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The Impact of Visual Impairment in Stroke (IVIS) Study – Evidence of Reproducibility

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ABSTRACT

Reporting generalisable data across stroke populations is important. We aimed to evaluate the Impact of Visual Impairment after Stroke (IVIS) visual assessment protocol in a different UK geographical area. This was a single-centre acute stroke unit, prospective study (IVIS-extension (IVIS-e) study) with comparison to a multi-centre acute stroke cohort (IVIS study). Orthoptists reviewed all stroke survivors with a standardised assessment of visual acuity, visual fields, ocular alignment, ocular motility, visual inattention and visual perception including a standardised follow-up strategy. 123 stroke survivors underwent visual screening: 42% women, 58% men, mean age 63.6 years and 86% ischaemic strokes. Ethnicity consisted of 68.3% white British and 28.5% being Pakistani, Indian, Caribbean, Bangladeshi, Black and Chinese. Two died and 28 could not be assessed. Of the 93 remaining, 10 stroke survivors (10.8%) had a normal visual assessment and 83 (89.2%) had visual impairments detected. Fifty-seven stroke survivors were assessed at their first orthoptic visit within 3 days of stroke onset; the remainder being assessed at subsequent orthoptic visits to the stroke unit. The visual profile was similar across the IVIS-e and original IVIS cohorts for most types of visual impairment although, overall, more visual impairment was detected in IVIS-e. Differences between the cohorts were primarily related to lower age and smaller white British ethnicity in the IVIS-e cohort. This likely relates to the differing population demographics for the two cohort geographical areas. Further roll-out of the IVIS assessment protocol to other regions and countries would improve detection of post-stroke visual impairment.

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Introduction

Visual impairment is highly prevalent in stroke populations and may encompass impaired central vision, visual field loss, eye movement deficits and/or visual perception deficits.[1] The prevalence of each type varies and although visual field loss and visual inattention are widely recognised post stroke, impaired central vision and eye movement deficits occur more commonly.[2]

Whilst there are studies on individual types of stroke-related visual impairment such as hemianopia and visual inattention, there are few that study visual impairment broadly. Ali and colleagues reported visual impairment data extracted from the Virtual Internet Stroke Trials Archive based on horizontal eye movement and visual field loss detection with the National Institute for Health Stroke Scale.[3] At baseline, collated trial data estimated visual impairment in 60.5%. In a convenience sample from two stroke units, Siong et al. reported prevalence of visual problems among stroke survivors in Hong Kong Chinese.[4] They found that, overall, the percentage of visual problems in their population was lower than that in Western populations. They confirmed a high percentage of eye movement abnormalities in 53.1%, a similar occurrence of visual field loss (26.5%) but lower occurrence of impaired central vision (29.8%). In Norway, responses to a postal questionnaire sent to stroke survivors 6 months after their stroke indicated that visual problems were experienced by 25.4%.[5] A study of consecutive stroke survivors on a stroke rehabilitation unit in the UK reported 28.6% with impaired central vision, 19.5% with visual field loss and 2.6% with diplopia.[6] There are clear differences in prevalence of visual impairment across these studies which likely relate to referrals from different settings (acute stroke units versus stroke rehabilitation units versus community), timing of assessment (acute versus chronic stroke), screening versus full visual

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assessment and eye specialist versus non-eye-trained clinician assessments.

In recent years the Impact of Visual Impairment after Stroke (IVIS) study was undertaken to establish incidence of new-onset visual impairment following stroke.[7] This prospective epidemiology study reported 60% incidence of new onset visual impairment and point prevalence of 73% visual impairment (new and prior visual impairment) in stroke survivors receiving in-patient acute stroke unit specialist visual assessment. Within this cohort, impaired central vision was reported in 56%, eye movement abnormalities in 40%, visual field loss in 28%, visual inattention in 27% and visual perceptual disorders in 5%.

