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Development and Evaluation of a Pediatric Epilepsy Training Program for First Level Providers in Zambia

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Abstract

Introduction. The developing world continues to face challenges in closing the large treatment gap for epilepsy, due to a high burden of disease and few experienced providers to manage the condition. Children with epilepsy are susceptible to higher rates of developmental impairments and refractory disease due to delays or absence of appropriate management as a result. We demonstrated that a structured education intervention on pediatric epilepsy can improve knowledge, confidence, and impact clinical practice of first level providers in Zambia. *Methods*. Three first-level facilities across Zambia were included. After initial pilot versions and revisions, the final course was implemented at each site. Pre- and post-intervention knowledge and confidence assessments were performed. Additionally, chart reviews were conducted prior to intervention and 4 months after completion of training at each site to assess change on management. *Results*. Twenty-three of the original 24 participants from all 3 sites completed the training; 48% clinical officers, 43% nurses, 9% other expertise. Of the 15 concepts tested by knowledge assessment, 12 showed trends in improvement, 7 of which were significant ($P < .05$). Chart reviews demonstrated significant improvement in documentation of seizure description ($P = .008$), seizure frequency ($P = .00$), and possible causes of seizures/epilepsy ($P = .034$). *Discussion*. Key elements of success to this program included hands on clinical skills building and case-based teaching, development of a program with direct and ongoing input from the target audience, and inclusion of assessments to monitor impact on clinical practice. Future studies looking at health outcomes are necessary to determine sustained impact.

Keywords

epilepsy, pediatrics, resource-limited, Africa

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What is already known about this topic?

Training programs designed for primary care providers in resource limited settings have been shown effective in specific disease management, however, those targeting epilepsy have primarily been focused on easily recognizable convulsive conditions, with early presentations of focal and subtle seizures often missed.

How this research contributes to the field?

This is one of the few pediatric epilepsy training interventions for resource-limited regions, unique in its process of development within country, and evaluation by not only knowledge assessments but also chart reviews to assess impact on practice change.

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What are your research's implication toward theory, practice, or policy?
This study demonstrates a successful pediatric epilepsy training for first level providers that can be effectively delivered within a 1-week period with minimal funding and large impact, thus, is of value for investment in resource-limited regions.

Introduction

Epilepsy accounts for 0.5% of the global burden of disease, with approximately 50 million people affected,[1,2] 80% of whom live in low and middle income countries (LMIC).[3-6] Our study is based in Zambia, where the prevalence of epilepsy is estimated as high as 14.6 per 1000 people.[7] Yet epilepsy is a highly treatable condition, with an estimated 70% of those affected achieving good seizure control on appropriate therapy.[8,9] Conversely, absence of treatment or incorrect management can lead to delays in people with epilepsy having frequent seizures before reaching access to appropriate care, which is a risk factor for refractory epilepsy,[9] and in children, developmental impairments.[10] In LMIC, the treatment gap—or percentage of people who are not accessing medical care or on appropriate medication—is above 70% to 80%.[11] In Zambia, the treatment gap is estimated as high as 95% in some rural regions.[12]

With only 1 child neurologist per 5 million people in LMIC,[13] the vast majority of neurological care must be delivered by non-specialist providers, most commonly paramedical providers.[13] Like many other African nations, Zambia has challenges in health force capacity, and in the past decade has been estimated to have less than half the required volume of medical providers to serve it's growing population of over 17 million people for even basic needs, particularly in rural areas.[14] These rural areas are served primarily by outreach services and health posts offering bare minimum of care, and level-1 health centers and district hospitals with basic medical services. In these centers, where the majority of care is delivered across rural regions of Zambia, non-specialist clinical officers are typically the main providers who triage and provide care with support of nurses and limited supervision by the few and highly burdened general medical doctors.[15] While this is an efficient model for general health care delivery, providing quality pediatric epilepsy management is only feasible with adequate training, which continues to be limited in the country, with this primary health workforce showing less than adequate knowledge on seizure management at baseline.[16,17]

