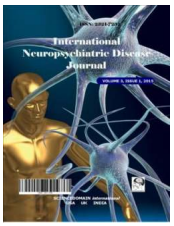

International Neuropsychiatric Disease Journal

9(4): 1-8, 2017; Article no.INDJ.35249
ISSN: 2321-7235, NLM ID: 101632319

Pediatric Neurologic Disorders at a Tertiary Healthcare Facility in North-Central Nigeria: A 5 Year Review

Emeka U. Ejeliogu[1*] and Esther S. Yiltok[1]

[1]Department of Paediatrics, University of Jos / Jos University Teaching Hospital, Nigeria.

Authors' contributions

This work was carried out in collaboration between both authors. Author EUE contributed to the concept, design, literature search, data collection and analysis, manuscript preparation, manuscript editing and manuscript review. Author ESY contributed to data collection, manuscript editing and manuscript review. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/INDJ/2017/35249
Editor(s):
(1) Elena Cecilia Rosca, Department of Neurology, University of Medicine and Pharmacy, Romania.
Reviewers:
(1) Mary V. Seeman, University of Toronto, Canada.
(2) M. C. J. Dekker, Kilimanjaro Christian Medical Centre, Tanzania.
Complete Peer review History: http://www.sciencedomain.org/review-history/20398

Original Research Article

Received 3rd July 2017
Accepted 4th August 2017
Published 7th August 2017

ABSTRACT

Background: Neurologic disorders in children are common occurrences in clinical practice; they constitute a major cause of morbidity and disability in childhood. Children with neurologic disorders in developing countries are faced with the added burden of poverty, inadequate health facilities, inadequate community services, poor parental education/awareness as well as lack of facilities for rehabilitative care.
Aim: To describe the pattern of neurologic disorders at a pediatric neurology clinic in a tertiary healthcare facility in north-central Nigeria.
Study Design: This was a retrospective descriptive study.
Place and Duration of Study: Pediatric neurology clinic, Jos University Teaching Hospital, Nigeria between January 2011 and December 2015.
Methodology: We reviewed the clinical records of all children seen at the pediatric neurology clinic of Jos University Teaching Hospital, Nigeria between January 2011 and December 2015. We extracted relevant information from the clinical records. We analysed the data obtained with EpiInfo version 7.2, results were expressed as descriptive statistics.

**Corresponding author: E-mail: emekam12@yahoo.com;*

Results: There were 8,307 consultations at the pediatric neurology clinic within the study period, accounting for 21.3% of all consultations at the pediatric specialist clinics. A total of 3,056 patients were seen at the clinic during the study period. Males were 1,785 (58.4%) while females were 1,271 (41.6%) with a male: Female ratio of 1.4:1. The 3,056 patients had a total of 4,967 neurologic disorders with an average of 1.6 disorders per patient. One thousand nine hundred and thirty-two (63.2%) had one disorder while 1,124 (36.8%) had multiple disorders. The commonest neurologic disorders seen during the study period were epilepsy 2,512 (50.6%), cerebral palsy 734 (14.8%), intellectual disability 677 (13.6%), speech defect 363 (7.3%) and hearing impairment 139 (2.7%).
Conclusion: Epilepsy and cerebral palsy were the commonest neurologic disorders observed in this study. Preventable causes such as severe birth asphyxia, neonatal jaundice and central nervous system infections were predominantly responsible for most of the childhood neurologic disorders seen in this study. Improvement in basic healthcare especially maternal, newborn and child care will help reduce the incidence of neurologic disorders in developing countries.

Keywords: Neurologic diseases; pattern; children; North-Central Nigeria.

1. INTRODUCTION

Neurologic disorders in children are common occurrences in clinical practice, they constitute a major cause of morbidity and disability in childhood.[1,2]. These disorders account for more than 20% of the world's disease burden with a greater majority of people affected living in Africa [3,4]. Children with neurologic disorders in the developing world are faced with the added burden of poverty, inadequate health facilities, inadequate community services, parental/caregiver low level of education/information or poor awareness, as well as lack of facilities for rehabilitative care.[5] Many of these disorders are chronic, frustrating to caregivers and parents and require adequate understanding to cope with management. The treatment period may be so long taking months to years, making room for a high rate of default from follow-up [4]. In developed countries, advances in diagnostic techniques and application of recent therapeutic measures have aided the characterization and definition of diseases, and has resulted in significantly improved outcome [6].