The IVIS study introduced a standardised vision assessment protocol across three acute stroke units in the North West of England and found similar rates of visual impairment across each of these stroke units.[7] The demographic population across these units was also similar for ethnicity (predominantly white British), gender and age at stroke. In order to consider generalisability/external validity (extent to which the findings of a study can be applicable to other settings), applicability (using inferences drawn from one study to another population) and reproducibility (findings of a study can be reproduced in a different environment and team) of the IVIS results we sought to evaluate the IVIS visual assessment protocol in a different geographical area in the UK with a population demographic different to the IVIS study. In this study, we report the use of the IVIS vision assessment protocol in an acute stroke unit in Bradford – the IVIS extension (IVIS-e) study. Bradford is the fifth largest metropolitan district in England and the larger population of Bradford is dominated by younger age groups with nearly 70% aged less than 50 years old.[8,9] The Bradford population is ethnically diverse with 64% identified as white British and with the largest proportion of people with Pakistani ethnic origin in England at 20%.[8,9]

Methods

Population

The incidence and point prevalence of visual impairment for the IVIS study have been fully reported previously.[7] In brief, IVIS recruited 1295 stroke admissions over a 1-year period from July 2014 to June 2015. The target population for the IVIS study and for the IVIS-e study was stroke survivors in the acute phase (within 2 weeks post-stroke onset) following admission to hospital with a clinical diagnosis of stroke confirmed by the admitting stroke physician.

Ethical approval was obtained from the Health Regulatory Authority (Research Ethics Committee reference 14/NW/0166) and the study was undertaken in accordance with the Tenets of Helsinki. This paper was written in accordance with the STROBE statement.[10]

Exclusion criteria were stroke survivors less than 18 years old. Inclusion criteria were stroke survivors 18 years of age or older with the ability to agree to vision assessment using verbal or non-verbal indications of agreement.

Recruitment

The IVIS-e cohort captured all stroke admissions over a 3-month time period. On a daily basis, the stroke research nurse team identified all stroke admissions to each of the recruiting stroke units. Details of each admitted patient (name, date of birth and hospital identification number) were forwarded to the research orthoptists. First visit for attempted vision assessment was made at the next designated orthoptic session on the stroke unit. The stroke unit had a minimum of two orthoptic sessions per week.

Assessment

Assessments on the stroke unit were carried out at the patient's bedside using portable equipment. Data were collected with regard to stroke type, gender, age at stroke, ethnicity and stroke severity. Following a review of the hospital notes for previous ocular history and case history taking from the patient and/or carer, a full, new comprehensive assessment of visual function was made with measurement of:

(1) Visual acuity for near and distance, monocular and binocular (logMAR,

Cardiff acuity cards, Vocational near visual acuity),
(2) Reading ability (Radner reading test),
(3) Colour vision (City test) and contrast sensitivity assessment (MARs test),
(4) Ocular alignment assessment (cover/uncover test),
(5) Rotation of eye movements (saccadic and smooth pursuit movements),
(6) Vergence (near point of convergence, divergence ability),
(7) Stereopsis (Frisby test plate),
(8) Fusional vergence (20 prism dioptre base-out, prism fusion range),
(9) Lid and pupil function,
(10) Visual field assessment (visual fields to confrontation, static/kinetic perimetry),
(11) Visual perception (questionnaire),
(12) Visual inattention (line bisection, cancellation task, clock drawing, memory-guided tasks, room description).

All assessments were carried out by stroke specialist orthoptists with expertise in working with this population of patients and following a standardised strategy (Figure 1).

Categories of visual problems

Types of visual problems were assigned to four categories including:

(1) Impaired central vision (defined as visual acuity less than 0.3 LogMAR equivalent),
(2) Ocular motility abnormalities:
  (2a) Ocular misalignment (defined as strabismus)
  (2b) Eye movement disorder (defined as incomplete ocular motility, e.g. gaze palsy, cranial nerve palsy, saccadic impairment, smooth pursuit impairment, vergence disorder)
  (2c) Binocular vision deficit (defined as impaired binocular coordination of both eyes in maintaining straight ocular alignment),
(3) Visual field loss (defined as loss of part of the central and/or peripheral field of vision, e.g. homonymous hemianopia, quadrantanopia, scotoma),
(4) Visual perceptual disorders (defined as impaired perception of visual objects or space, e.g. visual inattention, agnosia, alexia).

Sample and analysis

The IVIS study captured all stroke admissions over a one-year time period. With an IVIS cohort population of 1295 stroke admissions and assessment proportion of 0.8, with 95% confidence level and margin of error of 7%, the required sample size for the IVIS-e cohort was 115.