An effective way to improve knowledge in an efficient manner for task-shifting care is via use of algorithmic and module based trainings, which also can improve health seeking behaviors and awareness in communities.[5,18-20] Beneficial impact in regards to recognition of epilepsy, reducing stigma, and improving health seeking behaviors and treatment adherence by people with epilepsy has been seen in both large and small programs targeting epilepsy at the community worker or primary provider level.[21-25] However, these programs typically focus on convulsive epilepsy in patients of all ages. Training for more subtle pediatric seizure management issues is more complex yet remains in high need in the developing world. The Pediatric Epilepsy Training course developed by the British Paediatric Neurology Association is one of the few programs for non-specialist providers of varying level used with success in LMIC,[26] however impact on management changes has not yet been published. Additionally, the 1 day intense didactic workshop does not include the level of clinical skill building we have found required for rural community first level providers in our region based upon our prior work with clinical officers, wherein we found even multiple sessions of case-based lectures did not translate well into practical application of skills.[17] Experience from our prior educational intervention work in Zambia has highlighted the need for including strengthening knowledge at multiple provider levels, direct clinical skills training, and incorporating a evaluation mechanism to measure overall clinical practice change.[17]

Overall, demonstrating consistent benefits of education programs is difficult to achieve, as is creating mechanisms for sustainability. While the presumption is that offering any training could only be beneficial, false confidence in knowledge may lead to more management error and referral delays. Therefore, assessing ability to apply learned knowledge and monitoring impact on clinical practice is necessary to better evaluate task-shifting programs of this nature, and encourage stronger local investments in this domain. This study aims to demonstrate the benefit a case-based, on-site pediatric epilepsy training program adapted and refined for and by providers in Zambia, implemented across first level centers in 3 major provinces in this country, can have on provider knowledge and confidence, clinical application of skills, and on clinical practice change.

Methods

Participants

Three provinces across Zambia: Copperbelt, Lusaka, and Southern (Figure 1), were chosen for this project implementation due to the varying population distributions at each site, with Lusaka having the largest population of over 3 million people, followed by the second largest province in the nation, the Copperbelt with

Figure 1. Map of provinces of Zambia. Training was conducted in the Copperbelt, Lusaka, and Southern Provinces.

almost 2.5 million people, and then the Southern Province, with close to 2 million people,[27] as well as recommendations of sites per the Zambian Ministry of Health and local pediatricians. In coordination with the Zambian Ministry of Health and District Health Directors, appropriate first level health centers were further identified in each province, and coordination through the referral hospital in each province was arranged. In the Copperbelt Province, training was delivered at a first level hospital in Mufulira, approximately 1 to 2 hours away from the nearest referral hospitals. In Lusaka Province it was coordinated in Chilanga, a township approximately 20 km south of the capital city and national main referral hospital, University Teaching Hospital (UTH). Due to the nature of first level clinics in this region, 3 clinics were included at this site as each was serviced by only 2 to 3 providers. In the Southern Province, the participating first level clinic was a short distance from the level-2 hospital in the city, with complex cases all being referred to UTH in Lusaka. At the time of the training, none of the participating centers had a dedicated epilepsy or neurology clinic.

At each site, the District Health Directors and first level center supervisors selected appropriate participants for the course based on our requests for primarily clinical officers and nurses, high interaction level with pediatric patients, interest, likelihood they would remain in their post for at least 1 year, and ability to commit to the training. Gender and age were not considered in the selection. The Ministry of Health and District Health Directors supported the program, allowing work schedule flexibility so participants could fully attend the training.

Materials

Two child neurologists with expertise in epilepsy and experience in Zambia (AAP, OC) adapted established national and international epilepsy guidelines and resources for management of children in Zambia.[28,29] Materials were designed for the level of a non-specialist provider, with focus on practical application in the primary level setting. An experienced clinical officer who was working at the time with our pediatric neurology clinic at UTH further reviewed materials to ensure

appropriateness of language and training level for target audience. Further revisions were made after initial pilot implementation in 2017,[17] including creation of a standardized pediatric seizure history and assessment form to guide in clinical decision making based upon training materials and a validated questionnaire to aide epilepsy diagnosis in children in this region.[30] Further refinement was performed after additional testing of the materials at a first level rural hospital in 2018 with a small group of clinical officers, nurses, and medical officers, where provisionally revised case-based and hands-on clinical sessions were delivered by 2 child neurologists (AAP, OC) with open-ended feedback collected.

A 5 day course was ultimately developed, consisting of interactive and case-based didactics, including video review for seizure semiology and non-epileptic events, as well as 2 supervised clinical sessions with patients, 2 role-play sessions on history taking and psychosocial counseling, and case discussion sessions. Topics covered included general burden of epilepsy among children and specifically in Zambia, basic review of causes of seizures, how to perform an efficient pediatric neurology assessment, provoked versus unprovoked seizure diagnosis and management of acute seizures, seizure semiology, recognition of non-epileptic events, basic epilepsy management including initial diagnosis and follow-up, as well as mechanisms for referral, and review of associated comorbid conditions and psychosocial considerations.

