ejpmr, 2019,6(2), 10-15

SJIF Impact Factor 4.897

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Research Article

ISSN 2394-3211

EJPMR

COST ANALYSIS OF TREATMENT OF CHILDREN WITH MICROCEPHALY IN THE NATIONAL HEALTH SYSTEM OF BRAZIL

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Article Received on 20/11/2018 **Article Revised on 11/12/2018** **Article Accepted on 02/01/2019**

ABSTRACT

The aim of this study was to analyze the health costs of the treatment and monitoring of children with microcephaly in the first year of life, considering the increase in cases of microcephaly associated with maternal infection by the Zika virus (ZIKV). This is an exploratory and descriptive study with a quantitative approach. This research adopts the Activity-Based Costing (ABC) technique. The treatment of problems associated with microcephaly listed in the first year of life of children totaled US$5,937.97/year, with items related to clinical procedures accounting for most of the spending on health amounting to US$4,697.09 in the observed period, followed by procedures for diagnoses, with a total of US$634.00. In 2015, 1,227 cases of microcephaly were registered, 1,152 in the Northeast, which is the most affected by ZIKV, generating a cost to the public coffers of more than US$11 million annually.

Highlights

- Increase in the recorded cases of microcephaly in newborns in Brazil;
- Treatment not specific because the interventions depend on the degree of damage to the child;
- Public health agenda reform needed to take into consideration the health care costs in the first year of life of children with Zika virus-related microcephaly;
- Cost analysis was performed by Activity-Based Costing (ABC) technique, focusing on processes that drive cost, in this case, those related to the production of integral health care;
- Cost of microephaly cases in 2015 (1,227), represented US$11 million.

KEYWORDS: Public Health; Zika virus; Microcephaly; Cost analysis; Economic analysis.

1. INTRODUCTION

Since October 2015, Brazil has experienced a growing increase in the recording of cases of microcephaly in newborns[1], of secondary origin, potentially related to the Zika virus (ZIKV) epidemic, which affects the fetus in the uterus, or the infant during periods of rapid brain growth, especially in the first two years of life.[2]

Zika virus-related microcephaly is a new disease that is being described for the first time in history based on the outbreak that is occurring in Brazil.[3] It is characterized by the occurrence of microcephaly with or without other changes in the Central Nervous System (CNS) in children whose mothers have had a history of ZIKV infection during pregnancy.[4-6] This situation impacts on public health conditions, as it may be associated with epilepsy, cerebral palsy, delay in cognitive, motor and speech as well as vision and hearing problems.[7]

The quality of life of children and families is affected and microcephaly may also be responsible for an increase in neonatal infant mortality. In addition to the impairment of the quality of life of the children and their families, morbidity by microcephaly impacts on the health budget, which is a challenge for the organization of the National Health System (NHS).[8]

Microcephaly does not have a specific treatment because the interventions depend on the degree of damage to the child. Ideal follow-up is undertaken by a multidisciplinary team, depending on the damaged areas: neurologist, neuropediatrician, speech therapist, physiotherapist, psychologist, occupational therapist, psychopedagogue and other medical specialists.[9]

Considering the increase in the number of cases of microcephaly in Brazil and the impact on public health, the objective of this present study is to analyze the health

care costs incurred in the first year of life of children with microcephaly.

2. MATERIALS AND METHODS

The health system impact for Zika virus-related microcephaly was calculated from medical costs based on direct costs, including treatment as well as other associated costs, such as complications and support services.

Initially, an estimate from a spatio-temporal analysis of the prevalence of microcephaly in Brazil in the last five years (January, 2011 to January, 2016) was performed. The data were obtained by the Births Information System (SINASC) and Mortality Information (SIM), as well as epidemiological bulletins provided by the Brazilian Ministry of Health.