Descriptive statistics were used to report types of visual problems with categories such as hemianopic

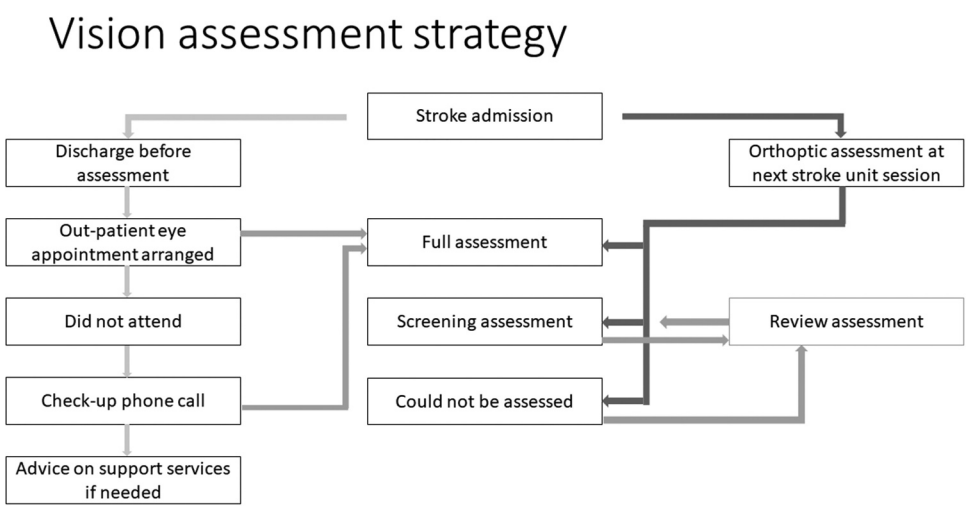

Figure 1. IVIS assessment strategy. Strategy to access visual assessment after stroke assessment

visual field loss, ocular motor cranial nerve or gaze palsies and central vision problems. Unpaired t test and chi-square test were used to compare the IVIS and IVIS-e cohorts for numerical and categorical data.

Results

The IVIS-e cohort consisted of 123 stroke admissions recruited over a 3-month period in the summer of 2018. Mean age at stroke onset was 63.6 years (standard deviation [SD] 21.5) and there were 57.7% males and 42.3% females. The mean Barthel score was 11.3 (SD 8.3). Stroke type was mainly ischaemic (86.2%). Ethnicity consisted of 68.3% white British and 28.5% being Pakistani, Indian, Caribbean, Bangladeshi, Black and Chinese.

Demographics of the IVIS study are outlined in Table 1 alongside the demographics for the IVIS-e study.

Visual assessments

Of 123 stroke admissions, two (1.6%) died and 28 (22.8%) could not be assessed (Figure 2). Reasons for non-assessment included early discharge (23, 18.7%), on the end of life pathway (4, 3.3%) or not on the stroke unit (1, 0.8%). Ninety-three stroke survivors underwent visual assessment. Of these, 10 (10.8%) had a normal visual assessment, significantly less than the IVIS cohort (p = .001), and were discharged from further orthoptic follow-up (Table 2).

Table 1. Demographics of stroke admissions.

		IVIS-e N = 123	IVIS N = 1295	Significance P =
Mean age in years (SD)		63.6 (21.5)	73.3 (13.7)	0.0001
Gender	Female	52 (42.3%)	628 (48.5%)	0.262
	Male	71 (57.7%)	667 (51.5%)	
Mean Barthel score (SD)		11.3 (8.3)	9.7 (7.8)	0.053
Stroke type	Ischaemic	106 (86.2%)	1132 (87.4%)	0.111
	Haemorrhagic	17 (13.8%)	163 (12.6%)	
Stroke laterality	Right	58 (47.2%)	593 (45.8%)	0.538
	Left	57 (46.3%)	626 (48.3%)	
	Bilateral	8 (6.5%)	76 (5.9%)	
Ethnicity	White British	84 (68.3%)	1216 (93.9%)	0.0001
	White Irish	0 (0%)	10 (0.8%)	
	White other	4 (3.3%)	21 (1.6%)	
	Other:	35 (28.4%)	48 (3.7%)	
	Indian	3 (2.4%)	9 (0.7%)	
	Pakistani	27 (22.0%)	7 (0.5%)	
	Bangladeshi	1 (0.8%)	1 (0.1%)	
	Caribbean	2 (1.6%)	1 (0.1%)	
	Black other	1 (0.8%)	3 (0.2%)	
	Chinese	1 (0.8%)	6 (0.5%)	
	Other	0	4 (0.3%)	

Notes. IVIS: Impact of Visual Impairment after Stroke; IVIS-e: Impact of Visual Impairment after Stroke extension; SD: standard deviation