The pattern of neurologic conditions may vary from one geographic location to another. The variation in prevalence and pattern of neurologic conditions reported in previous studies have been predicated on methodological differences between studies, variation in case definitions and sampling techniques and lack of age adjustment of rates with standard national and international population [7-9]. For example autism is a common condition among children in North America, [10,11] while most studies reported attention deficit hyperactivity disorder (ADHD) as the most common behavioral disorder among children in the United Kingdom [12]. Some studies from Africa indicated that cerebral palsy (CP) was the most prevalent neurologic condition among children with varying rates, [13-15] while others reported that epilepsy was the commonest neurologic disorder seen in children [16-18].

Local and regional studies on the pattern of neurologic disorders in children are valuable in understanding trends and characteristics of these conditions which will help in early diagnosis and proper management of the disorders, and also for designing and implementing preventive health strategies. This study was therefore aimed at describing the pattern of neurologic disorders at a pediatric neurology clinic in a tertiary healthcare facility in north-central Nigeria.

2. MATERIALS AND METHODS

2.1 Background of Study Area

Jos, the capital of Plateau state of Nigeria, is located in the north-central zone of the country. The Jos University Teaching Hospital is one of the three teaching hospitals in the zone. The population of the state was estimated at 3,206,531 in the 2006 census, with the state capital having a population of approximately 900,000.[19] Children (individuals below 18 years) constitute about 45% of the total population.

2.2 Study Site

This study was carried out in the pediatric neurology clinic of Jos university teaching hospital, Jos. The clinic runs every Monday at the pediatric out-patient department (POPD) of the hospital. It receives referrals from the

general pediatric out-patient clinic, general out-patient department, other pediatric specialist clinics, neuro-surgical clinic, and from other hospitals in different parts of the state and neighboring states. It also serves as a follow-up clinic for children that were admitted for neurologic diseases in the hospital. It attends to about 40 patients every clinic day.

2.3 Study Population

Subjects of the study were children with neurologic disorders seen at the pediatric neurology clinic between January 2011 and December 2015.

2.4 Study Design

This was a retrospective descriptive study.

2.5 Inclusion Criteria

All children aged <18 years with definitive diagnosis of neurologic disorder seen at the pediatric neurology clinic within the study period.

2.6 Exclusion Criteria

Any child without a definitive diagnosis was excluded from the study.

2.7 Data Collection

We reviewed the clinical records of all children seen at the pediatric neurology clinic of JUTH between January 2011 and December 2015. We extracted relevant information from the clinical records. Both single and multiple neurologic disorders documented in the clinical records of the patients were extracted and analysed.

2.8 Data Analysis

Data obtained was analysed with EpiInfo version 7.2. The results were expressed as descriptive statistics.

2.9 Ethical Consideration

Ethical approval for this study was obtained from the Health Research Ethical Committee (HREC) of Jos University Teaching Hospital. Since there was no direct contact with patients, informed consent was not necessary, however information obtained was kept confidential.

3. RESULTS AND DISCUSSION

3.1 Results

Seventeen children did not have definitive diagnoses and were excluded from the study. There were 8,307 consultations at the pediatric neurology clinic within the study period, accounting for 21.3% of all consultations at the pediatric specialist clinics. A total of 3,056 patients were seen at the clinic during the study period. Males were 1,785 (58.4%) while females were 1,271 (41.6%) with a male: female ratio of 1.4:1. One thousand six hundred and eleven (52.7%) were aged 1-5 years, 940 (30.8%) were aged 6-12 years, 371 (12.1%) were aged <1 year while 134 (4.4%) were aged 13-17 years. Table 1 shows the age and sex distribution of the patients.

The main reasons for presentation at the clinic were recurrent seizures and delayed developmental milestones. The 3,056 patients had a total of 4,967 neurologic disorders with an average of 1.6 disorders per patient. One thousand nine hundred and thirty-two (63.2%) had one disorder, 660 (21.6%) had two disorders, 281 (9.2%) had three disorders, 113 (3.7%) had four disorders while 70 (2.3%) had more than four disorders. In all 1,124 (36.8%) had multiple disorders. The commonest neurologic disorders seen during the study period were epilepsy 2,512 (50.6%), cerebral palsy 734 (14.8%), intellectual disability 677 (13.6%), speech defect 363 (7.3%) and hearing impairment 139 (2.8%). Table 2 shows the age distribution of neurologic disorders seen.

