Annual variations in the frequency of incident of stroke hospitalizations in Scotland- Part I.

Arsalan Moinuddin[1], James Lewsey[2], Sally Inglis[2]

[1.] Department of Physiology, Himalayan Institute of Medical Sciences, HIHT University, Jolly Grant, Dehradun, Uttarakhand, India, [2] Department of Public Health & Health Policy, University of Glasgow, Scotland, UK

Abstract

Stroke data on 157,639 incident stroke hospitalization in Scotland between 1986-2005 were obtained from Information Service Division Unit of Scotland. Monthly as well as seasonal variations in the frequency of incident stroke and its subtypes were evaluated by using Chi square goodness of fit test. Overall incident strokes show statically significant monthly (P < 0 .001; highest, December 9.0% and lowest : September 7.7%) variations. Depending upon stroke subtypes monthly variation was in the incident strokes frequency for ICH (December : 9.1% ; September : 7.7 %), IS (December; 8.8% ; September : 7.9%) and NS (December: 9.2 % ; September : 7.6 %). No statistically significant monthly variation was observed for subarachnoid haemorrhage. Factors promoting hypercoagulable state seem to be responsible for high frequency of incident stroke.

Introduction

Stroke is defined as "abrupt impairment of brain function by a variety of pathological changes involving one (focal) or several (multifocal) intracranial or extracranial blood vessels" [1] . In 80% cases it occurs due to too little blood flow to the brain (Ischemic stroke) and in 20% it is a result of parenchymatous haemorrhage (Haemorrahagic stroke) which can be intracerebral or subarachnoid in nature [2] . There are approximately 111,000 stroke incidents in UK every year [3] responsible for 53000 deaths [4]. Though there has been remarkable decline in the age-standardized stroke mortality rate since 1968 a lot of variability is still present within UK. The rates are highest in Scotland, followed by North England, Ireland, Wales and South England [5] . It is a known fact that strokes, like many other chronic disease has a complex multifactorial aeliogy. Genetics, familial history, age, sex, ethnicity and race are all non-modifiable risk factors. But other risk factors such as smoking, drinking, physical activity and diet can be modified to reduce the risk of stroke significantly.

Variable stroke risks during different period of a year are well documented. A study conducted in Athens (2003) showed an overall enhancement in stroke admission from November to April along with a predominance of ICH

and CES (cardio embolic strokes) cases in winter [6]. Belgium also found a great incidence of ICH in late autumn and winter months and it is hypothesized to be due to the effect of low temperature on blood pressure [7] . There has been a lot of variability in American studies and this may be due to large weather diversity in different regions of this continent. The temperature ranges from $+57^0$ C in California (Summer months) to -62^0 C in Alaska (winter months) [8] . Christie (1981) did an epidemiological study in Melbourne from 1978 – 1979 and found a spastically significant relationship between mean ambient temperature and stroke incidence [9] .

The aim of the present study is to find out if the frequencies of first stroke hospitalizations by months of the year are different to what we could expect if there was no association between stroke incidence and month of the year. A very large number of cases will be considered in present study to minimize the chance of error and at the same time attempts will be made to suggest measures to minimize the chance of having strokes.

Methods

Data relate to all incident hospitalization for stroke in Scotland between 1986-2005. The data set comprises of a sample size 157, 639 incident hospitalization.

Retrospective information's about the details of patients were collected from following sources.

1.   Information Service Division (ISD)

2.   National Health Service (NHS)

3.   Scottish Morbidity Record (SMR)

4.   General Register Office of Scotland (GROS)

Analysis was done using Chi-square goodness of fit test. For the analysis of variation in first stroke incidence as well as stroke subtypes through out different seasons, year was divided into four seasons as follows:

1. Winter – December, January, February

2. Spring – March, April, May

3. Summer – June, July, August

4. Autumn – September, October, November

Subtypes of the stroke considered in the present analyses are as follows:

1. Ischemic stroke (IS)

2. Intracerebral Haemorrhage (ICH)

3. Subarachnoid Haemorrhage (SAH)

4. Non – specific

Ethical approval was granted from faculty of Medicine Ethics Committee for Non-Clinical Research involving human subjects, University of Glasgow (Project No: FM00609). The retrospective data for research were approved by Privacy Advisory Committee (PAC).

