"Eye" don't see: an analysis of visual symptom reporting by stroke survivors from a large epidemiology study

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Keywords

Symptoms; Stroke; Vision; Service provision; Detection

Abstract

Aim: The purpose was to explore the reported symptoms of post-stroke visual impairment from a large multi-centre prospective epidemiology study.

Methods: Visual assessment, including a case history, visual acuity, ocular alignment, ocular motility, visual fields, visual inattention and visual perception, was attempted for all stroke admissions to three acute stroke units.

Results: Of 1500 stroke admissions, 1204 received a visual assessment, of which 867 had one or more visual impairments. Of those identified with visual impairment 44.4% reported visual symptoms. The most common visual symptoms were blurred/altered vision (22.1%), field loss (12.6%), diplopia (9.9%) and reading difficulties (9.7%).

703 were identified to have a new visual impairment, 47.1% reported visual symptoms. No visual symptoms were reported by 38.4% and 14.5% were unable to report symptoms. Visual symptoms were first reported at a median of 3 days (IQR2-8) and mean of 16.0 days (SD39.8) from stroke onset.

Those that reported symptoms were younger (p<0.001) and more independent (p<0.001) than those who were asymptomatic or unable to report. No significant difference was found between likelihood of reporting visual symptoms or not based on severity of reduced central vision, visual field loss or visual inattention. Stroke survivors with a manifest squint and cranial nerve palsies were significantly more likely to report symptoms.

Conclusions: Almost 40% of stroke survivors with new onset visual impairment do not or cannot report visual symptoms. Highlighting the importance of objective screening to ensure stroke survivors receive appropriate and timely referral to specialist services to access necessary treatment.

Introduction

Post-stroke visual impairment has an incidence of approximately 60% in stroke survivors inclusive of impaired central and/or peripheral vision, eye movement abnormalities and visual perception disorders [1]. There are a wide variety of possible visual symptoms which may be reported due to the variety of visual impairments post-stroke. One cohort study reported 84% of stroke survivors with suspected visual impairment had either a single visual symptom (56%) or multiple visual symptoms (28%) [2]. Symptoms of post-stroke visual impairment in order of prevalence were reported as visual field loss, blurred vision, reading difficulty followed by diplopia. Other less prevalent reported symptoms included oscillopsia, visual hallucinations, depth impairment, photophobia, achromatopsia

and difficulty recognising objects [2]. It has been reported that symptoms related to visual perception disorders are more likely to be under reported by patients [3, 4].

Some symptoms are specific to the type of visual impairment, for example loss of visual field in the presence of visual field defect and diplopia in the presence of ocular motility defects [5, 6]. Other symptoms however are not specific and span across a variety of visual impairments, for example reading difficulties and blurred vision [7]. Reading difficulty has been commonly associated with visual field loss, reduced convergence and saccadic abnormalities, with other associations including reduced central vision, perceptual issues, diplopia and nystagmus [5, 8].

It is not uncommon for stroke survivors to not report any visual symptoms despite having an identified ocular abnormality on clinical examination [2, 3, 6, 9]. It is well documented that symptoms are commonly not reported in the presence of visual inattention – as is expected in a condition in which individuals do not acknowledge part of their spatial environment [2, 10]. Further, about half of those identified as having stroke-induced strabismus were asymptomatic [2, 11, 12]. Symptoms specific to visual field loss are not reported in many stroke survivors, including a proportion who are diagnosed with visual anosognosia [2, 13, 14]. Presence or absence of visual symptoms is important when assessing stroke survivors. Detection of visual impairment is easier, clearly, if visual symptoms are reported. However, where stroke survivors do not report visual symptoms, the potential to miss the presence of visual impairment is high. Visual impairment is not externally obvious to observers in many cases. The observer cannot 'see' what the stroke survivor sees. Missed diagnosis can have considerable impact on general rehabilitation and to the daily life activities and quality of life for the individual [15-17].

It is therefore crucial to be aware of the proportion of stroke survivors who have asymptomatic visual impairment post-stroke, particularly in terms of screening methods and clinical protocols.

The purpose of this study was to explore the reported symptoms of post-stroke visual impairment from a large epidemiology study.