Table 1. Age and sex distribution of the patients

Age	Male (% of total)	Female (% of total)	Total (%)
<1 year	231 (7.5)	140 (4.6)	371 (12.1)
1-5 years	943 (30.9)	668 (21.8)	1611 (52.7)
6-12 years	529 (17.3)	411 (13.5)	940 (30.8)
13-17 years	82 (2.7)	52 (1.7)	134 (4.4)

Table 2. Age distribution of neurologic disorders

Neurologic disorder^	<1 year	1-5 years	6-12 years	13-17 years	Total (%)
Epilepsy	336 (6.8%)	1187 (23.9%)	883 (17.8%)	106 (2.1%)	2512 (50.6%)
Cerebral palsy	0 (0.0%)	680 (13.7%)	45 (0.9%)	9 (0.2%)	734 (14.8%)
Intellectual disability	0 (0.0%)	78 (1.6%)	563 (11.3%)	36 (0.7%)	677 (13.6%)
Speech defect	0 (0.0%)	310 (6.2%)	39 (0.8%)	14 (0.3%)	363 (7.3%)
Hearing impairment	16 (0.3%)	76 (1.5%)	32 (0.6%)	15 (0.3%)	139 (2.7%)
Down syndrome	42 (0.8%)	17 (0.3%)	0 (0.0%)	0 (0.0%)	59 (1.2%)
ADHD	0 (0.0%)	23 (0.5%)	15 (0.3%)	0 (0.0%)	38 (0.8%)
Traumatic nerve injury	13 (0.3%)	21 (0.4%)	4 (0.1%)	0 (0.0%)	38 (0.8%)
Visual impairment	18 (0.4%)	15 (0.3%)	4 (0.1%)	0 (0.0%)	37 (0.8%)
Headache disorders	0 (0.0%)	2 (0.04%)	16 (0.3%)	13 (0.3%)	31 (0.6%)
Hydrocephalus	24 (0.5%)	5 (0.1%)	0 (0.0%)	0 (0.0%)	29 (0.6%)
Movement disorders	0 (0.0%)	4 (0.1%)	22 (0.5%)	2 (0.04%)	28 (0.6%)
Neurocutaneous syndrome	23 (0.4%)	4 (0.1%)	0 (0.0%)	0 (0.0%)	27 (0.5%)
Brain tumors	0 (0.0%)	4 (0.1%)	17 (0.3%)	3 (0.1%)	24 (0.5%)
Congenital CNS malformation	18 (0.3%)	3 (0.1%)	0 (0.0%)	0 (0.0%)	21 (0.4%)
Autism spectrum disorder	0 (0.0%)	13 (0.3%)	6 (0.1%)	0 (0.0%)	19 (0.4%)
Myasthenia gravis	0 (0.0%)	2 (0.04%)	8 (0.2%)	6 (0.1%)	16 (0.3%)
Muscular dystrophy	0 (0.0%)	8 (0.2%)	2 (0.04%)	0 (0.0%)	10 (0.2%)
Others	23 (0.4%)	75 (1.5%)	43 (0.9%)	24 (0.5%)	165 (3.3%)

^some children had more than one neurologic disorder
ADHD: Attention Deficit Hyperactivity Disorder; CNS: Central Nervous System

The traumatic nerve injuries were made up of sciatic nerve injury following intramuscular injections and Erb's palsy. Movement disorders seen were predominantly tics. The Neurocutaneous syndromes consisted of Sturge-Weber syndrome, tuberous sclerosis, and neurofibromatosis. 'Others' included isolated idiopathic microcephaly, craniosynostosis, Guillain-Barre syndrome, congenital rubella syndrome, cerebrovascular accident, conversion disorder, malingering, chromosomal anomalies other than Down syndrome, facial nerve palsy, ptosis and strabismus.