Results

From Table 1, incident stroke hospitalizations for 157,639 patients, analyzed by Chi square goodness of fit test (p<0.001) showed significant monthly variations from 1986 – 2005. The highest stroke incidence was recorded in December 14,232 (9.0%, O/E = 1.06) and January 14,066 (8.9%, O/E=1.05), 852.6 and 686.6 more than the expected frequency (13,379.4) for December and January respectively. This was followed by 13,996 (8.9%, O/E = 1.05) incident stroke hospitalizations in March with the lowest incidence in September 12, 146 (7.7%, OE = 0.94) and August 12,452 (7.9 %, OE = 0.93) which were 801.8 and 927.4 less than the expected number of 12,947.8 and 13,379.4 respectively.

From Table 2, Subarachnoid haemorrhage (SAH) was diagnosed in 10,113 (6.4%) of total cases. Maximum incidence hospitalizations for stroke took place in the months of March (890, 8.9%, O/E = 1.04, 31.7 more than the expected 858.3) and May (887, 8.8%, O/E = 1.03, 28.7 more than expected 858.3). On the contrary least 816 (8.1 %, O/E = 0.95) incident strokes hospitalizations occurred in January (42.3 less than the expected 858.3). Almost equal number of incident strokes (8.5%, O/E = 1.00) , occurred between October and December. The Chi square goodness of fit test suggests that no significant monthly variation was observed in the stroke frequency (p=0.8) between 1986 – 2005.

As shown in Table 3, 12,400 cases of ICH were reported in Scotland over the period 1986 – 2005. The months of December (1,130, 9.1% , OE = 1.07, 77.6 more than expected 1,052.4) and March (1,125, 9.1 % , O/E = 1.07, 72.6 more than the expected 1, 052.4) recorded the highest number of ICH cases which was followed by May (1,077, 8.7 %, O/E = 1.02) and January (1.075, 8.7 % o/E = 1.02). The Frequency of incident ICH declined in September (949, 7.7%, O/E = 0.93, 69.5 less than the expected 1, 018.5) and August (878, 7.9%, O/E = 0.92, 74.4 less than the expected 1,052.4).The Chi square goodness of fit test (p<0.001) found significant monthly variations in ICH frequency.

A total of 43,498 (27.1%) incident stroke hospitalizations had diagnosis of ischemic stroke (IS) between 1986 and 2005 (Table 4) contributing approximately two third (27.1% out of 41.9%) of the total (157,639). A relatively large number of IS admissions were observed in December (3,834, 8.8 %, O/E = 142.2 more than the expected 3,691.8) and March (3, 803, 8.7%, O/E = 1.03, 111.2 more than the expected 3, 691.8) whereas the number of such hospitalizations was less in June (3, 442, 7.9 % O/E = 0.96, 130.7 less than the expected 3,572.7) and September (3,458, 7.9 %, O/E = 0.97, 114.7 less than the expected 3, 572.7). The Chi square of fit test (p<0.001) indicates significant monthly variations in IS occurrence.

The nonspecific category (Table 5) comprises of 91, 628 (58.1%) incident stroke hospitalizations equivalent to more than half of all stroke hospitalizations over this period (1986 – 2005). The frequency of non-specified incident strokes was highest in December (8,411, 9.2 %, O/E = 1.08) and January) 8,403, 9.2 %, O/E = 1.08) which was 634.2 and 626.2 more than the expected count of 7,776.8 respectively. On the contrary, the lowest number incident, non-specific strokes were recorded in the months of September, August and July with incidence of 6,927 (7.6%, O/E = 0.92), 7,147 (7.8 %, O/E = 0.92) and 7197 (7.99%, O/E = 0.93) respectively. The Chi square goodness of fit test recognizes this difference (p<0.001) in monthly stroke variations for NS category.

