Annals of Physical and Rehabilitation Medicine 64 (2021) 101459

Available online at
ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com

Review

Prevalence of spatial neglect post-stroke: A systematic review

Emily Esposito [a], Grigoriy Shekhtman [b,c], Peii Chen [b,d,*]

[a] Department of Psychology, University of California, Riverside, 900, University avenue, Riverside, CA, USA
[b] Centre for Stroke Rehabilitation Research, Kessler Foundation, 1199, Pleasant Valley Way, West Orange, NJ, USA
[c] Department of Psychology, Seton Hall University, 400, South Orange avenue, South Orange, NJ, USA
[d] Department of Physical Medicine and Rehabilitation, New Jersey Medical School, Rutgers University, 183, South Orange avenue, Newark, NJ, USA

ARTICLE INFO

Article history:
Received 26 May 2020
Accepted 26 October 2020

Keywords:
Spatial neglect
Hemispatial neglect
Unilateral spatial neglect
Stroke
Right brain
Left brain

ABSTRACT

Objective: Spatial neglect (SN) impedes stroke rehabilitation progress, slows functional recovery, and increases caregiver stress and burden. The estimation of SN prevalence varies widely across studies.
Background: We aimed to establish the prevalence of SN based on the injured cerebral hemisphere, recovery stage post-stroke, and diagnostic methodology.
Materials and methods: All journal articles published up to February 27, 2019 from CINAHL, PsycINFO, PubMed and Web of Science were searched. We selected original research articles that described observational studies, included both individuals with left brain damage (LBD) and those with right brain damage (RBD) post-stroke, and reported specific diagnostic methods for SN. All authors reached consensus for the final selection of 41 articles. Time post-stroke, patient selection criteria, study setting, SN diagnostic methods were extracted.
Results: A total of 6324 participants were included: 3411 (54%) with RBD and 2913 (46%) with LBD. Without considering time post-stroke or diagnostic methods, the occurrence rate of SN was 29% (38% after RBD and 18% after LBD). Using ecological assessments resulted in higher prevalence than using tests not directly related to daily life activities (53% vs. 24%). Using methods based on a single-cutoff criterion led to lower occurrence of SN than using multi-test methods (27% vs. 33%). The prevalence decreased from the acute to chronic stage post-stroke.
Conclusions: The estimated prevalence of SN after unilateral stroke is 30%. SN is more common after RBD than after LBD, but SN after LBD is still quite common. Using ecological assessments and multi-test methods to detect SN is preferred to using a single-cutoff criterion of a test that is not directly related to daily function. The decrease in SN prevalence over time is evident, but the exact prevalence in later stages cannot be estimated. More research is needed to better understand chronic SN.

1. Introduction

Spatial neglect (SN) is a syndrome resulting from damage to the neural networks critical to spatial attention and related cognitive and motor functions [1–3]. The neural networks involve all the major cortices, subcortical areas and structures, and white-matter fibres [4–10]. The syndrome typically renders abnormal bias toward the side of space ipsilateral to the injured cerebral hemisphere. Thus, affected individuals "neglect" (i.e., pay insufficient or no attention toward) the contralesional side of space, in a way that cannot be attributed to primary sensory or motor defects [11,12] That is, individuals with SN after right brain damage (RBD) typically neglect the left side of space, and those with SN after left brain damage (LBD) neglect the right side of space. The space can be close or on the body (personal space), within arm's reach (peripersonal space; near space), beyond arm's reach (extra-personal space; far space), or in one's mind (mental space) [13–15] The side of space can be classified based on the egocentric frame of reference (i.e., body-centered or viewer-centered) or an allocentric frame of reference (i.e., stimulus-centered or object-centered) [16–18]. Because SN research examines these many differing facets of SN, it advances not only the clinical fields of neuropsychology and neurology, but also the broad field of cognitive psychology and neuroscience in terms of

* Corresponding author at: Kessler Foundation, 1199, Pleasant Valley Way, 07052 West Orange, New Jersey, USA.
E-mail address: pchen@kesslerfoundation.org (P. Chen).

https://doi.org/10.1016/j.rehab.2020.10.010
1877-0657/© 2020 Elsevier Masson SAS. All rights reserved.

understanding spatial processing and attention control and understanding the roles played by these mechanisms in different cognitive and motor functions.

SN is typically presented as a failure to respond to or report to stimuli presented in the contralesional side of space, a failure to initiate or complete movement in or toward the contralesional side of space, a failure to report, manipulate, or produce information stored mentally, or a failure to keep the gaze or body posture centered but deviating toward the ipsilesional side [12,13,19,20]. The deficits created by SN disrupt basic self-care activities (e.g., dressing, grooming) [21,22], impair postural balance [23,24], interfere with reading ability [25–27], and impede navigation (e.g., avoiding furniture or walls when walking or using a wheelchair) [28–30]. SN also increases the risk of falls [31] and body injuries [32] and puts the affected individuals in danger of being struck by a vehicle when crossing the street [33,34]. Importantly, many individuals with SN are unaware of their own symptoms or the consequences of their deficits [35–39], which delays their seeking appropriate treatment or learning compensatory strategies. The disabling consequences of SN may last for a number of years after stroke [40–43], and family caregivers of affected individuals report greater burden and stress than family caregivers of stroke survivors without SN [44,45]. The profound impact of SN on stroke survivors and their families underscores the need for clinical implementation of research-informed assessments and evidence-based treatments. However, the prevalence of SN is undetermined, which impedes knowledge translation and further slows down research progress in seeking effective treatment [46].

The occurrence of SN varies across studies, from 20% to 80% [47–56], depending on brain lesion locations, time post-stroke, and assessment methods [21,46]. Overall, SN after RBD is more prevalent than SN after LBD [46,47,57], and left-sided SN is more severe than right-side SN. This situation may be related to the neural networks critical to spatial attention being predominately located in the right hemisphere [2,58]. Assessment directly related to daily functions (i.e., ecological assessment) [59] has shown greater sensitivity than conventional neuropsychological tests in detecting SN [60,61]. However, which test has greater specificity is difficult to determine, given that there is no gold standard for SN screening or diagnostic methods. SN is not a unitary disorder and presents a great variety of symptoms because spatial attention is essential to many perceptual, cognitive, and motor functions. SN impairs visual perception, auditory localisation, tactile spatial perception, proprioception, visuospatial memory, visuomotor control, and movement planning and initiation [2,12,62–65]. In studies aiming to establish SN prevalence, completing a comprehensive battery that covers every domain that may be affected by SN is challenging. For example, Ringman et al. [53] conducted an observational study in an acute care setting and determined the presence of SN based on one item on the National Institutes of Health Stroke Scale, which screens for extinction (i.e., a failure to detect a contralesional stimulus in the presence of an ipsilesional stimulus), one of many symptoms of SN. Extinction screening is quick and easy, requiring no device or equipment, and can be done in visual, auditory, and tactile modalities. However, whether the extinction test is as sensitive or representative as other tests for SN is unknown. Even in studies that used a popular battery, such as the Behavioural Inattention Test (BIT) [66], how SN is evaluated, varied. Some used the standard cut-off score [67], and others classified an individual as having SN as long as they demonstrated abnormal left-right asymmetry [68] in any one (or any number) of the multiple tests within the battery. Whether using the single-cutoff criterion or the multi-test methods is a better practice is unknown.

The purpose of the present study was to estimate the prevalence of SN post-stroke by a systematic review of the literature. To do so, we cast a wide net over all definitions, diagnostic methods, and criteria of SN. In this context, we define SN operationally as an abnormal left-right asymmetry presented in a specified assessment, or a test score below a pre-determined cut-off criterion. The latter does not necessarily indicate a left–right asymmetry, especially in a target cancellation test. However, using cut-off criteria on test scores is a common practice. Because of this, the present study did not distinguish subtypes of SN and thus included all of them (egocentric, allocentric, personal, peripersonal, extrapersonal, visual, tactile, auditory, representational, and motor neglect, etc.). Importantly, our objective was to establish the prevalence of SN post-stroke rather than post-right-brain stroke. Thus, we specifically selected studies that included both RBD and LBD individuals and excluded studies that did not include LBD or RBD individuals. This selection ensured that both LBD and RBD individuals included in a given study were assessed the same way. Our a priori questions were:

- What is the prevalence of SN among individuals with unilateral stroke?
- Does the prevalence of SN differ depending on the lesioned hemisphere, time post-stroke, or SN diagnosis methods?

2. Methods

2.1. Review procedures

We searched CINAHL, PsycInfo, PubMed and Web of Science for articles published from inception to February 27, 2019, by using the following search terms for the title or abstract: "spatial neglect" OR "visual neglect" OR "hemineglect" OR "visuospatial neglect" OR "unilateral neglect" OR "spatial inattention." Two authors (EE and GS) independently removed replicates, screened the titles and abstracts to identify those that were potentially eligible for full-text reviews, reviewed the full texts, and determined whether an article was included for analysis based on information extracted. This procedure created 2 sets of articles, which then were further reviewed and discussed by all 3 authors for the final decision. Any discrepancies were resolved by discussion.

2.2. Eligibility criteria and selection of studies

Once a full-text article was obtained, the article was evaluated according to the eligibility criteria:

- original research articles published in peer-reviewed journals;
- observational studies;
- including both RBD and LBD stroke survivors;
- reporting the number of patients with SN after RBD and the number of patients with SN after LBD;
- specifying the methods determining the presence of SN;
- written in English.

If the exact numbers of patients with SN after RBD or LBD were not reported but could be calculated based on the information available in a given article, the article was considered eligible. If the same cohort was reported in different articles but assessed at different times (e.g., acute and chronic), the articles were included; otherwise, studies of the same cohort were excluded. We excluded case studies, controlled or clinical trials, and reviews of the literature. We also excluded studies that specifically selected individuals based on the presence or absence of SN, used computer models, or focused on clinical populations unrelated to stroke as well as editorials and comments, replies and corrections.

2.3. Data synthesis

We extracted participant characteristics, time post-stroke, setting, and diagnostic methods (assessment and criteria used for determining the presence of SN), and number of individuals with RBD, LBD, SN after RBD and SN after LBD from the selected studies.

2.3.1. Diagnostic methods

Two authors (GS and PC) independently classified the types of assessment used in each study as "ecological" (e.g., text reading, Baking Tray Test [69], Catherine Bergego Scale) [70] or "non-ecological" (e.g., extinction screening, conventional subtests of the Behavioural Inattention Test [67], observation of basic limb movement in the contralesional and ipsilesional sides of space) [71] following similar criteria used in published reviews [59,72]. Studies were also classified as "single-cutoff criterion" or "multi-test methods" based on criteria specification for SN diagnosis. For example, Stone et al. [54] identified SN if abnormality was demonstrated in any one of the tests administered to their participants, so the study was classified as using "multi-test methods". Furthermore, a given study could use multiple tests on the same cohort, and some participants were able to be tested on all or some of the tests. In such case, each test resulted in different occurrence rates of SN, and we considered them as different data entry for prevalence analysis.