Methods

Data was collected in the Impact of Visual Impairment after Stroke (IVIS) study, a prospective epidemiology study, which was undertaken in three hospital hyper-acute and acute stroke units in the North West of England. All adult stroke survivors in the acute phase were recruited following admission to hospital with a clinical diagnosis of stroke confirmed by the admitting stroke physician. Brain imaging data was collected, where available, from radiology reports. The study excluded stroke survivors under the age of 18 years of age.

This study was undertaken in accordance with the Tenets of Helsinki with UK NHS research ethical approval (14/NW/0166). The research ethics panel waived the need for written patient consent. Verbal assent was sought, in accordance with normal clinical practice and hospital standard operating procedures. The statement issued by the Association of Medical Research Charities (AMRC) on the use of patient data for research was followed, for it to be essential to maintain confidentiality and to do no harm. This paper was written in accordance with the STROBE statement [18].

Each of the three stroke units had two orthoptic sessions per week with an additional outpatient orthoptic clinic for follow-up appointments after stroke unit discharge. Following a review of the hospital notes for previous ocular history and case history taking from the patient and/or carer, a full, new assessment of visual function was attempted by a stroke specialist orthoptist as soon as possible including assessment of visual acuity (logMAR, Vocational near visual acuity or Cardiff acuity cards), reading ability (Radner reading test), colour vision (City test), contrast sensitivity assessment (MARs test), ocular alignment (cover uncover test), ocular movements (saccadic, smooth pursuits and vergence), binocular vision (Bagolini glasses, 20 prism dioptre base out, prism fusion range, Frisby stereotest), visual fields (confrontation assessment, kinetic/static perimetry using an Octopus 900 perimeter (Haag Streit International, Switzerland)), visual inattention (line bisection, clock drawing, cancellation task and room description) and visual perception (tasks using common objects and pictures). The initial full assessment was undertaken at a median of 4 days post-stroke (range 0-435, IQR 7). Follow-up of those with visual impairment was weekly whilst an inpatient, and at clinically appropriate intervals for outpatients.

Descriptive statistics were used to report the types of visual symptoms reported. Independent samples analysis with One-way ANOVA and Kruskal Wallis H test were used for evaluation of age at stroke onset and stroke severity. Independent t test and Chi square test were used for evaluation of symptom reporting versus category of visual impairment. Odds ratio was calculated for visual symptoms according to type of visual impairment.

For the purposes of this analysis ocular motility grouped into eight categories; ocular cranial nerve palsies (third, fourth and sixth cranial nerve palsies), horizontal gaze defects (intranuclear ophthalmoplegia (INO), one and a half syndrome and horizontal gaze palsies), vertical gaze defects (vertical gaze palsy, skew deviation and dorsal midbrain syndrome), saccadic/smooth pursuit defects (saccadic palsy, smooth pursuit palsy, impaired gaze holding and cogwheel movements), vergence defects (convergence paralysis, divergence paralysis, convergence insufficiency), nystagmus,

abnormal binocular vision, and multiple ocular motility defects (two or more of the above defects). Visual field loss was grouped into two categories complete visual field loss (complete homonymous hemianopia) and partial visual field loss (partial homonymous hemianopia, complete/partial homonymous quadrantanopia)

Results

A total of 1500 stroke admissions were recruited across the three hospitals between July 2014 and September 2015. Of 1500, 296 patients did not undergo a visual assessment: 116 died prior to assessment and 180 were unable to undergo a visual assessment for a variety of reason which are outlined in Table 1. Of the remaining 1204 who were able to undergo a visual assessment, 337 had a normal assessment and 867 had one or more visual impairments.

Reporting of visual symptoms

Of 867 identified as having visual impairment 53.1% (n=460) were male and 46.9% (n=407) female with a mean age of 74.3 (SD 13.3) years. Stroke type was ischaemic for 90.0% (n=780) and haemorrhagic in 10.0% (n=87). Concomitant neurological deficits were common (n=781) including hemiplegia in 46.4% (n=362), aphasia in 11.7% (n=91), facial palsy in 11% (n=86), monoplegia in 6.7% (n=52) and dysarthria in 6% (n=47). Remaining neurological deficits included hemiparesis, pain, dysphagia, hearing loss, epilepsy, dementia and bulbar ataxia.

