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Research Article

EFFECT OF CLIMATOLOGICAL VARIABLES ON THE FREQUENCY OF INCIDENT TROKE HOSPITALIZATION DURING AUTUMN

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ABSTRACT
Stroke data were obtained as SMR01 (157, 639 incident stroke hospitalization in Scotlandbetween 1986-2005). To observe variation in weather parameter, with first stroke incidences per day, during autumn daily mean temperature/total rainfall/average daily atmospheric pressure was compared with frequency of incident strokes per day using ANOVA (Analysis of Variance). An analysis reveals an inverse statistically significant relationship for overage daily temperature during autumn whereas total daily rainfall and average daily atmospheric pressure exhibit borderline significance during same period. Correction of low temperature with stroke might be due to concurrent infection of respiratory system.

Keywords*: *Stroke, Hospitalization, Climatological Variables, Temperature, Atmospheric Pressure, Rainfall, Autumn

INTRODUCTION
Stroke is defined as "abrupt impairment of brain function by a variety of pathological changes involving intracranial or extracranial blood vessels" (Goldman and Bennete, 1999). Prognosis after attack of stroke seems to be very poor. Good number of people (25% to 30%) die in the initial three weeks and 33% to 66% in the 1st year following stroke incidence (Ebrahim, 1990). In U.K. itself about 111,000 stroke incidents are reported every year (BHFS Website, 2009). Yearly deaths in U.K. were reported to be 53,000 (BHFS Website, 2009). Though there has been remarkable decline in the stroke mortality rates since 1968 a lot of variability is still present within U.K. The rates are highest in Scotland, followed by North England, Ireland, Wales and South England (ISD, 2009).
Although overall climatological variability of stroke is appreciable in Europe and other continents like America, it is difficult to establish a specific trend due to large area wise weather differences and pathophysiological metamorphism. The aim of the present study is to assess whether there is any association between climatological variables (temperature, rainfall and atmospheric pressure) and incidence of stroke in Scotland (1986 – 2005) during autumn and suggest measures to reduce them.

MATERIALS AND METHODS
Stroke data relate to all incident hospitalization for stroke in Scotlandbetween 1986-2005. The data set comprises of a sample size 157, 639 incident hospitalization. Following service divisions were kind enough to provide informations about patients details year-wise.
1. National Health Service (NHS)
2. Information Service Division (ISD)
3. Scottish Morbity Record (SMR)

SPPS (Statistical Package for Social Sciences, 15.0 versions for Windows) was used for statistical analysis.
Weather data was obtained from the Met Office- UK's National Weather Service in the form of data sets which provide information about overage temperature, total rainfall and average atmospheric pressure on a daily basis from 1986 – 2005.

Temperature is measured at a height of 1.25 meters above ground level over a gross surface. A wide range of temperature recording is performed including air temperature, dew point, wet temperature, gross temperature and soil temperature and each is recorded using a different and specific type of thermometer. The values for temperature are noted in degree Celsius and tenths and values below 0^0C are preceded by a minus sign (Hall, 2010).
Rainfall is measured hourly, then totaled up for the daily total rainfall. The values of rainfall are noted in millimeters (mm), (25.4mm=1 inch) (Personal reference) (Hall, 2010).
Atmospheric pressure at any point on the Earth's surface is proportional to the weight of the air above it. It is measured using a precision aneroid barometer (PAB). The daily average air pressure is corrected to sea level and averaged out over the daily period 0.001 to 2400 GMT/UTS. The pressure unit used in meteorology was previously the millibar (one bar=1000 millibars). However, this has been replaced by the SI unit of pressure – the pascal (Pa) and one hectopascal (hPa) = 1 millibar (mb) (Hall, 2010).
To observe for variation in weather parameters with first stroke incidences per day, daily mean values of variables were compared with frequency of incident strokes per day using ANOVA (One way analysis of variance). Graphically it was presented by 95% confidence interval plot with number of strokes in a day on x-axis and weather parameters on y-axis.
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 were approved by Privacy Advisory Committee (PAC).

