Epilepsy Surgery in Low and Middle Income Countries: A Scoping Review

Musa M. Watila[a,b,c], Fenglai Xiao[a,d,e], Mark R. Keezer[a,b,f,g], Anna Miserocchi[a,h], Andrea S. Winkler[i,j], Andrew W. McEvoy[a,h], Josemir W. Sander[a,b,g*]

a. Department of Clinical and Experimental Epilepsy, UCL Institute of Neurology, National Hospital for Neurology and Neurosurgery, London WC1N 3BG, UK
b. Chalfont Centre for Epilepsy, Chalfont St Peter SL9 0RJ, UK
c. Neurology Unit, Department of Medicine, University of Maiduguri Teaching Hospital. PMB 1414, Maiduguri, Borno State. Nigeria
d. Department of Neurology, West China Hospital of Sichuan University, Chengdu, Sichuan, China
e. Magnetic Resonance Imaging Unit, Epilepsy Society, Gerrards Cross, UK
f. Centre hospitalier de l'Université de Montréal (CHUM), Hôpital Notre-Dame, Montréal, Québec, H2L 4M1, Canada
g. Stichting Epilepsie Instellingen Nederland (SEIN), Achterweg 5, 2103 SW Heemstede, Netherlands
h. Department of Neurosurgery, National Hospital for Neurology and Neurosurgery, London, UK
i. Centre for Global Health, Institute of Health and Society, University of Oslo, Kirkeveien 166, 0450 Oslo, Norway
j. Center for Global Health, Department of Neurology, Technical University of Munich, Ismaninger Strasse 22, 81675 Munich, Germany

Corresponding author

Ley Sander

Box 29, UCL Institute of Neurology, Queen Square, WC1N 3BG London, UK.

E-mail address: l.sander@ucl.ac.uk

Abstract

Background: Epilepsy surgery is an important treatment option for people with drug resistant epilepsy. Although surgical procedures are under-utilized worldwide, it is far worse in Low- and Middle-Income Countries (LMIC) and it is less clear to what extent people with drug resistant epilepsy receive such treatment at all. Here we review the existing evidence for the availability and outcome of epilepsy surgery in LMIC, and discuss some challenges and priority.

Methods: We used the six stage methodological framework developed by Arskey and O'Malley as a guide. We searched PubMed, Embase, Global Health Archives, Index Medicus for South East Asia Region (IMSEAR), Index Medicus for Eastern Mediterranean Region (IMEMR), Latin American & Caribbean Health Sciences Literature (LILACS), African Journal Online (AJOL), and African Index Medicus (AIM) to identify the relevant literature.

Results: We retrieved 148 articles on epilepsy surgery from 31 countries representing 22% of the 143 LMIC. Epilepsy surgery appears established in some of these centers in Asia and Latin America, while some are in their embryonic stage reporting procedures in a small cohort performed mostly by motivated neurosurgeons. The commonest surgical procedure reported was temporal lobectomies. The post-operative seizure-free rates and quality of life are comparable to those in the high-income countries (HIC). Some models have shown that epilepsy surgery can be performed within a resource-limited setting through collaboration with international partners and through the use of information and communication technology. The cost of surgery is a fraction of what is available in HIC.

Conclusion: This review has demonstrated the availability of epilepsy surgery in few LMIC. The information available is inadequate to make any reasonable conclusion of its existence as routine practice. Collaborations with international partners can provide an opportunity to bring high–quality academic training and technological transfer directly to surgeons working in these regions and should be encouraged.

Keywords: Epilepsy; Surgery; Low- and Middle-Income Countries; Access; Priority

1.0 Introduction

About a third of people with epilepsy continue to have uncontrolled seizures despite adequate and appropriate medical treatment [1, 2]. These persons with medically intractable epilepsy have a poorer quality of life (QOL), increased risk of injury and cognitive decline, poor psychosocial outlook and an increased chance of death compared to their seizure-free counterparts [3-6]. Over the last decades various epilepsy surgery techniques have evolved to become major treatment options, but they are underutilized [7]. The benefits of these surgeries outweigh the associated risks in achieving seizure freedom, improving quality of life and reducing mortality [8-17]; with about 60% of those who had temporal lobe resective surgery remaining seizure-free in the long-term [18, 19].

The extent of epilepsy surgery utilization, outcome and cost are not well known in Low- and Middle-Income Countries (LMIC). A global survey between 1980 and 1990 reported few published literature from LMIC and none from Africa [20]. By the end of 1999, epilepsy surgery was present in only 26 (18.3%) of 142 LMICs [21]. Whether the high 'surgical treatment gap' is due to mere exclusions from international surveys or underreporting of surgical practices, it is certain that underutilization is a more serious problem in LMIC than high-income countries (HIC), with the majority of health centers lacking the capacity to perform neurosurgery or even non-existent and most health personnel referring surgical candidates elsewhere [22].

Some of the most important factors for the high surgical treatment gap are the lack of organized structured care, lack of infrastructure, shortage of specialists and the cost of surgery [21, 23-25]. A recent review observed that barriers to epilepsy surgery are perpetuated by the uncertainty portrayed by medical practitioners towards surgical treatments, reflecting the knowledge gap, which may be more pervasive in LMIC [26]. With the increasing evidence of surgery as an important treatment option and the higher burden of epilepsy, it is important for health care providers and users in LMIC to know that there is more that can be done. At the same time, however, information on the availability of epilepsy surgery is scarce. This scoping review therefore aims to: i) identify the availability of epilepsy surgery in LMIC; ii) determine the resources available at these centers; iii)

determine the outcome and cost of surgical procedures; and iv) discuss the challenges and possible areas for potentially closing the surgical treatment gap in resource poor settings.

2.0 Methodology

This review was triggered by a growing concern on the standard of care for people with drug resistant epilepsy in LMIC. We considered various systematic approaches to review the literature on utilization of epilepsy surgery in these countries and decided to undertake a scoping review. We proposed that a scoping review will be an appropriate strategy to review and summarize a range of evidence in order to convey the breadth and depth of this less understood treatment option [27]. A scoping study was preferred over a systematic review or meta-analysis as it allows a range of study with varying designs to be incorporated without assessing the quality or using a systematic analytical interpretation of the literature [28]. A scoping review was therefore found to be ideal to help clarify surgical alternatives for people with medically intractable epilepsy in resource poor settings. We adopted the six stage methodological framework developed by Arksey and O'Malley [27]. This includes: (1) identifying the research questions; (2) identifying relevant studies; (3) selecting the appropriate studies; (4) charting the data; (5) collating, summarizing, and reporting the results; and (6) a consultation exercise with key stakeholders to inform and validate study findings.

2.1 Identifying the research questions

This review's primary interest was to map and broadly examine the literature on epilepsy surgery in LMIC. In order to do so we identified some research questions to guide our scope.

1. What is available regarding epilepsy surgery in LMIC from published literature?
2. What are the types of surgeries and outcomes, QOL and cost?
3. How important is collaboration and technological transfer between HIC and LMIC?

2.2 Identifying the relevant studies

We identified papers using the following databases: PubMed, Embase, Global Health Archives, Index Medicus for South East Asia Region (IMSEAR), Index Medicus for Eastern Mediterranean Region

(IMEMR), Latin American & Caribbean Health Sciences Literature (LILACS), Western Pacific Region Index Medicus (WPRIM) and African Index Medicus (AIM) via the WHO Global Index Medicus, and the African Journal Online (AJOL). The search was made using various combinations of the following key words ‘‘epilepsy’’ and ‘‘surgery’’ or “surgical’’ or “surgical procedures’’ or “resecti*’’ or “disconnecti*’’, or “neurostimulati*” and individual LMICs according to the World Bank classification (www.worldbank.org). Medical subject headings (MeSH) were used where appropriate and the references within each article were also reviewed to obtain further information (see Supplement 1 for the detailed search strategy). We included observational studies, clinical trials, case series and any publication reporting the conduct of epilepsy surgery, outcomes (based on the Engel classification or equivalent), mortality, complication, QOL or costs. Epilepsy surgery was defined as procedures undertaken mainly to control drug-resistant epilepsy as opposed to removing an acquired structural brain lesion. The surgical procedures include resective, disconnective, or neurostimulative surgical modalities, irrespective of year of publication or language.
Studies reporting neurosurgeries offered exclusively for brain tumors, infections and other conditions not associated with epilepsy were excluded. Although, reviews, meta-analysis, single case reports, letters, commentaries and editorials were excluded; they helped give a lead to relevant publications.

2.3 Study selection

We used a two-stage selection process. The initial selection process (done by MMW) involved the review of title and abstract to determine those likely to be eligible. The second part of the selection process involved two independent reviewers (MMW and FX), who reviewed the potentially eligible papers in more details resorting to abstracts and full articles. No study was excluded based on language as the authors understand the major languages spoken in the regions.