3.2 Discussion

This retrospective study reviewed the pattern of pediatric neurologic disorders at a tertiary health facility in north-central Nigeria. Results of this study showed that neurologic disorders accounted for about 21% of all consultations in the pediatric specialist clinics. This is similar to reports from other parts of Nigeria which showed that neurologic disorders are still very common in children in developing countries.[15-18,20,21] These disorders originate from many injuries the developing brain of children receive during the perinatal and postnatal periods. These injuries which lead to long term neurologic sequelae primarily include severe birth asphyxia (SBA), neonatal jaundice (NNJ) and central nervous system (CNS) infections. This is worsened by the fact that many women in developing countries still deliver at home [22,23]. Many of the newborns delivered at home are not brought to the health facility for routine newborn examination and screening. Factors responsible for this high level of home delivery include

poverty, low level of education or poor awareness, traditional and cultural beliefs and practices, far distance to and high cost of health facilities, and inadequate transportation services. Improving economic situation of families, female education, provision of basic healthcare facilities with skilled birth attendants within reach of most people, and community support will help reduce the number of women that deliver at home.

Sixty-five percent of the children in this study were aged <5 years, this is similar to reports from previous studies [3,20]. This may be because of the fact that some of the neurologic disorders are congenital in nature and therefore present soon after birth, also features of neurologic disorder usually become obvious during the period of rapid brain development. The male: female ratio was 1.4:1, this was not statistically significant. This is also similar to reports from previous studies [3,20].

The commonest neurologic disorder seen in this study was epilepsy. This is similar to reports from Norway [24], Japan [25], Eritrea [20] and some parts of Nigeria [16-18] but differs from reports from Sagamu [13] and Zaria [15] both in Nigeria where cerebral palsy was the commonest neurologic disorder, and Saudi Arabia [26] where intellectual disability was the commonest disorder. The high prevalence of epilepsy may be due to increasing awareness that epileptic seizure is a medical condition which is treatable as against prior believe that it is caused by evil spirit manipulation and witchcraft attacks.[27] It is possible that public enlightenment has contributed to its knowledge on etiology and treatment modalities; thus, many more parents come to the hospital with their children for proper diagnoses and treatment.[16] Epileptic seizures were most common in children aged 1-5 years followed by 6-12 year age group.

Based on International classification of epileptic seizures and electroencephalographic (EEG) features, the commonest type of seizure seen in our study was generalized tonic clonic (GTC) seizure. This is similar to previous reports in developing countries. [3,28,29] but contrasts with a report from USA [30] which showed that partial seizures were the commonest type. The reason why GTC seizure is more common than partial seizure in developing countries is not very clear but may be related to the fact that GTC seizures are very frightening to family members which will make them more likely to seek health care.

Cerebral palsy (CP) was the second commonest neurologic disorder seen in this study, accounting for about 15% of all cases. This is similar to previous reports in developing countries [16-18]. Similar to epilepsy, most cases of CP presented in the 1-5 year age group. CP usually results from non progressive injury to the developing brain, the injury could occur during the antenatal, perinatal and postnatal periods. In developing countries most cases of CP are due to preventable and treatable perinatal and postnatal events like SBA, NNJ and CNS infections [13,31]. Improvement in basic healthcare especially maternal and newborn care will help reduce the incidence of CP in developing countries.

Intellectual disability (ID) was the third commonest neurologic disorder seen in this study, accounting for about 14% of the cases. This is similar to previous report from Nigeria [17]. Eighty-eight percent of the cases of ID were diagnosed in school age children (6-12 years). ID may only become apparent when children start school and consistently perform poorly. In addition the tools we used in diagnosing ID (Ziler draw-a-man test and Raven's Standard Progressive Matrices) can only be administered from 4 years of age.

It is noteworthy that some children had sciatic nerve injury from intramuscular injections most of which were unnecessary and were given at patent medicine stores, primary health centres and private hospitals. Efforts should be made to create public awareness on the need to eliminate unnecessary injections and re-train healthcare workers on appropriate administration of injections.

