in the past two decades have decreased, according to the World Health Federation stroke is still the second leading cause of death in the world. In 2010, the absolute number of people with first stroke was 16.9 million and the number of stroke survivors was 33 million [1]. Among the survivors of stroke, 22 to 50% [2,3] experience cognitive impairment, such as aphasia, neglect, reduced processing speed and impaired attention [4], with direct consequences for dependency in activities of daily living and functional outcomes [5].

Neurorehabilitation after stroke is focused on compensational strategy training and restitution-focused training [6]. Compensational training aims to compensate for the lost function by using remaining intact functions. Restitution-focused treatments consist of frequent repetition or stimulation of the affected function by high-intensity training [7,8]. Therefore, therapists often prescribe intensive exercise regimes for patients [9]. However, a study found that only 31 percent of patients actually performed exercises as recommended [10].

Recently, computer-based cognitive rehabilitation (CBCR) programmes, especially serious brain games, have emerged as a tool for restitution-focused treatment in stroke patients. It is expected that serious brain training helps patients in recovering from a stroke by making training more fun, as monotony of repeated motions is decreased and direct feedback about performance is provided [9,11,12]. However results about the effect of restitution-focused computer training are still conflicting [13,14,15]. Studies are often hampered by low adherence rates [16,17,18,19], although this is one of the main requirements for success of an intervention as well as improved patient outcomes [20]. Laver et al. (2015) concluded in their review that studies should provide more detail in their reporting of adherence of stroke patients with CBCR interventions [15]. Moreover, the impact of the extent of supervision on stroke patients' adherence with restitution-focused interventions is unknown. It was found in a review of Kelders et al. (2012) that frequency of interaction with a counselor was a significant predictor for adherence with web-based health interventions in different patient groups ($p < 0.001$) [21].

The goal of this study was to contribute to a better understanding of the impact of supervision on stroke patients' training adherence with restitution-focused interventions, as a potential factor to increase adherence, ultimately leading to better treatment outcomes for those recovering from stroke. The aim of the study was to describe stroke patients' adherence with a home-based 8-week brain training programme (Lumosity Inc.®) by comparing two frequencies of health professional's supervision. The hypothesis of the study was that a CBCR training with more supervision would lead to higher training adherence in stroke patients [21].

Materials & Methods

Study design

The present study on adherence was part of a randomized controlled trial (RCT) evaluating the effectiveness of an 8-week CBCR programme on cognitive functioning, quality of life (QoL) and self-efficacy as compared to a passive intervention [22]. In this study no effect of the CBCR programme were found on cognitive functioning, quality of life or self-efficacy when compared to the control group, except for very limiting effects on working memory and speed. A profile of the study is shown in Figure 1.

The current study compares patients in the original intervention group who received supervision eight times during the CBCR intervention period (S8) vs. the original control group who underwent the CBCR intervention after the original RCT and received supervision twice during the intervention period (S2). For the present analysis the data from all patients who agreed to take part in the programme were used.

Patients in the S2 group received weekly information about stroke during the period that the S8 group received their intervention. The information provision was not interactive, it provided unidirectional information about brain differences between men and woman, the influence of stress on brain function and possible difficulties with living with a damaged brain. No new information was provided in these brain facts that were not already extensively addressed during previous rehabilitation treatment. Each week, during a period of 8 weeks, new information (text or a video clip) was added to the website. The study was approved by the Medical Ethical Review Board of The Leiden Medical Centre (P 12.190). The CONSORT (Consolidated Standards of Reporting Trials) guidelines were used for adequate reporting of the study [22].

[Figure 1 near here].

Recruitment and inclusion

Inclusion criteria for participation in the study were: age between 45 and 75 years, diagnosed with stroke 12-36 months ago, having self-perceived cognitive impairments (extracted from a checklist accompanying the recruitment letter), having access to the Internet, being able to visit the rehabilitation centre and having time to participate. Exclusion criteria were: antidepressant use; receiving actual treatment for cognitive impairments; severe aphasia; lack of computer skills; not being proficient in Dutch; participants with psychological disorders in need of treatment; patients with physical disorders known to impact cognition. Patients were recruited from the participating rehabilitation centers.

The recruitment procedure is described in more detail in a previous report [23]. In total, 142 patients meeting the inclusion criteria were screened for eligibility, of whom 53 were eventually randomised to the S8 group and 57 patients to the S2 group. 50 patients (94%) in the treatment group and 57 patients (100%) in the control group completed the study. Of the S2 group, 52 accepted the offer to participate in the programme after the trial was completed. A flow chart of the inclusion is shown in Figure 2.

Intervention

The CBCR intervention was a home-based brain training programme with a duration of 8 weeks. The duration of 8 weeks for both the intervention and the follow-up were based on clinical expertise by the research team and the health professionals involved in the project team. All participants received a user identification and password to log on to a website providing access to the brain training (www.spelenderwijsbeter.nl). The training software was supplied by Lumosity Inc.®. This programme was selected because it targets multiple cognitive domains and adapts the level of difficulty of games to a patients' own abilities. In total, 16 games were used targeting five cognitive domains: attention, speed, memory, flexibility and problem solving.

The minimum requested total playtime was 600 minutes. Patients were encouraged to complete at least one session a day (approximately 15-20 minutes) on at least 5 days per week. Each session, random selections of three games were assigned to the participant, each game lasting about five minutes. Patients were able to play longer after finishing the training session. Furthermore, participants were instructed to complete an extra game session when they missed one game session and/or were not able to play 5 days a week. With each game, all patients started at the same level of difficulty. The difficulty level was then raised or lowered depending on the performance in the previous round of the respective game. The software provided feedback about game scores and how much games were completed. Patients could receive reminders for training by e-mail or a text message for mobile phone.

Supervision

During the training period, patients from the S8 group received digital support by a supervisor. Supervisors were three health care providers (a psychologist, physical therapist and occupational therapist) from the two rehabilitation centers that participated in the study. The supervision consisted of a short meeting with their own supervisor at the first assessment day in the rehabilitation centre. Moreover, digital support was provided to patients weekly during the 8-week training period by their supervisor by telephone if training adherence was lower than five times a week.