2.4 Charting the data

In order to have a clear focus on the charting process, a data-charting form was developed to extract information from the literature (Table 1). The data-charting form was developed from the revised version of quality guidelines for pre-surgical epilepsy evaluation and surgical epilepsy treatment by

the Austrian, German, and Swiss working group [29]. The aim of the guideline is to instruct on the minimum standard requirement for running an epilepsy surgery facility. This served as a guide to understand what is available from LMIC, as what is a minimum requirement in Europe may not be the same elsewhere in LMIC [30].

2.5 Collating, summarizing, and reporting the results

We collected and sorted key information from the eligible articles and summarized them in tables. The key information in addition to the minimum standard requirements; include author, year of publication, name of center and country, period of recruitment, types of surgeries, number operated, follow-up duration, outcome measures, mortality, complications, collaborations, QOL and cost. Where available the outcomes from neurostimulative procedures like vagus nerve stimulation (VNS) were recorded. A narrative review was also used to report other information. We recognize the inherent challenges with retrieving data from LMIC due to varying methodologies of the papers and their reporting guidelines, therefore some of the information we report have been derived from multiple articles and sources.

Various outcome measures are being used by surgeons, but we retrieved those reporting either the Engel or ILAE outcome classifications. The differences and their utility have been discussed in the ILAE commission report on classification of outcome following epilepsy surgery [31]. The Engel classification is used widely, but results from different centers may not be easily compared, while the ILAE classification is easier to use. Both the ILAE and the Engel classification, however, have a good inter-rater reliability and significant correlation between the two [32] (Supplement 2 shows details of the outcome scores).

2.6 Consultation with key stakeholders

The optional stakeholder meeting was not conducted due to lack of funding. This work is an iterative work in progress and findings should guide stakeholders on action areas and determine where in-depth analysis is required.

3.0 Results

The initial search identified a total of 1,365 publications, 158 duplicates were removed, while 201 full texts articles were assessed for eligibility. During the review 53 potentially eligible studies were excluded. These included neurosurgical procedures for tumors, infections and others that cannot be classified as epilepsy surgery. In addition some were conference abstracts that had incomplete information and were difficult to extract (Figure 1 shows flowchart of the selection process).

A total of 148 publications from 31 countries met the eligibility criteria; representing 21.7% of the 143 LMIC as shown in Table 2 [33-180]. The information retrieved was from published journal articles and some website sources. The publications were mainly longitudinal studies, case-series, case-control studies and one randomized controlled study. They include nine publications from six African countries [33-42]; 52 publications from 12 Latin American and the Caribbean countries [43-94]; 85 publications from 13 Asian countries [83, 94-177] and three publications from two Eastern European countries [178-180]. The bulk of the published literatures are from India, China, and Brazil. The papers retrieved spanned over 60 years, but only seven papers were published before the year 2000. A closer look at some of these papers especially from India, Brazil and China reveal multiple publications from the same cohort. These publications show that a more recent paper incorporates subjects or is a subset of a cohort reported from older papers.

The results on the minimum standard requirements (Table 2) showed that most centers had the minimum technical equipment. Information on whether they had sufficient qualified personnel or adequate training was mainly not mentioned or difficult to extract. Some papers reported on collaborative work between HIC and LMIC in Uganda [36-38], Tunisia [41], Thailand, India and Argentina [83, 105], Pakistan [168], and Iran [171]. The collaborative epilepsy surgery program between North America and the CURE Children's Hospital of Uganda (CCHU) assessed the feasibility of an epilepsy surgery program in a resource-poor setting using just video-electroencephalography (EEG) and computed tomography (CT) volumetric analysis [38]. The Tunisian epilepsy surgery program at the Charles Nicolle Hospital Tunis and the French hospital at Rouen via the EUMEDCONNECT, is an internet network project where clinical, EEG and radiological information are transferred from Tunis to France for discussion and evaluation [41].

Detailed illustration of the general characteristics, outcomes measures, complications and mortality is shown in Supplement 3. Table 3 shows the general characteristics of 98 papers reporting outcome measures of various epilepsy surgeries according to either the Engel or ILAE classifications. The commonest surgeries performed at these centers are temporal and extra-temporal resective surgeries, disconnective surgeries like corpus callosotomies, hemispherectomies and sub-pial resections. The varying reporting methods, number of candidates, classification of surgery type and the duration of follow-up made reporting our results on outcome difficult. The majority reported outcome measures based on the Engel classification. The reported outcome measures ranged mostly between 40% to 80% (for Engel Class I) and 50% to 90% (for Engel Class I and II) in carefully selected subjects. Complications are transient or minor; while major complications or mortality is rare. These results appear better for temporal lobe surgeries. Table 4 shows neurostimulative techniques like VNS [57, 86, 120, 138, 151, 157, 173] and deep brain stimulation [73], which reflected that the majority of subjects had more than 50% seizure reduction with follow-ups ranging between one to four years. Table 5 showed that the indicators of QOL improved after surgery [37, 47, 50, 59, 93, 98, 101, 122, 126, 134, 159, 160, 165, 175, 177], except in one study [62].

Table 6 reports on the cost of epilepsy surgery [66, 70, 71, 114, 117, 144, 147, 164, 168, 171, 172] and VNS [138], the cost of epilepsy surgery as at 2014 ranges between US$500 in Iran to approximately US$8,000 in China.

4.0 Discussion

This scoping review was undertaken to assess the situation of epilepsy surgery in LMIC. The current status of published evidence reports epilepsy surgery in about a fifth of LMIC. Our findings suggest that the utilization of epilepsy surgery has evolved considerably in some centers in Asia and Latin America with an increasing trend in places like India, China and Brazil [182] but appears embryonic in some other countries, particularly in sub-Saharan Africa. A large proportion of the retrieved papers are case series or experiences using small sample size of carefully selected candidates performed by motivated neurosurgeons and may not necessarily portray that epilepsy surgery is an established current practice in these countries. We observed that epilepsy centers were not evenly distributed, but

located in bigger more affluent cities. This geographical disparity has been observed in a previous review [21]. A review of epilepsy surgery in India showed that geographical disparity is a common problem, and only 2 centers in big cities contributed to more than 50% of 420 surgeries performed annually, which is far from adequate [183].

The surgeries reported were mainly resective, few disconnective, and much fewer neuro-stimulative techniques. The commonest surgery was for temporal lobe epilepsy; this may have been targeted because it impacts the greatest and has an excellent opportunity for seizure freedom from clinical trials [18]. It is noteworthy to observe that the seizure outcome after surgery was good in the majority of subjects and comparable to other centers in HIC. Similarly, complications and mortalities from surgery did not appear to be significantly different from those reported in HIC [17, 184]. Those that had surgery also had an improved QOL, employability and lower perceived stigma compared to those who did not, especially for those who were seizure free [37, 50, 159]. The similar short-term outcome rates in LMIC compared with HIC may be due to centers performing straight forward cases in carefully selected candidates. It will be important to know the longer-term outcome of these surgical candidates, but some of the studies had a high loss to follow-up which is a common problem in LMIC [185].

Some of the established centers had adequate infrastructure, manpower and training, but this is not universal. The Ugandan experience shows that the lack of sophisticated modern equipment should not be a limitation to surgery [36, 38]. Their model utilized technology and expertise that was reasonably available and could function sustainably in resource-poor setting. Training was possible through the establishment of collaborations with neurosurgeons in HIC. This form of collaboration where expert skill and knowledge were exchanged with centers in the West was also noted at the Charles Nicolle Hospital in Tunisia [41], the Aga Khan University Hospital in Pakistan [167] and the Shiraz University of Medical Sciences in Iran [171]. The successes of these models were achieved through the tri-facetted approach of technological transfer, twinning, and manpower training [30]. It also shows the role information and communications technology (ICT) can play in intellectual and skills transfer, showing that the model used could be replicated elsewhere. With comparable seizure-free rates to HIC, these surgical experiences give hope that epilepsy surgery can be a routine treatment

using the minimum available requirements that are more likely to be available in LMIC in comparison to the myriad of equipment used in more affluent societies for epilepsy surgeries. The Pediatric Epilepsy Surgery Task Force of the ILAE Commissions of Pediatrics and Diagnostics in formulating recommendations for pre-surgical evaluation in children observed that many of the tests employed is resource intense, and that failure to carry out all diagnostic tests possible nor insisting on one particular ancillary test should not hamper the conduct of surgery. They suggested that evaluation should be done according to the needs of the clinical cohorts and country-specific resources [186]. The training of personnel in view of the profound manpower shortages in LMIC can be done through collaborations with experts from HIC [187].