Annual variations in incident stroke hospitalization.

Table 1. *All stroke incidence in Scotland (1986 – 2005) by months of Year*

Months of admission	Observed frequency of Stroke	n (%)	Expected frequency of Stroke	Observed/ Expected	Observed/ Expected
January	14,066	(8.9)	13,379.4	686.6	1.05
February	12,650	(8.0)	12,192.5	457.5	1.04
March	13,996	(8.9)	13,379.4	616.6	1.05
April	13,301	(8.4)	12,947.8	353.2	1.03
May	13,289	(8.4)	13,379.4	-90.4	0.99
June	12,629	(8.0)	12,947.8	-318.8	0.98
July	12,627	(8.0)	13,379.4	-752.4	0.94
August	12,452	(7.9)	13,379.4	-927.4	0.93
September	12,146	(7.7)	12,947.8	-801.8	0.94
October	13,274	(8.4)	13,379.4	-105.4	0.99
November	12,977	(8.2)	12,947.8	29.2	1.00
December	14,232	(9.0)	13,379.4	852.6	1.06
Total	1,57,639	100.0			

Table 2. *All SAH stroke incidence by months of Year (1986 – 2005)*

Months of admission	Observed frequency of Stroke	n (%)	Expected frequency of Stroke	Observed Expected	Observed/Ex pected
January	816	(8.1)	858.3	-42.3	0.95
February	797	(7.9)	782.2	14.8	1.02
March	890	(8.8)	858.3	31.7	1.04
April	908	(8.0)	830.6	-21.6	0.97
May	887	(8.8)	858.3	28.7	1.03
June	842	(8.3)	830.6	11.4	1.01
July	838	(8.3)	858.3	-20.3	0.97
August	847	(8.4)	858.3	-11.3	0.99
September	812	(8.0)	830.6	-18.6	0.98
October	859	(8.5)	858.3	0.70	1.00
November	859	(8.5	830.6	28.4	1.03
December	857	(8.5)	858.3	-1.3	1.00
Total	10,113	100.0			

Table 3. *All ICH stroke incidence by months of Year (1986 – 2005)*

Months of admission	Observed frequency of Stroke	n (%)	Expected frequency of Stroke	Observed Expected	Observed/ Expected
January	1,075	(8.7)	1,052.4	22.6	1.02
February	1,044	(8.4)	959.1	84.9	1.09
March	1,125	(9.1)	1,052.4	72.6	1.07
April	1,014	(8.2)	1,018.5	-04.5	1.00
May	1,077	(8.7)	1,052.4	24.6	1.02
June	977	(7.9)	1,018.5	-41.5	0.96
July	985	(7.9)	1,052.4	-67.4	0.94
August	978	(7.9)	1,052.4	-74.4	0.92
September	949	(7.7)	1,018.5	-69.5	0.93
October	1,040	(8.4)	1,052.4	-12.4	0.99
November	1,006	(8.1)	1,018.5	-12.5	0.99
December	1,130	(9.1)	1052.4	77.6	1.07
Total	12,400	100.0			

Table 4. All IS stroke incidence by months of Year (1986 – 2005)

Months of admission	Observed frequency of Stroke	n (%)	Expected frequency of Stroke	Observed Expected	Observed/ Expected
January	3, 772	(8.7)	3,691.8	80.2	1.02
February	3,412	(7.8)	3,364.3	47.7	1.01
March	3,803	(8.7)	3,691.8	111.2	1.03
April	3,680	(8.5)	3,572.7	107.3	1.03
May	3,629	(8.3)	3,691.8	-62.8	0.98
June	3,442	(7.9)	3,572.7	-130.7	0.96
July	3,607	(8.3)	3,691.8	-84.8	0.98
August	3,480	(8.0)	3,691.8	-211.8	0.94
September	3,458	(7.9)	3,572.7	-114.7	0.97
October	3,746	(8.6)	3,691.8	54.2	1.01
November	3,635	(8.4)	3,572.7	62.3	1.02
December	3,834	(8.8)	3,691.8	142.2	1.04
Total	43,498	100.0			