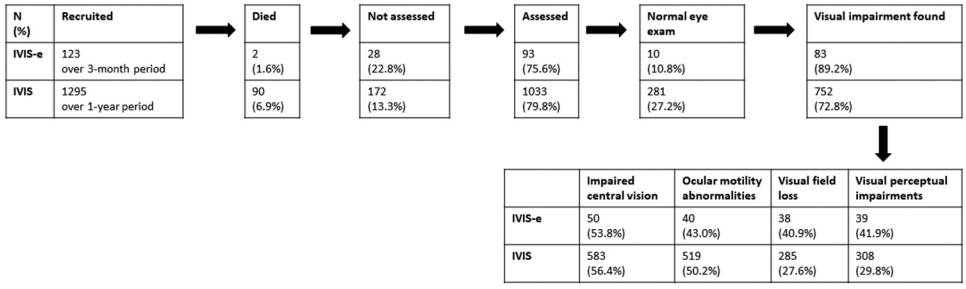

Figure 2. Incidence of post-stroke visual impairment. Flowchart of recruited stroke admissions for visual assessment, non-assessment and categories of diagnosis

Eighty-three (89.2%) had visual impairments detected, which was significantly more than the IVIS cohort (p = .001). These were inclusive of impaired central vision (n = 50), eye movement abnormalities (alignment/eye motility/binocular vision: n = 40), visual field loss (n = 38), visual perceptual disorders (visual inattention/visual perceptual difficulty [n = 39]). Fifty-seven stroke survivors were assessed at their first (baseline) orthoptic visit (within 3 days of stroke onset), 17 at a second visit and the remainder (19) being assessed at subsequent (3rd to 9th) orthoptic visits to the stroke unit when eventually able to undergo visual testing. The second and third visits were typically within 3–7 days of the first baseline visit because of a minimum two orthoptic sessions per week at each stroke unit.

Discussion

The primary differences between the IVIS and IVIS-e cohorts were age and ethnicity. The mean age was lower by about 10 years in the IVIS-e cohort. Nearly 70% of the Bradford population are aged less than 50-years-old, which partly explains the lower age group at stroke onset for our stroke cohort.[8,9] However, this may also represent more strokes occurring at a younger age in this population. Ethnicity in the IVIS-e cohort was 68% white British versus 94% in the IVIS cohort, and 28.5% Indian/Pakistani/Bangladeshi/Caribbean/Black other/Chinese versus 0.04%, respectively. In the Bradford population generally, 64% identify as white British but Bradford has the largest proportion of people with Pakistani ethnic origin in England at 20%.[8,9] Individuals of South Asian decent have strokes at a significantly younger age compared with white people and also have greater stroke risk factors such as diabetes and hypertension.[11,12] In the UK, about one-quarter of strokes occurs in working age and this has considerable impact to individual quality of life and daily life activities but, further, carries added NHS and social care burden.[13]

No differences were found between the two cohorts for stroke type, stroke laterality or stroke severity. There were more males recruited to the IVIS-e cohort although in both studies there were more males than females.

The percentage of those dying prior to visual assessment or those unable to have visual assessment at any time varied with less percentage deaths, but

Table 2. Categories of visual impairment.

	IVIS-e (n = 123)				IVIS (n = 1295)				Significance
	Assessed (n = 93) Normal visual assessment: n = 10 (10.8%) Abnormal visual assessment, n = 83 (89.2%)				Assessed (n = 1033) Normal visual assessment: n = 281 (27.2%) Abnormal visual assessment: n = 752 (72.8%)				 *P* = .001 *P* = .001
N %	Defect present	New	Prior	Part prior	Defect present	New	Prior	Part prior	
Impaired central vision	50 53.8%	19	30	1	583 56.4%	208	277	98	*P* = .597
Ocular motility abnormalities	40* 43.0%	30	10	0	519* 50.2%	393*	105*	21	*P* = .334
Ocular misalignment	6 6.5%	2	4	0	168 16.3%	110	58	0	*P* = .012
Eye movement disorder	40 43.0%	30	10	0	450 43.6%	358	71	21	*P* = .899
Binocular vision deficit	7 7.5%	1	6	0	222 21.5%	167	55	0	*P* = .001
Visual field loss	38 40.9%	37	1	0	285 27.6%	257	24	4	*P* = .007
Visual perceptual disorders	39 41.9%	39	0	0	308* 29.8%	306*	2	0	*P* = .0001
Visual inattention	34 36.5%	34	0	0	279 27%	279	0	0	*P* = .051
Visual perception	5 5.4%	5	0	0	54 5.2%	52	2	0	*P* = .620

Notes. IVIS: Impact of Visual Impairment after Stroke; IVIS-e: Impact of Visual Impairment after Stroke extension.