The cost of epilepsy surgery reported in this review is a fraction of what it cost in western countries [71]. The issues of cost and affordability are not straightforward [188], as what is regarded as cheap may not necessarily be affordable to the majority of people in LMIC, as those who access this care are probably city dwellers, more educated and of higher socioeconomic class [26]. Epilepsy surgery is an expensive venture requiring some of the most expensive technologies in the surgical field and therefore establishing neurosurgical centers is a challenge for most LMIC with an already dysfunctional primary care system and the majority of persons unable to access first line antiepileptic drugs. In view of the high burden of epilepsy in LMIC, it is debated whether surgery may be a cost-effective long-term investment that may benefit more people in the long run [188]. Studies evaluating the costs of surgical versus medical treatment observed that although surgical treatment requires a large initial expenditure it was superior because of the greater seizure-free rate, with the long term cost-analysis favoring surgery as the cost-time curves intersect in a few years [189-191]. These cost-analyses comparing medical and surgical therapy of epilepsy should be interpreted with caution since the cost of surgery and benefit gained by seizure reduction are not linear and that measuring just the reduction in seizure frequency in the short-term is inadequate to compare costs. The benefit of epilepsy surgery to a substantial number of persons in LMIC, however, may outweigh the cost with regards to the transformative power of a seizure-free life. The capacity to empower a sufferer and the community, restoration of livelihood and the contribution to the local economy by freeing the care-giver and family from the economic and social burden may be reasons to prioritize epilepsy surgery

[188]. Cost-effectiveness of epilepsy surgery should be an area for further studies, as analyses from HIC may not reflect the situation in LMIC due to the weak economic capacity and regional complexities. The equity proposed for people with epilepsy is usually jeopardized by causes of inequality such as poverty, illiteracy and the marked urban-rural disparities which are deep-rooted and difficult to control in the poorer regions [192]. Strengthening primary health care, improving the referral pathway and expanding health insurance coverage may help diminish this inequality [193-195]. The provision of epilepsy surgery may sometimes not correlate with a country's socioeconomic status, since the higher the gross domestic product the higher the health expenditure. For example some Middle Eastern countries may not have a problem with infrastructure, but may lack expertise, while African countries are more likely to have problems with both.

Lesion-related epilepsies may be higher in LMIC. The high prevalence of febrile seizures, malaria and other CNS infestations may act as initial precipitating injury for developing hippocampal sclerosis [196]. An important research priority will be to investigate the burden of lesion-related epilepsy and the number of potential surgical candidates within a geographical context. This could make a case that epilepsy surgery may have been unfairly neglected compared to surgical treatment of other public health conditions [197]. Health care providers also have an ethical obligation to identify and facilitate access to epilepsy surgery for these vulnerable subgroups [198]. Whether minimally invasive surgeries may be a cost effective or efficacious option is an ongoing discussion, as subjects may be more willing to undergo minimally-invasive procedures due to lower perceived risks [199].

Several limitations are noted in this scoping analysis. Firstly, this review may not necessarily reflect all epilepsy surgeries performed in LMIC, as we have information from only 22% of countries. Due to the difficulty in retrieving literature from LMICs we may have excluded relevant information outside of our search. Unfavorable results of epilepsy surgery are also less likely to be published in journal articles. Secondly, it was difficult comparing results across board, based on the varying facilities, differing methodological approaches, lack of uniformity in reporting outcome measures and different follow-up times. The use of international standardized methods for future work would help improve comparability [29]. International multicenter studies involving some LMIC prove that it is possible to produce an evidence-based practice with good quality data [83, 105]. Thirdly, despite attempting to

use a consistent clear approach following the scoping analysis framework [27], one of the problems we encountered is that the current available literature does not give holistic information. Some articles were excluded from the final analysis because of lack of access to the full text, although reviewing these abstracts substantiated the findings that some are conference abstracts from previous works. We also excluded articles reporting other neurosurgical procedures; however these papers may indicate a center's potential technical expertise to perform epilepsy surgery if given the necessary support and improvement. Fourthly, a stake holders meeting which is the sixth optional item of the scoping framework was not done. Our experiences from this review have shown that it is a necessary requirement and it would have been good to interact with the two stakeholder groups – the service providers and users. For example, we observed that the lack of data on the number of qualified personnel and staff training from the literature retrieved was considerable. Interaction with stakeholders and a visit to these centers would have given a first-hand assessment of what surgical facilities are available and not just relying on published articles. An alternative to a stakeholders meeting would have been to send questionnaires to the centers. Lastly, we did not retrieve information on referral pattern and how PWE access surgical options and how long it took, this would have been important to understand barriers from the health user's point of view. Understanding the structural, cultural, financial and political barriers limiting epilepsy surgery will be an important initial step in prioritizing epilepsy surgery.

5.0 Conclusion

This review demonstrates the availability of surgical treatment for epilepsy in some LMIC, with an increasing trend in a few. Some experiences have shown that epilepsy surgery can be performed within the resource-poor settings through collaboration with international partners. ICT can be an important tool for skill transfer. These collaborations with international partners can provide an opportunity to bring high–quality academic training and technological transfer directly to surgeons and should be encouraged. The high cost of implementing surgery may not be a limitation to some LMIC countries, but rather a problem of deciding how to prioritize and allocate resources [200]. Governments should weigh the immediate large monetary investment with the long term benefits and

sustainability. We acknowledge the limitation of data acquisition in LMIC; therefore we may not have fully retrieved all the information regarding epilepsy surgery. Even where surgeries are performed, the small number operated and varying reporting methods make any reasonable conclusions regarding its definite continued existence difficult.

Acknowledgements:

This work was carried out at UCLH/UCL Comprehensive Biomedical Research Centre, which receives a proportion of funding from the UK Department of Health's National Institute for Health Research Biomedical Research Centres funding scheme. We would like to acknowledge Kate Brunskill of the UCL Institute of Neurology Library for her bibliographic assistance. MMW is a Commonwealth Scholar, funded by the UK government.

Author Contributions

MMW – Study concept and design, data acquisition, data interpretation, manuscript production; FX – Data acquisition, data interpretation, manuscript production; MRK – Data interpretation, technical input and critical review of manuscript; AM – Data interpretation and critical review of manuscript; ASW – Technical input and critical review of manuscript; AWM - Technical input and critical review of manuscript; JWS – Study concept and design, critical review of manuscript. All authors approved the final version. JWS is the guarantor.

Conflict of Interest:

MMW, FX, AM and ASW have no conflict of interest. MRK receives research support from UCB and Eisai, and has received unrestricted educational grants from UCB and personal fees from UCB, Sage Therapeutics, and Novartis. AWM has received support from UCB, Baxter, and Cyberonics. JWS receives research support from the Marvin Weil Epilepsy Research Fund and the UK Epilepsy Society endows his current position. He has received research funding from Eisai and UCB, personal fees from Eisai, UCB, Bial and Janssen outside of the submitted work.

References

[1] Devinsky O. Patients with refractory seizures. N Engl J Med 1999;340:1565-1570.

[2] Kwan P, Brodie MJ. Phenobarbital for the treatment of epilepsy in the 21st century: A critical review. Epilepsia 2004;45:1141-1149.

[3] Hanna N, Black M, Sander J, Smithson W, Appleton R, Brown S, et al. National Sentinel clinical audit of epilepsy-related death: report 2002. Epilepsy-death in the shadows. The Stationery Office, 2002.

[4] Hitiris N, Mohanraj R, Norrie J, Brodie MJ. Mortality in epilepsy. Epilepsy Behav 2007;10:363-376.

[5] Ryvlin P, Kahane P. Does epilepsy surgery lower the mortality of drug-resistant epilepsy? Epilepsy Res 2003;56:105-120.

[6] Kwan P, Schachter SC, Brodie MJ. Drug-resistant epilepsy. N Engl J Med 2011;365:919-926.

[7] Moshé SL, Perucca E, Ryvlin P, Tomson T. Epilepsy: new advances. Lancet 2015;385:884-898.

[8] Vickrey BG, Rausch R, Engel Jr J, Ary C, Visscher B, Hays R, et al. Outcomes in 248 patients who had diagnostic evaluations for epilepsy surgery. Lancet 1995;346:1445-1449.

[9] Wiebe S, Blume WT, Girvin JP, Eliasziw M. A randomized, controlled trial of surgery for temporal-lobe epilepsy. N Engl J Med 2001;345:311-318.

[10] Sperling MR, Harris A, Nei M, Liporace JD, O'Connor MJ. Mortality after epilepsy surgery. Epilepsia 2005;46:49-53.

[11] Freitag H, Tuxhorn I. Cognitive function in preschool children after epilepsy surgery: rationale for early intervention. Epilepsia 2005;46:561-567.

[12] Engel J, Mcdermott MP, Wiebe S, Langfitt JT, Stern JM, Dewar S, et al. Early surgical therapy for drug-resistant temporal lobe epilepsy: a randomized trial. JAMA 2012;307:922-930.

[13] Hamid H, Blackmon K, Cong X, Dziura J, Atlas LY, Vickrey BG, et al. Mood, anxiety, and incomplete seizure control affect quality of life after epilepsy surgery. Neurology 2014;82:887-894.