Cost analysis was performed using the Activity-Based Costing (ABC) technique, focusing on processes that drive cost. ABC is a tool that allows better visualization of costs by analyzing the activities performed within a company and their respective relations with the products, considering an "activity" as a process that appropriately combines people, technologies, materials, methods and their environment, with the objective of producing products.[10,11]

First, health care to children with microcephaly was divided into two groups: expected problems and possible complications of microcephaly. Second, the activities were classified into clinical, diagnostic, and surgical procedures. Third, costs were allocated for each procedure, considering kind of intervention, the expected frequency of care and the expected frequency of complications. Finally, with regard to the use of cost objectives from services of activity centers, the monetary cost of the medical services provided was calculated.

The economic onus was estimated as the medical expense for each child, in the first year of life, based on national epidemiological indicators.

The values are presented in U.S. dollars, considering that the Brazilian currency (Real) was equivalent to US$0.32 on the day the data was analyzed.

3. RESULTS AND DISCUSSION

3.1 Spatio-temporal analysis of the prevalence of microcephaly: Between 2011 to 2014, the mean number of births of children with microcephaly in Brazil was less than 10 children per year in each region. In Brazil, in 2011, there were 139 cases; in 2012 there were 175; in 2013 there were 167; and in 2014, 147 cases of microcephaly were reported.

Then there was a significant increase in the number of cases of microcephaly in Brazil, with 1,227 cases of microcephaly recorded in 2015, of which, the majority were recorded in the states of the northeast region (91%). The North, Southeast and Central-West regions had, respectively, 1%, 5% and 3%.

Despite the need to interpret data about Zika virus-related microcephaly from the literature with caution, it has been made clear that the risk of severe adverse pregnancy and infant outcomes after maternal ZIKV infection are substantial.[4-6,12]

A possible explanation for this is found in the serious problems of water supply and garbage collection, precarious sanitation networks, excessive production of non-biodegradable materials, climate changes that significantly alter the rainfall regime and ambient temperature and also In the process of urbanization of complex urban agglomerations on the outskirts of cities, which are inexhaustible sources of breeding sites of the vector responsible for the spread of the ZIKV in the country.

3.2 Cost analysis of the provision for health care for children with microcephaly in the first year of life

Considering the spatio-temporal analysis of the prevalence of microcephaly, more than 1,000 new cases were reported in one year, which represents a major impact on public health, thus requiring a remodeling of the care network to follow up affected children.

The treatment of injuries and predicted problems in the first year of life of children with microcephaly totaled US$5,937.97/year. The items related to clinical procedures represented the majority of health expenditures, US$4,697.09, followed by procedures for diagnostic purposes, US$634.00. The item that generated the lowest cost of care was those related to surgical procedures, which generated an expense of US$408.88/year to be spent on the provision of medical care, follow-up and treatment to individuals affected by microcephaly.

Health costs could be higher than US$10,000 per year, if we consider the cost of injuries and predicted problems plus the frequent complications (probability of occurrence: 90%).

The most costly complications of the disease are chronic and incapacitating motor injuries of US$1,953.92, responsible for the highest expense/year, followed by epilepsy and hyperactivity (US$1,804.80) and neurological complications and cognitive impairment (US$1,158.74).

Table 1 presents the estimates of costs in the first year of life of the victims of microcephaly, related to the occurrence of diseases and problems predicted by this disease.

Table. 1: The estimates of costs in the first year of life of the victims of microcephaly, related to the occurrence of diseases and problems predicted by this disease.

