



Review Article

## The humanitarian aid of neurosurgical missions in Peru: A chronicle and future perspectives

Jhon E. Bocanegra-Becerra, Nicole M. Castillo-Huerta<sup>1</sup>, Alonso Ludeña-Esquivel<sup>1</sup>, O. Nicole Torres-García<sup>1</sup>, Martha I. Vilca-Salas<sup>1</sup>, Milagros F. Bermudez-Pelaez<sup>1</sup>

School of Medicine, Universidad Peruana Cayetano Heredia, Lima, Peru.

E-mail: Jhon E. Bocanegra-Becerra - jhon.bocanegra.b@upch.pe; \*Nicole M. Castillo-Huerta - nicole.castillo@upch.pe; Alonso Ludeña-Esquivel - alonso.ludena@upch.pe; O. Nicole Torres-García - olinda.torres@upch.pe; Martha I. Vilca-Salas - martha.vilca@upch.pe; Milagros F. Bermudez-Pelaez - milagros.bermudez@upch.pe



\*Corresponding author:

Nicole M. Castillo-Huerta  
School of Medicine,  
Universidad Peruana Cayetano  
Heredia, San Martín de Porres,  
Lima, Peru.

nicole.castillo@upch.pe

Received : 12 October 2022  
Accepted : 29 October 2022  
Published : 25 November 2022

DOI  
10.25259/SNI\_940\_2022

Quick Response Code:



### ABSTRACT

**Background:** The unmet neurosurgical need has remained patent in developing countries, including Peru. However, continuous efforts to overcome the lack of affordable care have been achieved, being neurosurgical missions one of the main strategies. We chronicle the humanitarian labor of organizations from high-income countries during their visit to Peru, the contributions to local trainees' education, and the treatment of underserved patients. Furthermore, we discuss the embedded challenges from these missions and the future perspective on long-term partnerships and sustainability.

**Methods:** This is a narrative review. We searched the literature in PubMed and Google Scholar about neurosurgical missions conducted in Peru.

**Results:** Since 1962, twelve organizations from high-income countries have delivered humanitarian help in Peru by training local neurosurgeons, treating low-income patients, and providing surgical instrumentation. Out of the three main regions of Peru, cities on the coast and highlands have hosted most of these missions, with no reported outreach in the amazon area. About 75% of the organizations are headquartered in the United States, followed by Canada, Luxembourg, and Spain. In addition, 50% of the organizations have an active partnership. The predominant focus of these missions has been pediatrics, neuro-oncology, and spine surgery.

**Conclusion:** Neurosurgical missions have represented a strategy to close the disparity in education and treatment in Peru. However, additional efforts must be conducted to improve long-term partnership and sustainability, such as adopting standardized indicators for progress tracking, incorporating remote technologies for continuous training and communication, and expanding partnerships in less attended areas.

**Keywords:** Altruism, Global neurosurgery, Medical missions, Peru

### INTRODUCTION

In 2015, the Lancet Commission on Global Surgery, due to the increased need for surgical and anesthesia care in low- and middle-income countries (LMICs), published an update on the state of surgical care and proposed solutions to overcome disparities.<sup>[23]</sup> It was estimated that 143 million additional surgical procedures are required in LMIC. For example, in Peru, almost 40% of the population has no access to neurosurgical services, and it is estimated that there is one neurosurgeon per 115,207 people.<sup>[31]</sup>

This is an open-access article distributed under the terms of the Creative Commons Attribution-Non Commercial-Share Alike 4.0 License, which allows others to remix, transform, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

©2022 Published by Scientific Scholar on behalf of Surgical Neurology International

Neurosurgical missions have attempted to reduce the disparity in the access and training of the local workforce in developing countries. Although expensive, they have demonstrated to be a cost-effective solution to reduce the burden of neurosurgical diseases in poor communities.<sup>[32]</sup> Historically, Peru has received support from organizations of high-income countries through collaborative work with the local health system. Together, they have attended to the difficult access and affordability of neurosurgical treatment.

The chronicle of these experiences highlights the significant contribution to the treatment of Peruvian patients and the education of local trainees, especially of people living in areas with an absent neurosurgical workforce, modern equipment, or limited neurosurgical training. In addition, we describe future perspectives on long-term partnerships, progress tracking, and promotion of new collaborations.

## MATERIALS AND METHODS

We reviewed the literature in PubMed and Google Scholar about neurosurgical missions conducted in Peru. We included information in original articles, organizations' annual reports, and websites.

## RESULTS

Twelve organizations from high-income countries have delivered humanitarian help in cities on the coast and highlands of Peru by training local neurosurgeons, treating low-income patients, and providing surgical instrumentation [Table 1]. The oldest reported mission was conducted in 1962. Out of the three main regions of Peru, cities on the coast and highlands have hosted most of these missions, with no reported outreach in the amazon area [Figure 1]. About 75% of the organizations are headquartered in the United States, followed by Canada, Luxembourg, and Spain. About 50% of the organizations have an active partnership and 50% have no available data regarding their current mission status. These missions have been centered around several subspecialties with a predominant focus on pediatrics, neuro-oncology and spine surgery; others include vascular, epilepsy, and trauma. We did not find information on standardized indicators for progress tracking in most organizations. One organization has held the most prolonged and continuous partnership for over 15 years.