[14] Lau T, Miller T, Klein T, Benbadis SR, Vale FL. Temporal lobe surgery in medically refractory epilepsy: a comparison between populations based on MRI findings. Seizure 2014;23:20-24.

[15] Shurtleff HA, Barry D, Firman T, Warner MH, Aguilar-Estrada RL, Saneto RP, et al. Impact of epilepsy surgery on development of preschool children: identification of a cohort likely to benefit from early intervention. J Neurosurg Pediatr 2015;16:383-392.

[16] Skirrow C, Cross JH, Harrison S, Cormack F, Harkness W, Coleman R, et al. Temporal lobe surgery in childhood and neuroanatomical predictors of long-term declarative memory outcome. Brain 2015;138:80-93.

[17] Sperling MR, Barshow S, Nei M, Asadi-Pooya AA. A reappraisal of mortality after epilepsy surgery. Neurology 2016;86:1938-1944.

[18] Téllez-Zenteno JF, Dhar R, Wiebe S. Long-term seizure outcomes following epilepsy surgery: a systematic review and meta-analysis. Brain 2005;128:1188-1198.

[19] West S, Nolan SJ, Cotton J, Gandhi S, Weston J, Sudan A, et al. Surgery for epilepsy. The Cochrane Library 2015. 10.1002/14651858.CD010541.pub2

[20] Silfvenius H. A global survey on epilepsy surgery, 1980-1990: a report by the Commission on Neurosurgery of Epilepsy, the International League against Epilepsy. Epilepsia 1997;38:249-255.

[21] Wieser HG, Silfvenius H. Overview: epilepsy surgery in developing countries. Epilepsia 2000;41 Suppl 4:S3-9.

[22] Wilmshurst JM, Burman R, Gaillard WD, Cross JH. Treatment of infants with epilepsy: common practices around the world. Epilepsia 2015;56:1033-1046.

[23] Diop AG, de Boer HM, Mandlhate C, Prilipko L, Meinardi H. The global campaign against epilepsy in Africa. Acta Trop 2003;87:149-159.

[24] Chin J. Epilepsy treatment in sub-Saharan Africa: closing the gap. Afr Health Sci 2012;12:186-192

[25] Watila MM, Keezer MR, Angwafor SA, Winkler AS, Sander JW. Health service provision for people with epilepsy in sub-Saharan Africa: A situational review. Epilepsy Behav 2017;70:24-32.

[26] Jetté N, Sander JW, Keezer MR. Surgical treatment for epilepsy: the potential gap between evidence and practice. Lancet Neurol 2016;15:982-994.

[27] Arksey H, O'Malley L. Scoping studies: towards a methodological framework. Int J Soc Res Methodol 2005;8:19-32.

[28] Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. Implement Sci 2010;5:69.

[29] Rosenow F, Bast T, Czech T, Feucht M, Hans VH, Helmstaedter C, et al. Revised version of quality guidelines for presurgical epilepsy evaluation and surgical epilepsy therapy issued by the Austrian, German, and Swiss working group on presurgical epilepsy diagnosis and operative epilepsy treatment. Epilepsia 2016;57:1215-1220.

[30] Nayel MH. Mutual benefits from epilepsy surgery in developed and developing countries. Epilepsia 2000;41 Suppl 4:S28-30.

[31] Wieser H, Blume W, Fish D, Goldensohn E, Hufnagel A, King D, et al. Proposal for a new classification of outcome with respect to epileptic seizures following epilepsy surgery. Epilepsia 2001;42:282-286.

[32] Durnford AJ, Rodgers W, Kirkham FJ, Mullee MA, Whitney A, Prevett M, et al. Very good inter-rater reliability of Engel and ILAE epilepsy surgery outcome classifications in a series of 76 patients. Seizure 2011;20:809-812.

[33] Krynauw RA. Infantile hemiplegia treated by removing one cerebral hemisphere. J Neurol Neurosurg Psychiatry 1950;13:243.

[34] Butler JT. The role of epilepsy surgery in southern Africa. Acta Neurol Scand Suppl 2005;181:12-16.

[35] Ruberti RF. Surgery of intractable epilepsy in Africa. AJNS 1997;16.

[36] Boling W, Palade A, Wabulya A, Longoni N, Warf B, Nestor S, et al. Surgery for pharmacoresistant epilepsy in the developing world: A pilot study. Epilepsia 2009;50:1256-1261.

[37] Fletcher A, Sims-Williams H, Wabulya A, Boling W. Stigma and quality of life at long-term follow-up after surgery for epilepsy in Uganda. Epilepsy Behav 2015;52:128-131.

[38] Mandell JG, Hill KL, Nguyen DT, Moser KW, Harbaugh RE, McInerney J, et al. Volumetric brain analysis in neurosurgery: Part 3. Volumetric CT analysis as a predictor of seizure outcome following temporal lobectomy. J Neurosurg Pediatr 2015;15:133-143.

[39] Lahjouji F, Belaïdi H, Errguig L, Birouk N, Kably B, Khamlichi A, et al. Temporal lobe epilepsy surgery: a non invasive presurgical protocol (a moroccan experience). Epilepsies 2007;19:179-187.

[40] Souirti Z, Sghir A, Belfkih R, Messouak O. Focal drug-resistant epilepsy: Progress in care and barriers, a Morroccan perspective. J Clin Neurosci 2016;34:276-280.

[41] Khiari HM, Khemiri E, Parain D, Hattab N, Proust F, Mrabet A. Epilepsy surgery program in Tunisia: an example of a Tunisian French collaboration. Seizure 2010;19:74-78.

[42] Kassem H, El Shiekh F, Wafaie A, Abdelfattah S, Farghaly H, Afifi L. Presurgical evaluation of refractory temporal lobe epilepsy: Comparison of MR imaging, PET and ictal SPECT in localization of the epileptogenic substrate. The Egyptian Journal of Radiology and Nuclear Medicine 2013;44:641-649.

[43] Alonso NB, da Silva TI, Westphal-Guitti AC, Azevedo AM, Caboclo LOSF, Sakamoto AC, et al. Quality of life related to surgical treatment in patients with temporal lobe epilepsy due to mesial temporal sclerosis. J Epilepsy Clin Neurophysiol 2006;12:233-241. 10.1590/S1676-26492006000700009

[44] Araújo Filho GMd, Gomes FL, Mazetto L, Marinho MM, Tavares IM, Caboclo LOSF, et al. Pre-surgical mood disorders associated to worse post-surgical seizure outcome in patients with refractory temporal lobe epilepsy and mesial temporal sclerosis. J Epilepsy Clin Neurophysiol 2012;18:21-25. 10.1590/S1676-26492012000100006

[45] Jardim AP, Neves RS, Caboclo LO, Lancellotti CL, Marinho MM, Centeno RS, et al. Temporal lobe epilepsy with mesial temporal sclerosis: hippocampal neuronal loss as a predictor of surgical outcome. Arq Neuropsiquiatr 2012;70:319-324. 10.1590/S0004-282X2012000500003

[46] Amaral LCd, Portela EJ, Oliveira MMRd, Lara MT, Sousa-Pereira SRd, Seabra LCS, et al. Tratamento cirúrgico da epilepsia refratária: análise de 34 casos atendidos no Hospital das Clínicas da UFMG. Arq Bras Neurocir 2014;33. 10.1055/s-0038-1626257

[47] Frayman L, Cukiert A, Forster C, Ferreira VB, Buratini JA. Qualidade de vida de pacientes submetidos a cirurgia de epilepsia. Arq Neuropsiquiatr 1999;57:30-33. 10.1590/S0004-282X1999000100006.

[48] Cukiert A, Sousa A, Machado E, Buratini JA, Forster C, Argentoni M. Results of surgery in patients with bilateral independent temporal lobe spiking (BITLS) with normal MRI or bilateral

mesial temporal sclerosis (MTS) investigated with bilateral subdural grids. Arq Neuropsiquiatr 2000;58:1009-1013.

[49] Baldauf CM, Cukiert A, Argentoni M, Baise-Zung C, Forster CR, Mello VA, et al. Surgical outcome in patients with refractory epilepsy associated to MRI-defined unilateral mesial temporal sclerosis. Arq Neuropsiquiatr 2006;64:363-368. 10.1590/S0004-282X2006000300003

[50] Zanni KP, Bianchin MA, Marques LHN. Qualidade de vida e desempenho ocupacional de pacientes submetidos à cirurgia de epilepsia. J Epilepsy Clin Neurophysiol 2009;15:114-117. 10.1590/S1676-26492009000300004

[51] Meguins LC, Adry RA, Silva Júnior SC, Pereira CU, Oliveira JG, Morais DF, et al. Longer epilepsy duration and multiple lobe involvement predict worse seizure outcomes for patients with refractory temporal lobe epilepsy associated with neurocysticercosis. Arq Neuropsiquiatr 2015;73:1014-1018.