Visual symptoms were reported by 44.4% (n=385) of stroke survivors: 186 reported a single symptom and 199 reported a combination of multiple symptoms (two or more), with nine being the maximum number of different symptoms reported. No visual symptoms were ever reported by 42.8% (n=371) and 12.8% (n=111) were unable to report any symptoms at any point during their follow-up. Presence or absence of visual symptoms was not associated with type of stroke (p=0.216) but were significantly associated with severity of stroke (p=0.007) with worse stroke severity on Barthel score for those not reporting visual symptoms. Symptoms were first reported at a median 3 days (IQR 2-8) and mean of 15.6 days (SD 39.6) after stroke onset. Visual symptoms were reported in 41.1% (n=321) of those with concomitant neurological deficits. Of relevance to symptom reporting ability are neurological deficits of aphasia, dysarthria and dementia which were present in 20.4% (n=159) of concomitant neurological deficits.

Type of visual symptom

The most common visual symptom was blurred, altered or reduced vision, reported by 192 (22.1%) stroke survivors identified as having visual impairment. This was followed by visual field loss (12.6%,

n=109), diplopia (9.9%, n=86) and reading difficulties (9.7%, n=84). Seven percent (n=61) reported their visual symptoms had been present prior to their stroke event.

Of the 867 with visual impairment, 162 (18.7%) were identified as having pre-existing visual impairment with no new component, 376 (43.4%) had a new visual impairment and 327 (37.7%) had a new component of visual impairment in addition to a pre-existing issue. It was not possible to establish if visual impairment was new or pre-existing in two cases.

New versus prior visual impairment

The demographics of those with new or partially new visual impairments post-stroke were comparable to that of those identified with any visual impairment (Table 2). Visual symptoms were reported by 47.1% (n=331) of those identified with a new or partially new visual impairment: 158 reported a single symptom and 173 reported a combination of multiple symptoms (two or more). No visual symptoms were ever reported by 38.4% (n=270) and 14.5% (n=102) were unable to report any symptoms at any point during their follow-up. Symptoms were first reported at a median 3 days (IQR 2-8) and mean of 16.0 days (SD 39.8) after stroke onset.

The top four reported symptoms by those with new or partially new visual impairment were in the same order as for the entire group identified with visual impairment, outlined in Table 3.

New and partially new visual impairment

For 703 stroke survivors, the visual symptoms reported separated by visual impairment category are outlined in Figure 1. Also presented in Figure 1 are the odds of reporting a specified symptom in the presence of a specified visual impairment for the primary expected symptom and visual impairment, the most frequently associated visual impairment with the four most commonly presenting symptoms and all visual impairment types when no symptoms are reported. A large proportion of each type of visual impairment (i.e. impaired central vision, visual field loss, eye movement abnormalities and visual perceptual disorders) either reported no symptoms or were unable to report the presence of symptoms. The most common symptoms for each type of visual impairment are as follows: blurred/altered vision reported with reduced central vision (23.2%), ocular alignment, motility or binocular vision defects (21.1%) and visual inattention (21.9%), and field loss reported with visual field loss (30.5%) and visual perception disorder (43.9%).

The demographics and types of new visual impairment, depending on whether stroke survivors reported symptoms, reported being asymptomatic or were unable to report symptoms, are outlined

in Table 4. Those that reported symptoms were younger (p <0.001) and were more independent (less severe stroke) when assessed using the Barthel Index (p <0.001) than those who were either visually asymptomatic or those unable to report visual symptoms.

The stroke type for those with visual impairment was infarction in 89.2% and haemorrhage in 10.8%. The lateralisation of the stroke was right-sided in 46.2%, left-sided in 48.2% and bilateral in 5.5%. Brain imaging was obtained by CT scan in 599 (85.2%) and by MRI scan in 68 (9.7%): 36 (5.1%) did not have an imaging report available. The areas reported to be affected were as follows; 18% (n=166) anterior circulation with no other specified area, 17.4% (n=161) basal ganglia, 12.4% (n=115) middle cerebral artery, 12.6% (n=116) parietal lobe, 9.4% (n=87) occipital lobe, 7.9% (n=73) frontal lobe, 5.3% (n=49) temporal lobe, 4.5% (n=45) cerebellum, 4.1% (n=38) brainstem, 2.7% (n=25) periventricular, 2.5% (n=23) posterior circulation with no other specified area, 1.8% (n=17) posterior cerebral artery, 1.1% (n=10) anterior cerebral artery, 0.2% (n=2) intraventricular. This includes 182 individuals with multiple affected areas (Table 5). The symptoms of blurred/altered vision and reading difficulty were common across many locations of stroke. Visual field loss was notably more present for locations relating to the visual pathway, e.g., parietal and occipital lobes. Visual hallucinations were typical for occipital lobe lesions. Diplopia was notably more common for locations involved in control of eye movement pathways e.g., brainstem, basal ganglia and cerebellum.