Table 5. Non-specific stroke incidence by months of Year (1986 – 2005)

Months of admission	Observed frequency of Stroke	n (%)	Expected frequency of Stroke	Observed Expected	Observed/ Expected
January	8,403	(9.2)	7,776.8	626.2	1.08
February	7,397	(8.1)	7,086.9	310.1	1.04
March	8,178	(8.9)	7,776.8	401.2	1.05
April	7,798	(8.5)	7,525.9	272.1	1.04
May	7,696	(8.4)	7,776.8	-80.8	0.99
June	7,368	(8.0)	7,525.9	-157.9	0.98
July	7,197	(7.9)	7,776.8	-579.8	0.93
August	7,147	(7.8)	7,776.8	-629.8	0.92
September	6,927	(7.6)	7,525.9	-598.9	0.92
October	7,629	(8.3)	7,776.8	-147.8	0.98
November	7,477	(8.2)	7,525.9	-48.9	0.99
December	8,411	(9.2)	7,776.8	634.2	1.08
Total	91,628	100.0			

Discussion

Constant striking finding was highest stroke incidence for overall as well as most of the subtypes (ICH, IS,NS) in December and January and least in September. However there was no statistically significant correlation between SAH and months of the year. Finding of an overall maximum stroke during winter as compared to summer occurred in majority of the studies on stroke so a globally [9-12]. A report of increased stroke incidence found in autumn additionally supports the present observations of high risk in December [13].

It is assumed that respiratory infections such as influenza, pneumonia and bronchitis developed during low atmosphere temperature played a role in the aetiology of stroke. Administration of influenza

vaccination alone declined 16% of cerebrovascular accidents in an elderly population [14].

There is some evidence present that influenza causes complications in atherosclerotic disease by producing a hyper-coagulable state [15].

High incidence of stroke frequency in December and January can also be attributed to serum concentration of plasma fibrinogen which enhances with lowering of temperature [16].

Comparatively less emphasis is given to SAH incidence in context of seasonal variations despite its catastrophic consequences and minimal prior warning signs in comparison to other stroke sub-types [17].

In the present analysis of incident stroke hospitalizations in Scotland (1986 – 2005) a statistically significant December and January increase in ICH incidence (p<0.001) was found which is in close agreement with many previous studies [18-20].

Ischaimic stroke frequency during December and March was found to be high which is in close agreement with many studies [10,21,22].

Some of the generalized assumptions for decrease stroke incidence during summer (September) include reduction in alcohol consumption [11,23].
This study has large sample size (157, 639) and is conducted over a period of 20 years. Thus the results are highly unlikely to be a product of chance.

Protection from cold weather, decrease alcohol consumption and maintaining blood pressure within the safe range during winter season constitutes some of the precautionary measures.