[52] Meguins LC, Adry RA, Silva-Junior SC, Araújo Filho GM, Marques LH. Shorter epilepsy duration is associated with better seizure outcome in temporal lobe epilepsy surgery. Arq Neuropsiquiatr 2015;73:212-217.

[53] Paglioli E, Palmini A, Paglioli E, Da Costa JC, Portuguez M, Martinez JV, et al. Survival analysis of the surgical outcome of temporal lobe epilepsy due to hippocampal sclerosis. Epilepsia 2004;45:1383-1391.

[54] Almeida AG, Nunes ML, Palmini AL, Costa JC. Incidence of SUDEP in a cohort of patients with refractory epilepsy: the role of surgery and lesion localization. Arq Neuropsiquiatr 2010;68:898-902. 10.1590/S0004-282X2010000600013

[55] Hemb M, Palmini A, Paglioli E, Paglioli EB, da Costa JC, Azambuja N, et al. An 18-year follow-up of seizure outcome after surgery for temporal lobe epilepsy and hippocampal sclerosis. J Neurol Neurosurg Psychiatry 2013;84:800-805.

[56] Meneses MS, Rocha SB, Kowacs PA, Andrade NO, Santos HL, Narata AP, et al. Tratamento cirúrgico da epilepsia do lobo temporal: análise de 43 casos consecutivos. Arq Neuropsiquiatr 2005;63:618-624. 10.1590/S0004-282X2005000400012

[57] Meneses MS, Rocha SFB, Simão C, Santos HNHLd, Pereira C, Kowacs PA. Vagus nerve stimulation may be a sound therapeutic option in the treatment of refractory epilepsy. Arq Neuropsiquiatr 2013;71:25-30.10.1590/S0004-282X2013000100006

[58] Nascimento FA, Gatto LAM, Silvado C, Mäder-Joaquim MJ, Moro MS, Araujo JC. Anterior temporal lobectomy versus selective amygdalohippocampectomy in patients with mesial temporal lobe epilepsy. Arq Neuropsiquiatr 2016;74:35-43.

[59] Guimaräes CA, Souza EAP, Montenegro MA, Cendes F, Guerreiro MM. Cirurgia para epilepsia na infância: avaliaçäo neuropsicológica e de qualidade de vida. Arq Neuropsiquiatr 2003;61:786-792. 10.1590/S0004-282X2003000500016

[60] Bonilha L, Kobayashi E, Mattos JPV, Honorato DC, Li LM, Cendes F. Value of extent of hippocampal resection in the surgical treatment of temporal lobe epilepsy. Arq Neuropsiquiatr 2004;62:15-20. 10.1590/S0004-282X2004000100003

[61] Yasuda CL, Valise C, Saúde AV, Pereira FR, Costa ALF, Morita ME, et al. Regeneração de atrofia de substância branca após a cirurgia de epilesia: evidências estruturais através da morfometria baseada em voxel. J Epilepsy Clin Neurophysiol 2009;15:07-11. 10.1590/S1676-26492009000100003.

[62] Gagliardi IC, Guimarães CA, Souza EAP, Schmutzler KMR, Guerreiro MM. Quality of life and epilepsy surgery in childhood and adolescence. Arq Neuropsiquiatr 2011;69:23-26. 10.1590/S0004-282X2011000100006

[63] Sales LV, Velasco TR, Funayama S, Ribeiro LT, Andrade-Valenca LP, Neder L, et al. Relative frequency, clinical, neuroimaging, and postsurgical features of pediatric temporal lobe epilepsy. Braz J Med Biol Res 2006;39:1365-1372. 10.1590/S0100-879X2006001000013

[64] Terra VC, Scorza FA, Cavalheiro EA, Wichert-Ana L, Pinto KG, Machado HR, et al. Pediatric epilepsy surgery and sudden unexpected death epilepsy: the contribution of a Brazilian epilepsy surgery program. Childs Nerv Syst 2010;26:1075-1079.

[65] Bianchin MM, Velasco TR, Wichert-Ana L, Alexandre V, Jr., Araujo D, Jr., dos Santos AC, et al. Characteristics of mesial temporal lobe epilepsy associated with hippocampal sclerosis plus neurocysticercosis. Epilepsy Res 2014;108:1889-1895.

[66] Campos MG, Godoy J, Mesa MT, Torrealba G, Gejman R, Huete I. Temporal lobe epilepsy surgery with limited resources: Results and economic considerations. Epilepsia 2000;41:S18-S21.

[67] Acevedo HG, Zambrano EV, Olivares OP, Taha LM, Taha YlM. Resultados de callosotomía en adultos con diagnóstico de epilepsia refractaria y drop-attack. Rev Chil Neuro-psiquiatr 2015;53:86-92. 10.4067/S0717-92272015000200003

[68] Brian R, Trejos H, Sittenfeld M, Loría J, Segura J, Cáceres A, et al. Cirugía de la epilepsia en Costa Rica. Neuroeje 2003;17:69-73.

[69] Fernandez-Concepcion O, Lopez Jimenez M, Valencia-Calderon C, Calderon-Valdivieso A, Recasen-Linares A, Reyes-Haro L, et al. Safety and effectiveness of surgery for epilepsy in children. Experience of a tertiary hospital in Ecuador. Neurologia 2018.

[70] Fandino-Franky J, Torres M, Narino D, Fandino J. Corpus callosotomy in Colombia and some reflections on care and research among the poor in developing countries. Epilepsia 2000;41 Suppl 4:S22-27. 10.1111/j.1528-1157.2000.tb01541.x

[71] Tureczek IE, Fandino-Franky J, Wieser HG. Comparison of the epilepsy surgery programs in Cartagena, Colombia, and Zurich, Switzerland. Epilepsia 2000;41 Suppl 4:S35-40.

[72] Benedetti-Isaac J, Torres-Zambrano M, Fandino-Franky J, Dussan-Ordonez J, Herrera-Trujillo A, Guerra-Olivares R, et al. Long-term surgical outcomes in patients with drug-resistant temporal lobe epilepsy and no histological abnormalities. Neurologia 2013;28:543-549.

[73] Benedetti-Isaac JC, Torres-Zambrano M, Vargas-Toscano A, Perea-Castro E, Alcala-Cerra G, Furlanetti LL, et al. Seizure frequency reduction after posteromedial hypothalamus deep brain stimulation in drug-resistant epilepsy associated with intractable aggressive behavior. Epilepsia 2015;56:1152-1161.

[74] Freire C ID, Valencia D C, Ruiz A NP, Villamizar S I, Freire F IA. Resultados de cirugía de epilepsia en la Fundación Cardiovascular de Colombia: serie de casos. Acta Neurol Colomb 2016;32:108-114. 10.22379/2422402284

[75] Jiménez Torres MJ, Aliaga Rocabado M, Torrejón López R. Recurrencia de rrisis epilépticas post tratamieto quirúrgico para cirugía epillepsia en el servicio neurocirugía del hospital materno infantil. Rev méd (La Paz) 2014;20:15-22.

[76] Mejía-Tupa MA, Pérez-Galdos P, Tori-Murgueytio A, Del Solar-Tafur M, Anicama-Lima WE, Campos-Puebla MG. Cirugía de epilepsia en el Hospital Nacional Guillermo Almenara: primeros siete casos. Acta méd peru 2014;31:199-212.

[77] Mejía-Tupa MA. Cirugía de epilepsia en el HNGAI. Acta méd peru 2015;32:63-63.

[78] Pomata HB, Bartuluchi M, Lubieniecki F, Pociecha J, Caraballo R, Cáceres E, et al. Malformación del desarrollo cortical: nuestra experiencia acerca de 150 casos. Rev Argent Neurocir 2010;24:93-103.

[79] Caraballo R, Bartuluchi M, Cersosimo R, Soraru A, Pomata H. Hemispherectomy in pediatric patients with epilepsy: a study of 45 cases with special emphasis on epileptic syndromes. Childs Nerv Syst 2011;27:2131-2136.

[80] Vázquez C, Cuello M, Rubino P, Prosen A, Tanriover N, Perasolo M, et al. Esclerosis temporal mesial: paradigma de la epilepsia de resolución quirúrgica. Rev argent neurocir 2008;22:59-73.

[81] Vazquez C, Jesús Barrios Ld, Bartuluchi M, Medina C, Petre C, Pomata H. Hemisferectomías y hemi-hemisferectomías: nuestra experiencia acerca de 49 casos. Rev argent neurocir 2008;22:131-133.

[82] Donadio M, D'Giano C, Moussalli M, Barrios L, Ugarnes G, Segalovich M, et al. Epilepsy surgery in Argentina: long-term results in a comprehensive epilepsy centre. Seizure 2011;20:442-445.

[83] Zaknun JJ, Bal C, Maes A, Tepmongkol S, Vazquez S, Dupont P, et al. Comparative analysis of MR imaging, ictal SPECT and EEG in temporal lobe epilepsy: a prospective IAEA multi-center study. Eur J Nucl Med Mol Imaging 2008;35:107-115.