Type and severity of visual impairment

An independent t-test found no significant difference between stroke survivors reporting being asymptomatic and those reporting symptoms based on visual acuity level at near (p=0.458) and distance (p=0.141). The median visual acuity for near and distance were similar for both those that were asymptomatic and those that reported symptoms as outlined in Table 6A.

A chi-square test found a significant difference (p <0.005) between symptomatic and asymptomatic stroke survivors depending on whether their squint was controlled (latent) or not (manifest). Stroke survivors with a manifest squint had a higher proportion reporting the presence of symptoms (76.2%), compared to those with controlled deviations (53.7%), as outlined in Table 6B.

The reporting of symptoms in different types of ocular motility defects are outlined in Table 6C, the Chi-square test indicated potential statistically significant differences (p <0.001) in proportions of stroke survivors reporting symptoms or not dependent on type of ocular motility defect. Post-hoc analysis involved pairwise comparisons using the z-test of two proportions with a Bonferroni correction. The proportion of stroke survivors reporting symptoms was statistically significantly higher

in the presence of 3rd, 4th or 6th cranial nerve palsies (p=0.006), than other types of ocular motility defects e.g. supranuclear ocular motor disorders, nystagmus or vergence disorders.

No significant difference (p=0.770) was found between symptomatic and asymptomatic stroke survivors depending on the severity of visual field loss (complete vs. partial). Those with partial visual field loss reported symptoms related to their vision loss (67.7%) almost as much as those with complete visual loss (69.7%) (Table 6D).

The reporting of symptoms in different groups of visual inattention severity (mild, severe, and unknown) are outlined in Table 6E. There were no significant differences in proportions of stroke survivors that reported symptoms with different visual inattention severity, p=0.919.

It was not possible to divide those with visual perceptual disorders due to the small number of cases (n=57) and that a high proportion of these had multiple problems alongside perception deficits.

Discussion

In this large epidemiology study overall, 43% of stroke survivors did not report visual symptoms despite the presence of objectively confirmed visual impairment. Over 38% had new onset visual impairment due to the stroke and over 14% were unable to report any symptoms. This could have been due to other stroke related sequalae such as aphasia or reduced cognition and such co-existent neurological deficits were found in 20.4%. Raising awareness of the high number of non-reported visual symptoms is important. Typically, visual symptoms are expected in new onset visual conditions. The absence of visual symptoms, thus, must be explored through questioning for alternative symptoms, assessment of compensatory visual strategies or documenting associated deficits that prevent reporting. and such co-existent neurological deficits were found in 20.4%. Raising awareness of the high number of non-reported visual symptoms is important. Typically, visual symptoms are expected in new onset visual conditions. The absence of visual symptoms, thus, must be explored through questioning for alternative symptoms, assessment of compensatory visual strategies or documenting associated deficits that prevent reporting.

The group that were unable to report their symptoms were older and the most dependent following their stroke. Whilst not quite as dependent as those that were unable to report symptoms, the group who did not report visual symptoms were also older and more dependent than those that reported symptoms.

This study is in agreement with previous studies which found stroke survivors with a suspected visual impairment commonly do not report any visual symptoms [2, 3, 6, 9-14].

Type of visual symptom is important. The most commonly reported symptoms in this study were blurred or altered vision (22.4%), visual field loss (14.1%), diplopia (11.0%) and reading difficulty (10.5%). In general, stroke screening typically considers visual field loss with routine use of tools such as the National Institution of Health Stroke Scale (NIHSS) [19]. However, assessing visual acuity or eye alignment is not routine [20]. Specialist screening tools will include assessment of visual acuity (commonly linked with symptom of blurred vision), eye alignment (symptom of diplopia) and reading (non-specific symptom). Such screening is important as these symptoms can impact considerably on daily life activities and result in poor quality of life. Such symptoms also impede general rehabilitation such as safe mobilisation and the ability to use written instructions for medications and rehabilitation [15-17].