2.3.2. Time post-stroke

The classification on time post-stroke was based on the review of participants' time post-stroke and the setting in which a given study was conducted because of unspecified time information provided in some articles as well as the differences in healthcare facility across countries and regions. Four categories regarding time post-stroke emerged:

- acute: first week post-stroke in acute care and general hospital settings;
- subacute: 1 week to 3 months post-stroke in inpatient rehabilitation and general hospital settings;
- post-acute: 6 months to 1 year post-stroke in inpatient rehabilitation and general hospital settings;
- chronic: > 1 year post-stroke in community and outpatient settings.

Studies, that did not specifically select participants based on time post-stroke or did not provide information on time post-stroke or study setting, were not classified. Any discrepancies were resolved by discussion among the 3 authors.

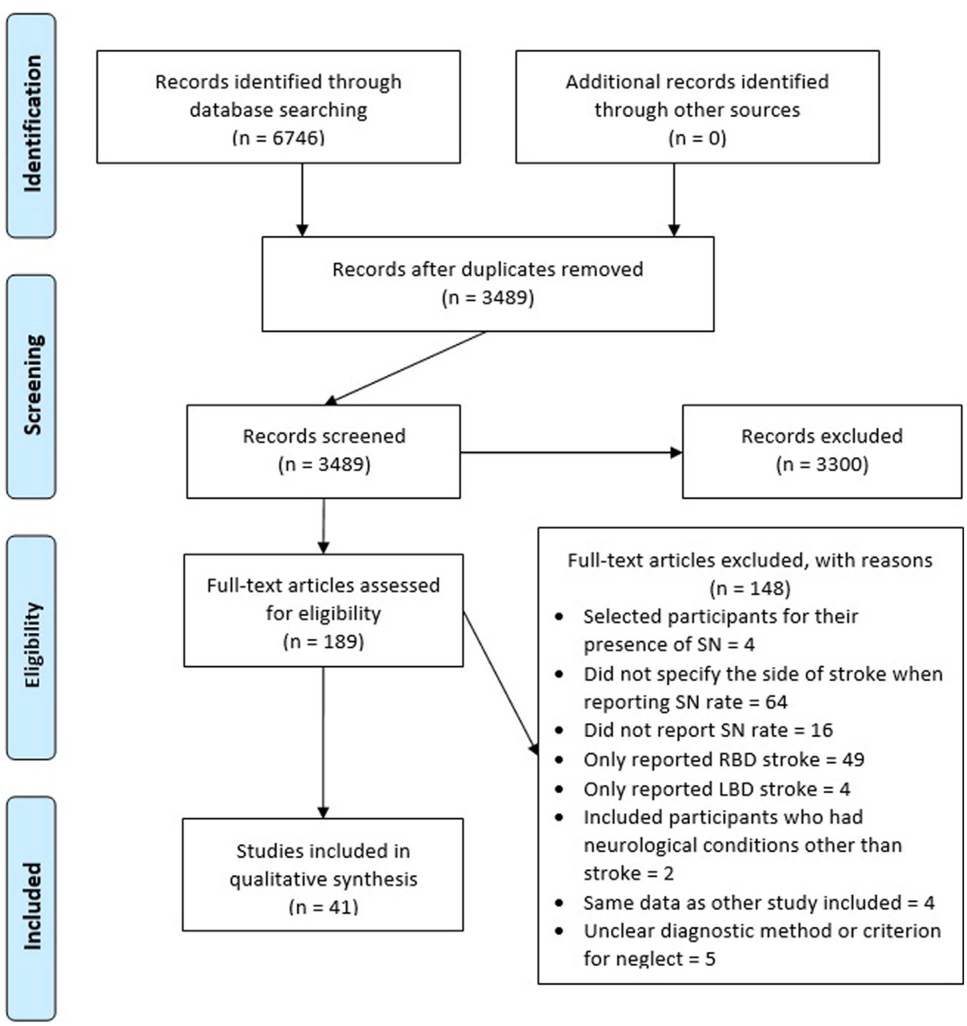

Fig. 1. PRISMA flow diagram. LBD: left brain damage; RBD: right brain damage; SN: spatial neglect.

3. Results

The two independent reviewers selected 50 articles, and all authors reached consensus for the final selection of 41 (82%) articles to be included in the analysis (Fig. 1). The studies were conducted in 15 countries, with one study each from Australia, France, Georgia, Japan, New Zealand, Switzerland, and Turkey; 2 studies from Belgium; 3 were from Germany and the United States; 4 from Sweden; 5 from Canada and Italy; and 6 from The Netherlands and the United Kingdom. A total of 6324 participants were included: 3411 (54%) with RBD and 2913 (46%) with LBD. Across all the 41 studies, SN was more prevalent after RBD than after LBD (Table 1). Without considering diagnostic methods or time post-stroke, the overall occurrence rate of SN was 29%. Specifically, it was 38% after RBD and 18% after LBD.

Fig. 2 summarises the results based on diagnostic methodology. Fewer studies used ecological than non-ecological assessments (7 vs. 35), but studies using ecological assessments resulted in a higher prevalence of SN (53%) [47,54,69,73–76] than studies using non-ecological assessments (24%) [41,43,48,50–55,71,77–101]. One study was counted for both ecological and non-ecological assessments because it included both types [54]. For the diagnostic criteria, one study was excluded because the information was unclear [86], and 2 studies were classified in both types of diagnostic criteria because they used them to detect different SN subtypes [54,78]. Thus, 24 (59%) studies used a single-cutoff criterion to determine the presence of SN, and 18 (44%) used multi-test methods. Overall, we found lower occurrence rate of SN for studies using a single-cutoff criterion than multi-test methods (27% vs. 33%).

Using our classification for "time post-stroke" as described in Methods, 11 (27%) studies were classified as "acute" [53,54,71,73,74,79,80,86,92,97,99], 22 (54%) "subacute" [41,43,47,48,51,52,55,69,76,77,82,84,85,87,89,91,93–95,98,100,101], 1 (2%) "post-acute" [48], and one (2%) "chronic" [88]; 7 (17%) could not be classified [50,75,78,81,83,90,96]. For one of the studies, participants were assessed at 2 time points that fell into 2 categories, so the results were classified as both subacute and post-acute, based on the time point [48]. The prevalence of SN decreased from acute (34%) to chronic (17%) stage (Fig. 3).

The studies reviewed dated back in 1972 (Table 1). With almost half a century between the oldest and latest studies, we acknowledged the potential changes in diagnostic methods over time. Thus, we conducted a post-hoc analysis to examine whether the SN occurrence rate differed in the literature by classifying 21 (51%) articles published before 2000 as "old" and 20 (49%) articles published in 2000 and later as "recent." Without considering diagnostic methods or time post-stroke, the overall occurrence rate of SN was 27% in the old studies (35% vs. 19% after RBD vs. LBD) and 32% in the recent literature (42% vs. 18% after RBD vs. LBD).

We repeated the same analyses described in the ad hoc analysis for each group. Fig. 4 summarises the prevalence change as a function of time post-stroke. Many of the old studies (13/21; 62%) were conducted during the subacute stage, and none focused on the chronic stage. The trend of decreasing SN occurrence rate was apparent, consistent with the trend shown in Fig. 3. In the recent group, no study focused on the post-acute stage, and the occurrence rate appeared higher in the subacute than acute stage. Fig. 5 presents the results based on diagnostic methodology. The patterns were consistent with those in Fig. 2, showing higher SN

Table 1
Studies included in the systematic review of special neglect (SN).

Study	Setting	Country	Criteria	Time post-stroke	Diagnostic methods and criteria for SN	Rate of SN
Acute (with the first week post-stroke in acute care and general hospital settings)						
Appelros et al. (2002)[c]	University hospital	Sweden	First stroke, able to complete all the assessments in the right time period, and no recurrent stroke, stroke-like symptoms, acute vertigo, disturbances of consciousness or transient ischemic attack	1–4 days	Line crossing, letter cancellation and line bisection (from the BIT), Baking Tray Task and two personal neglect tests (comb test, razor/compact test and eyeglasses test and hand touching)	RBD: 40/126 (31.7%) LBD: 25/146 (17.1%)
Becker and Karnath (2007)	University centre of neurology	Germany	First stroke, unilateral stroke and no other neurological disorders, tumours or history of lesions	2.9 days (average)	Bells test	RBD: 11/42 (26.2%) LBD: 1/41 (2.4%)
Becker and Karnath (2010)	University centre of neurology	Germany	First stroke, unilateral stroke, and no diffuse or brain stem strokes	48.3 hrs (average)	Letter cancellation, bells test, Albert's test, copying test	RBD: 30/71 (42.3%) LBD: 6/53 (11.3%)
Kumral et al. (2002)	University stroke unit	Turkey	Anterior ACA infarction, first stroke and no border-zone ACA/MCA/PCA stroke	Within 1 week	Line bisection and line cancellation	RBD: 3/16 (18.8%) LBD: 1/30 (3.3%)
Motomura et al. (1986)	Brain and heart centre, cardio-vascular centre and department of neuro-psychiatry in a medical college	Japan	Thalamic hemorrhage, testing within 7 days of onset, and no more than minimal disturbance of consciousness from the onset	Within 7 days	Line bisection, line cancellation, draw a man, copy a cube	RBD: 11/20 (55.0%) LBD: 0/13 (0.0%)
Ringman et al. (2004)	Hospital	US	Between 18 and 85 years old, stroke symptoms lasting 1 to 24 hrs, ischemic stroke, independent prior to stroke on the Barthel Index and no resolution of neurologic symptoms or an isolated mild neurologic deficit	Within 7 days	NIH Stroke Scale neglect subscore (Cookie Theft Picture)	RBD: 165/386 (42.7%) LBD: 77/394 (19.5%)

Table 1 (*Continued*)