A structured plan with instructions and a timeline was provided to the supervisors. Moreover, during a meeting at the start of the intervention and evaluations during the intervention these instructions were discussed with the supervisors. Supervisors were instructed that contact was aimed at: (1) providing assistance needed to solve problems impairing a patient to play (e.g. help with software problems, explaining game instructions, install a reminder for training appointments, etc.), (2) providing strategies to achieve or improve adherence by using the Plan-Do-Check-Act method and (3) encourage patients to increase training frequency by using motivational interviewing. Moreover, patients were able to contact their supervisor themselves by email or telephone anytime they needed assistance, for instance in case of problems with training software or questions about a certain game.

Patients from the S2 group received supervision twice during the training period: a short meeting with their supervisor at the start of the brain training and contact by telephone once, after 4 weeks of training. They were encouraged to contact the supervisor by email or telephone in case they experienced difficulties using the training.

Assessments

The main outcome of interest in the current study was training adherence during the intervention period. Moreover, patient characteristics were used to determine which variables predict adherence. These data were retrieved from medical records and online questionnaires.

Adherence

Training adherence was measured by registering the patients' frequency of logging on to the website of the study during the total training period of 8 weeks and for each week. This was done in order to determine whether patients played 40 times in total (five times a week during 8 weeks) as was required. Data were automatically recorded by the software of the website and therefore gathered independently of the provider of the software. In addition, the patients' playtime, expressed as the minutes played during the 8-week training period for all cognitive domains together and for each cognitive domain (attention, memory, speed, flexibility, problem solving) were registered. These data were provided by Lumosity Inc.®. Logging into the brain training and not playing any game was not registered as playtime.

Patient characteristics

Demographic characteristics included gender, age (years) and level of education (low: primary and lower vocational education; middle: secondary and middle vocational education; high: higher vocational and university education) [24]. In addition, living situation (alone/together with spouse or other(s)), daily functioning (dependent/independent) and participation in paid work (yes/no) were recorded. Stroke characteristics included the affected hemisphere (left/right/other), type of stroke (infarction/hemorrhage), time between stroke and enrollment and length of stay in the rehabilitation center (in months).

Physical and psychological characteristics included Health related quality of life (HRQoL), measured with a Dutch version of the short Stroke Specific Quality of Life Questionnaire (SSQoL) with higher scores indicating better quality of life (range 12-60) [25], self-perceived cognitive failures, measured with a Dutch version of the 25-item Cognitive Failures Questionnaire (CFQ) with higher scores indicating less cognitive failure (range 0-100) [26] and self-efficacy, measured with a Dutch version of the general self-efficacy scale (SES) with higher scores indicating greater self-efficacy (range 10-40) [27,28].

Analysis

Patients' baseline characteristics and adherence with the CBCR programme were analysed using descriptive analyses. Data were presented as the number with percentage, median with the range or mean with SD. It was tested if variables were normally distributed by means of the Kolmogorov-Smirnov normality-test. Differences between the S8 group and S2 group were analysed with independent t-tests, Mann-Whitney U tests or Chi-square test, where appropriate.

Logistic regression analyses were used to examine the impact of the extent of supervision on training adherence. Adherence (high and moderate versus low) was dichomotized to be used as dependent variable. Moderate/ high adherence was defined as ≥300 minutes, as this was half of the required amount of total playtime (600 minutes). Low adherence was defined as <300 minutes of total playtime. All cognitive domains were included. The impact of supervision (group S8/ group S2) was included as independent variable, while adjusting for the following potential confounders: age, sex, educational level, type of stroke, affected hemisphere, cognitive failure (CFQ), quality of life (QoL) and self-efficacy (SES). Moreover, multiple logistic regression analyses with a stepwise backward selection procedure were executed in order to determine which variables predict adherence. Variables with the highest *P* value were removed one by one from the prediction model, until all remaining variables were $P<0.05$. All analyses were performed with the SPSS statistical software package (version 21).

Results

Patient characteristics

The analysis on adherence concerned 53 patients who were allocated to group S8 and 52 patients in group S2, who agreed to participate in the CBCR programme after the trial ended (Figure 2). Characteristics of the 105 patients included in the study are presented in Table 1. The mean age of all patients was 59 (range 46-74) and 66 (63%) of the patients were male. Patient characteristics were similar for group S8 (baseline) and group S2 (t=16 weeks), except for more patients who had had a haemorrhage in group S8 (21/53; 40%) compared to group S2 (11/52; 21%) ($p=0.04$).

[Table 1 near here].

Adherence

A number of 21 out of the 105 (20%) included patients failed to complete any game. Reasons for not playing at all, as recorded by the supervisor, were: technical problems with the computer (n = 6), lack of motivation (n = 6), health problems (n = 4), vacation (n = 3), hospital stay (n = 1), finding training too difficult (n = 1). From the remaining 84 patients who completed at least one training session, 46 patients (87%) were in the S8 group and 38 (73%) in the S2 group ($p<0.01$, Chi-Square). Data about adherence for both groups are presented in Table 2.

The median total play time was 424 minutes (range 27-216; 71%) in the total population. The median playtime in group S8 was 528 min (range 63-1264; 88%) vs. 193 min (range 27-2162; 32%) in group S2 ($p<0.001$ Mann Whitney U). In the total group, 24 out of 84 patients (29%) played ≥600 minutes. In groups S8 and S2, 19/53 (36%) and 5/52 (10%), of the patients played ≥600 minutes ($p<0.001$, Chi-Square). The median frequency of logging into the website during the training period was 66 (1-164) in group S8 and 47 (1-318) in group S2 ($p<0.001$ Mann Whitney U). A number of 7 patients from group S2 did not receive interaction with their supervisor after 4 weeks of brain training, since they did not respond to any of the calls.