Assessments

The intervention effectiveness was assessed by a 15-item knowledge assessment and 13-item confidence survey, both given before module delivery and at the completion of the training program. The knowledge assessment contained 15 multiple choice questions directed toward common pediatric epilepsy management issues covered in the training. Equivalent pre- and post-assessments covering the same 15 topics at a similar complexity level were designed, with each pair of questions individually tested by child neurologists on the study team to achieve final agreement between all. The order of question topics was randomly administered in the pre- and post-assessments to further reduce bias. The 13-item self-assessment of practice confidence used a 3 point scale, with questions labelled as either clinical practice behaviors estimated to be performed at frequencies of $<25\%$ (1), 25% to 75% (2), $>75\%$ (3) or ability to do the task in question as uncertain (1), confident some of the time (2), or confident majority of the time (3). For post-assessments, language specified that participants should estimate their confidence in practice behaviors going forward after this course. Two additional free-text questions on impact of training were collected with the confidence assessments and not scored but included in general evaluation of program impact.

Impact on clinical practice was assessed by chart review. Local research assistants performed pre-intervention reviews of charts prior to the educational intervention and 4 months post-intervention. As documentation in this setting is limited, chart reviews assessed for presence or absence of 5 metrics felt necessary for appropriate clinical care of seizures and epilepsy in children which were emphasized during training. These included child's current weight (for appropriate medication dosing), seizure description, seizure frequency, seizure medication, and indication of possible cause for the seizures/epilepsy (by documentation of history or prior workup). The research assistants were trained by a pediatric epileptologist (AAP) on what documentation per metric qualified and examples were practiced and evaluated to ensure standardization of the process. Due to the nature of clinical care in our setting, individual provider charts could not be assessed, and the review was conducted of the general pool of pediatric epilepsy/seizure patient charts at each center. Participants in the training were not informed of the chart review process to minimize bias. At the Southern Province clinic site, patients with epilepsy were referred to the Level-2 hospital prior to our intervention, therefore records were obtained on the children with epilepsy there, with records accessed via a newly implemented electronic medical system, which was not seen at our other sites to date.

Methodology for This Research Followed SRQR Guidelines[31]

Statistical Analyses

Data was analyzed by SPSS version 26. Frequency tables were generated for pre- and post-knowledge assessment scores within sites, overall, and by breakdown of topic assessed, as well as overall confidence assessments by the 3 point scale, with means compared using *paired t-test*. Analysis of presence of absence of pre-determined important epilepsy chart documentation metrics were compared pre- and post-intervention by *Wilcoxon Signed Rank test*. All analyses were performed with significance set at 5% and P-value $<.05$ considered statistically significant.

Ethical Approval and Informed Consent

Ethical approval was obtained via the Boston Children's Hospital Institutional Review Board IRB-P00024375, University of Zambia Biomedical Research Ethics

Table 1. Demographics of Participants.

	Site 1: Copperbelt (N = 6[a])	Site 2: Lusaka (N = 11)	Site 3: Southern (N = 6)
Sex (M)	2 (33%)	2 (18%)	2 (33%)
Clinical officers	3 (50%)	5 (45%)	3 (50%)
Nurses	3 (50%)	5 (45%)	2 (33%)
Medical doctors	0 (0.0%)	0 (0.0%)	1 (0.17%)
Other/pharmacy	0 (0.0%)	1 (0.09%)	0 (0.0%)
Average # years job experience (SD)	7.7 (12.6)	9.1 (12.4)	8.5 (9.15)

[a]Original 7, 1 participant (male clinical officer) did not complete the program.

Table 2. Mean Score Improvement Post-intervention. Significant Improvement Seen Across All Sites Combined with Positive Trends Individually Seen.

	Mean score pre-intervention	Mean score post-intervention	*t*	Sig. (2-tailed)
Site 1: Copperbelt	40%	73%	−3.033	.009
Site 2: Lusaka	44%	79%	−3.456	.004
Site 3: Southern	48%	58%	−0.880	.394
Total across all sites	44%	72%	−3.261	.006

Committee UNZA-331/2019, Zambian National Health Research Authority and respective provincial and district level offices for each site. Appropriate informed consent was obtained during this study as per approved protocols.

Results

A total of 24 participants were originally enrolled across the 3 sites. One was excluded from the final program due to inability to complete the course. The remainder of the 23 participants completed every session. Forty-eight percent of the participants were clinical officers, 43% nurses, and the remaining 9% of other expertise (1 medical doctor and 1 pharmacist-included per request of district health officer); average years of job experience across all participants was 8.4 (Table 1). This representation of professions and expertise is typical of primary health settings in Zambia and distributed similarly across the 3 sites included.