Acknowledgement

Reference

1. Goldman L, Bennett JC. Cecil textbook of medicine, 21st edition; 1999: 2092, 2109- 2112, 2113-2115.
2. Woolf N. Pathology: Basic and Systemic, WB Saunders Company Ltd 1998; 1144.
3. British Heart Foundation's Statistic Website Stroke Statistics 2009 (cited 2010 March 12) Available from http://www.hearthstats.org/temp/chaptersp2hs2hs.pdf"
4. British Heart Foundation's Statistics website, stroke Statistics 2009 (cited 2010 March 12) Available from http://www.heartstats.org/temp/chapter sp1.pdf
5. Information Service Division (ISD) Scotland Website Stroke, (cited 2010 March 12), Summary of latest publications, available from http://www.isdscotland.org/isd/5783.html
6. Spenges K, Vemmos KN, Tsivagonlis G, Synetus A, Zokopoulos N, Zis VP, Vassilopoulos D. Seasonal variation of hospital admissions caused be acute stroke in Athens, Greece. Journal of Stroke and Cerebrovascular Disease. 2003; 12 93-96.
7. Capon A, Demeurisse G, Zheng L. Seasonal variations of cerebral hemorrhage in 236 consecutive cases in Brussels. Stroke 1992; 236: 24-27.
8. South travels (cited 2010 March 12) available from http://www.southtravels.com/america/usa/weather.html\Christic D, Stroke in Melbourne, Australia: an epidemiological study. Stroke 1981; 12: 467-469.
9. Azevedo E, Ribeiro JA, Lopes F, Martins R, Cold HB: A risk factor for stroke ? J Neurol 1995; 242: 217-221.
10. Tsemnetizis, SA, Kennet RP, Hitchcock E.R., G.U.J.S., Beevers D.G. Seasonal variations of cerebrovascular disease. Acta Neurochirurgica 1991; 111: 80-83.
11. Bakonjic R, Zecn. Strokes and the weather. A quantitive statistical study. J Neurol Sci 1968; 6: 483-491.
12. Laaidi K, Minier D, Osseby GV, Couvreur G, Besancenot JP, Moreau T, Giroud M. Seasonal variation in stroke incidence and the influence of the meterological conditions. Rev Neural (Paris) 2004; 160: 321-320.
13. Nichol KL, nordin J, Mullooly J, Lask R, Fill brandt K, Iwane. M. Influenza vaccination and reductions in hospitalizations for cardiac disease and stroke among the elderly. New England Journal of Medicine, 2003r; 348 (14): 1322-1332.
14. Turin TC, Kita Y, Murakami V, Rumana N, Sugihara H, Morita Y, Tomioka N, Okayana A, Nakamura Y, Abbott RD, Ueshima H. Higher stroke incidence in the spring season regardless of conventional risk facros: Takashima stroke registry, Japan, 1988-2001, Stroke 2008 Mar; 39 (3): 745-752.
15. Staut RW, Crawfer OV, seasonal variations in fibrinogen concentrations among elderly people. Lancet 1991; 338 (8758): 9-13.
16. Chyatte D, Terence TL, Bronstein K and Brass LM. Seasonal fluctuations in the incidence of intracrainial aneurysm rupture and its relationship to changing climate conditions Journal of Neurosurgery 1994; 81: 525-530.
17. Crespany T, Csiriban M, Szasz J. Is stroke death related to seasons ? A retrospective study in East – Hungary. Journal of the Neurological Science, 1997; 150 suppl: S78-S79.
18. Kojimo S, Omura T, Wakamatsu W, Kishi M, Yamayaki T, Iida M and Kamachi Y; Prognosis and disability of stroke patients after 5 years in Akito, Japan, Stroke 1990; (1): pp 72-77.
19. Passero S, Reale F, Ciacci G, Zei E. Differing Temporal Patterns of Onset in Subgroups of patients with Intracerebral hemorrhage. Stroke 2000; 3: 1538-1544.
20. Shinkawa A, Lleda K, Hasuo Y, Kiyohara Y, Fujishima M. Seasonal variations in stroke incidence in Hisayama, Japan. Stroke 1990; 21 (9): 1262-1267.
21. Wang H, Sekine M, Chen S, Kagamimori S. A study of weekly and seasonal variations of stroke onset. International Journal of Biometeorology 2002; 47 (1): 13-20.
22. Abe T, Ohde S, Ishimalsu S, Ogata H, Hasegama t, Nakamura T and Tokudo Y. Effects of meteorological factors on the onset of subarachnoid hemorrhage: A time – series analysis, Journal of Clinical Neuroscience, 2008; 15 (9): 1005-1010.

Correspondence to:

Arsalan Moinuddin
c/o Nafis Ahmad Faruqi
Department of Anatomy
J.N. Medical College
AMU, Aligarh 202002, UP, India