The Odds Ratio of being in the moderate and high adherence group was 3.4 [95% CI 1.98 – 5.96] ($p=0.00$) for patients who received weekly supervision (group S8), –0.9 [95% CI 0.86 – 1.02] ($p=0.06$) for older age (each year of life), 1.65 [95% CI 0.78 – 3.46] ($p=0.19$) for higher self-perceived quality of life (SSQoL), 1.0 [95% CI 0.99 – 1.05] (p=0.26) for higher subjective cognitive failure (CFQ), 1.1 [95% CI 0.92 – 1.08] (p=0.50) for higher self-efficacy (SES) and 1.8 [0.67 – 4.60] (p=0.25) for patients with a high educational level.

[Table 2 near here].

Discussion

The aim of this study was to compare two different types of support on training adherence in chronic stroke patients. This study found that only 24 out of 105 patients (23%) were able to complete the required amount of playtime (600 minutes) of brain training. Training adherence was significantly higher for the patients in group S8 (median 528 minutes, range 63-1264) compared to patients in group S2 (median 193 minutes, range 27-2162). A small proportion of patients (5/52, 10%), who had interaction with a supervisor twice (group S2), were able to complete the training. Therefore, there are some implications that systematic, regular interaction with a supervisor can increase stroke patients' training adherence with a restitution-focused intervention performed at home.

The observation of non-adherence to a CBCR training programme in patients with stroke is in line with findings of other studies [16,17,18,19]. The adherence rate for all patients found in the current study was 29% (36% in group S8 vs. 10% in group S2), but cannot be compared to those studies because of lack of adequate reporting of training adherence [15]. Compared to an average adherence rate of 50% found in a review of 101 publications about Web-based interventions in different areas (chronic conditions, lifestyle and mental health) adherence was low [21], which confirms non-adherence with CBCR programmes is a problem among patients with stroke.

Although a number of patient characteristics were examined with respect to their association with training adherence, apart from the extent of supervision, no other predictors were found in the current study. Therefore it remains unclear for which patients with stroke a CBCR programme in its current form is most suitable. The intensity of training (600 minutes within 8 weeks) might be too demanding for stroke patients. It should be further investigated if lower intensity of training can improve adherence among patients with stroke.

The current study has a number of limitations. First, patients in the S8 group were allocated to the intervention group during the RCT and probably received in general more attention (outside the weekly contact) compared to patients from group S2. Second, interactions between the supervisors and patients were not logged (e.g. topics of conversation and duration of contacts) and could therefore not be verified. It cannot be truly concluded that patients who received more support from supervisors showed greater levels of adherence than those who received very little support.

Third, there should be the same time difference between being informed about the study and the start of the intervention in both groups. Patients in the S8 group started the training straight away when it was still exciting and novel, while patients in the S2 group had to wait 16 weeks when excitement could have waned. On the other hand, those patients were probably still motivated to participate in the brain training, given the option to start the training themselves (self-selection). Moreover, the control group has been given some information about stroke at the time when the intervention group was underwent the brain training procedure. This passive intervention could have had limited impacts on the patients. But the information was very general and previously received by patients during their rehabilitation process.

In conclusion, the overall adherence with an online brain training was low and it seems that serious brain training is not suitable for all initially motivated chronic stroke patients. Moreover, despite a number of methodological limitations in the study design, this study provides ground to further investigate the effect of the extent of supervision on training adherence of stroke patients with restitution-focused training. Although only little or no effects were found on cognitive functioning, self-efficacy and quality of life of the restitution-focused brain training in the overall study [23], this seems important since low adherence rates undermine the effect of interventions. A future study is recommended comparing three groups operating simultaneously with one intervention group receiving weekly support, a second intervention group receiving only two episodes of support and a control group.

Declaration of interest

The authors report no declarations of interest. The authors alone are responsible for the content and writing of the paper.

References

1. Feigin VL, Roth GA, Naghavi M, et al. Global burden of stroke and risk factors in 188 countries, during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *The Lancet Neurology*. 2014: 245-255.
2. Douiri A, Rudd AG, Wolfe CD. Prevalence of poststroke cognitive impairment South London stroke register 1995–2010. *Stroke*. 2013; 44(1): 138–145.
3. Gargano JW, Reeves MJ. Sex differences in stroke recovery and stroke-specific quality of life results from a statewide stroke registry. *Stroke*. 2007; *38*(9): 2541-2548.
4. Cumming TB, Marshall RS, Lazar RM. Stroke, cognitive deficits, and rehabilitation: still an incomplete picture. *International Journal of Stroke*. 2013; 8(1): 38-45.
5. Appelros P, Nydevik I, Terént A. Living setting and utilisation of ADL assistance one year after a stroke with special reference to gender differences. *Disability and rehabilitation*. 2006; 28(1): 43-49.
6. van de Ven RM, Murre JM, Veltman DJ, Schmand BA. Computer-Based Cognitive Training for Executive Functions after Stroke: A Systematic Review. *Frontiers in human neuroscience*. 2016; 10.
7. Hamzei F, Liepert J, Dettmers C, Weiller C, Rijntjes M. Two different reorganization patterns after rehabilitative therapy: an exploratory study with fMRI and TMS. *Neuroimage.* 2006; 31: 710–720. doi: 10.1016/j.neuroimage.2005.12.035
8. Langhorne P, Coupar F, Pollock A. Motor recovery after stroke: a systematic review. *The Lancet Neurology*. 2009; 8: 741-754.
9. Alankus G, Lazar A, May M, Kelleher C. Towards customizable games for stroke rehabilitation. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. 2010: 2113-2122.
10. Shaughnessy M, Resnick BM, Macko RF. Testing a model of post-stroke exercise behavior. *Rehabilitation Nursing: The Official Journal of the Assoc. of Rehabil. Nurses.* 2006; 1: 15-21.
11. Lumsden J, Edwards EA, Lawrence NS, Coyle D, Munafò MR. Gamification of cognitive assessment and cognitive training: a systematic review of applications and efficacy. *JMIR Serious Games*. 2016; 4(2).

