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ON THE ANALYSIS OF STROKE IN INFANT IN ENUGU STATE: A POISSON PROCESS.

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ABSTRACT

The incidence of stroke is usually associated with adults and the elderly. Little or no knowledge of the incidence is associated with infants, children, and young adults; as such cannot even be thought to occur before birth. In media enlightenment on the existence of stroke in infants which took place in Enugu State; many were unaware of the incidence of stroke in infants in that region. Therefore this study aimed at verifying the existence of the incidence of stroke in infants in Enugu State. Recorded data confirmed the existence of this illness in infants; although it is seen as a rear occurrence. The existing data were analysed using the Poisson distribution function to determine if the data followed a random process. The result of the analysis led to the acceptance of the **fit** at 5% significance level; this revealed that the data used for the study followed a random process. However it is pertinent to mention that this illness is actionable. This study therefore calls for more awareness on the existence of this illness in infants to forestall future/further occurrences.

Keywords: Infants, Incidence, Poisson process, Prenatal stroke, Random process

INTRODUCTION

Stroke is a major cause of death and disability in high-income countries. The burden of stroke in sub-Saharan Africa is viewed to be high. However, specific stroke data are scarce from resource-poor countries. Common believe is that stroke occurs predominantly in the elderly with little knowledge that it also strikes infants, children, young adults and can even occur before birth with equally devastating results. Stroke affects several hundreds of children in United Kingdom (UK), Europe and Africa each year and is one of the top ten causes of childhood mortality (fullerton et al, 2002). Reported Incidence rates of ischaemic stroke in the young vary according to study design and population structure. The annual incidence of young stroke in the UK has been estimated at approximately 10 per 100, 000 (female: male, 1.6:1.3) in a prospective, community-based study. Most reports of young stroke apply to age limit of 45 years in the study Population. (Martine et al, 1997). Studies have shown that the risk of stroke in children is greatest in the first year of life, and peaks during the prenatal period and that it also occurs in about one out of every 4,000 live births (Lloyd-Jones d, et al, 2009). A prenatal stroke means a stroke that occurs in a baby anytime from after 28 weeks of pregnancy up to 28 days after birth. A permanent injury to the brain caused by a stroke can become a cause of recurrent seizures (i.e., epilepsy). Prenatal strokes are thought to be the second most common cause of prenatal seizures. It occurs with a frequency of 1 in 4,000 live births. About 17% of full term babies who suffer prenatal seizures have suffered strokes. The study by Roya et al (2015) on Prevalence of Stroke in Neonates who admitted with Seizures in Neonatal Intensive Care Unit showed that Prevalence of stroke was 8%, 2.3% and 3.4% in Doppler ultrasonography, CT scan and MRI reports respectively. They observed that Umbilical venous catheterization was the risk factor of stroke in the univariate and multivariate analysis with P-value of 0.001; Odd's Ratio of 10.39 and 95% Confidence Interval of 2.72-39.77. They concluded that most common form of seizure was focal clonic seizures which were 78.6% in neonates with stroke.

Also in a study to investigate the level of prevalence of stroke in children; Gerald and Steven (1995) using Chi square test, observed that out of the 592 interviewed in infants, of which 350 (59%) were males and 242 (40%) were females. The total number of respondents with stroke was 481 (81.2%) while 111 (18.8%) had no stroke. They concluded that the prevalence of knowledge of stroke in infants is high (81.2%) among patients attending out patients clinics in U.K. Furthermore, the result of statistical analysis on Predictors of outcome of stroke in infants and children based on clinical data and radiologic correlates showed that hemorrhagic infarction demonstrated by brain CT with p-value of 0.031 and patients who presented with a generalized neurological disorder, with or without seizures with p value of 0.036 were associated with increased risk of immediate death. The study concluded that these may therefore serve as outcome predictors of stroke in the paediatric age group (Keidan et al 1994). Stroke has been increasingly recognized in children in recent years, but diagnosis and management can be difficult because of the diversity of underlying risk factors and the absence of a uniform treatment approach. Children and adolescents with stroke have remarkable differences in presentation compared to older patients.

Rael et al, (2007) in their study titled "Acutely and Retrospectively Diagnosed Perinatal Stroke: A Population-Based Study" estimated the incidence of perinatal arterial ischemic and hemorrhagic stroke in Estonia, to study the first clinical signs and to identify possible differences in predisposing factors and outcome between acutely and retrospectively diagnosed cases of perinatal stroke. They observed that the incidence rate of perinatal stroke in Estonia is 63 per 100 000 live births and the main clinical findings in the neonatal period were seizures, abnormalities of muscular tone, and disturbed level of alertness. Previously identified risk factors occurred in 32% of cases. Children with early diagnosis had more often adverse events during pregnancy and delivery (P 0.05) and developed more severe stage of hemi paresis compared with children with late diagnosis (P 0.05).