Overall, significant improvement was seen on equivalent pre- and post-knowledge assessments designed to assess key epilepsy management skills (Table 2). One site (Southern) did not individually demonstrate a significant improvement, however a positive trend was seen. Across individual topics, there was a significant improvement seen in recognizing syncope versus seizure, the correct anti-seizure medication (ASM) choice in persons with HIV, management of infantile spasms and absence epilepsy, recognizing to optimize the first ASM before adding another, and ability to recognize symptomatic epilepsy and diagnose epilepsy. Of note, while not significant, negative trends were seen in febrile seizure management after our course, as well as in recognition of psychogenic nonepileptic seizures and importance of reviewing seizure history before making changes (Figure 2).

Open-ended questions and group discussions revealed a pre-intervention general discomfort to treat children with epilepsy due to poor knowledge and comfort, and inconsistent medication access. At all 3 sites, prior to intervention, the overall burden of epilepsy in the region was grossly underestimated by participants, even when some acknowledged knowing children with epilepsy directly in the community or their own families. After training, all participants reported an overall increase in confidence in management skills (Figure 3), a recognition of pediatric epilepsy as a prevalent condition and potential impact for care from their level, and at 2 of the 3 sites, social media networking was utilized to build a community of providers and support among those trained and our team. All continued to endorse that they would benefit from further training and requested increased support from the government on medication access, as that remained a continued barrier of care.

Chart reviews were undertaken in the month prior to the education intervention at each site, with a follow-up performed 4 months after intervention at 2 of the 3 sites. Due to travel restrictions imposed by the 2020 COVID-19 pandemic, planned follow-up at the Southern Province site could not be completed, therefore analyses of this data included both total data as well as sub-analyses excluding the data from the Southern Province, to remove confounding effects of site variability in doc-

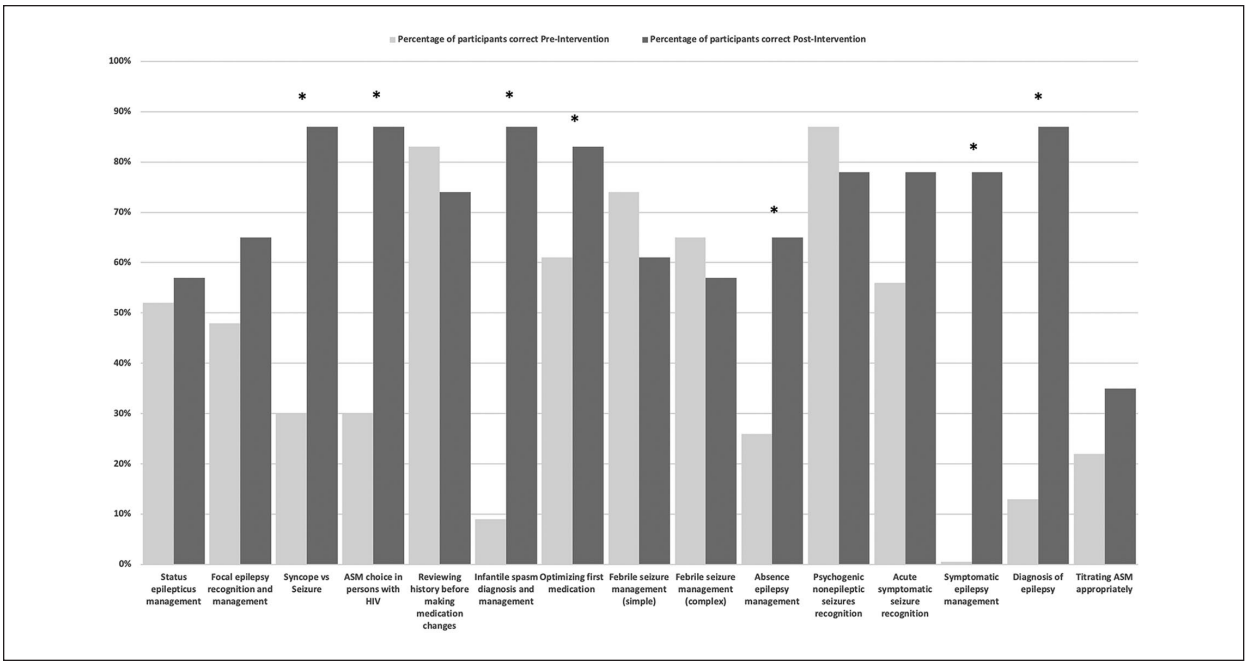

Figure 2. Improvement across topics represented as percentage of participants who answered correctly pre- versus post-intervention. Trends of improvement were seen across most topics, with significant improvement ($P < .05$) (*) seen in recognition of syncope versus seizure, selecting the correct anti-seizure medication (ASM) in persons with HIV, management of infantile spasms, absence epilepsy treatment, optimizing first ASM, and recognition and diagnosis of epilepsy.