12. Cicerone KD, Langenbahn DM, Braden C, et al. Evidence-based cognitive rehabilitation: updated review of the literature from 2003 through 2008. *Archives of physical medicine and rehabilitation*. 2011; 92(4): 519-530.
13. Poulin V, Korner-Bitensky N, Dawson DR, Bherer L. Efficacy of executive function interventions after stroke: a systematic review. *Topics in stroke rehabilitation*. 2012; 19(2): 158-171.
14. das Nair R, Cogger H, Worthington E, Lincoln, NB. Cognitive Rehabilitation for Memory Deficits After Stroke - An Updated Review.
15. Laver KE, George S, Thomas S, Deutsch JE, Crotty M. Virtual reality for stroke rehabilitation. *The Cochrane Library*. 2015
16. Cruz VT, Pais J, Bento V, et al. A rehabilitation tool designed for intensive web-based cognitive training: Description and usability study. *JMIR research protocols*. 2013; 2(2): 59.
17. Bergquist TF, Yutsis M, Sullan MJ. Satisfaction with Cognitive Rehabilitation Delivered via the Internet in Persons with Acquired Brain Injury. *International journal of telerehabilitation*. 2014; 6(2): 39.
18. Connor BB, Standen PJ. So much technology, so little time: factors affecting use of computer-based brain training games for cognitive rehabilitation following stroke. *Proceedings of the 9th International Conference on Disability, Virtual Reality and Associated Technologies*. 2012: 53-59.
19. Åkerlund E, Esbjörnsson E, Sunnerhagen KS, Björkdahl A. Can computerized working memory training improve impaired working memory, cognition and psychological health? *Brain Injury*. 2013; 27: 1649–1657.
20. Duncan PW, Horner RD, Reker DM, et al. Adherence to postacute rehabilitation guidelines is associated with functional recovery in stroke. *Stroke*. 2002; 33(1): 167-178.
21. Kelders SM, Kok RN, Ossebaard HC, Van Gemert-Pijnen, JE. Persuasive system design does matter: a systematic review of adherence to web-based interventions. *Journal of medical Internet research*. 2012; 14(6): 152.
22. Moher D, Hopewell S, Schulz KF, et al. CONSORT 2010 explanation and elaboration: Updated guidelines for reporting parallel group randomised trials. *Journal of Clinical Epidemiology*. 2010; 63(8), e1–e37.

23. Wentink MM, Berger MAM, de Kloet AJ, et al. (2016). The effects of an 8-week computer-based brain training programme on cognitive functioning, QoL and self-efficacy after stroke. *Neuropsychological rehabilitation*. 2016; *26*(5-6): 847-865.
24. Centraal Bureau voor de Statistiek (CBS). (2006). The Dutch Standard Classification of Education, SOI 2006 [PDF file]. Retrieved from: https://www.cbs.nl/en-gb/background/2008/24/the-dutch-standardclassification-of-education-soi-2006.
25. Post MWM, Boosman H, van Zandvoort MM, Passier PECA, Rinkel GJE, Visser-Meily JMA. Development and validation of a short version of the Stroke-Specific QoL Scale. *Journal of Neurology, Neurosurgery and Psychiatry*. 2011; 82: 283–286.
26. Broadbent DE, Cooper PF, FitzGerald P, Parkes KR The Cognitive Failures Questionnaire (CFQ) and its correlates. *British Journal of Clinical Psychology*. 1982; 21: 1–16.
27. Merckelbach H, Muris P, Nijman H, de Jong PJ. Self-reported cognitive failures and neurotic symptomatology. Personality and Individual Differences. 1995; 20: 715–724.
28. Schwarzer R, Jerusalem M. Generalized self-efficacy scale. Measures in health psychology: A user's portfolio. Causal and Control Beliefs. 1995; 1: 35–37.