Study	Setting	Country	Criteria	Time post-stroke	Diagnostic methods and criteria for SN	Rate of SN
Siekierka-Kleiser et al. (2006)	Stroke unit	Germany	First stroke, middle cerebral artery stroke, acute motor hemi-syndrome with upper limb, full consciousness, ability to comply with tasks, symptoms within 72 hr of hospital admission and no aphasia	Within 7 days	Castaigne et al.'s methods (1970, 1972) for motor neglect	RBD: 14/30 (46.7%) LBD: 5/22 (22.7%)
Stone et al. (1991)[c]	Hospital	UK	Acute hemispheric stroke	3 days	Neglect battery	RBD: 13/18 (72.2%) LBD: 16/26 (61.5%)
Stone, Halligan and Greenwood (1993)[c]	Hospital	UK	First stroke and acute stroke	2–3 days	Modified BIT, "hemi-inattention," tactile extinction, allaesthesia, visual extinction	RBD Modified BIT: 50/61 (82.0%) Hemi-Inattention: 44/63 (69.8%) Tactile Extinction: 34/52 (65.4%) Allaesthesia: 32/56 (57.1%) Visual Extinction: 14/60 (23.3%) LBD Modified BIT: 48/74 (64.9%) Hemi-Inattention: 43/87 (49.4%) Tactile Extinction: 15/43 (34.9%) Allaesthesia: 5/46 (10.9%) Visual Extinction: 2/81 (2.5%)
Tatuene et al. (2016)	Stroke unit of a hospital	Switzerland	First stroke, acute stroke, admission within 15 days of stroke onset and no pre-existing alterations of visual or cognitive functions	Within 15 days, 3.7 days (average)	Ota's cancellation task and line bisection task (5 cm and 20 cm)	RBD: 9/36 (25.0%) LBD: 8/33 (24.2%)
Van Nes et al. (2009)	Neurology wards of hospitals	The Netherlands	First stroke, supratentorial stroke, within two weeks of the stroke, and no diminished level of consciousness, primary visual deficits, aphasia, non-stroke related sensory or motor impairments or concomitant cognitive problems that impair ability to follow simple verbal instructions	5.5 days (average)	Star cancellation and letter cancellation (BIT subtests)	RBD: 15/44 (34.1%) LBD: 2/34 (5.9%)
Subacute (1 week to 3 months post-stroke in inpatient rehabilitation and general hospital settings)						
Albert (1973)	Neuropsychology research unit	US	Unilateral cerebral lesion and right-handedness	At least 3 weeks	Line cancellation	RBD: 11/30 (36.7%) LBD: 11/36 (30.6%)
Azouvi et al. (2006)[c]	Subacute facility	France	Subacute stroke	11.02 days (average)	Bells test, figure copying, clock drawing, line bisection, overlapping figures test, reading, and writing	RBD: 175/206 (85.0%) LBD: 34/78 (43.6%)
Chen et al. (2015)[c]	Inpatient rehabilitation facility	US	First stroke, able to complete assessments within 72 hr of admission, unilateral stroke, and 18–99 years old	Admission 6 days (median) Discharge 26 days (median)	Catherine Bergego Scale via Kessler Foundation Neglect Assessment Process	RBD Admission: 65/85 (76.5%) Discharge: 42/74 (56.8%) LBD Admission: 17/36 (47.2%) Discharge: 9/34 (26.5%)

Table 1 (*Continued*)

Study	Setting	Country	Criteria	Time post-stroke	Diagnostic methods and criteria for SN	Rate of SN
Denes et al. (1982)[a]	Department of physical therapy in a geriatric hospital	Italy	Motor deficit after stroke, unilateral stroke, right handedness and no history of motor deficit or neurological disease	Admission 53.5 days (average) Follow-Up 6 months later	Copying Crosses Test	RBD Admission: 8/24 (33.3%) Follow-Up: 7/24 (29.2%) LBD Admission: 5/24 (20.8%) Follow-up: 2/24 (8.3%)
Edmans and Lincoln (1987)[b]	Hospitals	UK	First stroke, unilateral stroke, understand English, hemiplegia, able to sit during assessment, and no previous stroke, head injury or dementia	4 weeks	Cancellation, copying words and copying shapes from the Rivermead Perceptual Assessment Battery	RBD Cancellation Contralateral: 23/75 (30.7%) Ipsilateral: 4/75 (5.3%) Copying Words Contralateral: 7/75 (9.3%) Ipsilateral: 21/75 (28.0%) Copying Shapes Contralateral: 14/75 (18.7%) Ipsilateral: 6/75 (8.0%) LBD Cancellation Contralateral: 6/75 (8.0%) Ipsilateral: 11/75 (14.7%) Copying Words Contralateral: 24/75 (32.0%) Ipsilateral: 2/75 (2.7%) Copying Shapes Contralateral: 9/75 (12.0%) Ipsilateral: 2/75 (2.7%)
Gauthier, Dehaut, and Joanette (1989)	Hospital	Canada	Right handedness, first stroke, unilateral lesions	Within 3 months	Bells Test	RBD: 10/19 (52.6%) LBD: 3/20 (15.0%)
Halligan, Marshall and Wade (1989)	Rehabilitation centre	UK	Right handedness, unilateral stroke and able to understand tasks	85.5 days (average)	BIT	RBD: 26/54 (48.1%) LBD: 4/26 (15.4%)
Kalra et al. (1997)	Stroke unit	UK	Partial anterior circulation infarction, between a 3 and 5 on an impairment scale (so-called "middle group") at 1 to 2 weeks post-stroke, and no hemianopsia and severe dysphasia	1 to 2 weeks	Rivermead Perceptual Assessment Battery	RBD: 32/75 (42.7%) LBD: 15/71 (21.1%)
Korner-Bitensky, Mayo and Kaizer (1990)	Stroke unit of a rehabilitation hospital	Canada	First stroke and no confusion, primary visual impairment, homonymous hemianopsia, neurological condition, severe comprehension disorder, temporary discharge over 10 days, or bilateral motor or sensory loss	59.8 days (average)	Computerised REACT program	RBD: 25/70 (35.7%) LBD: 11/89 (12.4%)
Lafosse et al. (2005)	Rehabilitation centre	Belgium	First stroke, between 35 and 80 years old, unilateral ischemic MCA stroke, and no severe cognitive disorientation, or history of dementia, neurological, or psychiatric disorders	52.29 days (average)	Line cancellation test	RBD: 15/55 (27.3%) LBD: 4/50 (8.0%)

Table 1 (*Continued*)

Study	Setting	Country	Criteria	Time post-stroke	Diagnostic methods and criteria for SN	Rate of SN
Marsh and Kersel (1993)	Stroke rehabilitation unit of a hospital	New Zealand	60 years or older, not blind, at least one functional hand, infarction, and no illness precluding rehab, pre-stroke physical or mental disorder, too disabled to participate	Between 15 and 20 days, with a mean of 17.15 days	Line crossing test, star cancellation test, indented paragraph reading test, line bisection test	RBD: 10/17 (58.8%) LBD: 1/8 (12.5%)
McGlone, Losier and Black (1997)	Hospital	Canada	Acute, unilateral stroke, able to sit up, cooperate and complete the protocol	Within 2 months	Sunnybrook Battery for Hemispatial Neglect (drawing and copying, line bisection, line cancellation, figure cancellation)	RBD: 43/71 (60.6%) LBD: 21/67 (31.3%)
Mosidze, Mkheidze and Makashvili (1994)	Hospital	Georgia	Right handedness, unilateral ischemic stroke, and no hemianopsia, oculomotor disorders, aphasia, bilateral damage or significant differences between patients in treatment procedures or education level	3 weeks	Figure copying	RBD: 39/290 (13.4%) LBD: 1/100 (1.0%)
Nijboer, Kollen and Kwakkel (2013)	Rehabilitation hospital	The Netherlands	Between 30–80 years old, first stroke, MCA or ACA region stroke, unable to walk at first assessment, no complicating medical history, and able to give informed consent	8.13 days (average)	Line bisection	RBD: 42/59 (71.2%) LBD: 9/42 (21.4%)
Nijboer and Van Der Stigchel (2019)	Inpatient rehabilitation hospital	The Netherlands	At least 18 years old, normal or corrected-to-normal visual activity and no severe deficits in communication and/or understanding	34.3 days (average)	Computer-based shape cancellation test	RBD: 27/106 (25.5%) LBD: 12/101 (11.9%)
Nijboer et al. (2013)	Rehabilitation hospitals	The Netherlands	First stroke, one-sided supratentorial lesion, above 18 years old, written or verbal consent, premorbid ability to speak Dutch, and no disabling comorbidity or SAH	50.0 days (average)	Letter cancellation test	RBD: 47/115 (40.9%) LBD: 6/69 (8.7%)
Plourde et al. (1993)	Hospital	Canada	First stroke, unilateral stroke and no neurological disease	Between 1 to 2 months, 46 days (average)	Line cancellation test (Albert's test)	RBD: 19/41 (46.3%) LBD: 5/36 (13.9%)
Rose et al. (1994)	Acute care	Canada	Independent prior to stroke, stroke within 3 weeks, adequate basic touch sensation, first stroke, no history of alcohol or substance abuse, dementia, or psychosis and not extremely frail or visually impaired	1 month	Face-Hand Test of tactile extinction	RBD: 5/14 (35.7%) LBD: 0/5 (0.0%)
Ten Brink et al. (2019)	Inpatient rehabilitation centre	The Netherlands	Assessed on neglect assessment within two weeks of admission and ischemic stroke or delayed cerebral ischemia after SAH	Part 1 25.8 days (average) Part 2 24.4 days (average)	Part 1 Computerised shape cancellation test Part 2 Computerised line bisection	RBD Part 1: 19/51 (37.3%) Part 2: 13/61(21.3%) LBD Part 1: 9/37 (24.3%) Part 2: 5/42 (11.9%)
Ten Brink et al. (2017)[b]	Inpatient rehabilitation centre	The Netherlands	Screened for SN, able to perform the object cancellation task completely, data on hemisphere of lesion and no discrepancy between side of SN between peripersonal and extrapersonal space	24.7 days (average)	Digital object cancellation task, line bisection and Catherine Bergego Scale	RBD Contralateral SN: 41/171 (24.0%) Ipsilateral SN: 11/171 (6.4%) LBD Contralateral SN: 19/146 (13.0%) Ipsilateral SN: 9/146 (6.2%)
Tham and Tegner (1996)[c]	Neurology department of a hospital	Sweden	No requirements	Between 3 and 30 days	Baking Tray Task	RBD: 13/28 (46.4%) LBD: 6/24 (25.0%)

Table 1 (*Continued*)