About 37% of children in this study had multiple neurologic disorders, this is higher than the 29.6% reported in Eritrea.[20] Most of the patients with multiple disorders had SBA, NNJ or CNS infections. These three conditions have been implicated in long term neurodevelopmental sequelae in children in developing countries [32-34]. Because individuals with one major neurologic disorder may have more than one, a thorough evaluation should be performed to identify other neurologic disorders present. Identifying all the patient's disabilities and needs is very important in providing a comprehensive multidisciplinary care in order to improve the patient's overall outcome. It is also known that one neurologic disorder can lead to another one if is not treated early. Uncontrolled seizures can

lead to secondary brain damage and the development of other neurologic disorders like intellectual disability. Hearing impairment can lead to speech delay if is not identified early. Early identification and proper management of neurologic disorders is therefore important in preventing the development of secondary neurologic disorders.

The prevalence and pattern of neurologic disorders in developing countries have not changed over a long period of time. Resources need to be channelled towards designing and implementing preventive measures that will reduce the prevalence of such disorders. There is also need to develop advanced diagnostic, therapeutic and rehabilitative techniques that will help improve the quality of life and overall outcome of children with neurologic disorders.

4. CONCLUSION

Similar to previous reports, epilepsy and cerebral palsy were the commonest neurologic disorders observed in this study. Many of these children will require long term specialised care including multidisciplinary care. Preventable causes such as severe birth asphyxia, neonatal jaundice and central nervous system infections were predominantly responsible for most of the childhood neurologic disorders seen in this study. Improvement in basic healthcare especially maternal, newborn and child care will help reduce the incidence of neurologic disorders in developing countries.

5. LIMITATIONS

We lack facilities for genetic studies which could have helped in identifying the etiologies of some of the neurologic disorders seen in our hospital.

CONSENT

It is not applicable.

ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee has been collected and preserved by the authors.

ACKNOWLEDGEMENT

We thank the resident doctors of department of Paediatrics, JUTH for making this work possible.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Byford J, Veenstra N, Gi S. Towards a method for informing the planning of community-based rehabilitation in Papua New Guinea. PNG Med J. 2003;46: 63–80.
2. Kawakatsu Y, Kaneko S, Karama M, Honda S. Prevalence and risk factors of neurological impairment among children aged 6-9 years: From population based cross sectional study in Western Kenya. BMC Pediatr. 2012;12:186-92.
3. Obi JO, Sykes RM. Neurological diseases as seen at the out-patient paediatric neurology clinic in Benin City. Ann Trop Paediatr. 1984;4:217–20.
4. Singhal BS. Neurology in developing countries. Arch Neurol. 1998;55:1019–1021.
5. Birbeck GL. Barriers to care of patients with neurological disease in rural Zambia. Arch Neurol. 2000;57:414-17.
6. Mathers CD, Lopez AD, Murray CJL. The burden of disease and mortality by condition: Data, Methods, and Results for 2001. In: Lopez AD, Mathers CD, Ezzati M, Jamison DT, Murray CJL, eds. Global burden of disease and risk factors. New York: Oxford University Press. 2006;45–240.
7. Gourie-Devi M, Rao VN, Prakashi R. Neuro-epidemiological study in semi-urban and rural areas in South India: Pattern of neurological disorders including motor neurone disease. In: Gourie-Devi M, ed. Motor neurone disease global clinical patterns and international research. New Delhi: Oxford Publishers. 1987; 11-21.
8. Bharucha NE, Bharucha EP, Dastur HD, Schoenberg BS. Pilot survey of the prevalence of neurological disorders in the

Parsi community of Bombay. Am J Prev Med. 1987;3:293-9.

9. Razdan S, Kaul RH, Motta A, Kaul S, Bhatt RK. Prevalence and pattern of major neurological disorders in rural Kashmir (India). Neuroepidemiol. 1986;13:113-114.
10. Hirtz D, Thurman DJ, Gwinn-Hardy K, Mohamed M, Chaudhuri AR, Zalutsky R. How common are the common neurological disorders? Review article. Neurol. 2007;68:326-37.
11. Baio J. Prevalence of autism spectrum disorders – autism and developmental disabilities monitoring network, 14 sites, United States, 2008. Surveillance Summaries. 2012;61(3):1-19.
12. Boston Children‘s Hospital. A Harvard Medical School Teaching Hospital; 2011. Available:http://www.childrenshospital.org/az/site610/mainpage