There are a variety of reasons why stroke survivors with confirmed visual impairment do not report any symptoms. This study has highlighted milder severity in some types of visual impairment; visual acuity, visual field loss and visual inattention does not appear to effect whether the stroke survivor reports the presence of symptoms or not. For example, as many stroke survivors with complete or partial visual field loss did or did not report related visual symptoms. For those not reporting visual symptoms, regardless of severity of the visual condition, this may represent perceptual compensation. However, for other visual impairments such as mild depth impairment or mild saccadic dysmetria for which compensation may be easier, symptoms may simply not be present or appreciated. Others may realise their vision is different following the stroke, for example slightly reduced visual acuity or binocular vision or partial far periphery visual field loss, however it does not inconvenience them or cause them to alter their activity. Thus, they do not report visual concerns. Some are very aware of their visual symptoms but are reluctant to report them, such as visual hallucinations or other visual perceptual disorders due to fear for their mental health. Others purposively do not wish to report their visual symptoms because they wish to return to specific activities such as driving.

Some stroke survivors have prior visual impairment to which their visual symptoms are related. This study did not explore the symptoms of stroke survivors with pre-existing visual impairment without a new component but concentrated on the majority that had new onset visual impairment and symptoms. Regardless of visual impairment being new or pre-existent, the presence of visual impairment and its detection is important to ensuring the full assessment of each patient such that their rehabilitation needs are fully met. It is also important to consider whether other stroke sequalae are having an impact on an individual's previous coping mechanisms i.e. holding a magnifying glass to enable reading.

Where visual symptoms were reported, this was typically soon after stroke onset (median 3 days) although some only became aware of their visual symptoms at a later stage, potentially after discharge home. The latter is not unusual. Some stroke survivors are not fully aware of their vision immediately in the acute stroke phase because of not being in familiar surroundings and lacking general awareness [21]. It is only when some individuals start to mobilise and self-care, or return home, that they become aware of issues with their vision.

This study highlights the importance of comprehensive screening for all stroke survivors to detect the presence of visual impairment, as clinicians cannot rely on stroke survivors to consistently report visual symptoms. Relying on reports of symptoms will likely result in a substantial number of stroke survivors having undetected visual impairment that further causes issues with rehabilitation and leading to long-term unmet needs [22]. The lack of reported symptoms in the presence of identified visual impairment supports the need for systematic visual assessment of all stroke survivors at an early stage. This visual assessment should include objective assessments and not solely rely on the patient being able to report their symptoms [23, 24].

Identifying visual impairment is crucial in initiating management for the individual's visual impairment. Many types of visual impairment are readily treated with amelioration of symptoms, using treatment options that are both clinically and cost effective [20, 25]. Use of care pathways can be helpful, particularly when the type of visual impairment has been established [26, 27]. This enables referral to the appropriate service for access to the relevant treatment options. It is important to note that presence of visual symptoms is not a requirement for management. In a study surveying stroke specialist orthoptists, 11% reported they would always provide management to a stroke survivors with an asymptomatic visual impairment and 65% would provide management on a case by case with the aim of improving quality of life [28].

The main limitation to this study is that the stroke population was confined to the North West of England with recruitment from three stroke units. However, the population demographics for our study are similar to the reported demographics for the North West of England [29]. Further, our results have been found to be generalisable to other UK areas with different demographic stroke populations. Other limitations are that both visual fields and ocular motility defects were categorised and not graded numerically for a more detailed analysis of the severity of visual impairment and reporting symptoms. In addition, due to participants being identified as having multiple visual impairments as

well as multiple symptoms, it was not always possible to identify which visual impairment caused each specific visual symptom. For example, common symptoms were blurred/altered vision and reading difficulty but these symptoms could be due to reduced central vision, eye movement abnormality or visual field loss and, for stroke survivors who had all of these visual conditions combined, the symptom could not be ascribed to just one of the conditions.

There are over 100,000 new strokes per annum in the UK [30]. Considering the high rate of unreported visual symptoms in this study, a worryingly large number of stroke survivors may have undetected visual problems as not all stroke units have access to vision services [31]. This may risk long-term harm in terms of their well-being, function, mobility and independence.

Our results are potentially of relevance to other countries outside the UK [15, 32]. It is likely that visual impairment occurs just as frequently in stroke cohorts in other countries. Many countries have access to orthoptic services but, in the absence of such services, involvement of other eye care professionals (e.g. ophthalmologists and optometrists) should be considered. It is important that appropriate visual screening methods and care pathways are put in place to maximise the detection rate of visual impairment.