Study	Setting	Country	Criteria	Time post-stroke	Diagnostic methods and criteria for SN	Rate of SN
Viken et al. (2012)	Neurological department of a university hospital	Sweden	Acute onset of clinical symptoms suggestive of stroke, under 70 years old, ischemic stroke, and no etiology other than ischemic stroke or diagnosis of cancer at an advanced stage, infectious hepatitis or human immunodeficiency viruses	Between 1 and 51 days, 8 days (median)	Star cancellation test	RBD: 46/168 (27.4%) LBD: 33/189 (17.5%)
Post-acute (6 months to 1 year post-stroke in inpatient rehabilitation and general hospital settings)						
Denes et al. (1982)[a]	Department of physical therapy in a geriatric hospital	Italy	Motor deficit after stroke, unilateral stroke, right handedness and no history of motor deficit or neurological disease	Admission 53.5 days (average) Follow-Up 6 months later	Copying Crosses Test	RBD Admission: 8/24 (33.3%) Follow-Up: 7/24 (29.2%) LBD Admission: 5/24 (20.8%) Follow-Up: 2/24 (8.3%)
Chronic (> 1 year post-stroke in community and outpatient clinic settings)						
Linden et al. (2005)	University hospital	Sweden	70 years or older, able to consent and no severe disorders that required specialized care at other units	19.9 months (average)	Star cancellation test	RBD: 15/75 (20.0%) LBD: 7/56 (12.5%)
Other (time post-stroke unspecified or not limited to one specific time frame above, in mixed settings)						
Barbieri and Renzi (1989)	Neurological wards	Italy	Right handedness, able to complete testing and unilateral stroke	Not specified	Picking up circular wells from a wooden board while blindfolded (tactile neglect) and visual, tactile and auditory extinction	RBD Tactile Neglect: 3/38 (7.9%) Extinction: 12/30 (40.0%) LBD Tactile Neglect: 2/46 (4.3%) Extinction: 8/39 (20.5%)
Colombo, De Renzi and Faglioni (1976)	University centre for psychiatric and neurological diseases	Italy	Right handedness, unilateral stroke and able to complete the tests	Not specified	Copying drawings and Raven's CPM	RBD Copying Drawings: 21/53 (39.6%) Raven's CPM: 17/53 (32.1%) LBD Copying Drawings: 16/50 (32.0%) Raven's CPM: 16/50 (32.0%)
Gainotti, Caltagirone and Miceli (1977)	Not specified	Italy	Right handedness, unilateral stroke, able to complete the tasks and no impaired consciousness, history of diffuse or bilateral cerebral damage	Not specified	Raven's CPM	RBD: 96/173 (55.5%) LBD: 37/170 (21.8%)
Gainotti, Messerli and Tissot (1972)	Clinic of mental diseases at a university and neuro-psychological unit of the department of neurology	Italy	Unilateral stroke and able to complete the tasks	Not specified	Copying designs (omissions of small lateral figure, omission of large lateral figure or unfinished figures)	RBD Small Lateral Figure: 32/114 (28.6%) Large Lateral Figure: 19/114 (16.7%) Unfinished Figures: 27/114 (23.7%) LBD Small Lateral Figure: 22/108 (20.4%) Large Lateral Figure: 3/108 (2.8%) Unfinished Figures: 1/108 (0.9%)

Table 1 (*Continued*)

Study	Setting	Country	Criteria	Time post-stroke	Diagnostic methods and criteria for SN	Rate of SN
Meyer et al. (2016)	Neuro-rehabilitation centres	Belgium	First stroke, assessed within 6 months, motor and/or somatosensory impairment in upper limb, 18 years old or older, substantial cooperation to perform assessment, functionally independent pre-strike, and no other neurological impairments, SAH, tumour, encephalitis, TBI, or serious communication or language impairments	Between 12 days and 6 months, with a median 82 days	Star cancellation test	RBD: 22/73 (30.1%) LBD: 5/48 (10.4%)
Paolucci, McKenna and Cooke (2009)[c]	Multiple hospitals, inpatient and outpatient	Australia	18 years or older, medically stable, able to speak, read, understand English, able to complete tasks, participating in OT and allowed by their OT, not too low consciousness, able to use hand for assessment tasks, and no receptive aphasia or disorder of cognitive function	Between 2 and 451 days; 43.5 days (average)	The Occupational Therapist Adult Perceptual Screening Test	RBD; 57/107 (53.3%) LBD: 31/90 (34.4%)
Sunderland, Wade and Langton Hewer (1987)	Stroke registry from general practitioners	UK	First stroke, unilateral stroke and alive at 3 weeks post-stroke	3 weeks, 6 months and 1 year	Raven's CPM	RBD 3 Weeks: 7/67 (10.4%) 6 Months: 2/63 (3.2%) 1 Year: 1/56 (1.8%) LBD 3 Weeks: 4/88 (4.5%) 6 Months: 0/71 (0.0%) 1 Year: 1/67 (1.5%)

ACA: anterior cerebral artery; BIT: Behavioural Inattention Test; LBD: left brain damage; MCA: middle cerebral artery; NIH: National Institutes of Health; OT: occupational therapy; PCA: posterior cerebral artery; Raven's CPM: Raven's Coloured Progressive Matrices; RBD: right brain damage; SAH: subarachnoid hemorrhage; TBI: traumatic brain injury.

[a] Denes et al. (1982) assessed patients at subacute and post-acute stages.
[b] Ten Brink et al. (2017) and Edmans and Lincoln (1987) report both ispi- and contra-lateral neglect rates.
[c] Studies that used ecological assessments.

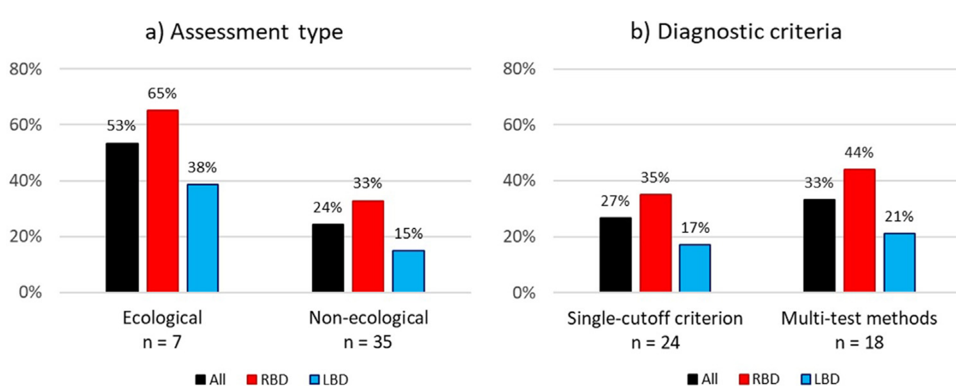

Fig. 2. Prevalence of spatial neglect based on diagnostic methodology. The number of studies is indicated for each category. A total of 41 studies were reviewed, but the total number of studies in (a) is 42 because one study was counted in both categories. The total number of studies in (b) is 42, because one study was excluded and 2 studies were counted in both categories. LBD: left brain damage; RBD: right brain damage.

occurrence rates with ecological assessment and multi-test methods than non-ecological assessment and single-cutoff criterion methods.

4. Discussion

The present systematic review aimed to establish the prevalence of SN after unilateral stroke. For the 41 articles reviewed and a total of 6324 individuals with unilateral stroke, the general occurrence rate of SN was 29%, with greater prevalence after RBD than after LBD (38% vs. 18%). The overall rates were similar in studies published before and after the year 2000, 27% and 32%, respectively. Thus, the estimated prevalence of SN was close to 30% regardless of lesion location, diagnostic methods, or time post-stroke.

SN is indeed more prevalent after RBD than after LBD, and this is true across all 41 studies we reviewed. This result supports that attention networks involve both cerebral hemispheres, but are predominantly located in the right hemisphere [2,58]. From the

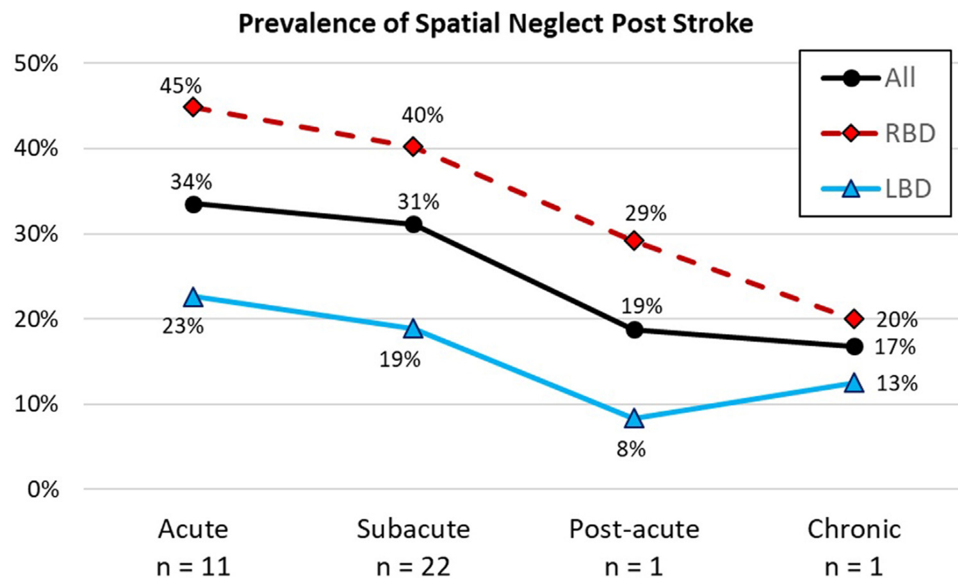

Fig. 3. Prevalence of spatial neglect over time post-stroke. The number of studies is indicated for each category. LBD: left brain damage; RBD: right brain damage.

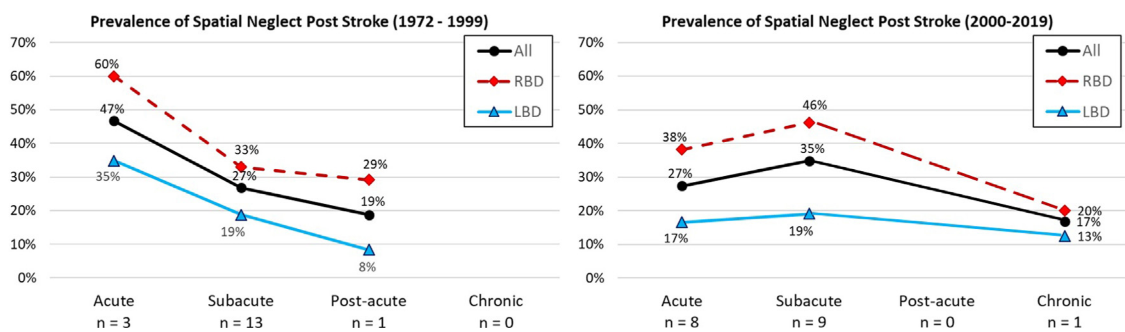

Fig. 4. Prevalence of spatial neglect over time post-stroke before and after year 2000 in the literature. The number of studies is indicated for each category. LBD: left brain damage; RBD: right brain damage.

perspective of clinical care, the prevalence of SN after LBD is lower than that after RBD, but cannot be considered rare. SN post-LBD is usually less severe than SN post-RBD [31,55,102], but the impact of SN on rehabilitation outcomes does not differ between individuals with LBD or RBD stroke [32,103]. We suggest that clinicians screen all stroke patients for SN regardless of the injured hemisphere.

The occurrence rate of SN changes, based on diagnosis methodology. We found that using ecological assessments increased the prevalence as compared with using tests that are not directly related to daily functions. This finding is consistent with the literature demonstrating that ecological assessments are more sensitive to detecting SN than are conventional neuropsychological tests [60,61]. Unlike neuropsychological tests, ecological assessments are often not specific to a perceptual modality, a cognitive domain, or a motor function; rather, ecological assessments evaluate the ability to perform a task that requires all the necessary perceptual, cognitive, and motor elements (e.g., the Baking Tray Test [69] and reading tasks) [104]. If one of the elements is impaired, the task cannot be completed or cannot be completed effectively. Thus, ecological assessments may not lead to an impairment-specific diagnosis (e.g., visual neglect, tactile neglect, representational neglect, or motor neglect), but they are useful in revealing SN symptoms efficiently. The number of studies using ecological assessment was much smaller than that of studies using non-ecological tests (7 vs. 35), but we found a great variety of ecological assessments as well as non-ecological tests for SN. However, we do not have evidence to suggest that using a particular ecological assessment is sufficient to identify all patients with SN.