* Note that these numbers are not a sum of the numbers of sub categories of deficit. Many stroke survivors have more than one condition within each category. For example, a stroke survivor with an ocular motility abnormality may have ocular misalignment and eye movement disorder and binocular vision deficit. Similarly, a stroke survivor with a visual perceptual disorder may have visual inattention and another visual perception deficit.

greater percentage not assessed, in the IVIS-e cohort. Reasons for being unable to undergo visual assessment were, however, similar for those on end of life care or not being available on the stroke unit. A greater percentage were discharged earlier in the IVIS-e cohort which may reflect this cohort being recruited a number of years after the IVIS cohort, reflecting, in part, the move to earlier supported discharge in more recent years.[13]

There was a comparable assessment schedule for when stroke survivors were able to undergo visual assessment with most having visual assessment at their first orthoptic visit or at subsequent visits—typically within one week of stroke onset. Presence of visual impairment can hinder general rehabilitation for stroke.[5,14] Early detection of stroke-related visual is important and a key recommendation from the IVIS and this extension study.[7] This allows earlier management of the visual problem such that visual symptoms are improved or ameliorated, with subsequent improved engagement with general rehabilitation.[14] Early detection enables sharing of vision information with the multi-disciplinary stroke team such that their assessment and management options can be adapted accordingly.[7] Sharing of vision information with the stroke survivor and families is of added importance to their knowledge and awareness of stroke impact.[15]

There were less stroke survivors in the IVIS-e cohort with normal eye examinations and more with impaired visual function, which was significantly different to the IVIS cohort. Whilst similar proportions from IVIS and IVIS-e had impaired central vision, ocular motility abnormalities and visual perception difficulties, a greater proportion from the IVIS cohort had visual field loss and visual inattention. Discrepancies may reflect natural variance across populations and the different sample sizes for both studies. They do not reflect different assessment strategies as the research team for both studies was the same with use of the same standardised assessment strategy. Further they are less likely to reflect more serious strokes in the extension cohort as the Barthel scores across both studies were not significantly different. The discrepancy may also reflect the age difference between both cohorts. The IVIS study reported significantly more visual impairment in older stroke survivors.[7] Thus, the younger stroke cohort in IVIS-e may account for less visual impairment cases in that cohort.

In this study we sought to determine generalisability, applicability and reproducibility of the findings from the IVIS study. We wished to explore how the use of the IVIS assessment strategy would be in a different geographical population in the UK. Despite a different cohort in terms of ethnicity and age, the reasons for being able to undertake visual assessment were similar, and the occurrence of visual impairment in the stroke cohort, were high, indicating generalisability (external validity) and reliability in application of the IVIS strategy. We acknowledge the limitation of exploring just one new region in this study and the small sample size in comparison to the original IVIS cohort. However, we met our sample size estimate for this single-centre extension study but recommend further roll-out of the study protocol. In particular, independent use of the assessment protocol outside our research team is welcomed.

Conclusions

IVIS-e has provided the opportunity, in a different UK geographical area with different demographic factors to evaluate the IVIS visual assessment strategy. There were significant differences for age and ethnicity in the IVIS-e cohort and the visual profile differed across the IVIS and IVIS-e cohorts with more visual impairment overall in IVIS-e, perhaps due to differences in sampling and population demographics, but not due to stroke severity or the assessment strategy. Our aim in this study was to consider generalisability and reproducibility of the IVIS vision assessment strategy in a different UK area. We conclude that this strategy can be implemented in other acute stroke populations. We recommend further roll-out of the IVIS assessment protocol to other regions and countries to further improve capture of stroke-related visual impairment and evaluate its incidence and prevalence in different populations.

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Transparency statement

The lead author confirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Declaration of interest statement

The authors report no conflicts of interest.

Ethics

This study had institutional ethical approval and was undertaken in accordance with the Tenets of Helsinki. Informed consent was obtained if the participants attended and participated in the focus group meetings.

Data availability statement

Data can be accessed via direct contact with the lead author on reasonable request.

Author contributions

FR provided oversight for the study and led the writing of the paper. LH contributed to data collection, reviewing the draft paper and approving the final version.

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