Conclusions

Nearly 40% of stroke survivors with new onset ocular abnormality identified on clinical examination do not or cannot report visual symptoms. This highlights an important aspect of screening following stroke admission. Where reporting of visual symptoms by stroke survivors cannot be relied upon, appropriate screening measures must be put in place such that visual impairment can be objectively detected. In turn, relevant care pathways can be followed for stroke survivors to ensure appropriate and timely referral to specialist services and for access to the necessary treatment for their individual needs.

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Tables and Figures

Table 1: Reasons and frequency why visual assessment was not possible.

Table 2: Demographics of all stroke survivors identified as having visual impairment and stroke survivors identified as having new or partially new visual impairment excluding pre-existing visual impairment with no new component.

Table 3: Types and frequency of symptoms reported by all stroke survivors identified as having visual impairment and stroke survivors identified as having new or partially new visual impairment.

Table 4: Demographics and types of new/partially new visual impairment for stroke survivors who reported symptoms, were asymptomatic or unable to report symptoms. * Indicates statistical significance.

Table 5: Type and location of stroke versus reporting of visual symptoms and category of visual impairment.

Table 6: **S**troke survivors who reported symptoms or were asymptomatic by visual impairment category and broken down by type or severity of visual impairment. Those unable to report presence of symptoms were excluded from this analysis.

Figure 1: Symptoms reported separated by visual impairment diagnosis.

Table 1

	n=
Died prior to assessment	117
Discharge from hospital prior to assessment	54
Palliative care	34
Medically unwell	25
Asleep	20
Not on ward	15
Unwilling to assent	9
Lacking attention	6
Lacking cognition	6
Unconscious	4
Fatigue	2
Other	4

Table 2

		Visual impairment n=867	New/partially new n=703
Gender % (n)	**Male**	53.1 (460)	53.9 (379)
	Female	46.9 (407)	45.9 (323)
Age Mean (SD)		74.3 (13.3)	74.4 (13.4)
Type of stroke % (n)	**Ischaemic**	90.0 (780)	89.2 (627)
	Haemorrhagic	10.0 (87)	10.8 (76)

Table 3

Symptoms	All visual impairment (n=867)		New/partially new visual impairment (n=703)	
	Frequency	Percentage (%)	Frequency	Percentage (%)
No symptoms	371	42.4	270	38.4
Blurred, altered or reduced vision	192	22.1	158	22.4
Field loss	109	12.6	99	14.1
Diplopia	86	9.9	77	11.0
Reading difficulty	84	9.7	74	10.5
Visual hallucinations	36	4.2	33	4.7
Watering eyes	29	3.3	26	3.7
Dry or gritty eyes	19	2.2	19	2.7
Photophobia	11	1.3	11	1.6
Image movement problems	10	1.2	10	1.4
Oscillopsia	10	1.2	10	1.4
Difficulty identifying people/items in clutter	9	1.0	8	1.1
Visual disorientation	7	0.8	7	1.0
Increased glare from surfaces	6	0.7	5	0.7
Changes in depth, distance	5	0.6	5	0.7
Visual illusions	5	0.6	5	0.7
Colour problems	4	0.5	4	0.6
Face recognition problems	4	0.5	3	0.4
Eye strain	3	0.3	2	0.3
Migraine with aura	3	0.3	4	0.6
After-images	2	0.2	2	0.3
Inattention	2	0.2	2	0.3
Polyopia	2	0.2	2	0.3
Static images appear to move	2	0.2	2	0.3
Difficulty with object recognition	1	0.1	1	0.1
Getting lost	1	0.1	1	0.1
Other	27	3.1	25	3.6
Unable to report	111	12.8	102	14.5