A comprehensive evaluation with multiple tests and assessments is recommended. As mentioned above, SN is multimodal and can be manifested across domains. One test or single-cutoff criterion is not likely to adequately capture SN impairments, symptoms, or related dysfunctions in a way that multiple tests or a single test performance evaluated multiple ways can. For example, the Bells Test can evaluate SN based on the accurate response, lateralised omission difference, and starting location [60], which is more sensitive to capturing SN than using a single evaluation method [76]. Lindell et al. [105] showed that at least 10 tests were needed to capture all 24 SN patients in their sample of 34 stroke patients with RBD. Consistently, the present review demonstrated that using multi-test methods led to a higher occurrence rate than using a single-cutoff criterion, in both RBD and LBD patients. However, one must keep in mind the risk of false discovery by using multiple screening tests and assessment methods, given the great variety of assessments and tests used in research studies, as revealed by the present review. There is a critical need to determine which tests to include in a battery and how many ways to evaluate performance on a given test. Only then can the “gold standard” of the SN diagnosis be specified.

From the present review, we estimate that one third of stroke survivors at the acute stage have SN. This is alarming because the presence of SN at early stages is associated with poor long-term recovery [41,106,107]. However, SN may be under-detected and

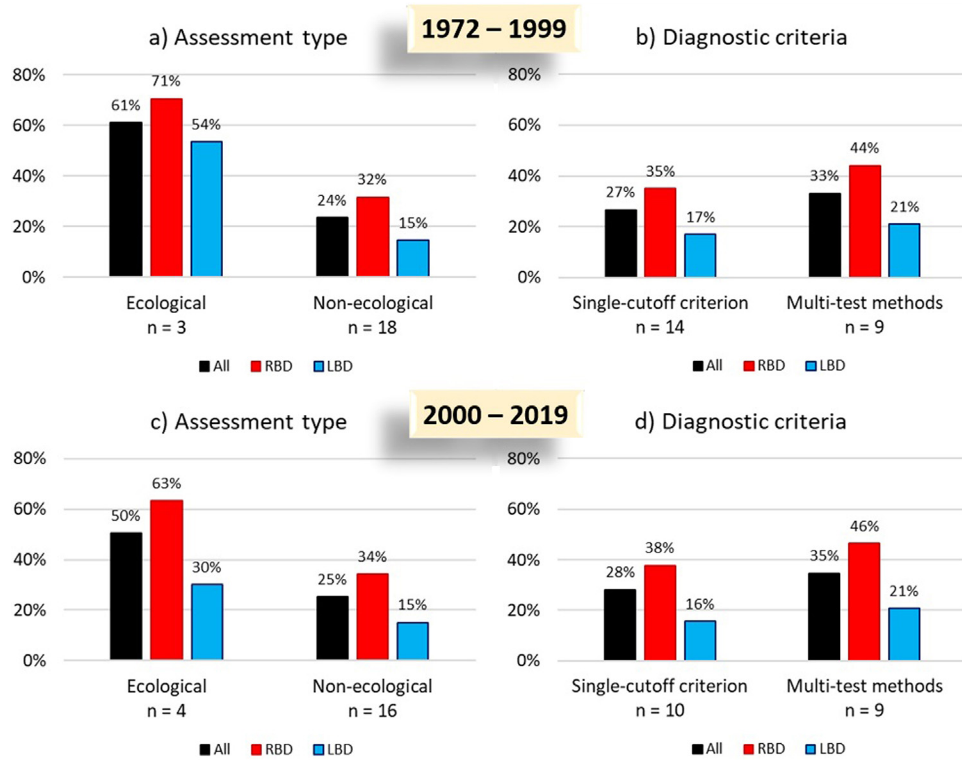

Fig. 5. Prevalence of spatial neglect based on diagnostic methodology before (a,b) and after year 2000 (c,d) in the literature. The number of studies is indicated for each category. LBD: left brain damage; RBD: right brain damage.

thus under-treated clinically [108,109]. Only when SN is detected can the stroke survivor be evaluated in detail and treated properly. The gap between current and best practices with respect to patient assessment prevents people with SN from getting the services they need and contributes to suboptimal patient outcomes [108–112]. Many clinicians misunderstand SN as a visual dysfunction rather than acknowledge it as a cognitive disorder that leads to a wide range of symptoms that are not limited to the visual modality. Some consider SN a "parietal problem" or "right brain problem", and immediately skip SN screening for patients who have subcortical or left-brain lesions [110]. This belief is simply not true; as the present review showed, approximately 20% of people with LBD stroke have SN at the acute and subacute stages.

Our review revealed that the occurrence rate of SN decreased over time, but we acknowledge that the estimated prevalence of SN at post-acute and chronic stages may not be as generalisable as that at acute and sub-acute stages. In addition, when evaluating studies before and after year 2000, the SN occurrence rate appeared to be higher at the subacute than acute stage. This finding could be a result of many factors, such as the changed environment of clinical research and the development of new assessments. Most studies reviewed were conducted at the acute (first week post-stroke in acute-care and general hospital settings) and subacute stages (1 week to 3 months post-stroke in inpatient rehabilitation and general hospital settings). Only one study involved the post-acute category (6 months to one year post-stroke in inpatient rehabilitation and general hospital settings) [48] and one study in the chronic category (> 1 year post-stroke in community and outpatient settings) [88]. Our review criterion mandated that our selected studies include both stroke patients with RBD and those with LBD, which may have reduced the number of usable studies that investigated later stages post-stroke. Although left-sided SN is studied relatively extensively at different stages post-RBD stroke [7,106,113–116], as evidenced by the low number of studies in our review, few studies have focused on chronic SN after LBD. This is a knowledge gap that needs to be addressed by future studies that incorporate comprehensive assessments and follow both LBD and RBD patients from acute to chronic stages.

Although we are unable to estimate the prevalence of SN in later stages post-stroke, the trend of decreasing SN prevalence over time is evident [106,113]. This decrease may be attributed to the effectiveness of rehabilitation care [47] or spontaneous recovery [114]. However, SN can still persist for a long time in some individuals, especially those with brain damage in the ventral frontal cortex [115], superior and middle temporal gyri [116], or basal ganglia [7,116], or a fasciculus connecting occipital, temporal, parietal and frontal cortices [116,117]. It is important to continue seeking effective treatment or tailored neuro-rehabilitative interventions for patients whose SN symptoms persist long after they have completed all the standard rehabilitation therapies.

4.1. Study limitations

There are several limitations of this review. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [118] were followed for the present systematic review study, but the study was not registered at the international prospective register of systematic reviews (PROSPERO) [119]. This oversight may have misled other researchers to perform the same or similar review studies. At the time this study was completed, no systematic review on the same topic of the present study was registered. Therefore, the risk of duplicated efforts is low. Despite having systematically searched 4 electronic databases, we may have missed some relevant studies. Studies may have been published in journals that were not covered by the databases. In addition, this review only included published studies; therefore, studies that were submitted and not accepted for publication or were accepted for publication only recently would be excluded. Only English-written articles were included, so this systematic review may not be a complete representation of the evidence available worldwide. Finally, studies may not have been identified with the search strategy we used, especially considering that SN is a notorious syndrome with various names and definitions. Although we cast a wide net in trying to identify all the published articles focused on all types of SN and lateralised inattention, some articles might not have been considered in the review.

5. Conclusion

The estimated prevalence of SN after unilateral stroke is 30%, regardless of brain lesion location, diagnostic methodology, or time post-stroke. SN is more common after RBD than after LBD, but SN after LBD is still quite common (almost 20%). Using ecological assessments and multi-test methods to detect and diagnose SN is preferred to using a single-cutoff criterion of a test that is not directly related to daily function. We found decreased SN prevalence over time, but the number of studies focused on later stages was not comparable to those focused on earlier stages. More research is needed to better understand chronic SN.

Funding

Part of this work was supported under a grant from the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR; no. 90IFDV0001). NIDILRR is a centre within the Administration for Community Living (ACL), Department of Health and Human Services (HHS) of the United States. The contents of this manuscript do not necessarily represent the policy of NIDILRR, ACL, or HHS, and you should not assume endorsement by the US Federal Government. The work was also partly supported by the Wallerstein Foundation for Geriatric Improvement.

Disclosure of interest

The authors declare that they have no competing interest.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.rehab.2020.10.010.

References

[1] Mesulam MM. Spatial attention and neglect: parietal, frontal and cingulate contributions to the mental representation and attentional targeting of salient extrapersonal events. Philos Trans R Soc Lond B Biol Sci 1999;354:1325–46. http://dx.doi.org/10.1098/rstb.1999.0482 [PubMed PMID: 10466154; PubMed Central PMCID: PMC1692628].

[2] Corbetta M, Shulman GL. Spatial neglect and attention networks. Annu Rev Neurosci 2011;34:569–99. http://dx.doi.org/10.1146/annurev-neuro-061010-113731 [PubMed PMID: 21692662; PubMed Central PMCID: PMC3790661].

[3] Barrett AM, Boukrina O, Saleh S. Ventral attention and motor network connectivity is relevant to functional impairment in spatial neglect after right brain stroke. Brain Cogn 2019;129:16–24. http://dx.doi.org/10.1016/j.bandc.2018.11.013 [PubMed PMID: 30522777; PubMed Central PMCID: PMC6377801].

[4] He BJ, Snyder AZ, Vincent JL, Epstein A, Shulman GL, Corbetta M. Breakdown of functional connectivity in frontoparietal networks underlies behavioural deficits in spatial neglect. Neuron 2007;53:905–18. http://dx.doi.org/10.1016/j.neuron.2007.02.013 [PubMed PMID: 17359924].

[5] Carter AR, McAvoy MP, Siegel JS, Hong X, Astafiev SV, Rengachary J, et al. Differential white matter involvement associated with distinct visuospatial deficits after right hemisphere stroke. Cortex 2017;88:81–97. http://dx.doi.org/10.1016/j.cortex.2016.12.009 [PubMed PMID: 28081452; PubMed Central PMCID: PMC5462627].

[6] Umarova RM, Beume L, Reisert M, Kaller CP, Kloppel S, Mader I, et al. Distinct white matter alterations following severe stroke: longitudinal DTI study in neglect. Neurology 2017;88:1546–55. http://dx.doi.org/10.1212/wnl.0000000000003843 [PubMed PMID: 28330962].

[7] Berger MF, Johannsen L, Karnath HO. Subcortical neglect is not always a transient phenomenon: evidence from a 1-year follow-up study. J Clin Exp Neuropsychol 2009;31:617–23. http://dx.doi.org/10.1080/13803390802403672 [PubMed PMID: 19031324].

[8] Karnath HO, Rorden C. The anatomy of spatial neglect. Neuropsychologia 2012;50:1010–7. http://dx.doi.org/10.1016/j.neuropsychologia.2011.06.027 [PubMed PMID: 21756924; PubMed Central PMCID: PMC3348466].