[84] Oddo S, Solis P, Consalvo D, Seoane E, Giagante B, D'Alessio L, et al. Postoperative neuropsychological outcome in patients with mesial temporal lobe epilepsy in Argentina. Epilepsy Res Treat 2012;2012:370351.

[85] Velasco Monroy AL, Aguado Carrillo G, Sandoval Olivares L, Vazquez Barron D. [Intracranial electrode recording prognostic value in anterior temporal lobectomy and hypocampectomy]. Gac Med Mex 2013;149:143-151.

[86] Alonso-Vanegas MA, Austria-Velasquez J, Lopez-Gomez M, Brust-Mascher E. Chronic intermittent vagal nerve stimulation in the treatment of refractory epilepsy: experience in Mexico with 35 cases. Cir Cir 2010;78:15-23, 24.

[87] Alonso-Vanegas MA, Garcia RMB, Castillo-Montoya C, San-Juan D, Senties-Madrid H, Mascher EB, et al. Long term surgical results in supplementary motor area epilepsy surgery. Clin Neurophysiol 2016;127:e315.

[88] Alonso-Vanegas MA, San-Juan D, Buentello Garcia RM, Castillo-Montoya C, Senties-Madrid H, Mascher EB, et al. Long-term surgical results of supplementary motor area epilepsy surgery. J Neurosurg 2017:1-7.

[89] Programa de Cirugía de Epilepsia. Cirugía de epilepsia: experiencia en el Hospital de Clínicas de Montevideo. Rev Méd Urug 2006;22:36-45.

[90] Natola MA, Jobst B, Scaramelli A, Bogacz A, Braga P, Spire W, et al. Establishing a comprehensive epilepsy surgery center in South America, the dartmouth-uruguayan experience. Epilepsy Currents Conference: 64th Annual Meeting of the American Epilepsy Society, AES and 3rd Biennial North American Regional Epilepsy Congress San Antonio, TX United States Conference Publication: 2011;11.

[91] Gonzalez Zerpa R, Soto Reyes A, Contreras G. Epilepsy surgery of the temporal lobe in an epilepsy center in Venezuela. Six years of experience. Epilepsia 2017;58 (Supplement 5):S114-S115.

[92] Chacón LMM, Catasús CS, Bender JE, Bayard JB, García ME, Maeso IG, et al. A neurofunctional evaluation strategy for presurgical selection of temporal lobe epilepsy patients. MEDICC Rev 2009;11:30.

[93] Bender del Busto JE, Morales Chacón L, Rodríguez Mutuberría L, López Pérez M, Hernández Toledo L. Evaluación de la calidad de vida en pacientes con epilepsia refractaria del lóbulo temporal intervenidos quirúrgicamente. Rev Habanera Cienc Méd 2010;9:569-575.

[94] Morales LM, Sanchez C, Bender JE, Bosch J, Garcia ME, Garcia I, et al. A neurofunctional evaluation strategy for presurgical selection of temporal lobe epilepsy patients. MEDICC Rev 2009;11:29-35.

[95] Bhatia M, Singh VP, Jain S, Gaekwad S, Bal CS, Sarkar C, et al. Epilepsy surgery in India: All India Institute of Medical Sciences experience. J Assoc Physicians India 1999;47:492-495.

[96] Shukla G, Bhatia M, Singh VP, Jaiswal A, Tripathi M, Gaikwad S, et al. Successful selection of patients with intractable extratemporal epilepsy using non-invasive investigations. Seizure 2003;12:573-576.

[97] Sarkar C, Sharma MC, Deb P, Singh VP, Chandra PS, Gupta A, et al. Neuropathological spectrum of lesions associated with intractable epilepsies: a 10-year experience with a series of 153 resections. Neurol India 2006;54:144-150.

[98] Ahmad FU, Tripathi M, Padma M, Gaikwad S, Gupta A, Bal C, et al. Health-related quality of life using QOLIE-31: before and after epilepsy surgery a prospective study at a tertiary care center. Neurol India 2007;55:343.

[99] Tripathi M, Singh MS, Padma MV, Gaikwad S, Bal CS, Tripathi M, et al. Surgical outcome of cortical dysplasias presenting with chronic intractable epilepsy: a 10-year experience. Neurol India 2008;56:138-143.

[100] Chandra PS, Padma VM, Shailesh G, Chandreshekar B, Sarkar C, Tripathi M. Hemispherotomy for intractable epilepsy. Neurol India 2008;56:127.

[101] Dagar A, Chandra PS, Chaudhary K, Avnish C, Bal CS, Gaikwad S, et al. Epilepsy surgery in a pediatric population: a retrospective study of 129 children from a tertiary care hospital in a developing country along with assessment of quality of life. Pediatr Neurosurg 2011;47:186-193.

[102] Chandra SP, Tripathi M. Endoscopic epilepsy surgery: Emergence of a new procedure. Neurol India 2015;63:571.

[103] Dwivedi R, Ramanujam B, Chandra PS, Sapra S, Gulati S, Kalaivani M, et al. Surgery for Drug-Resistant Epilepsy in Children. N Engl J Med 2017;377:1639-1647.

[104] Malhotra V, Chandra SP, Dash D, Garg A, Tripathi M, Bal CS, et al. A screening tool to identify surgical candidates with drug refractory epilepsy in a resource limited settings. Epilepsy Res 2016;121:14-20.

[105] Barbaro NM, Quigg M, Ward MM, Chang EF, Broshek DK, Langfitt JT, et al. Radiosurgery versus open surgery for mesial temporal lobe epilepsy: The randomized, controlled ROSE trial. Epilepsia 2018;59:1198-1207.

[106] Daniel R, Chandy M. Epilepsy surgery: overview of forty years experience. Neurol India 1999;47:98.

[107] Daniel R, Joseph T, Gnanamuthu C, Chandy M. Hemispherotomy for paediatric hemispheric epilepsy. Stereotact Funct Neurosurg 2001;77:219-222.

[108] Rao MB, Radhakrishnan K. Is epilepsy surgery possible in countries with limited resources? Epilepsia 2000;41 Suppl 4:S31-34.

[109] Sylaja P, Radhakrishnan K, Kesavadas C, Sarma P. Seizure outcome after anterior temporal lobectomy and its predictors in patients with apparent temporal lobe epilepsy and normal MRI. Epilepsia 2004;45:803-808.

[110] Panda S, Radhakrishnan VV, Radhakrishnan K, Rao RM, Sarma SP. Electro-clinical characteristics and postoperative outcome of medically refractory tumoral temporal lobe epilepsy. Neurol India 2005;53:66. 10.4103/0028-3886.15061

[111] Radhakrishnan A, Radhakrishnan K, Radhakrishnan VV, Mary PR, Kesavadas C, Alexander A, et al. Corpora amylacea in mesial temporal lobe epilepsy: clinico-pathological correlations. Epilepsy Res 2007;74:81-90.

[112] George L, Iyer RS, James R, Sankara Sarma P, Radhakrishnan K. Employment outcome and satisfaction after anterior temporal lobectomy for refractory epilepsy: a developing country's perspective. Epilepsy Behav 2009;16:495-500.

[113] Ramesha KN, Rajesh B, Ashalatha R, Kesavadas C, Abraham M, Radhakrishnan VV, et al. Rasmussen's encephalitis: experience from a developing country based on a group of medically and surgically treated patients. Seizure 2009;18:567-572.

[114] Chemmanam T, Radhakrishnan A, Sarma SP, Radhakrishnan K. A prospective study on the cost-effective utilization of long-term inpatient video-EEG monitoring in a developing country. J Clin Neurophysiol 2009;26:123-128.

[115] Chaudhry N, Radhakrishnan A, Abraham M, Kesavadas C, Radhakrishnan VV, Sankara Sarma P, et al. Selection of ideal candidates for extratemporal resective epilepsy surgery in a country with limited resources. Epileptic Disord 2010;12:38-47.

[116] Ramesha KN, Mooney T, Sarma PS, Radhakrishnan K. Long-term seizure outcome and its predictors in patients with recurrent seizures during the first year after temporal lobe resective epilepsy surgery. Epilepsia 2011;52:917-924.

[117] Dash GK, Radhakrishnan A, Kesavadas C, Abraham M, Sarma PS, Radhakrishnan K. An audit of the presurgical evaluation and patient selection for extratemporal resective epilepsy surgery in a resource-poor country. Seizure 2012;21:361-366.

[118] Asranna A, Radhakrishnan A, Thomas SV, Menon R, Cherian A. Temporal trends in pediatric epilepsy surgery 2000-2014; A lower-middle income country perspective from India. J Neurol Sci 2017;381 (Supplement 1):335.

[119] Rao MB, Arivazhagan A, Chaturvedi J. Epilepsy surgery for focal cortical dysplasia. Stereotact Funct Neurosurg 2017;95 (Supplement 1):264.