    (Accesse: 15th May 2017)
13. Ogunseli T, Ogundeyi M, Ogunfowora O, Olowu A. Socio-clinical issues in cerebral palsy in Sagamu, Nigeria. South Afr J Child Health. 2008;2(3):120–4.
14. Couper J. Prevalence of child disabilities in rural Kwazulu-Natal. South Afr Med J. 2002;92:549-52.
15. Wammanda RD, Onalo R, Adama SJ. Pattern of neurological disorder presenting at a paediatric neurology clinic in Nigeria. Ann Afr Med. 2007;6(2):73-5.
16. Franks-Briggs AI, Alikor EAD. Pattern of paediatric neurological disorders in Port Harcourt, Nigeria. Int J Biomed Sci. 2011;7(2):145–149.
17. Lagunju IA, Okafor OO. An analysis of disorders seen at the Paediatric Neurology Clinic, University College Hospital, Ibadan, Nigeria. West Afr J Med. 2009;28(1):38-42.
18. Izuora GI, Iloeje SO. A review of neurological disorders seen at Paediatric Neurology Clinic of University of Nigeria Teaching Hospital, Enugu. Ann Trop Paediatr. 1989;9(4):185-190.
19. Population and housing census 2006: Priority table volume III, population distribution by sex, State, LGA and Senatorial District. National Population Commission of Nigeria, Abuja; 2010.
20. Ogbe Z, Nyarang'o P, Mufunda J. Pattern of neurological diseases as seen in outpatient children: The experiences from Orotta Referral Hospital Asmara, Eritrea. J Eritrean Med Association. 2006;1(1):1-5.
21. Omole JO, Olaogun MOB, Mbada CE. Pattern of neurological conditions seen at the outpatient paediatric physiotherapy unit of a Nigerian Tertiary Hospital: A-five year review. Journal of Exercise Science and Physiotherapy. 2013;9(2):105-12.
22. Austin A, Fapohunda B, Langer A, Orobaton N. Trends in delivery with no one present in Nigeria between. 2003 and 2013. Int J Womens Health. 2015;7:345–56.
23. Fapohunda BM, Orobaton NG. When women deliver with no one present in Nigeria: Who, What, Where and so what? PLoS ONE. 2013;8(7):e69569.
24. Waaler PE, Pedersen SJ, Sommerfelt K. Child neurology in a regional hospital. Tidsskr Nor Laegeforen. 1991;111(10): 1226-1229.
25. Nomura Y. Today and tomorrow in child neurology at a neurological clinic for children--the importance of child neurology as the life-long neurology. No To Hattatsu. 2005;37(3):231-8.
26. Al Salloum AA, El Mouzan MI, Al Herbish AS, Qurashi MM. The Prevalence of neurological disorders in saudi children: A Community-Based Study. J Child Neurol. 2011;26(1):21-4.
27. Jallon P. Epilepsy in developing countries. Epilepsia. 1997;38:1143–51.
28. Almu S, Tadesse Z, Cooper P, Hackett R. The prevalence of epilepsy in Zay Society, Ethiopia –an area of high prevalence. Seizure Epub. 2006;15(3):211-3.
29. Kaiser C, Benninger C, Asaba G, Rating D. Clinical and electro-clinical classification of epileptic seizure in west Uganda. Bull Soc Pathol Exot. 2000;93(4):255-9.
30. Kotsopoulos I, De Krom M, Kessels F, Lodder J, Troost J, Twellar M, Van Merode T, Knottnerus A. Incidence of epilepsy and predictive factors of epileptic and non-epileptic seizures. Seizure. 2005;14(3): 175-82.
31. Frank-Briggs A, Alikor EAD. Sociocultural issues and causes of cerebral palsy in Port Harcourt, Nigeria. Nig J Paediatr. 2011; 38(3):115–9.

32. Pin TW, Eldridge B, Galea MP. A review of developmental outcomes of term infants with post-asphyxial neonatal encephalopathy. Eur J Paediatr Neurol. 2009;13(3):224-34.
33. Shapiro SM. Chronic bilirubin encephalopathy: Diagnosis and outcome. Semin Fetal Neonatal Med. 2010;15(3): 157-163.
34. Edmond K, Clark A, Korczak VS, Sanderson C, Griffiths UK, Rudan I. Global and regional risk of disabling sequelae from bacterial meningitis: A systematic review and meta-analysis. Lancet Infect Dis. 2010;10(5):317–28.

© 2017 Ejeliogu and Yiltok; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/20398