[9] Thiebaut de Schotten M, Tomaiuolo F, Aiello M, Merola S, Silvetti M, Lecce F, et al. Damage to white matter pathways in subacute and chronic spatial neglect: a group study and 2 single-case studies with complete virtual in vivo tractography dissection. Cereb Cortex 2014;24:691–706. http://dx.doi.org/10.1093/cercor/bhs351 [PubMed PMID: 23162045].

[10] Hillis AE. Neurobiology of unilateral spatial neglect. Neuroscientist 2006;12:153–63. http://dx.doi.org/10.1177/1073858405284257 [PubMed PMID: 16514012].

[11] Heilman KM, Valenstein E. Mechanisms underlying hemispatial neglect. Ann Neurol 1979;5:166–70. http://dx.doi.org/10.1002/ana.410050210 [PubMed PMID: 426480].

[12] Heilman KM, Watson RT, Valenstein E. Neglect and related disorders. In: Heilman KM, Valenstein E, editors. Clinical Neuropsychology. 5th ed, New York: Oxford University; 2012. p. 296–348.

[13] Rode G, Pagliari C, Huchon L, Rossetti Y, Pisella L. Semiology of neglect: an update. Ann Phys Rehabil Med 2017;60:177–85. http://dx.doi.org/10.1016/j.rehab.2016.03.003 [PubMed PMID: 27103056].

[14] Rode G, Fourtassi M, Pagliari C, Pisella L, Rossetti Y. Complexity vs. unity in unilateral spatial neglect. Rev Neurol (Paris) 2017;173:440–50. http://dx.doi.org/10.1016/j.neurol.2017.07.010 [PubMed PMID: 28843415].

[15] Aimola L, Schindler I, Simone AM, Venneri A. Near and far space neglect: task sensitivity and anatomical substrates. Neuropsychologia 2012;50:1115–23. http://dx.doi.org/10.1016/j.neuropsychologia.2012.01.022 [PubMed PMID: 22306826].

[16] Farah MJ, Brunn JL, Wong AB, Wallace MA, Carpenter PA. Frames of reference for allocating attention to space: evidence from the neglect syndrome. Neuropsychologia 1990;28:335–47. http://dx.doi.org/10.1016/0028-3932(90)90060-2 [PubMed PMID: 2342640].

[17] Hillis AE, Rapp B, Benzing L, Caramazza A. Dissociable coordinate frames of unilateral spatial neglect: "viewer-centered" neglect. Brain Cogn 1998;37:491–526. http://dx.doi.org/10.1006/brcg.1998.1010 [PubMed PMID: 9733562].

[18] Medina J, Kannan V, Pawlak MA, Kleinman JT, Newhart M, Davis C, et al. Neural substrates of visuospatial processing in distinct reference frames: evidence from unilateral spatial neglect. J Cogn Neurosci 2009;21:2073–84. http://dx.doi.org/10.1162/jocn.2008.21160 [PubMed PMID: 19016599; PubMed Central PMCID: PMC2828044].

[19] Salvato G, Sedda A, Bottini G. In search of the disappeared half of it: 35 years of studies on representational neglect. Neuropsychology 2014;28:706–16. http://dx.doi.org/10.1037/neu0000062 [PubMed PMID: 24548125].

[20] Fruhmann-Berger M, Karnath HO. Spontaneous eye and head position in patients with spatial neglect. J Neurol 2005;252:1194–200. http://dx.doi.org/10.1007/s00415-005-0831-y [PubMed PMID: 15895307].

[21] Chen P, Hreha K, Fortis P, Goedert KM, Barrett AM. Functional assessment of spatial neglect: a review of the Catherine Bergego Scale and an introduction of the Kessler Foundation Neglect Assessment Process. Top Stroke Rehabil 2012;19:423–35. http://dx.doi.org/10.1310/tsr1905-423 [PubMed PMID: 22982830; PubMed Central PMCID: PMC3445290].

[22] Mark VW. Acute versus chronic functional aspects of unilateral spatial neglect. Front Biosci 2003;8:E172–89. http://dx.doi.org/10.2741/973 [PubMed PMID: 12456357].

[23] van Nes IJW, van Kessel ME, Schils F, Fasotti L, Geurts ACH, Kwakkel G. Is visuospatial hemineglect longitudinally associated with postural imbalance in the postacute phase of stroke? Neurorehabil Neural Repair 2009;23:819–24. http://dx.doi.org/10.1177/1545968309336148 [PubMed PMID: 19465506].

[24] Nijboer TC, Ten Brink AF, van der Stoep N, Visser-Meily JM. Neglecting posture: differences in balance impairments between peripersonal and extrapersonal neglect. Neuroreport 2014;25:1381–5. http://dx.doi.org/10.1097/wnr.0000000000000277 [PubMed PMID: 25340562].

[25] Galletta EE, Campanelli L, Maul KK, Barrett AM. Assessment of neglect dyslexia with functional reading materials. Top Stroke Rehabil 2014;21:75–86. http://dx.doi.org/10.1310/tsr2101-75 [PubMed PMID: 24521842; PubMed Central PMCID: PMC3929236].

[26] Vallar G, Burani C, Arduino LS. Neglect dyslexia: a review of the neuropsychological literature. Exp Brain Res 2010;206:219–35. http://dx.doi.org/10.1007/s00221-010-2386-0 [PubMed PMID: 20714712].

[27] Boukrina O, Chen P, Budinoska T, Barrett AM. Exploratory examination of lexical and neuroanatomic correlates of neglect dyslexia. Neuropsychology 2020;34:404–19. http://dx.doi.org/10.1037/neu0000619 [PubMed PMID: 31999167; PubMed Central PMCID: PMC7249258].

[28] Tromp E, Dinkla A, Mulder T. Walking through doorways: an analysis of navigation skills in patients with neglect. Neuropsychol Rehabil 1995;5:319–31. http://dx.doi.org/10.1080/09602019508401475.

[29] Berti A, Smania N, Rabuffetti M, Ferrarin M, Spinazzola L, D'Amico A, et al. Coding of far and near space during walking in neglect patients. Neuropsychology 2002;16:390–9. http://dx.doi.org/10.1037//0894-4105.16.3.390 [PubMed PMID: 12146686].

[30] Aravind G, Lamontagne A. Perceptual and locomotor factors affect obstacle avoidance in persons with visuospatial neglect. J Neuroeng Rehabil