[120] Jayalakshmi S, Panigrahi M, Kulkarni DK, Uppin M, Somayajula S, Challa S. Outcome of epilepsy surgery in children after evaluation with non-invasive protocol. Neurol India 2011;59:30.

[121] Panigrahi M, Vooturi S, Jayalakshmi S. Complications of Epilepsy Surgery: A Single Surgeon's Experience from South India. World Neurosurg 2016;91:16-22.

[122] Ravat S, Iyer V, Muzumdar D, Shah U, Pradhan P, Jain N, et al. Clinical characteristics, surgical and neuropsychological outcomes in drug resistant tumoral temporal lobe epilepsy. Int J Surg 2016;36:436-442.

[123] Ravat S, Iyer V, Panchal K, Muzumdar D, Kulkarni A. Surgical outcomes in patients with intraoperative Electrocorticography (EcoG) guided epilepsy surgery-experiences of a tertiary care centre in India. Int J Surg 2016;36:420-428.

[124] Shah U, Desai A, Ravat S, Muzumdar D, Godge Y, Sawant N, et al. Memory outcomes in mesial temporal lobe epilepsy surgery. Int J Surg 2016;36:448-453.

[125] Chowdhury FH, Haque MR, Islam MS, Sarker M, Kawsar K, Sarker A. Microneurosurgical management of temporal lobe epilepsy by amygdalohippocampectomy (AH) plus standard anterior

temporal lobectomy (ATL): a report of our initial five cases in Bangladesh. Asian J Neurosurg 2010;5:10-18.

[126] Liang S, Li A, Zhao M, Jiang H, Yu S, Meng X, et al. Epilepsy surgery in tuberous sclerosis complex: emphasis on surgical candidate and neuropsychology. Epilepsia 2010;51:2316-2321.

[127] Guan Y, Guoming L, Jian Z. Temporoparietooccipital and parietooccipital disconnection in patients with intractable epilepsy. Neurol Asia 2013;18:57-59.

[128] Dong Y-F, Cheng J-L, Zhang L. Operation of medial temporal lobe epilepsy with hippocampus lesion. J Clin Neurosurg 2012;6:017.

[129] Wang E-H, Wang H-F, Zhou J-L, Qiao H, Zhu C, Ma J, et al. Surgical treatment on patients with multiple focus of refractory epilepsy 65 case [J]. Journal of Bengbu Medical College 2011;7:026.

[130] Guangming Z, Wenjing Z, Jiuluan L, Zhaohui S, Bingqing Z, Gaoxiang S, et al. Long-term therapeutic effects of corticoamygdalohippocampectomy for bilateral mesial temporal lobe epilepsy. Surg Neurol Int 2013;4. 10.4103/2152-7806.121405

[131] Jia-tang W, Dong L, Qi-fu T. Surgical treatment of intractable temporal lobe epilepsy. J Clin Neurosci 2008;2:022.

[132] Kuang Y-Q, Gu J-W, Dang S-H, Wang H-M, Luo Y-H, Yang T, et al. Microsurgical treatment of temporal lobe arachnoid cysts complicated with epilepsy. Medical Journal of Chinese People's Liberation Army 2011;36:114-115.

[133] Liang C, Tang Y, Mu H, Guo T, Du Y, Yue X, et al. Corpus Callosotomy for Patients With Intractable Seizures: An Insight Into the Rapid Relapse. J Craniofac Surg 2015;26:e795-798.

[134] Liang S, Wang S, Zhang J, Ding C, Zhang Z, Fu X, et al. Long-term outcomes of epilepsy surgery in school-aged children with partial epilepsy. Pediatr Neurol 2012;47:284-290.

[135] Luan G, Sun Z, Bai Q, Wang C. Surgical treatment of intractable epilepsy combined with bipolar electrocoagulation on functional cortex. Stereotact Funct Neurosurg 2002;77:233-238.

[136] Sun Z, Luan G, Zhou J, Sun Z, Luan G, Zhou J. Combined operation for complex intractable epilepsy. Chin J Neurosurg 2002;18:219-221.

[137] He W, Wang XY, Zhou L, Li ZM, Jing XH, Lv ZL, et al. Transcutaneous auricular vagus nerve stimulation for pediatric epilepsy: study protocol for a randomized controlled trial. Trials 2015;16:371.

[138] Meng FG, Jia FM, Ren XH, Ge Y, Wang KL, Ma YS, et al. Vagus Nerve Stimulation for Pediatric and Adult Patients with Pharmaco-resistant Epilepsy. Chin Med J (Engl) 2015;128:2599-2604.

[139] Yang M, An N, Liu S. The localization of epileptogenic foci with continual sphenoidal electrodes in temporal epilepsy. Chin J Stereot Funct Neurosurg 2007;1:001.

[140] Yang M, An N, Liu S. Surgical treatment of temporal lobe epilepsy in 189 patients. Chin J Stereot Funct Neurosurg 2008;3:004.

[141] Yang M-H, Yang H-A, An N. Analysis of Curative Effects of Microsurgery on Intractable Temporal Epilepsy. Chin J Clinical Neurosurg 2009;3:008.

[142] Yang W, Yu Q, Shen C. Combined operations for treatment of intractable epilepsy. J Clin Neurosurg 2004;3:009.

[143] Yang W, Yu Q, Pu P. A combination of minimally invasive procedures for unilateral mixed temporal lobe epilepsy. Chin J Stereot Funct Neurosurg 2007;3:002.

[144] Wu XT, Li L, Yan B, Stefan H, Lei D, Zhou D. How to effectively constrain the cost of presurgical evaluation for resective surgery in low-income population: clinically oriented opinions. Seizure 2011;20:425-427.

[145] Zeng TF, An DM, Li JM, Li YH, Chen L, Hong Z, et al. Evaluation of different antiepileptic drug strategies in medically refractory epilepsy patients following epilepsy surgery. Epilepsy Res 2012;101:14-21.

[146] Zeng TF, Li YH, An DM, Chen L, Lei D, Zhang B, et al. Effectiveness of levetiracetam use following resective surgery in patients with refractory epilepsy: a prospective observational study. Epilepsy Res 2014;108:1904-1911.

[147] Chen J, Lei D. Surgery: a cost-effective option for drug-resistant epilepsy in China. World Neurosurg 2014;82:e375-376.

[148] Yang PF, Zhang HJ, Pei JS, Tian J, Lin Q, Mei Z, et al. Intracranial electroencephalography with subdural and/or depth electrodes in children with epilepsy: techniques, complications, and outcomes. Epilepsy Res 2014;108:1662-1670. 1

[149] Yang P-F, Pei J-S, Zhang H-J, Lin Q, Mei Z, Zhong Z-H, et al. Long-term epilepsy surgery outcomes in patients with PET-positive, MRI-negative temporal lobe epilepsy. Epilepsy Behav 2014;41:91-97.

[150] Yu S, Lin Z, Liu L, Pu S, Wang H, Wang J, et al. Long-term outcome of epilepsy surgery: a retrospective study in a population of 379 cases. Epilepsy Res 2014;108:555-564.

[151] Wang H, Chen X, Lin Z, Shao Z, Sun B, Shen H, et al. Long-term effect of vagus nerve stimulation on interictal epileptiform discharges in refractory epilepsy. J Neurol Sci 2009;284:96-102.

[152] Lin Y, Zhang Y, Kang D. The relationship between degrees of resection of the epileptic foci and the effect in intractable epilepsy. Chin J Stereot Funct Neurosurg 2001;2:003.

[153] Zonghui L, Quanjun Z, Shiyue L. The study of multiple subpial transection to the cortex expending focus. Chin J Neurosurg 1997:03.

[154] Piao YS, Lu DH, Chen L, Liu J, Wang W, Liu L, et al. Neuropathological findings in intractable epilepsy: 435 Chinese cases. Brain Pathol 2010;20:902-908

[155] Al-Ghanem SS, Al-Oweidi AS, Tamimi AF, Al-Qudah AA. Anesthesia and electrocorticography for epilepsy surgery: a Jordanian experience. Middle East J Anaesthesiol 2009;20:31-37.

[156] Faleh-Tamimi A, Qudah A. Surgical treatment of temporal lobe epilepsy. Personal experience. Neurocirugia (Astur) 2002;13:33-37.

[157] Aburahma SK, Alzoubi FQ, Hammouri HM, Masri A. Vagus nerve stimulation therapy in a developing country: a long term follow up study and cost utility analysis. Seizure 2015;25:167-172.

[158] Alsemari A, Al-Otaibi F, Baz S, Althubaiti I, Aldhalaan H, MacDonald D, et al. Epilepsy surgery series: a study of 502 consecutive patients from a developing country. Epilepsy Res Treat 2014;2014.

[159] Locharernkul C, Kanchanatawan B, Bunyaratavej K, Srikijvilaikul T, Deesudchit T, Tepmongkol S, et al. Quality of life after successful epilepsy surgery: evaluation by occupational achievement and income acquisition. J Med Assoc Thai 2005;88 Suppl 4:S207-213.