Injuries and predicted problems	Care/Interventions	Cost of Assistance (Unit Value) USD$	Expected frequency of care (Number of visits/month)	Cost of Assistance (within 1 year)
Clinical Procedures				
Epilepsy and hyperactivity	Consultation with neurologist	$3.20	1	$38.40
Speech disorders	Consultation with speech therapist	$3.20	1	$38.40
Cerebral palsy	Recreational therapy	$2.03	20	$487.68
Lower tonus (sucking, swallow and sustain head problems).	Consultation with physiatrist	$3.20	1	$38.40
Cognitive impairment, motor lesions, chronics and disabling	Consultation with physiotherapist	$2.03	20	$487.68
Ventriculomegaly	Physical therapy	$2.03	20	$487.68
Cognitive impairment	Medication and/or talking therapies	$2.03	20	$487.68
Vision problems	Consultation with ophthalmologist	$3.20	1	$38.40
	Pilates	$2.03	20	$487.68
Hearing loss uni- or bilateral	Consultation with otolaryngologist	$3.20	1	$38.40
Calcification ou lissencephaly	Consultation with neuropediatrician	$3.20	1	$38.40
Speech disorders	speech therapy	$3.49	20	$837.12
Cognitive impairment, motor lesions, chronics and disabling.	Physiotherapy sessions	$2.03	20	$487.68
Arthrogryposis	Hydrotherapy, (psychomotricity sessions and stretching exercises).	$2.03	20	$487.68
Insufficient motor coordination	Occupational therapy	$0.90	20	$215.81
Surgical Procedures				
Cognitive impairment	Surgical intervention	$258.48	1	$258.48
Facial distortion	Surgery in same cases	$150.40	1	$150.40
Procedure for purposes Diagnosis				
Ventriculomegaly	Diagnostic procedures	$139.43	1	$139.43
Hearing loss uni- or bilateral	Diagnostic procedures	$14.90	1	$14.90
Lower tonus (sucking, swallow and sustain head problems).	Assessment and indication of the adequate physiotherapy	$6.13	1	$6.13
Vision problem	Fundoscopy	$18.48	1	$36.95
Hearing loss problem	Potencial Evocado do tronco auditivo encefálico(PEATE)	$7.76	1	$15.51
Vision problem	Emissão otoacústica Evocada (EOE)	$4.32	1	$8.65
Epilepsy, hyperactivity and Cerebral palsy	Resonance	$86.00	1	$172.00
Epilepsy, hyperactivity and Cerebral palsy	Tomography	$31.18	1	$62.36

Speech difficulties	Diagnostic procedures	$11.41	1	$11.41
Serious ocular abnormalities (Retinal Atrophy, retinal spot, abnormalitiy in the optic nerve).	Ophthalmic Assessment	$22.66	1	$22.66
Calcification ou lissencephaly	Diagnostic procedures	$144.00	1	$144.00
Total		**$932.95**		**$5,739.97**
Notes: The values will be presented in US$ Dollars, considering that the Brazilian currency (Real) equivalent to US$0.32.				

Table 2 shows the cost estimates by weighing the frequency of complications of microcephaly.

Table 2: The cost estimates by weighing the frequency of complications of microcephaly.

Possible Complications	**Probability of complications (%)**	**Average cost of intervention (unit value) USD$**	**Expected frequency of intercurrences**	**Average cost of interventions considering frequency of occurrence**
Respiratory complications	30%	$97.22	3	$291.65
Neurological Complications Cognitive impairment	90%	$128.75	9	$1,158.74
Retardation of neuropsychomotor development	90%	$2.03	20	$487.68
Seizures	90%	$14.40	12	$172.80
Hearing loss uni- or bilateral	50%	$14.90	12	$178.79
Arthrogryposis	45%	$142.41		$997.70
Lower tonus (sucking, swallow and sustain head problems).	50%	$2.03	20	$487.68
Calcification ou lissencephaly	25%	$144.00	7	$1,007.98
Serious ocular abnormalities (Retinal Atrophy, retinal spot, abnormalitiy in the optic nerve).	50%	$22.66	12	$271.95
Motor lesions, chronics and disabling	90%	$11.33	20	$1,953.92
Ventriculomegaly	15%	$139.43		$567.16
Epilepsy and hyperactivity	50%	$150.40	12	$1,804.80
Speech difficulties	90%	$3.49	20	$837.12
Total		**R$ 873.04**		**$10,217.96**
Notes: The values will be presented in USD$ Dollars, considering that the Brazilian currency (Real) equivalent to US$0.32.				