2014;11:38. http://dx.doi.org/10.1186/1743-0003-11-38 [PubMed PMID: 24645796; PubMed Central PMCID: PMC3994560].
[31] Chen P, Hreha K, Kong Y, Barrett AM. Impact of spatial neglect in stroke rehabilitation: evidence from the setting of an inpatient rehabilitation facility. Arch Phys Med Rehabil 2015;96:1458–66. http://dx.doi.org/10.1016/j.apmr.2015.03.019 [PubMed PMID: 25862254; PubMed Central PMCID: PMC4519421].
[32] Wee JY, Hopman WM. Comparing consequences of right and left unilateral neglect in a stroke rehabilitation population. Am J Phys Med Rehabil 2008;87:910–20. http://dx.doi.org/10.1097/PHM.0b013e3181858bd [PubMed PMID: 18936556].
[33] Navarro MD, Llorens R, Noe E, Ferri J, Alcaniz M. Validation of a low-cost virtual reality system for training street crossing: a comparative study in healthy, neglected and non-neglected stroke individuals. Neuropsychol Rehabil 2013;23:597–618. http://dx.doi.org/10.1080/09602011.2013.806269 [PubMed PMID: 23767963].
[34] Kim J, Kim K, Kim DY, Chang WH, Park CI, Ohn SH, et al. Virtual environment training system for rehabilitation of stroke patients with unilateral neglect: crossing the virtual street. Cyberpsychol Behav 2007;10:7–15. http://dx.doi.org/10.1089/cpb.2006.9998 [PubMed PMID: 17305443].
[35] Jehkonen M, Ahonen JP, Dastidar P, Koivisto AM, Laippala P, Vilkki J, et al. Predictors of discharge to home during the first year after right hemisphere stroke. Acta Neurol Scand 2001;104:136–41. http://dx.doi.org/10.1034/j.1600-0404.2001.00025.x [PubMed PMID: 11551232].
[36] Berti A, Ladavas E, Della Corte M. Anosognosia for hemiplegia, neglect dyslexia, and drawing neglect: clinical findings and theoretical considerations. J Int Neuropsychol Soc 1996;2:426–40. http://dx.doi.org/10.1017/S135561770000151X [PubMed PMID: 9375168].
[37] Ronchi R, Bolognini N, Gallucci M, Chiapella L, Algeri L, Spada MS, et al. (Un)awareness of unilateral spatial neglect: a quantitative evaluation of performance in visuospatial tasks. Cortex 2014;61:167–82. http://dx.doi.org/10.1016/j.cortex.2014.10.004 [PubMed PMID: 25481474].
[38] Tham K, Borell L, Gustavsson A. The discovery of disability: a phenomenological study of unilateral neglect. Am J Occup Ther 2000;54:398–406. http://dx.doi.org/10.5014/ajot.54.4.398 [PubMed PMID: 10932310].
[39] Chen P, Toglia J. Online and offline awareness deficits: anosognosia for spatial neglect. Rehabil Psychol 2019;64:50–64. http://dx.doi.org/10.1037/rep0000207 [PubMed PMID: 29648845].
[40] Kong KH, Chua KSG, Lee J. Recovery of upper limb dexterity in patients more than 1 year after stroke: frequency, clinical correlates and predictors. NeuroRehabilitation 2011;28:105–11. http://dx.doi.org/10.3233/nre-2011-0639 [PubMed PMID: 21447911].
[41] Nijboer TC, van de Port I, Schepers V, Post M, Visser-Meily A. Predicting functional outcome after stroke: the influence of neglect on basic activities in daily living. Front Hum Neurosci 2013;7:e00182. http://dx.doi.org/10.3389/fnhum.2013.00182 [PubMed PMID: 23675336; PubMed Central PMCID: PMC3650314].
[42] Nijboer TC, Kollen BJ, Kwakkel G. The impact of recovery of visuospatial neglect on motor recovery of the upper paretic limb after stroke. PLoS ONE 2014;9:e100584. http://dx.doi.org/10.1371/journal.pone.0100584 [PubMed PMID: 24950224; PubMed Central PMCID: PMC4065089].
[43] Nijboer TC, Kollen BJ, Kwakkel G. Time course of visuospatial neglect early after stroke: a longitudinal cohort study. Cortex 2013;49:2021–7. http://dx.doi.org/10.1016/j.cortex.2012.11.006 [PubMed PMID: 23332473].
[44] Chen P, Fyffe DC, Hreha K. Informal caregivers' burden and stress in caring for stroke survivors with spatial neglect: an exploratory mixed-method study. Top Stroke Rehabil 2017;24:24–33. http://dx.doi.org/10.1080/10749357.2016.1186373 [PubMed PMID: 27216085].
[45] Buxbaum LJ, Ferraro MK, Veramonti T, Farne A, Whyte J, Ladavas E, et al. Hemispatial neglect: subtypes, neuroanatomy, and disability. Neurology 2004;62:749–56. http://dx.doi.org/10.1212/01.wnl.0000113730.73031.f4 [PubMed PMID: 15007125].
[46] Bowen A, McKenna K, Tallis RC. Reasons for variability in the reported rate of occurrence of unilateral spatial neglect after stroke. Stroke 1999;30:1196–202. http://dx.doi.org/10.1161/01.str.30.6.1196 [PubMed PMID: 10356099].
[47] Chen P, Chen CC, Hreha K, Goedert KM, Barrett AM. Kessler Foundation Neglect Assessment Process uniquely measures spatial neglect during activities of daily living. Arch Phys Med Rehabil 2015;96:869–76. http://dx.doi.org/10.1016/j.apmr.2014.10.023 [PubMed PMID: 25461827; PubMed Central PMCID: PMC4410062].
[48] Denes G, Semenza C, Stoppa E, Lis A. Unilateral spatial neglect and recovery from hemiplegia: a follow-up study. Brain 1982;105:543–52. http://dx.doi.org/10.1093/brain/105.3.543 [PubMed PMID: 7104665].
[49] Fullerton KJ, McSherry D, Stout RW. Albert's test: a neglected test of perceptual neglect. Lancet 1986;1:430–2. http://dx.doi.org/10.1016/s0140-6736(86)92381-0 [PubMed PMID: 2868349].
[50] Gainotti G, Messerli P, Tissot R. Qualitative analysis of unilateral spatial neglect in relation to laterality of cerebral lesions. J Neurol Neurosurg Psychiatry 1972;35:545–50. http://dx.doi.org/10.1136/jnnp.35.4.545 [PubMed PMID: 5049813; PubMed Central PMCID: PMC494120].
[51] Kalra L, Perez I, Gupta S, Wittink M. The influence of visual neglect on stroke rehabilitation. Stroke 1997;28:1386–91. http://dx.doi.org/10.1161/01.str.28.7.1386 [PubMed PMID: 9227688].
[52] McGlone J, Losier BJ, Black SE. Are there sex differences in hemispatial visual neglect after unilateral stroke? Neuropsychiatry Neuropsychol Behav Neurol 1997;10:125–34 [PubMed PMID: 9150514].
[53] Ringman JM, Saver JL, Woolson RF, Clarke WR, Adams HP. Frequency, risk factors, anatomy, and course of unilateral neglect in an acute stroke cohort. Neurology 2004;63:468–74. http://dx.doi.org/10.1212/01.wnl.0000133011.10689.ce [PubMed PMID: 15304577].
[54] Stone SP, Halligan PW, Greenwood RJ. The incidence of neglect phenomena and related disorders in patients with an acute right or left hemisphere stroke. Age Ageing 1993;22:46–52. http://dx.doi.org/10.1093/ageing/22.1.46 [PubMed PMID: 8438666].
[55] Ten Brink AF, Verwer JH, Biesbroek JM, Visser-Meily JMA, Nijboer TCW. Differences between left- and right-sided neglect revisited: a large cohort study across multiple domains. J Clin Exp Neuropsychol 2017;39:707–23. http://dx.doi.org/10.1080/13803395.2016.1262333 [PubMed PMID: 27951747].
[56] Hammerbeck U, Gittins M, Vail A, Paley L, Tyson SF, Bowen A. Spatial neglect in stroke: identification, disease process and association with outcome during inpatient rehabilitation. Brain Sci 2019;9. http://dx.doi.org/10.3390/brainsci9120374 [PubMed PMID: 31847166; PubMed Central PMCID: PMC6956021].
[57] Beis JM, Keller C, Morin N, Bartolomeo P, Bernati T, Chokron S, et al. Right spatial neglect after left hemisphere stroke: qualitative and quantitative study. Neurology 2004;63:1600–5. http://dx.doi.org/10.1212/01.wnl.0000142967.60579.32 [PubMed PMID: 15534242].
[58] Heilman KM, Van Den Abell T. Right-hemisphere dominance for attention: the mechanism underlying hemispheric asymmetries of inattention (neglect). Neurology 1980;30:327–30. http://dx.doi.org/10.1212/wnl.30.3.327 [PubMed PMID: 7189037].
[59] Azouvi P. The ecological assessment of unilateral neglect. Ann Phys Rehabil Med 2017;60:186–90. http://dx.doi.org/10.1016/j.rehab.2015.12.005 [PubMed PMID: 26830087].
[60] Azouvi P, Samuel C, Louis-Dreyfus A, Bernati T, Bartolomeo P, Beis JM, et al. Sensitivity of clinical and behavioural tests of spatial neglect after right hemisphere stroke. J Neurol Neurosurg Psychiatry 2002;73:160–6. http://dx.doi.org/10.1136/jnnp.73.2.160 [PubMed PMID: 12122175; PubMed Central PMCID: PMC1737990].
[61] Pitteri M, Chen P, Passarini L, Albanese S, Meneghello F, Barrett AM. Conventional and functional assessment of spatial neglect: clinical practice suggestions. Neuropsychology 2018;32:835–42. http://dx.doi.org/10.1037/neu0000469 [PubMed PMID: 29975073; PubMed Central PMCID: PMC6188804].
[62] Adair JC, Barrett AM. Spatial neglect: clinical and neuroscience review: a wealth of information on the poverty of spatial attention. Ann N Y Acad Sci 2008;1142:21–43. http://dx.doi.org/10.1196/annals.1444.008 [PubMed PMID: 18990119; PubMed Central PMCID: PMC2962986].
[63] Harvey M, Rossit S. Visuospatial neglect in action. Neuropsychologia 2012;50:1018–28. http://dx.doi.org/10.1016/j.neuropsychologia.2011.09.030 [PubMed PMID: 21978832].
[64] Ogourtsova T, Archambault P, Lamontagne A. Impact of post-stroke unilateral spatial neglect on goal-directed arm movements: systematic literature review. Top Stroke Rehabil 2015;22:397–428. http://dx.doi.org/10.1179/1074935714z.0000000046 [PubMed PMID: 25906788].
[65] Tanaka H, Hachisuka K, Ogata H. Sound lateralisation in patients with left or right cerebral hemispheric lesions: relation with unilateral visuospatial neglect. J Neurol Neurosurg Psychiatry 1999;67:481–6. http://dx.doi.org/10.1136/jnnp.67.4.481 [PubMed PMID: 10486395; PubMed Central PMCID: PMC1736561].
[66] Wilson B, Cockburn J, Halligan PW. Behavioural Inattention Test. London: Thames Valley Test Company; 1987.
[67] Halligan PW, Cockburn J, Wilson BA. The behavioural assessment of visual neglect. Neuropsychol Rehabil 1991;1:5–32. http://dx.doi.org/10.1080/09602019108401377.
[68] Halligan PW, Robertson I, Pizzamiglio L, Homberg V, Weber E, Bergego C. The laterality of visual neglect after right hemisphere damage. Neuropsychol Rehabil 1991;1:281–301. http://dx.doi.org/10.1080/09602019108402259.
[69] Tham K, Tegner R. The baking tray task: a test of spatial neglect. Neuropsychol Rehabil 1996;6:19–25. http://dx.doi.org/10.1080/713755496 [PubMed PMID: 22106860].
[70] Azouvi P, Marchal F, Samuel C, Morin L, Renard C, LouisDreyfus A, et al. Functional consequences and awareness of unilateral neglect: study of an evaluation scale. Neuropsychol Rehabil 1996;6:133–50. http://dx.doi.org/10.1080/713755501.
[71] Siekierka-Kleiser EM, Kleiser R, Wohlschlager AM, Freund HJ, Seitz RJ. Quantitative assessment of recovery from motor hemineglect in acute stroke patients. Cerebrovasc Dis 2006;21:307–14. http://dx.doi.org/10.1159/000091535 [PubMed PMID: 16490939].
[72] Champod AS, Frank RC, Taylor K, Eskes GA. The effects of prism adaptation on daily life activities in patients with visuospatial neglect: a systematic review. Neuropsychol Rehabil 2018;28:491–514. http://dx.doi.org/10.1080/09602011.2016.1182032 [PubMed PMID: 27181587].
[73] Appelros P, Karlsson GM, Seiger A, Nydevik I. Neglect and anosognosia after first-ever stroke: incidence and relationship to disability. J Rehabil Med 2002;34:215–20. http://dx.doi.org/10.1080/165019702760279206 [PubMed PMID: 12392236].
[74] Stone SP, Wilson B, Wroot A, Halligan PW, Lange LS, Marshall JC, et al. The assessment of visuospatial neglect after acute stroke. J Neurol Neurosurg Psychiatry 1991;54:345–50. http://dx.doi.org/10.1136/jnnp.54.4.345 [PubMed PMID: 2056321; PubMed Central PMCID: PMC488491].