[160] Kanchanatawan B, Kasalak R. Quality of life in Thai intractable epileptic patients with and without surgery. J Med Assoc Thai 2012;95:1232-1238.

[161] Kanchanatawan B, Limothai C, Srikijvilaikul T, Maes M. Clinical predictors of 2-year outcome of resective epilepsy surgery in adults with refractory epilepsy: a cohort study. BMJ open 2014;4:e004852.

[162] Srinivas HV, Shah U. Comorbidities of epilepsy. Neurol India 2017;65:S18-s24. 10.4103/neuroindia.NI_922_16

[163] Visudhiphan P, Bunyaratavej S, Visudtibhan A, Chiemchanya S, Laothamatas J, Sarnvivad P, et al. Temporal lobectomy for intractable complex partial seizures in pediatric patients. J Med Assoc Thai 1999;82:778-783.

[164] Kitwitee P, Unnwongse K, Srikijvilaikul T, Yadee T, Limwattananon C. Cost-Utility of Video-Electroencephalography Monitoring Followed by Surgery in Adults with Drug-Resistant Focal Epilepsy in Thailand. World Neurosurg 2017;98:750 – 760.

[165] Mikati MA, Comair YG, Rahi A. Normalization of quality of life three years after temporal lobectomy: a controlled study. Epilepsia 2006;47:928-933.

[166] Mikati MA, Ataya N, El-Ferezli J, Shamseddine A, Rahi A, Herlopian A, et al. Epilepsy surgery in a developing country (Lebanon): ten years experience and predictors of outcome. Epileptic Disord 2012;14:267-274.

[167] Ahmed SN, Mann C, Siddiqui F, Sheerani M, Syed NA, Snyder T, et al. Experiences from an international tele-epilepsy collaboration. Can J Neurol Sci 2009;36:582-586.

[168] Tahir MZ, Sobani ZA, Quadri SA, Ahmed SN, Sheerani M, Siddiqui F, et al. Establishment of a comprehensive epilepsy center in pakistan: initial experiences, results, and reflections. Epilepsy Res Treat 2012;2012:547382.

[169] Sheerani M. Development of a comprehensive epilepsy surgery programme in Pakistan. J Pak Med Assoc 2005;55:32-37.

[170] Asadi-Pooya AA, Malekmohamadi Z, Kamgarpour A, Rakei SM, Taghipour M, Ashjazadeh N, et al. Corpus callosotomy is a valuable therapeutic option for patients with Lennox-Gastaut syndrome and medically refractory seizures. Epilepsy Behav 2013;29:285-288.

[171] Asadi-Pooya AA, Ashjazadeh N, Kamgarpour A, Taghipour M, Rakei SM, Farazdaghi M, et al. Management of epilepsy in resource-limited areas: establishing an epilepsy surgery program in Iran. Med J Islam Repub Iran 2014;28:24.

[172] Asadi-Pooya AA, Rakei SM, Kamgarpour A, Taghipour M, Ashjazadeh N, Razmkon A, et al. Outcome after temporal lobectomy in patients with medically-refractory mesial temporal epilepsy in Iran. J Neurosurg Sci 2015.

[173] Pakdaman H, Amini Harandi A, Abbasi M, Karimi M, Arami MA, Mosavi SA, et al. Vagus nerve stimulation in drug-resistant epilepsy: the efficacy and adverse effects in a 5-year follow-up study in Iran. Neurol Sci 2016;37:1773-1778.

[174] Ozkara C, Ozyurt E, Hanoglu L, Eskazan E, Dervent A, Kocer N, et al. Surgical outcome of epilepsy patients evaluated with a noninvasive protocol. Epilepsia 2000;41 Suppl 4:S41-44.

[175] Aydemir N, Ozkara C, Canbeyli R, Tekcan A. Changes in quality of life and self-perspective related to surgery in patients with temporal lobe epilepsy. Epilepsy Behav 2004;5:735-742.

[176] Hirfanoglu T, Serdaroglu A, Kurt G, Erdem A, Capraz I, Bilir E, et al. Outcomes of resective surgery in children and adolescents with focal lesional epilepsy: The experience of a tertiary epilepsy center. Epilepsy Behav 2016;63:67-72.

[177] Sayuthi S, Tharakan J, Pieter MS, Salmah WM, Madhavan M, Tahir A, et al. Neuropsychological assessment in epilepsy surgery - preliminary experience in a rural tertiary care hospital in north East malaysia. Malays J Med Sci 2009;16:39-43.

[178] Kasradze S, Alkhidze M, Lomidze G, Japaridze G, Tsiskaridze A, Zangaladze A. Perspectives of epilepsy surgery in resource-poor countries: a study in Georgia. Acta Neurochir (Wien) 2015;157:1533-1540.

[179] Augusta University. Augusta University Surgical Epilepsy Surgery Program at the Georgia Health Sciences University [online].

[180] Matkovskii VS, Iova AS, Timirgaz VV. [25 years' experience in surgically treatment of the epilepsy]. Zh Vopr Neirokhir Im N N Burdenko 2007:27-35.

[181] Srikijvilaikul T, Bunyarattavej K, Deesudchit T, Locharernkul C, Tepmongkol S, Lerdlum S. Outcome after temporal lobectomy for hippocampal sclerosis: Chulalongkorn Comprehensive Epilepsy Program experiences. Neurol Asia 2004;9:127.

[182] Qiu J. Epilepsy surgery: challenges for developing countries. Lancet Neurol 2009;8:420-421.

[183] Menon RN, Radhakrishnan K. A survey of epilepsy surgery in India. Seizure 2015;26:1-4.

[184] Hader WJ, Tellez-Zenteno J, Metcalfe A, Hernandez-Ronquillo L, Wiebe S, Kwon CS, et al. Complications of epilepsy surgery—a systematic review of focal surgical resections and invasive EEG monitoring. Epilepsia 2013;54:840-847.

[185] Perucca E. Treatment of epilepsy in developing countries. BMJ 2007;334:1175-1176.

[186] Jayakar P, Gaillard WD, Tripathi M, Libenson MH, Mathern GW, Cross JH, et al. Diagnostic test utilization in evaluation for resective epilepsy surgery in children. Epilepsia 2014;55:507-518.

[187] Harvey AS, Cross JH, Shinnar S, Mathern GW, Taskforce PESS. Defining the spectrum of international practice in pediatric epilepsy surgery patients. Epilepsia 2008;49:146-155.

[188] Platt M, Sperling MR. A comparison of surgical and medical costs for refractory epilepsy. Epilepsia 2002;43:25-31.

[189] Wiebe S, Gafni A, Blume WT, Girvin JP. An economic evaluation of surgery for temporal lobe epilepsy. J Epilepsy 1995;8:227-235.

[190] Malmgren K, Hedström A, Granqvist R, Malmgren H, Ben-Menachem E. Cost analysis of epilepsy surgery and of vigabatrin treatment in patients with refractory partial epilepsy. Epilepsy Res 1996;25:199-207.

[191] Schiltz NK, Kaiboriboon K, Koroukian SM, Singer ME, Love TE. Long-term reduction of health care costs and utilization after epilepsy surgery. Epilepsia 2016;57:316-324.

[192] Ravallion M. Growth, inequality and poverty: looking beyond averages. World development 2001;29:1803-1815.

[193] Meyer ACL, Dua T, Boscardin WJ, Escarce JJ, Saxena S, Birbeck GL. Critical determinants of the epilepsy treatment gap: A cross-national analysis in resource-limited settings. Epilepsia 2012;53:2178-2185.

[194] Chin MH. Advancing equity in healthcare. BMJ 2015;350.h1617.

[195] Cross JH, Jayakar P, Nordli D, Delalande O, Duchowny M, Wieser HG, et al. Proposed criteria for referral and evaluation of children for epilepsy surgery: recommendations of the Subcommission for Pediatric Epilepsy Surgery. Epilepsia 2006;47:952-959.

[196] Preux P-M, Druet-Cabanac M. Epidemiology and aetiology of epilepsy in sub-Saharan Africa. Lancet Neurol 2005;4:21-31.

[197] Megiddo I, Colson A, Chisholm D, Dua T, Nandi A, Laxminarayan R. Health and economic benefits of public financing of epilepsy treatment in India: An agent-based simulation model. Epilepsia 2016;57:464-474.

[198] Ibrahim GM, Barry BW, Fallah A, Snead III OC, Drake JM, Rutka JT, et al. Inequities in access to pediatric epilepsy surgery: a bioethical framework. Neurosurg Focus 2012;32:E2.

[199] Schiltz NK, Fernandez-Baca Vaca G. Epidemiologist's view: Addressing the epilepsy surgery treatment gap with minimally-invasive techniques. Epilepsy Res 2018;142:179-181.

[200] Klein R. Dimensions of rationing: who should do what? BMJ 1993;307:309-311.