Obiechina et al (2001), carried out a study on Surgery of brain disease and attack; using time series analysis in national surgery of brain attack in U.K for stroke in childhood to be the ratio of 1:1 for males and had no results in females, and conclude that there is a significant increase with that of males to females at age of 6 months to 2 years. However, the long-lasting physical, emotional and social effects of stroke on an individual near the beginning of their light affects not only the individual themselves but also their family and society as a whole.

According to the study by Nelson, (et al 2004), the few days before and after birth are a time of special risk for stroke in both mother and infants probably related to activation of coagulation mechanisms in this critical period. Arterial ischemic stroke around the time of birth is recognized in about one in 4000 full-term infants, and may present with neurological and systemic signs in the newborn. Neonatal seizures are most commonly the clinical finding that triggers assessment. In other children, prenatal stroke is recognized only retrospectively, with emerging hemi paresis or seizures after the early months of life.

Prenatal strokes usually occur during delivery or right after delivery because the body doesn't get enough oxygen while travelling through the birth canal. Stroke also can occur in older kinds but are usually caused by another condition that stops the flows of blood to the brain or causes bleeding in the brain, (Lynch, et al, 2002). Studies have shown that approximately 70% of babies who suffer prenatal stroke go on to develop childhood epilepsy. Nonetheless, with appropriate treatment and follow-up by a paediatric neurologist, more than 60% of these infants become seizure-free over the years. (Rob and Terry, 2006)

The brain damage that occurs during a stroke can cause a number of other problems throughout a child's life; such as Cerebral palsy, Mental retardation, Paralysis or weakness on one side, Communication problems, Vision deficits, Psychological difficulties.(Harry, 2013). In a study on the incidence, characteristics, and short-term consequences of hospitalizations for stroke in Maputo, Mozambique. The authors viewed that the burden of disease associated with stroke is high in Maputo, emphasizing the importance of primary prevention and improvement of the ly

standards of care in a developing country under epidemiological transition. (Albertino, 2010). Stroke is often of a lower priority for clinical services and research than other diseases with a similar or lower public health impact. The reasons for this varies between countries, though , a common theme is seen as lack of readily accessible comparative data to help mount a political case and awareness for the development of national strategies to address the burden of stroke (Amanda et al, 2014).

Studies have shown the prevalence of stroke in infants in both developed and developing parts of the world, although its awareness is still low and uncommon in Enugu State. This study therefore aims at verifying if stroke really exist in infants in Enugu State; and if it does; does it occur at random? This will be done using past records of the incidence in the study area. Since its knowledge is still uncommon, Poisson distribution will be most appropriate as it models events, particularly uncommon events.

MATERIAL AND METHODS

The data used for this study were past records on the incidence of stroke in Infants. The data were collected as recorded from university of Nigeria Teaching hospital Ituku-Ozalla Enugu; for the period of 2001 to 2015. The data are as presented on table 1 below

TABLE1. Cases Of Stroke In Infants From Year 2001 To 2015

Data Presentation

YEAR	MALE	FEMALE	TOTAL
2001	1	-	1
2002	1	-	1
2003	-	-	-
2004	-	-	-
2005	2	-	2
2006	-	1	1
2007	-	-	-
2008	1	1	2
2009	1	1	2
2010	3	-	3
2011	-	1	1
2012	-	-	-
2013	-	-	-
2014	1	2	3
2015	-	2	2
TOTAL	**10**	**8**	**18**

From table 1 above, it can be seen that data actually exists for stroke in infants implying the existence of the incidence of stroke cases in infants; though it shows rare occurrences. It is necessary to determine if these data were generated through a random process. As already mentioned that Poisson distribution is considered most appropriate tool, brief discussion on the tool is quite necessary.

Poisson distribution

A Poisson distribution is the probability distribution that results from a statistical experiment that has the following properties:

i) The experiment results in outcomes that can be classified as successes or failures.
ii) The average number of successes (μ) that occurs in a specified region is known.
iii) The probability that a success will occur is proportional to the size of the region.
iv) The probability that a success will occur in an extremely small region is virtually zero.