3.3 Spatio-temporal distribution of microcephaly in Brazil versus absolute cost assimilation for health care in the first year of life This spatio-temporal distribution of microcephaly in Brazil, and health expenditures incurred is worrying, since estimates indicate that to cover the annual cost, it would be necessary to spend more than US$ 10,000.00 per year to treat one single affected child.

To care for a child with microcephaly means a lifetime of follow-up. The northeastern region of Brazil is home to half of the Brazilian population living below the poverty line. The majority of the population depends exclusively on Brazil's national health system, which increases the challenge in combating the disease vector (*Aedes aegypti*), the control of maternal infection (ZIKV) in addition to the diagnosis and early treatment of the affected children (Zika virus-related microcephaly).

According to the Ministry of Health, Brazil has a network of 1,544 rehabilitation services, units that offer care in rehabilitation specialties in the auditory, visual, intellectual and motor modalities. Of this total, 138 services are Specialized Centers in Rehabilitation (SCR), units that offer two to four specialties. The maintenance of these rehabilitation services, according to the Ministry of Health, costs the public coffers US$ 208 million per year. The National Plan to Combat Microcephaly provides for the authorization of another 64 SCRs to cover "care gaps" - in regions where the Specialized Attention offer is not enough. The annual cost with these new SCRs is estimated at US$ 43 million.[13]

Despite the need to improve the care network for infected pregnant women and for children with microcephaly, the most effective measure to address this problem is the control of the *Aedes aegypti* mosquito to reduce the number of cases of mosquito-borne diseases.

This is supported in the literature.[14] The Zika virus continues to spread, decisions regarding resource allocations to control the outbreak underscore the need to reweigh policies according to their cost and the health burden they could avert. In this study, the authors estimated the probability of microcephaly in infants born to Zika-infected women (0.49% to 2.10%) based on microcephaly incidence data from the Northeast of Brazil, and calculated that each microcephaly case incurs the loss of 29.95 DALYs (disability-adjusted life-years) per case, as well as direct medical costs of US$91,102 per lifetime.

Considering the parameters of the WHO (World Health Organization) that established the willingness-to-pay thresholds in terms of Cost-Effectiveness (the per-capita GDP - Gross Domestic Product, or three times the per-capita GDP)[15], the intervention in Brazil, considering the GDP in 2015 would be US$ 9,24 million, approximately. But it would be necessary to study the number of infections by ZIKV, especially the ZIKV infections in the first trimester of pregnancy, to justify the investment.

This study did not include a Cost-Effectiveness analysis for infection by ZIKV.

In conclusion, the data from the present study show that in 2015, there was a large increase in the records of Zika virus-related microcephaly, resulting in a large epidemic of microcephaly by Congenital infection, with 1,227 cases being recorded in Brazil.

The health costs analysis for the treatment and follow-up of children with microcephaly in the first year of life revealed that in order to cover the predicted diseases, considering the natural history of the disease, the amount of US$ 5,937.97 per affected individual would need to be attributed, anually. To cover costs in the 1st year of life considering the frequency of complications with probability ocurrence above 90%, it would be necessary to spend more than US$ 10,000/individual/year. Considering the number of cases of microcephaly in 2015 (1,227), this would represent a cost to the public coffers in Brazil of approximately US$11 million.

The data indicate that the cost impact of this epidemic on the public health coffers is great. The afflicted come mainly from a low income population, living on the periphery of urban areas and in areas of risk of infection. This population largely depends on public health assistance. Given the increase in cases of microcephaly and the potential costs associated, we have concluded that it is imperative to reformulate the public health agenda in Brazil.

ETHICAL CONSIDERATIONS

Ethical issues (Including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, etc) have been completely observed by the authors.

ACKNOWLEDGMENTS

The authors wish to thank all the managers of Public Health Course, at the Federal University of Pernambuco, to support data collection. The English version of this text has been revised by a native speaker, Sidney Pratt, Canadian, BA, MAT (The Johns Hopkins University), RSA diploma (TEFL).

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests.

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