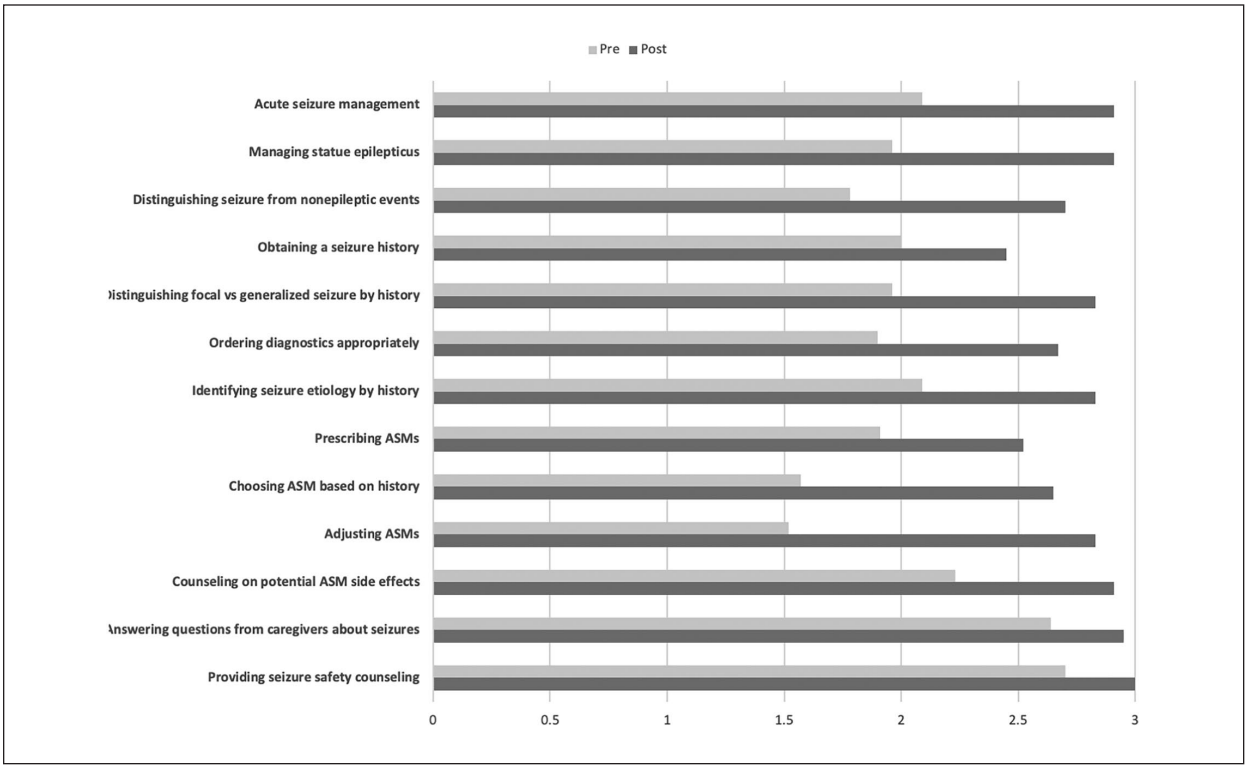

Figure 3. Self-reported confidence in following aspects of pediatric epilepsy care. Confidence of providers in pediatric epilepsy management was measured by self-report on an adjusted 1 (low) to 3 (high). Significant improvement ($P < .05$) seen in all measures with exception of answering questions from caregivers, which was of high confidence at baseline.