[75] Paolucci A, McKenna K, Cooke DM. Factors affecting the number and type of impairments of visual perception and praxis following stroke. Austr Occup Ther J 2009;56:350–60. http://dx.doi.org/10.1111/j.1440-1630.2008.00743.x [PubMed PMID: 20854541].
[76] Azouvi P, Bartolomeo P, Beis JM, Perennou D, Pradat-Diehl P, Rousseaux M. A battery of tests for the quantitative assessment of unilateral neglect. Restor Neurol Neurosci 2006;24:273–85 [PubMed PMID: 17119304].
[77] Albert ML. A simple test of visual neglect. Neurology 1973;23:658–64. http://dx.doi.org/10.1212/wnl.23.6.658 [PubMed PMID: 4736313].
[78] Barbieri C, De Renzi E. Patterns of neglect dissociation. Behav Neurol 1989;2:13–24. http://dx.doi.org/10.3233/ben-1989-2102 [PubMed PMID: 24486942].
[79] Becker E, Karnath HO. Incidence of visual extinction after left versus right hemisphere stroke. Stroke 2007;38:3172–4. http://dx.doi.org/10.1161/strokeaha.107.489096 [PubMed PMID: 17962601].
[80] Becker E, Karnath HO. Neuroimaging of eye position reveals spatial neglect. Brain 2010;133:909–14. http://dx.doi.org/10.1093/brain/awq011 [PubMed PMID: 20157012].
[81] Colombo A, De Renzi E, Faglioni P. The occurrence of visual neglect in patients with unilateral cerebral disease. Cortex 1976;12:221–31. http://dx.doi.org/10.1016/s0010-9452(76)80003-2 [PubMed PMID: 1000990].
[82] Edmans JA, Lincoln NB. The frequency of perceptual deficits after stroke. Clin Rehabil 1987;1:273–81. http://dx.doi.org/10.1177/026921558700100403.
[83] Gainotti G, Caltagirone C, Miceli G. Poor performance of right brain-damaged patients on Raven's coloured matrices: derangement of general intelligence or of specific abilities? Neuropsychologia 1977;15:675–80. http://dx.doi.org/10.1016/0028-3932(77)90071-9 [PubMed PMID: 896023].
[84] Halligan PW, Marshall JC, Wade DT. Visuospatial neglect: underlying factors and test sensitivity. Lancet 1989;2:908–11. http://dx.doi.org/10.1016/s0140-6736(89)91561-4 [PubMed PMID: 2571823].
[85] Korner-Bitensky N, Mayo NE, Kaizer F. Change in response time of stroke patients and controls during rehabilitation. Am J Phys Med Rehabil 1990;69:32–8. http://dx.doi.org/10.1097/00002060-199002000-00008 [PubMed PMID: 2302336].
[86] Kumral E, Bayulkem G, Evyapan D, Yunten N. Spectrum of anterior cerebral artery territory infarction: clinical and MRI findings. Eur J Neurol 2002;9:615–24. http://dx.doi.org/10.1046/j.1468-1331.2002.00452.x [PubMed PMID: 12453077].
[87] Lafosse C, Kerckhofs E, Troch M, Vereeck L, Van Hoydonck G, Moeremans M, et al. Contraversive pushing and inattention of the contralesional hemispace. J Clin Exp Neuropsychol 2005;27:460–84. http://dx.doi.org/10.1080/13803390490520463 [PubMed PMID: 15962692].
[88] Linden T, Samuelsson H, Skoog I, Blomstrand C. Visual neglect and cognitive impairment in elderly patients late after stroke. Acta Neurol Scand 2005;111:163–8. http://dx.doi.org/10.1111/j.1600-0404.2005.00391.x [PubMed PMID: 15691284].
[89] Marsh NV, Kersel DA. Screening tests for visual neglect following stroke. Neuropsychol Rehabil 1993;3:245–57. http://dx.doi.org/10.1080/09602019308401439.
[90] Meyer S, De Bruyn N, Lafosse C, Van Dijk M, Michielsen M, Thijs L, et al. Somatosensory impairments in the upper limb post-stroke: distribution and association with motor function and visuospatial neglect. Neurorehabil Neural Repair 2016;30:731–42. http://dx.doi.org/10.1177/1545968315624779 [PubMed PMID: 26719352].
[91] Mosidze VM, Mkheidze RA, Makashvili MA. Disorders of visuospatial attention in patients with unilateral brain damage. Behav Brain Res 1994;65:121–2. http://dx.doi.org/10.1016/0166-4328(94)90081-7 [PubMed PMID: 7880451].
[92] Motomura N, Yamadori A, Mori E, Ogura J, Sakai T, Sawada T. Unilateral spatial neglect due to hemorrhage in the thalamic region. Acta Neurol Scand 1986;74:190–4. http://dx.doi.org/10.1111/j.1600-0404.1986.tb07854.x [PubMed PMID: 3788481].
[93] Nijboer TCW, Van der Stigchel S. Visuospatial neglect is more severe when stimulus density is large. J Clin Exp Neuropsychol 2019;41:399–410. http://dx.doi.org/10.1080/13803395.2019.1566444 [PubMed PMID: 30727817].
[94] Plourde G, Joanette Y, Fontaine FS, Laplante L, Renaseau-Leclerc C. The severity of visual hemineglect follows a bimodal frequency distribution. Brain Cogn 1993;21:131–9. http://dx.doi.org/10.1006/brcg.1993.1010 [PubMed PMID: 8442930].
[95] Rose L, Bakal DA, Fung TS, Farn P, Weaver LE. Tactile extinction and functional status after stroke: a preliminary investigation. Stroke 1994;25:1973–6. http://dx.doi.org/10.1161/01.str.25.10.1973 [PubMed PMID: 8091440].
[96] Sunderland A, Wade DT, Langton Hewer R. The natural history of visual neglect after stroke. Indications from two methods of assessment. Int Disabil Stud 1987;9:55–9. http://dx.doi.org/10.3109/03790798709166235 [PubMed PMID: 3680107].
[97] Tatuene JK, Allali G, Saj A, Bernati T, Sztajzel R, Pollak P, et al. Incidence, risk factors and anatomy of peripersonal visuospatial neglect in acute stroke. Eur Neurol 2016;75:157–63. http://dx.doi.org/10.1159/000444709 [PubMed PMID: 26937947].
[98] Ten Brink AF, Biesbroek JM, Oort Q, Visser-Meily JMA, Nijboer TCW. Peripersonal and extrapersonal visuospatial neglect in different frames of reference: a brain lesion-symptom mapping study. Behav Brain Res 2019;356:504–15. http://dx.doi.org/10.1016/j.bbr.2018.06.010 [PubMed PMID: 29940260].
[99] van Nes IJW, van der Linden S, Hendricks HT, van Kuijk AA, Rulkens M, Verhagen WIM, et al. Is visuospatial hemineglect really a determinant of postural control following stroke? An acute-phase study. Neurorehabil Neural Repair 2009;23:609–14. http://dx.doi.org/10.1177/1545968308328731 [PubMed PMID: 19118129].
[100] Viken JI, Samuelsson H, Jern C, Jood K, Blomstrand C. The prediction of functional dependency by lateralised and non-lateralised neglect in a large prospective stroke sample. Eur J Neurol 2012;19:128–34. http://dx.doi.org/10.1111/j.1468-1331.2011.03449.x [PubMed PMID: 21631651].
[101] Gauthier L, Dehaut F, Joanette Y. The bells test: a quantitative and qualitative test for visual neglect. Int J Clin Neuropsychol 1989;11:49–54.
[102] Suchan J, Rorden C, Karnath HO. Neglect severity after left and right brain damage. Neuropsychologia 2012;50:1136–41. http://dx.doi.org/10.1016/j.neuropsychologia.2011.12.018 [PubMed PMID: 22230231; PubMed Central PMCID: PMC3348265].
[103] Yoshida T, Mizuno K, Miyamoto A, Kondo K, Liu M. Influence of right versus left unilateral spatial neglect on the functional recovery after rehabilitation in sub-acute stroke patients. Neuropsychol Rehabil 2020;1–22. http://dx.doi.org/10.1080/09602011.2020.1798255 [PubMed PMID: 32703088].
[104] Beschin N, Cisari C, Cubelli R, Della Sala S. Prose reading in neglect. Brain Cogn 2014;84:69–75. http://dx.doi.org/10.1016/j.bandc.2013.11.002 [PubMed PMID: 24321197].
[105] Lindell AB, Jalas MJ, Tenovuo O, Brunila T, Voeten MJM, Hamalainen H. Clinical assessment of hemispatial neglect: evaluation of different measures and dimensions. Clin Neuropsychol 2007;21:479–97. http://dx.doi.org/10.1080/13854040600630061 [PubMed PMID: 17455032].
[106] Farne A, Buxbaum LJ, Ferraro M, Frassinetti F, Whyte J, Veramonti T, et al. Patterns of spontaneous recovery of neglect and associated disorders in acute right brain-damaged patients. J Neurol Neurosurg Psychiatry 2004;75:1401–10. http://dx.doi.org/10.1136/jnnp.2002.003095 [PubMed PMID: 15377685; PubMed Central PMCID: PMC1738754].
[107] Oh-Park M, Hung C, Chen P, Barrett AM. Severity of spatial neglect during acute inpatient rehabilitation predicts community mobility after stroke. PM R 2014;6:716–22. http://dx.doi.org/10.1016/j.pmrj.2014.01.002 [PubMed PMID: 24412266; PubMed Central PMCID: PMC4090300].
[108] Chen P, McKenna C, Kutlik AM, Frisina PG. Interdisciplinary communication in inpatient rehabilitation facility: evidence of under-documentation of spatial neglect after stroke. Disabil Rehabil 2013;35:1033–8. http://dx.doi.org/10.3109/09638288.2012.717585 [PubMed PMID: 23072734; PubMed Central PMCID: PMC3660412].
[109] Edwards DF, Hahn MG, Baum CM, Perlmutter MS, Sheedy C, Dromerick AW. Screening patients with stroke for rehabilitation needs: validation of the post-stroke rehabilitation guidelines. Neurorehabil Neural Repair 2006;20:42–8. http://dx.doi.org/10.1177/1545968305283038 [PubMed PMID: 16467277].
[110] Menon-Nair A, Korner-Bitensky N, Wood-Dauphinee S, Robertson E. Assessment of unilateral spatial neglect post stroke in Canadian acute care hospitals: are we neglecting neglect? Clin Rehabil 2006;20:623–34. http://dx.doi.org/10.1191/0269215506cr974oa [PubMed PMID: 16894806].
[111] Menon-Nair A, Korner-Bitensky N, Ogourtsova T. Occupational therapists' identification, assessment, and treatment of unilateral spatial neglect during stroke rehabilitation in Canada. Stroke 2007;38:2556–62. http://dx.doi.org/10.1161/strokeaha.107.484857 [PubMed PMID: 17673707].
[112] Petzold A, Korner-Bitensky N, Salbach NM, Ahmed S, Menon A, Ogourtsova T. Determining the barriers and facilitators to adopting best practices in the management of post-stroke unilateral spatial neglect: results of a qualitative study. Top Stroke Rehabil 2014;21:228–36. http://dx.doi.org/10.1310/tsr2103-228 [PubMed PMID: 24985390].
[113] Cassidy TP, Lewis S, Gray CS. Recovery from visuospatial neglect in stroke patients. J Neurol Neurosurg Psychiatry 1998;64:555–7. http://dx.doi.org/10.1136/jnnp.64.4.555 [PubMed PMID: 9576556; PubMed Central PMCID: PMC2170051].
[114] Jehkonen M, Laihosalo M, Koivisto AM, Dastidar P, Ahonen JP. Fluctuation in spontaneous recovery of left visual neglect: a one-year follow-up. Eur Neurol 2007;58:210–4. http://dx.doi.org/10.1159/000107941 [PubMed PMID: 17823534].
[115] Rengachary J, He BJ, Shulman GL, Corbetta M. A behavioural analysis of spatial neglect and its recovery after stroke. Front Hum Neurosci 2011;5:29. http://dx.doi.org/10.3389/fnhum.2011.00029 [PubMed PMID: 21519374; PubMed Central PMCID: PMC3075878].
[116] Karnath HO, Rennig J, Johannsen L, Rorden C. The anatomy underlying acute versus chronic spatial neglect: a longitudinal study. Brain 2011;134:903–12. http://dx.doi.org/10.1093/brain/awq355 [PubMed PMID: 21156661; PubMed Central PMCID: PMC3044829].
[117] Shah P, Spaldo N, Barrett AM, Chen P. Assessment and functional impact of allocentric neglect: a reminder from a case study. Clin Neuropsychol 2013;27:840–63. http://dx.doi.org/10.1080/13854046.2013.783120 [PubMed PMID: 23560431; PubMed Central PMCID: PMC3759518].
[118] PRISMA.. PRISMA: transparent reporting of systematic reviews and meta-analysis 2015; 2015 [cited 2019 February 1; available from: http://www.prisma-statement.org/].
[119] Centres for Reviews and Dissemination of University of York. PROSPERO: International prospective register of systematic reviews. Available from: https://www.crd.york.ac.uk/prospero/.