Figure 1. Study profile

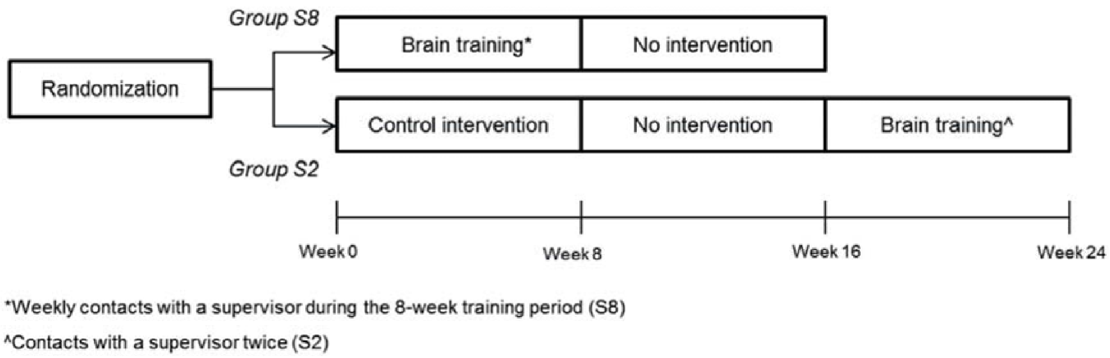


Figure 2. Flow of inclusion

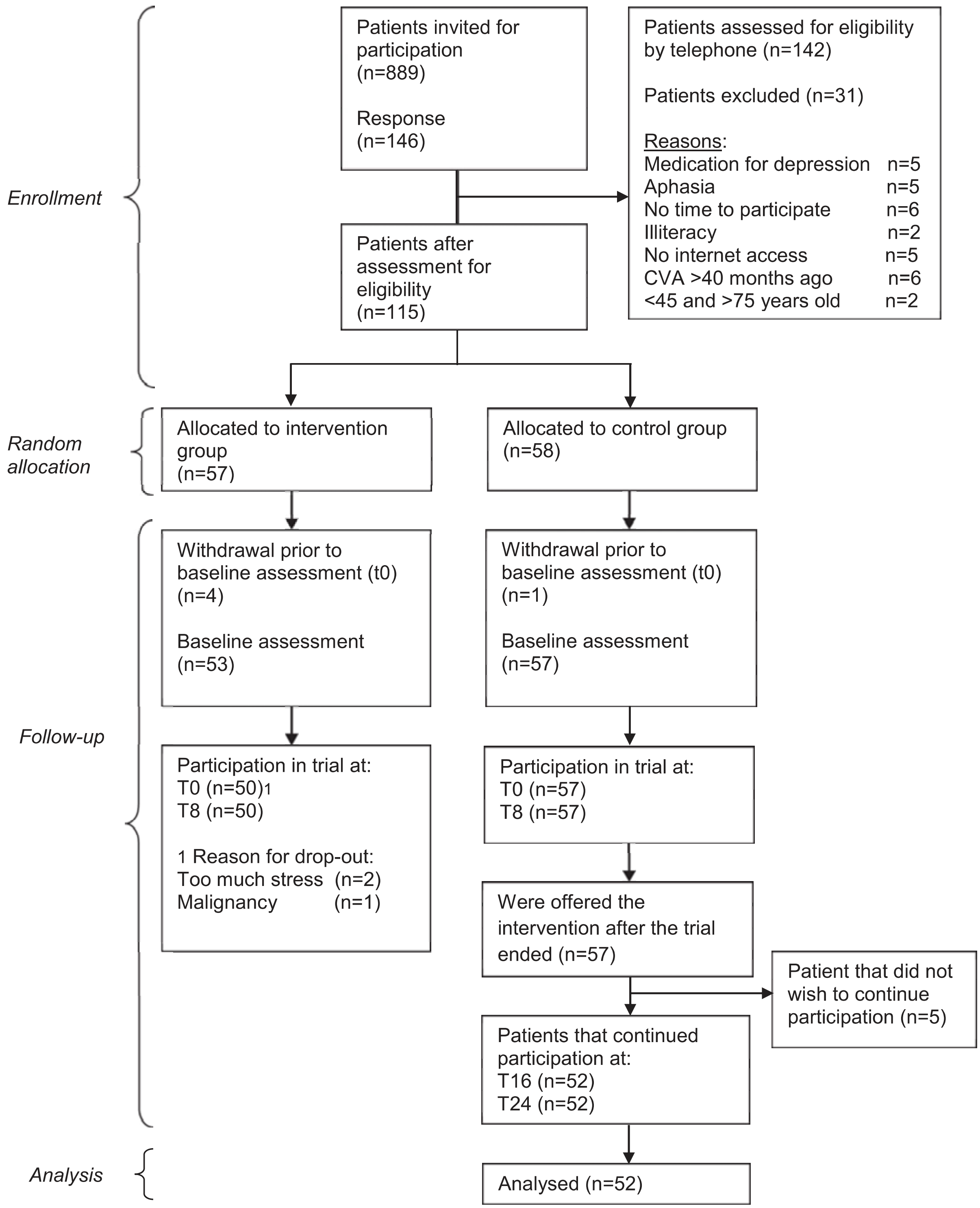


Table 1. Baseline characteristics of patients with stroke who participated in an 8-week CBCR programme, presented for all patients and per group.

	All patients (n=105)	Group 1 (n=53)	Group 2 (n=52)	Between groups (*P*-value)*
Age in years; median (range)	59 (46-74)	59 (46-74)	59 (46-73)	0.85
Sex, male;	66 (63)	34 (64)	32 (62)	
Type of stroke:				
Infarction, n (%)	68 (67)	29 (55)	41 (79)	
Haemorrhage, n (%)	34 (32)	21 (40)	11 (21)	0.04
Unknown ‡, n (%)	3 (6)	3 (5)	0 (0)	
Location of stroke:				
Hemisphere left, n (%)	50 (48)	23 (43)	27 (52)	
Hemisphere right, n (%)	50 (48)	26 (49)	24 (46)	0.21
Basal ganglia, n (%)	3 (3)	3 (6)	0 (0)	
Unknown ‡, n (%)	2 (2)	1 (2)	1 (2)	
Time from stroke onset to randomization in months; mean (SD)	25 (8.2)	26 (9.1)	25 (7.5)	0.32
Time spent in rehabilitation centre in months; mean (SD)	5.8 (3.6)	6 (3.6)	5 (3.4)	0.23
Educational status ¥:				
Low, n (%)	36 (34)	17 (32)	19 (36)	
Intermediate, n (%)	33 (32)	18 (34)	15 (29)	0.94
High, n (%)	36 (34)	18 (34)	18 (35)	
Living alone, n (%)	26 (25)	13 (25)	13 (25)	0.84
Independent in daily functioning, n (%)	101 (96)	52 (98)	54 (95)	0.35
Participation in paid work, n (%)	32 (31)	14 (26)	18 (35)	0.33
Subjective cognitive failure≠; median (IQR)	63 (20)	63 (19)	63 (20)	0.62
Quality of life~; median (IQR)	3.7 (2.5)	3.7 (2.4)	3.8 (2.4)	0.57
Self-efficacy^; median (IQR)	30 (15)	28 (14)	30 (15)	0.83

*Differences between the groups were analysed with independent t-tests, Mann-Whitney U tests or Chi-square test, where appropriate.
‡ No data were available for medical status.
¥ Low: lower technical and vocational training; median: secondary technical and vocational training; and high: higher technical and vocational training and university.
≠ Measured with the Cognitive Failures Questionnaire (CFQ): range 0-100; higher scores indicating less cognitive failure.
~ Measured with the Stroke Specific Quality of Life Questionnaire (SSQoL): range 12-60; higher scores indicating better quality of life.
^ Measured with the General Self Efficacy Scale (GSES): range 10-40; higher scores indicating greater self-efficacy.