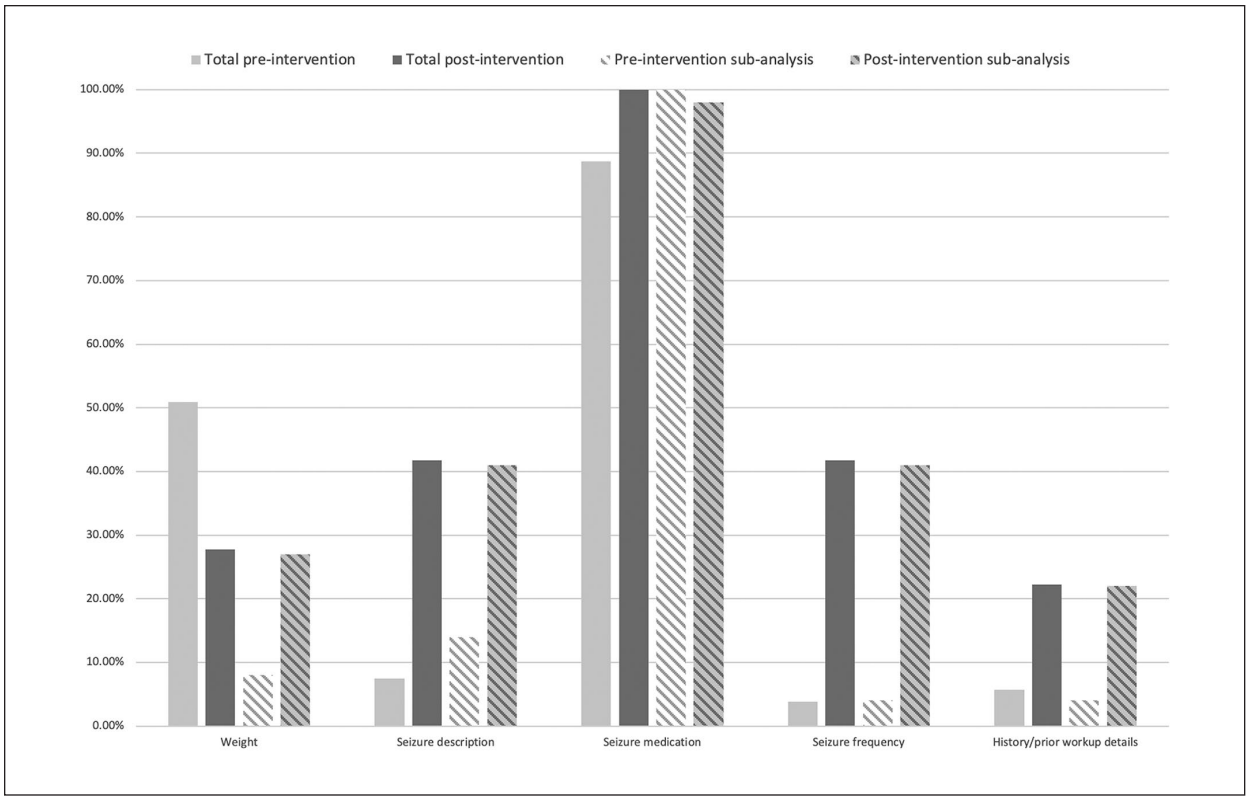

Figure 4. Documentation of key epilepsy indicators pre- and post-intervention. Percentage of charts with documented indicators; sub-analyses included only sites where both pre- and post-intervention data was available (Lusaka and Copperbelt) to eliminate potential confounders of site variability in chart documentation.

umentation (Figure 4). There was significant improvement in documentation of seizure description ($P=.008$), seizure frequency ($P=.00$), and possible causes of seizures/epilepsy ($P=.034$), collectively. Although similar trends are seen when Southern province data is excluded, the only difference large enough to be significant with the sample size reduction was seizure frequency documentation ($P=.005$). Notably, after sub-analyses was performed to exclude the Southern province data, documentation of weight—the only factor that was previously seen to decline after intervention—now showed a trend of improvement. This is likely due to the requirements of electronic medical documentation entry parameters in the Southern province versus other 2 sites, thus skewing the pre-intervention data when all 3 sites were included.

Discussion

Our immersive pediatric epilepsy educational intervention in Zambia successfully demonstrated use of a clinical skill building and algorithmic approach to break down topics of relative complexity for applicable management knowledge. Beginning with experience within the region and refining further after significant feedback from local providers, our program demonstrated improved provider management, basic epilepsy skills knowledge, and improved clinical practices indicated by better documentation of important metrics for good epilepsy care. In addition, participants reported increased awareness of the presence of children with epilepsy in the community and increased satisfaction that they have tools available to improve their ability to deliver quality care. Finally, to the best of our knowledge, our study is also the first to incorporate review of medical records and therefore assess the impact of an epilepsy teaching intervention on medical care directly, in addition to provider knowledge improvement.