RESULTS

Autumn (Temperature): The 95% CI plot (Figure 1) demonstrates that the daily average temperature in Scotland is consistent around 9.5 ^{0}C at the beginning when the stroke frequency is between 1 -5 per day. Later on it drops from 9.5 ^{0}C to 9.0 ^{0}C as number of strokes increases to 13 per day. The slope of best fitted regression line 'β' is estimated as -0.055 which means that the average temperature decreases by 0.055 ^{0}C for each additional incident stroke increase on a given day. The 'p' value (<0.001) from ANOVA is highly significant and this supports the hypothesis of an inverse and statistically significant relationship (β= -0.055) between the number of strokes per day and daily average temperature.

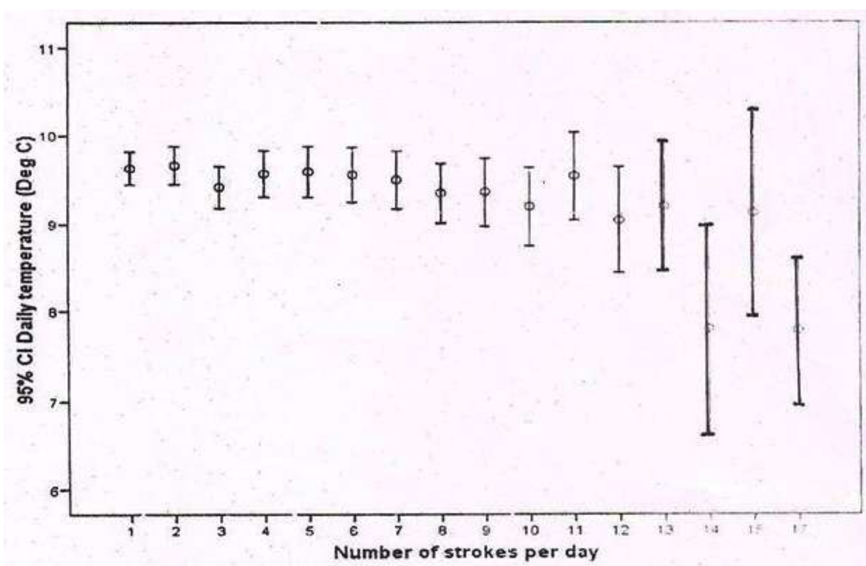

Figure 1: Daily mean temperature by number of strokes on a given day

Autumn (Rainfall): The 95% CI plot in figure 2 illustrates an increase (3 mm – 4 mm) in the amount of rainfall and also some variability in the pattern throughout the same incident stroke frequency. Also the presence of few outliers at the end may be considered less meaningful keeping the corresponding wide confidence intervals in mind (Figure 2).The slope of the best fitted regression line 'β' is estimated as 0.008 which means that the average rainfall increases by 0.008 mm for each additional incident stroke increase on a given day. Although, ANOVA test (p = 0.003) suggest a statistically significant relationship yet the plot pattern makes it difficult to establish a specific trend between daily total rainfall and number of strokes per day.