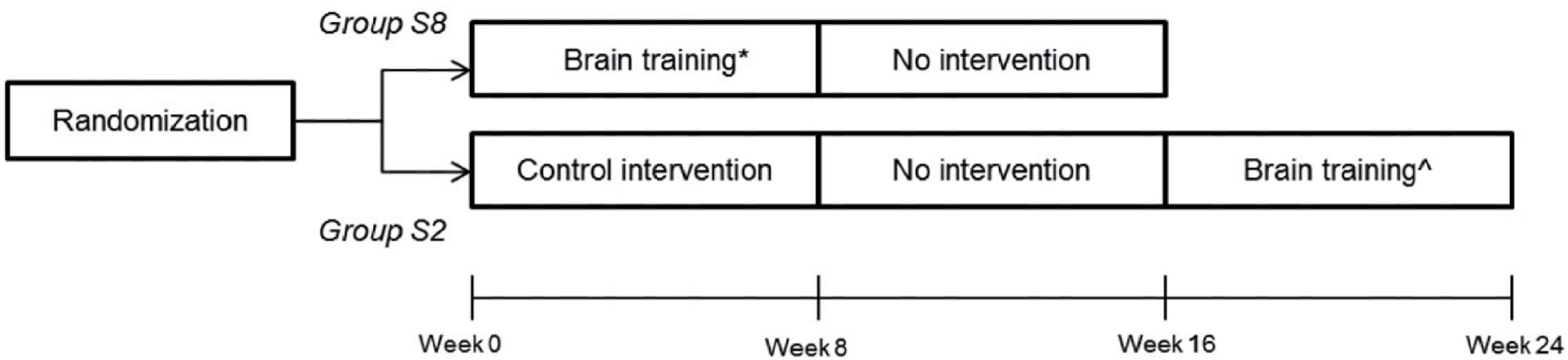
Table 2. Training adherence with an 8-week CBCR programme, presented for all stroke patients and per group*

	All patients (n=84)	Group 1 (n=46)	Group 2 (n=38)	Between groups (*P*-value)^
Total time played (minutes):	424 (27-2162)	528 (63-1264)	193 (27-2162)	<0.001
Total time played per cognitive domain (minutes), %:				
Attention	58 (2-466) (14)	60 (3-408) (11)	37 (2-466) (19)	0.002
Speed	49 (1-139) (12)	53 (3-139) (10)	6 (1-48) (3)	<0.001
Memory	168 (4-646) (40)	232 (26-646) (44)	95 (4-645) (49)	<0.001
Flexibility	87 (4-1009) (21)	109 (6-349) (20)	50 (4-1009) (26)	0.001
Problem solving	53 (1-265) (13)	81 (1-265) (15)	7 (2-168) (3)	<0.001
Frequency of logging on to the website (number):	50 (1-318)	66 (1-164)	47 (1-318)	<0.001

*Presented as the median total play time (in minutes) with the range and percentage of the total play time, unless indicated otherwise.

^Differences between the groups were analysed with independent t-tests, Mann-Whitney U tests or Chi-square test, where appropriate.

Figure 1



*Weekly contacts with a supervisor during the 8-week training period (S8)

^Contacts with a supervisor twice (S2)