Our prior work in this area has demonstrated both benefits and limitations of structured educational interventions for clinical officers in Zambia. The first pilot version of our training program used case-based didactic sessions, and while improved post-program knowledge was seen, there was poor practical application and limited sustained impact on care.[17] This highlights a weakness of many training programs of this nature, particularly in areas where clinical knowledge and experience of first level providers is typically limited to the

designated medical needs of the region, with epilepsy and neurologic conditions often neglected. Thus, while task shifting has long been pursued as a method to increase access to care in the developing world,[32] and successful utilization for convulsive epilepsy recognition across all ages has been demonstrated in several programs,[20-24,33] the complexity required for pediatric seizures and epilepsy must be considered. The base knowledge of these providers is limited in this area and training programs need to work in a style that they are familiar with to deliver impact, particularly for pediatric epilepsy, which requires extensive simplification for appropriate management at the level of a primary care provider, while maintaining appropriate standards of care. Our revision and feedback process, and evaluation results demonstrate that key elements of our program's success included expansion of provider inclusion, inclusion of referral sites, working within the site of care, and focusing on practical skills building.

Knowledge assessments showed an overall improvement after completing the course, with significant improvement in topics of syncope versus seizure recognition, using the correct antiseizure medication in persons with HIV, recognizing infantile spasms and absence epilepsy, including initial steps for management and referral when appropriate, and recognizing symptomatic epilepsy and diagnosing epilepsy in general. Improvement in these topics demonstrate the ability to train beyond convulsive seizure management, as well as target some of the most relevant concerns of pediatric epilepsy management in Zambia given the high prevalence of HIV and symptomatic epilepsy in the region. Early recognition of infantile spasms can arguably be one of the most impactful care management improvements as lack of knowledge of this syndrome leads to clinically devastating treatment delays.

Interestingly, although no significant negative performances were seen, a downward trend was noted for febrile seizure management, which was also noted in our pilot study.[17] Specifically, on the case based knowledge assessments, there was inconsistent performance on ability to determine what seizures with fever required escalation of evaluation and treatment versus those that met criteria for febrile convulsions without concerning features. As these are essential and high yield topics for the region, specific revisions and expansion were focused on these issues as a result of our prior experiences. In sessions with participants, both in clinical practice and case-based discussions, there appeared to be a good understanding of these concepts, however there was still a downward trend in performance. It remains unclear why this is an area of consistent poor performance and remains an area of concern given the importance to the region. Further revisions and evaluation to determine how to best teach these concepts going forward is required.

Our study was unique in utilizing chart reviews to further assess impact of this intervention. While chart reviews to assess the impact of short medical education programs in Zambia have been previously been performed, these looked at more directly accessible numbers, such as mortality, in tertiary care hospital records.[34] Assessing clinical practice change at lower level facilities is difficult due to numerous factors, including frequent reassignments of providers, limited patient records, and variations in how charts are maintained at each site. Complicating this further in our study was the implementation of a simple electronic medical system into the public health system in Zambia, currently only used at 1 site—the Southern province. This system prompts providers to include metrics of weight and medications, thus pre-chart reviews from this site were higher than others as a result, falsely impacting post-analysis data in these realms and requiring removal for accurate trends in these 2 indicators to be assessed. We had an additional complication due to the COVID-19 pandemic, as the planned post-intervention follow-up from the Southern province was cancelled due to travel restrictions at that time, thus limiting post-analyses. Despite these challenges, an improvement in documentation across sites was still appreciable, demonstrating not only the feasibility of performing such an assessment, but also the impact on clinical practice seen after our training. In particular, a specific recognition for documenting current seizure descriptions and frequency was noted to improve, showing increased awareness in the importance of these elements for pediatric epilepsy management as a result of the training. Interestingly, although we thought the use of the standardized form for pediatric neurology assessments would contribute to improved documentation, it did not seem to directly impact results as they were not included in the charts due to methods of documentation used, despite endorsement from providers on the benefit of the form as a guide in clinical assessments.

We did see direct engagement and improvement in the ability to perform a pediatric neurologic assessments, particularly for seizures, by utilizing the standardized form. Providers also showed excellent improvement in their ability to provide caregivers education about seizures and epilepsy with appropriate cultural context, discuss seizure safety issues, and importance of care through role-playing exercises, demonstrating the importance of these types of tools in clinical skills building. Additionally, a general positive impact on attitudes for providers in treating epilepsy

was seen, similar to other epilepsy task-shifting efforts in the developing world, where increased care access for epilepsy was subsequently noted.[21,22,24]