Application

The Poisson distribution applies in the following situations. When:

1. the event is something that can be counted in whole numbers;
2. occurrences are independent, so that one occurrence neither diminishes nor increases the chance of another;
3. the average frequency of occurrence for the time period in question is known; and
4. it is possible to count how many events **have** occurred, such as the number of times an event occurred in a given time or some time, but unnecessary to ask how many such events did not occur. This last point sums up the contrast with the Binomial situation, where the probability of each of two mutually exclusive events (**p** and **q**) is known. The Poisson distribution can be seen as the Binomial Distribution without the probability of failure (**q**). In those circumstances, and they are surprisingly common, the Poisson distribution gives the expected frequency profile for

events. It may be used in reverse, to test whether a given data set was generated by a random process. If the data fit the Poisson Expectation closely, then there is no strong reason to believe that something other than random occurrence is at work. On the other hand, if the data are lumpy, we look for what might be causing the lump. (*https://www.umass.edu/wsp/resources/**poisson**/)*

Assumptions: When is the Poisson distribution an appropriate model?

The Poisson distribution is an appropriate model if the following assumptions are true.

i. K is the number of times an event occurs in an interval and K can take values 0, 1, 2, …
ii. The occurrence of one event does not affect the probability that a second event will occur. That is, events occur independently.
iii. The rate at which events occur is constant. The rate cannot be higher in some intervals and lower in other intervals.
iv. Two events cannot occur at exactly the same instant.
v. The probability of an event in an interval is proportional to the length of the interval.(*https://www.umass.edu/wsp/resources/**poisson**/)*

If these conditions are true, then K is a Poisson random variable, and the distribution of K is a Poisson distribution and will follow the pattern shown on fig. 1 below.

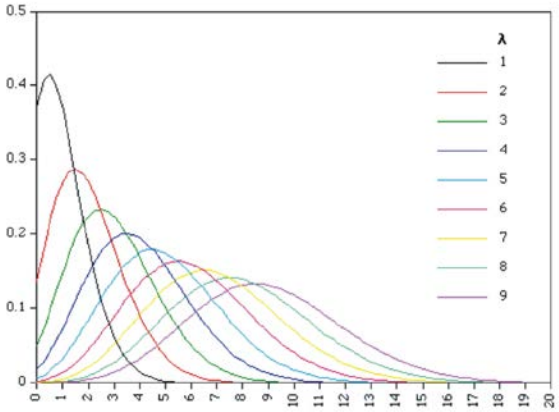

Figure 1: The Poisson Distributions

Fig 1 above simultaneously portrayed several Poisson distributions. Where the rate of occurrence of some event, ***r*** (**l**) is small, the range of likely possibilities will lie near the zero line. Meaning that when the rate **l** is small, zero is a very likely number to get. As the rate becomes higher, the center of the curve moves toward the right, and eventually, somewhere around **l** = 7, zero occurrences actually become unlikely. This is how the Poisson world looks graphically.

Method of Computation

The following is a review of the procedure of computing probabilities from the Poisson distribution:

1. Determine the parameter λ. This parameter is the average number of occurrences. It may be determined from observed or assumed data. A trial may consist of an instantaneous observation, counting events during a time interval, counting events in a unit area, etc.

$$\lambda = \frac{\textit{Total number of events observed}}{\textit{Total number of trials or time interval}} \quad (1)$$

$$P(o) = e^{-\lambda}$$

$$p(x) = \frac{\lambda^x e^{-\lambda}}{x!} \quad (2)$$

The value of e^x can be found by means of a log-log-duplex slide rule; e^{-x} is, of course, the reciprocal of e^x, Having obtained $\mathbf{e}^{-x}$ by slide rule or from tables, the individual terms of the Poisson distribution may be obtained by means of the following relationship for $p(x + \mathbf{1})$ which is particularly adapted to slide rule calculations from equation (2) above

$$p(x+1) = \frac{\lambda^{x+1} e^{-\lambda}}{x+1!} = \frac{\lambda^x e^{-\lambda} \lambda}{x!(x+1)} = \frac{\lambda}{x+1} p(x) \quad (3)$$

Thus, it follows that:

$$P(o) = e^{-\lambda}$$

$$P(1) = \frac{\lambda}{1} p(0)$$

$$P(2) = \frac{\lambda}{2} p(1) \quad (4)$$

$$P(3) = \frac{\lambda}{3} p(2) \text{ etc. (Gianne 2010)}$$

Cumulative Poisson distribution

In the section above, the probability of exactly 0, **1,** 2, 3 items per trial (or time interval) has been computed. In many problems it is desirable to compute such values as the probability that the number of items per trial is:

i.. k or less
ii greater than k
$> X^{0.02}_{5}$ less than k
iv. k or greater

These probabilities involve the cumulative Poisson distribution and may be expressed as follows:

P(x ≤ k) = Probability that x ≤ k

(5)

P(x > k) = 1 - p(x £ k)

$$= 1 - \sum_{x=0}^{k} \frac{\lambda^x e^{-\lambda}}{x!}$$ (6)

$P = 1 - \sum_{k-1}^{x=0} \frac{x_i}{y_x 6_{-y}}$ *k*-**1)**

(7)

P(... P(x < k)

$= \sum_{k-1}^{x=0} \frac{x_i}{y_x 6_{-y}}$ (8) (Daniel,1955)

Statement of Hypothesis

H_0: The data set follows a random process

Vs

$= \sum_{k}^{=x=0} h(x) = \sum_{k}^{x=0} \frac{x_i}{y_x 6_{-y}}$ does not follow a random

Decision Rule: At 5% significant level, if

Reject H_0 otherwise accept.
Acceptance of H_0 indicates that the Fit is significant.

Application of Poisson Distribution to the Data on Table 1 above.

P(X=x)

l

where:

l = mean

$X_5 = \left(\sum_{k}^{i=1} \frac{E^i}{V^i_5} \right) - \mu$ ber of the years) 1.2

Highest number of occurrence equals 3
From table 2 above, comparing the theoretical frequencies with the observed frequencies; it can be clearly seen that the sum of theoretical frequency corresponds to the sum of the observed frequencies.

Applying the cumulative Poisson distribution

P(x = 0, 1, 2, 3) =

P(x≤ 4) = 1- P[(x = 0, 1, 2, 3)]

= 1-P(x≤ 4)

= 1- (0.3012+0.3610+0.2100+0.0867)

= 1- 0.9589

= 0.0411

Table 2. Calculation of the Expected Frequencies**(Data from Table 1)**

Number of cases	Observed frequency (f)	$P_{(x)}$	Theoretical frequency (F) = $np_{(x)}$
0	5	0.3012	4.52
1	4	0.3610	5.42
2	2	0.0867	1.30
≥3	0	0.0411	0.62
Total	**15**	**1.000**	**15.01**

$\frac{0i}{I'S_0 6_{-IS}} + \frac{Ii}{I'S_I 6_{-IS}} + \frac{Si}{I'S_5 6_{-IS}} + \frac{3i}{I'S_3 6_{-IS}}$

To test for the goodness of fit of the Poisson distribution, using the formular below:

(9)

Table 3 χ^2 Test of Goodness of Fit from table 2 above.

Number of cases	Observed frequency (f)	Theoretical frequency (F)	$\frac{fi^2}{Fi}$
0	5	4.52	5.53
1	4	5.42	2.95
2	4	3.15	5.08
3	2	1.30	
≥3	0 } 2	0.62 1.92 }	2.08
Total	**15**	**15.01**	**15.64**

= 15.64 -15

= 0.64

ν = 4-2 =2

 = 5.991

Since 0.64 < 5.991, the fit is acceptable at the 5% significance level. We conclude that the data set were generated through a random process

RESULTS AND DISCUSSION

The existence of data on the incidence of stroke in infants actually confirms its existence in Enugu State. The incidence can be viewed as a low occurrence base on the available data as shown on table 1; this informs why the knowledge of its existence is uncommon and lacking in some cases. Since the incidence of stroke in infant is uncommon in the study area based on the available data, most appropriate statistical tool for such study is Poisson [illegible] which can also be used to determine [illegible] used for the study were generated [illegible]dom process. (Daniel,1955). Using a [illegible]robability density function, to [illegible] if the data generated for this study follows a random process, the result of the analysis based on $\chi 2$ goodness of fit test at the 5% significance level led to acceptance of the null hypothesis as stated in section 2.5 above. This showed that the data verifying the existence of stroke in infants in the area were generated through a random process. Since the result showed that the data followed a random process, it satisfies the assumptions of Poisson distribution as stated in section 2.2 above and the study can be said to follow a Poisson process.

CONCLUSION

The incidence of stroke in infants follows a random process based on this study. Existence of recorded data for this study verified the incidence of stroke in infants in Enugu State; though it is a rear occurrence; implying that it follows a Poisson process and the awareness is still low. This calls for the attention of medical/health practitioners to create awareness/sensitive the general public especially the parents; on the existence of this illness in infants and in some cases the unborn. This will help to check its occurrences and possibly forestall it entirely since the possible causes are known and its occurrence is still rare.

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