Figure 1

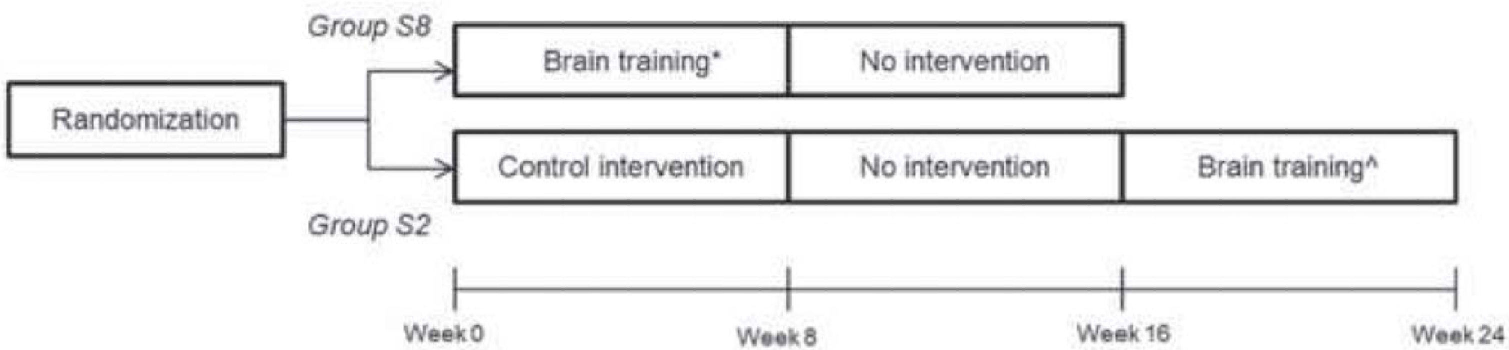


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Figure 2

Figure 2. Flow of inclusion

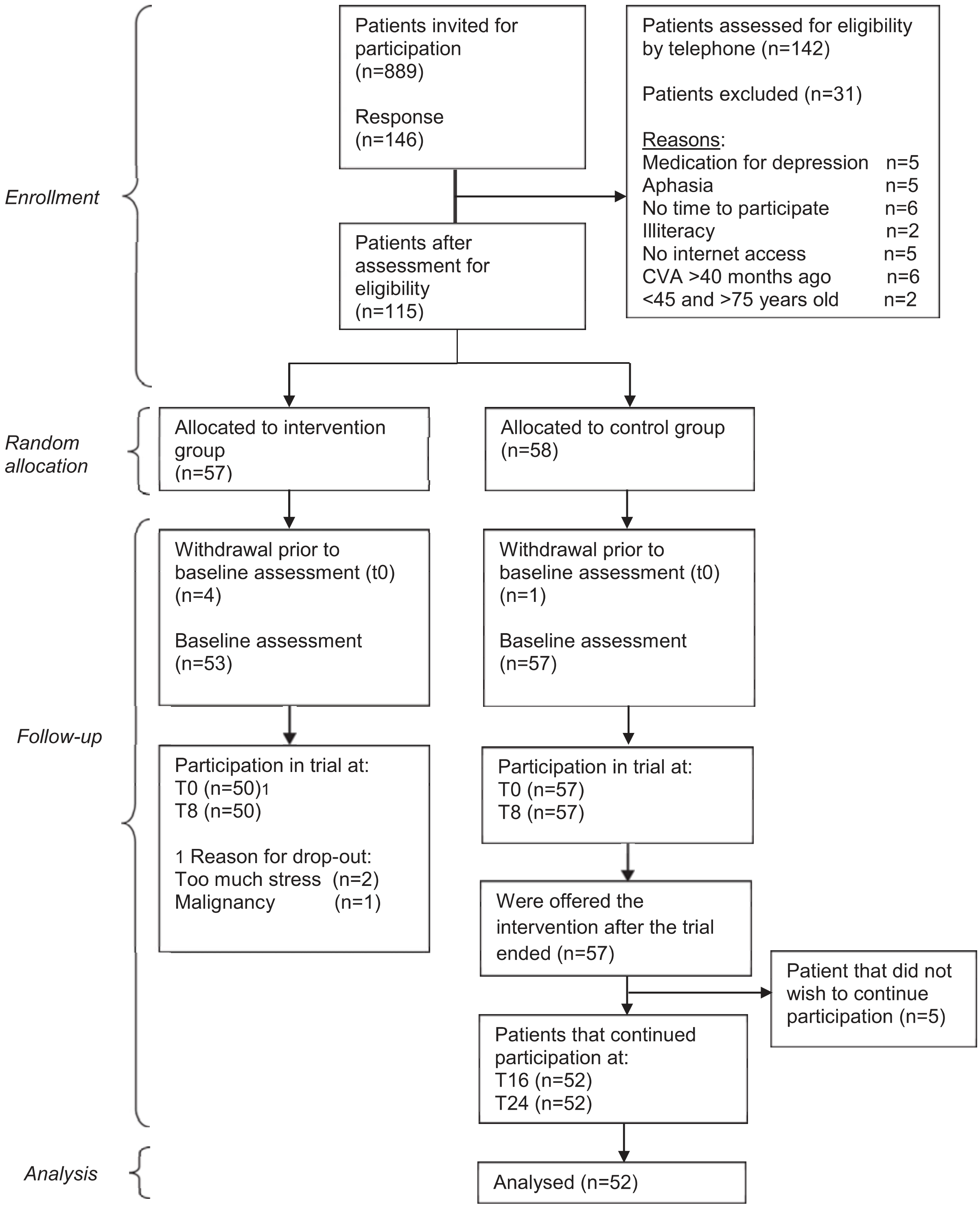


Figure 2

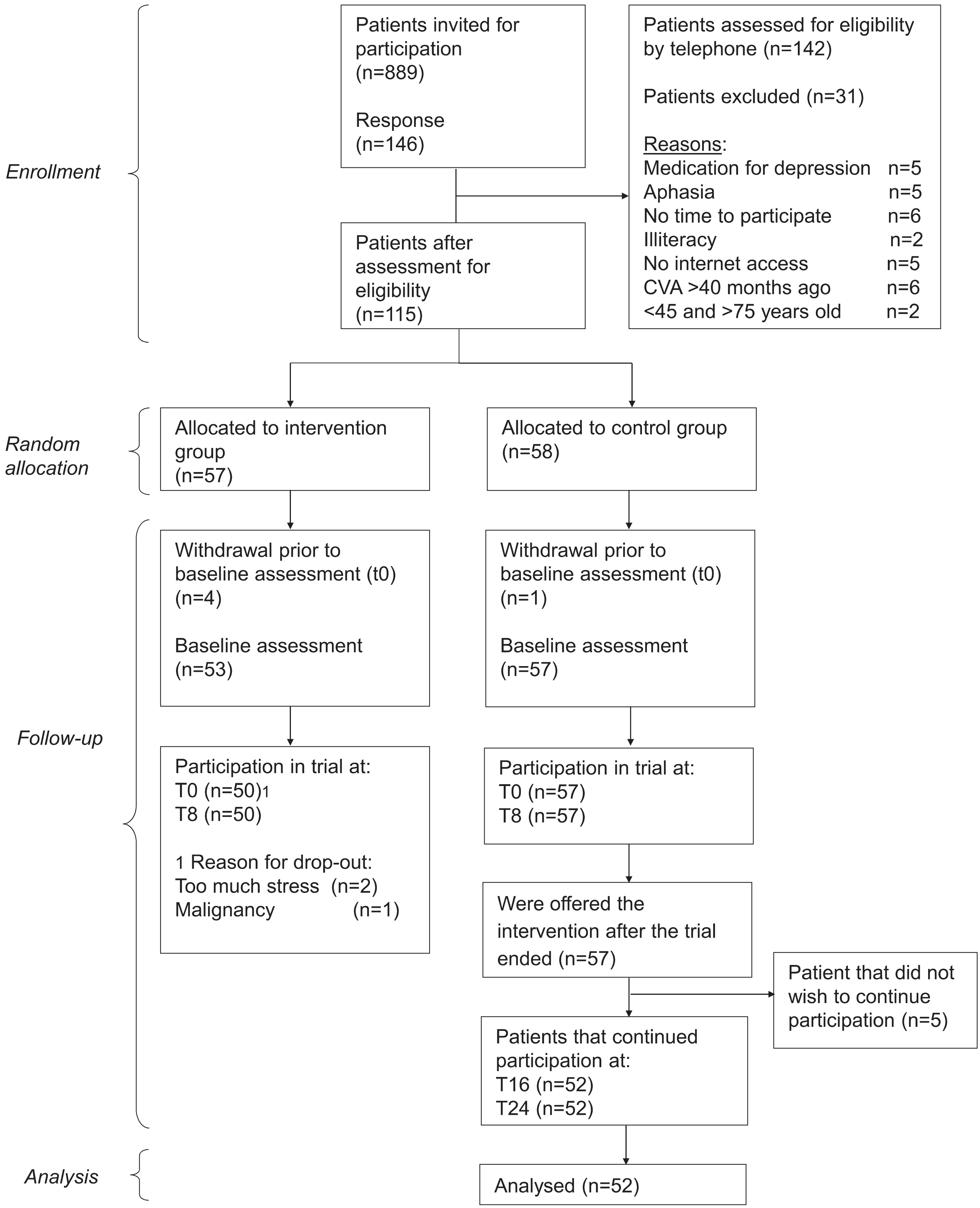
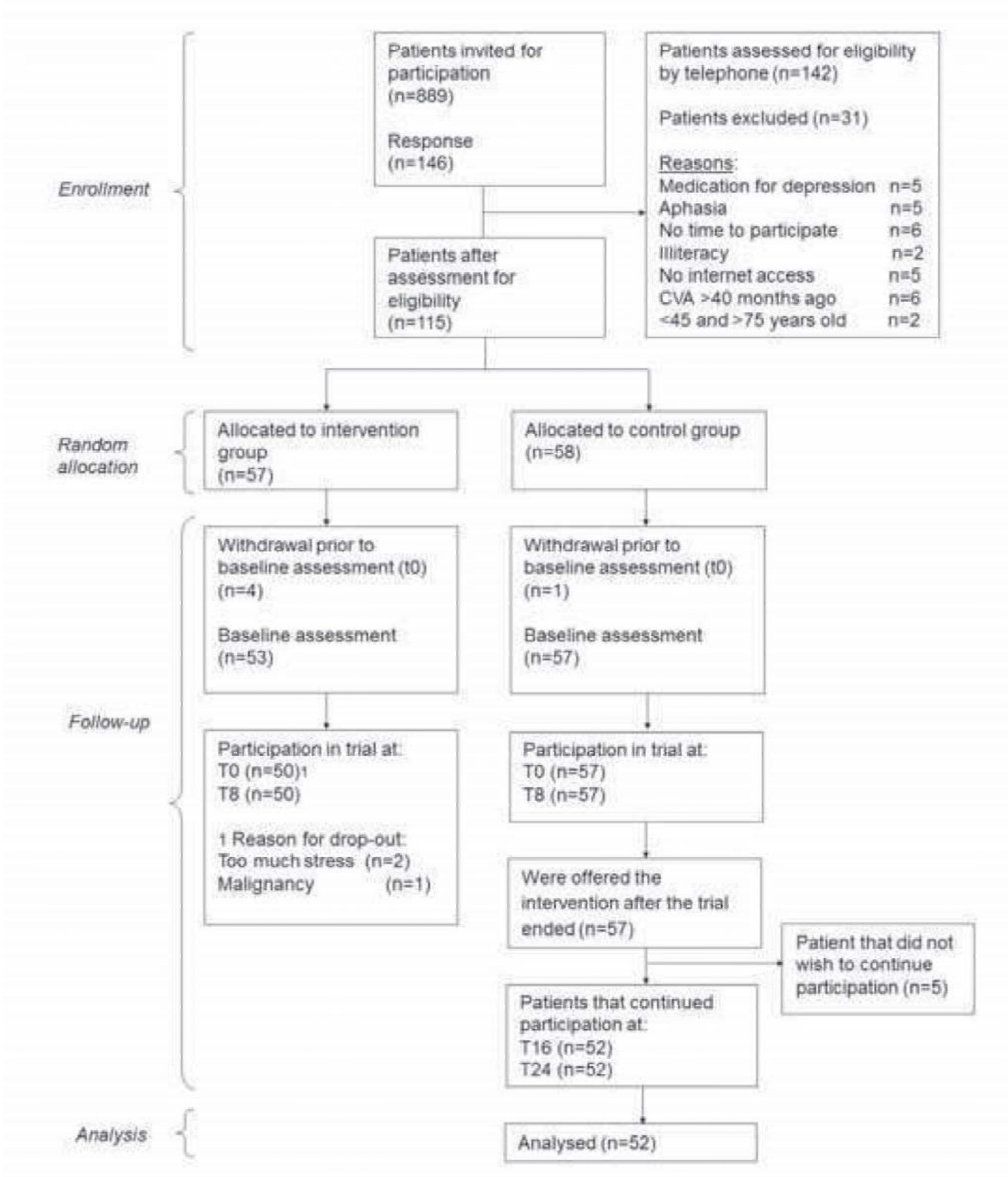

Enrollment
Patients invited for participation (n=889)
Response (n=146)
Patients assessed for eligibility by telephone (n=142)
Patients excluded (n=31)
Reasons:
Medication for depression n=5
Aphasia n=5
No time to participate n=6
Illiteracy n=2
No internet access n=5
CVA >40 months ago n=6
<45 and >75 years old n=2
Patients after assessment for eligibility (n=115)
Random allocation
Allocated to intervention group (n=57)
Allocated to control group (n=58)
Follow-up
Withdrawal prior to baseline assessment (t0) (n=4)
Baseline assessment (n=53)
Withdrawal prior to baseline assessment (t0) (n=1)
Baseline assessment (n=57)
Participation in trial at:
T0 (n=50)1
T8 (n=50)
1 Reason for drop-out:
Too much stress (n=2)
Malignancy (n=1)
Participation in trial at:
T0 (n=57)
T8 (n=57)
Were offered the intervention after the trial ended (n=57)
Patient that did not wish to continue participation (n=5)
Patients that continued participation at:
T16 (n=52)
T24 (n=52)
Analysis
Analysed (n=52)

Figure 2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Baseline assessment (n=57)
Participation in trial at: T0 (n=50)1 T8 (n=50)
1 Reason for drop-out: Too much stress (n=2) Malignancy (n=1)
Participation in trial at: T0 (n=57) T8 (n=57)
Were offered the intervention after the trial ended (n=57)
Patient that did not wish to continue participation (n=5)
Patients that continued participation at: T16 (n=52) T24 (n=52)
Analysis
Analysed (n=52)