An additional benefit seen by implementation of our program was engagement of the community and Zambian health system. The referral hospitals, local clinics, district health offices, and Ministry of Health all acknowledged the gaps present for epilepsy care of children in the country and provided strong support for the success of our program. This support was essential, as it allowed full cooperation for providers to attend the entirety of our training as part of their duties. Based on our prior experience in the region, we acknowledged training at each site in isolation would create gaps of care as there would be unequal knowledge distribution which impacts the referral process, which is hierarchical. Therefore, in addition to the program described, we additionally delivered short "trainings" to medical doctors at the referral hospitals of each first level facility. These sessions involved a short review of basic pediatric seizure and epilepsy management, focused on recognition of key concepts and medication management, utility of diagnostic testing, and specialist referral points. Within our sites, the providers, primarily nurses and clinical officers, then felt empowered to create specific clinic days in which to see children with seizures and epilepsy, raising awareness and improving access within the community. In addition, the providers who participated in our program developed a community within themselves, and approximately two-thirds have joined a private social media group to support each another in pediatric seizure/epilepsy management. This group consists of clinical officers, nurses, and doctors—not only from our current training process but also including providers who participated in earlier iterations of this program. Our team of child neurologists who have worked or are currently working in Zambia (AAP, OC, KLN) provide supervision and support as needed.

Additional limitations of our program include the follow-up time frame. Our goal has been to demonstrate a sustained impact over several months, however prior work has suggested that short-term epilepsy programs lose impact approximately 9 months after delivery.[33] Therefore, further assessment of sustained practice changes and refresher trainings is essential. As part of this mission, we are soon launching a web-based course on pediatric epilepsy management, based upon the training materials used in this course. While not a replacement for the interactive, case-based and hands-on clinical skills building this course provided, the online course provides a mechanism for refresher trainings (with built in online assessments) to improve retention of skills and recognition of when a repeat in-person training should be performed. An additional challenge we continue to face is medication supply. While we continue to work with the Ministry of Health, donor agencies and clinics to improve steady supplies of antiseizure medications, this is a continued issue, however engagement of the trained providers via our program increased essential interest and advocacy within the system to pursue this further, noted in on-going discussions with the sites since trainings. Thus, we are hopeful, given the already positive feedback from the Zambian health system, that improved recognition of the seizures and epilepsy in children will result in an increased demand—and prioritization—for seizure medication access in the region.

Improving access of pediatric epilepsy care in the developing world, where there is limited access to specialists and resources, is of crucial importance. While convulsive epilepsy is an essential component to any such program, we would argue that the more subtle pediatric seizures and syndromes can also have devasting impacts on development when treatment is delayed, therefore improving recognition in all of these types of conditions is critical for the primary health force in LMIC. In particular, as there is a higher rate of symptomatic and focal epilepsy due higher risks of acute brain injury in these regions, many seizures may be more subtle in this population and need for recognition in these regions essential.[35] Not only can delays in treatment lead to potentially avoidable or reducible impairments in development,[10] they also increase the risk of refractory epilepsy[9] in regions where treatment options are limited, making an already difficult to treat condition near impossible. Early recognized seizures have a high chance of treatment responsiveness, and thus lead to improved health, quality of life, and decreased burden on the health system. Task shifting programs to achieve improved access to quality pediatric epilepsy care is an important part of this goal, in combination with strengthening referral systems, subspecialist training, and medication access. Our program suggests one mechanism through which this important step of improving care by a provider at the first level of care can be achieved with good reliability. Expanding these interventions across other parts of the country, as well as consistent refresher trainings are required to ensure continued education and engagement and to improve pediatric epilepsy care in the region.

Conclusion

Overall, our study demonstrated a structured education intervention on pediatric epilepsy can improve knowledge, confidence, and positively impact clinical practice

of first level providers in Zambia. Key elements to the success of our program included adaptation of standardized guidelines for the setting, hands on clinical skills building and case-based teaching, and development of a program with direct and ongoing input from the providers for whom it was planned. With so few neurologists and even less child neurologists available globally, and only 2 in training accessible in Zambia, it is essential that non-specialist first-level clinical providers in this country triage cases of children with seizures and epilepsy appropriately so to avoid delays in appropriate care and overburdening of the system. Such an intervention has the promise to reduce the epilepsy treatment gap in this region as well as improve neurologic outcomes, as these providers are involved in the earliest points of care for children with epilepsy.

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Author Contributions

AAP, MMazumdar and OC: developed the research design and plan for implementation and analyses.
AAP: drafted the manuscript.
KLN: assisted with refining the research design for implementation, refining materials and assisting in direct implementation of the intervention.
MMathews, MS, and PK: coordinated Research coordination in Zambia.
MS and PK: also assisted in data collection.
LS, AK, TB, HVH, HJ: all contributed to refinemnet of materials and implementation of education interventions.
All authors performed critical revisions of the manuscripts and are accountable for the work presented, ensuring its integrity and accuracy.

Declaration of Conflicting Interests

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