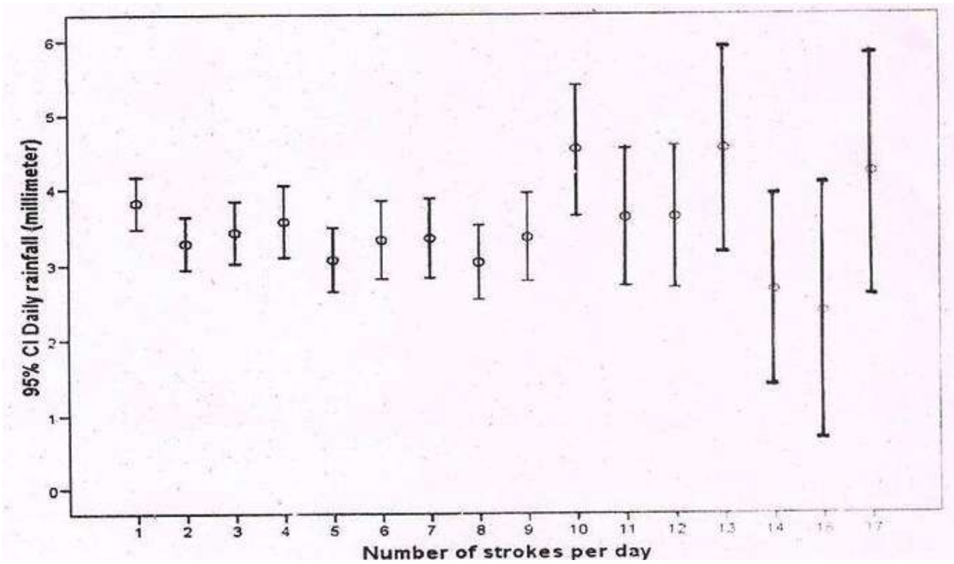

Figure 2: Daily total rainfall by number of strokes on a given day

Autumn (Atmospheric pressure): The 95% CI plot (figure 3), shows that the daily average atmospheric pressure is relatively consistent between 1009 and 1012 hPa while the number of strokes rises from 1 – 10 per day. This is followed by a variable and inconsistent pattern as stroke frequency rises further to 16. Thus although a borderline 'p' value of 0.06 (ANOVA test) suggests some evidence of variation in daily average atmospheric pressure with increasing stroke frequency, yet the pattern of plots and wide 95% CI (figure 2) are not conclusive enough to establish a statistically significant relationship between daily average atmospheric pressure and number of strokes per day.

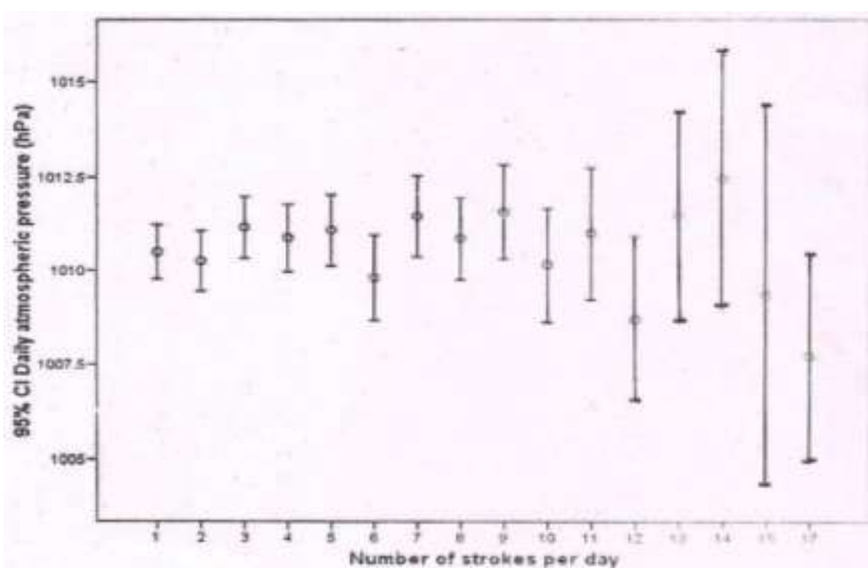

Figure 3: Daily average atmospheric pressure by number of strokes on a given day

DUSCUSSION

Temperature appears to be the only meteorological variable which showed significant variation with stroke frequency in autumn. An inverse statistically significant (P<0.001) relationship between average temperature and first incident stroke observed in present study was in accordance with a lot of studies in the past (Joseph *et al.*, 1965; Sung, 2006).

It is assured that respiratory infections such as influenza, pneumonia, bronchitis palyed a role in the aetiology of stroke. There is some evidence present that influenza causes complications in atherosclerotic disease by producing a hypercuagulable state (Turin *et al.*, 2008). Serum concentration of plasma fibrinogen enhances with lowering of temperature (Stout and Crawford, 1991). Previous report shows increased serum total cholesterol concentration (STCC) with a fall in temperature (Joseph *et al.*, 1965). C-reactive protein exhibits a peak during winter (Sung, 2006) when the temperature is lowest.

Our study has a large sample size (151, 639) and is connected over a period of 20 years, thus the results are highly unlikely to be a product of chance. Some precautionary measures are suggested to minimize the chance of stroke i.e. protection in cold weather, decrease in alcohol consumption and maintaining blood pressure within safe range during winter season.

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