Table 4

			Reported symptoms n=331	Asymptomatic n=270	Unable to report n=102	Significance (*p*)
Gender % (n)		**Male**	50.9 (193)	37.7 (143)	11.3 (43)	0.015*
		Female	42.6 (138)	39.2 (127)	18.2 (59)	
Age Mean (SD)			70.8 (13.9)	77.3 (12.3)	78.1 (11.5)	<0.001*
Type of stroke % (n)		**Ischaemic**	90.6 (300)	86.7 (234)	91.2 (93)	0.234
		Haemorrhagic	9.4 (31)	13.3 (36)	8.8 (9)	
Barthel Index Mean (SD)			10.7 (7.4)	8.3 (6.7)	2.7 (4.5)	<0.001*
Visual Impairment	**Reduced central vision** % (n)		44.4 (147)	54.8 (148)	58.8 (60)	
	Ocular motility defect % (n)		66.2 (219)	54.8 (148)	69.6 (71)	
	Visual field loss % (n)		48.6 (161)	31.9 (86)	50.0 (51)	
	Visual inattention % (n)		40.5 (134)	43.0 (116)	63.7 (65)	
	Visual perception problem % (n)		14.5 (48)	2.6 (7)	2.9 (3)	

Table 5

n=703	Type of stroke		Location of stroke													
	Ischaemic (n=627)	Haemorrhage (n=76)	Frontal lobe	Parietal lobe	Temporal lobe	Occipital lobe	Cerebellum	Brainstem	Basal ganglia	Peri-ventricular	Intra-ventricular	ACA	MCA	PCA	Anterior circulation	Posterior circulation
No symptoms (n=270)	234	36	33	52	17	19	12	8	68	11	2	7	41	4	72	2
Unable to report (n=102)	93	9	14	18	12	10	4	3	11	2	0	0	29	3	35	0
Symptomatic (n=331)	300	31	27	46	20	58	26	27	82	12	0	3	45	10	59	21
Blurred, altered or reduced vision (n=156)	137	19	12	29	11	32	10	8	34	7	0	0	21	7	27	8
Field loss (n=100)	89	11	9	17	9	35	2	0	24	4	0	0	14	5	16	4
Diplopia (n=75)	71	4	4	5	2	5	14	24	16	2	0	1	5	0	8	11
Reading difficulty (n=73)	69	4	6	14	3	19	4	3	11	4	0	0	14	4	9	3
Visual hallucinations (n=33)	30	3	2	2	1	13	3	1	6	0	0	2	5	1	8	0

Table 6.

	Symptoms present		Symptoms absent		
	Median (IQR)	**Range**	**Median (IQR)**	**Range**	**Significance (p)**
A: Central vision loss (Near n=347, Distance n=277)					
Near visual acuity (LogMAR)	0.46 (0.36)	0.10 – 2.00	0.50 (0.39)	0.04 – 2.00	0.458
Distance visual acuity (LogMAR)	0.32 (0.26)	0.00 – 2.00	0.36 (0.36)	0.00 – 2.00	0.141
	n	**%**	**n**	**%**	
B: Ocular misalignment (n=391)					
Controlled deviation	165	53.7	142	46.3	<0.005
Manifest deviation	64	76.2	20	23.8	
C: Ocular motility defects (n=371)					
Cranial nerve palsy (3^{rd}, 4^{th}, 6^{th} cranial nerve palsy)	17	89.5	2	10.5	0.006
Horizontal gaze defect (Intranuclear ophthalmoplegia, $1^{1/2}$ syndrome, horizontal gaze palsy)	4	30.8	9	69.2	0.330
Vertical gaze defect (Vertical gaze palsy, skew deviation, dorsal midbrain syndrome)	8	33.3	16	66.7	0.007
Saccadic / smooth pursuit defect (Saccadic palsy, smooth pursuit palsy, Impaired gaze holding, Cog wheel movements)	58	60.4	38	39.6	0.796
Vergence defect (Convergence paralysis, divergence paralysis, Convergence insufficiency)	14	51.9	13	48.1	0.413
Nystagmus	9	50.0	9	50.0	0.410
Abnormal binocular vision	17	45.9	20	54.1	0.810
Multiple ocular motility defects (≥2 of the above defects)	93	67.9	44	32.1	0.010

D: Visual field loss (n=219)

Complete visual field loss (Complete homonymous hemianopia)	62	69.7	27	30.3	0.770
Partial visual field loss (Partial homonymous hemianopia, Complete/partial homonymous quadrantanopia)	88	67.7	42	32.3	

E: Visual inattention (n=315)

Mild visual inattention	33	24.6	26	22.4	0.919
Severe visual inattention	73	54.5	65	56.0	
Unknown severity	28	20.9	25	21.6	

Figure 1: Symptoms reported separated by visual impairment diagnosis (n=703)