### A chronicle of neurosurgical missions in Peru

#### *Neurosurgical help onboard a ship*

In 1958, Dr. William B. Walsh founded Project Health Opportunities for People Everywhere (HOPE) as a humanitarian relief organization to offer help worldwide. Peru was gratefully considered a guest country after a

formal invitation by the North American Peruvian Medical Association president, Dr. Fernando Cabieses-Molina. Accordingly, in 1962 onboard a hospital ship, the "S.S. Hope," Project HOPE delivered its first mission to the Americas in Trujillo.<sup>[19,25,28]</sup> An outpatient clinic was set up at "Hospital Belén" and served as a referral center to the neurosurgical facilities on the sea; incredibly, the organization optimized the space to deliver conferences and display technical movies, and even perform craniotomies and cervical hemilaminectomies.<sup>[25]</sup> After a 10-month stay, Project HOPE contributed to improving medical education and providing care to unprivileged patients. For instance, it developed new medical curriculums and established health centers in poor areas.<sup>[29]</sup> Shortly after, it implemented Public Health programs at "Universidad Nacional de Trujillo," which inspired students to participate in medical missions decades later.<sup>[29]</sup> Furthermore, testimonials from local inhabitants have supported the organization's impact, including one from Teresa Tsu. She contracted polio — by the time Project HOPE was working in Trujillo — and received the offer to travel to Texas for physical rehabilitation. Thankfully, years later, she became a Spanish tutor at Austin Community.<sup>[21]</sup> Concomitantly, Trujillo also received the visit of Dr. J Patrick Johnson, director of The Spine Institute Foundation. In 1998, he provided educational sessions in neurological and musculoskeletal diseases. Posteriorly, he served in Lima and Arequipa during his medical explorations in 2002 and 2005.<sup>[39]</sup>

#### *A worldwide organization that provides volunteering opportunities to neurosurgeons*

The Foundation for International Education in Neurological Surgery (FIENS) was established in 1969 by a group of neurosurgeons willing to contribute to the development of neurosurgery in LMICs. It has served countries through volunteer neurosurgeons who teach on-site techniques, set new residency programs, and provide surgical assistance in operating rooms.<sup>[38]</sup>

Dr. Antonio Bernardo exemplified the FIENS mission when he embarked on a volunteer trip in 1999 and spent 14 months sharing his freshly acquired skills in residency and fellowship with local trainees in Peru. During this journey, he was surprised to find medical settings lacking computed tomography scans, the most basic surgical instruments, and neurosurgical personnel. Nevertheless, he contributed to installing several microsurgical dissection laboratories, participated in local congresses, and helped with surgeries in Lima and surrounding cities.<sup>[2]</sup> On the end of this enriching experience, Dr. Bernardo felt motivated to expand his raising professorship to new horizons. Notably, he now serves as associate faculty at many institutions globally. In addition, he directs "The Weill Cornell Medicine Surgical Innovation Laboratory for Skull Base Microsurgery," a state-of-the-art

**Table 1:** Summary of organizations.

Organization	Country of origin	Subspecialty/focus of interest	Years of missions' delivery	Current mission status in Peru
Health Opportunities for People Everywhere	The United States of America	Spine, trauma	1962	NA
Spine Institute Foundation	The United States of America	Spine	1998, 2002, and 2005	NA
Foundation for International Education in Neurological Surgery	The United States of America	Spine, trauma, tumor, and epilepsy	1999 and 2007–2009	NA
Americare Neurosurgery International	The United States of America	Pediatrics, spine, and tumor	2002	NA
Eagle Condor Humanitarian	The United States of America	Pediatrics, tumor, and spine	2013, 2014, and 2016–2019	Active
International Neurosurgical Children's Association	The United States of America	Pediatrics	2003–2020	Active
Peruvian-Canadian collaborative effort	Canada	Epilepsy	2011	Active
Neurosurgery, Education, and Development Foundation	Spain	Pediatrics	2009	NA
The C. Ehrnrooth Foundation	Luxembourg	Vascular and tumor	2016	NA
Mission Brain Foundation	The United States of America	Tumor	2019	Active
Heal International Medical Missions organization	The United States of America	Incipient labor in neurosurgery	2019	Active
Department of Neurosurgery at Vanderbilt University	The United States of America	Pediatrics	NA	Active

NA: Not available information

education facility that hosts one of the most comprehensive hands-on courses for residents and neurosurgeons worldwide.<sup>[41]</sup>

Between 2007 and 2009, a neurosurgeon from India contacted the president of FIENS, Dr. Merwyn Bagan, to express his desire to become a volunteer. Following his religious faith and despite discouraging comments from friends about working in a remote location without monetary compensation, Dr. Krishan K. Bansal felt a call to make a difference in the lives of those less fortunate. Thus, after leaving his home country to pursue this campaign, he visited three cities in Northwest Peru, including Chiclayo, Piura, and Trujillo. Dr. Bansal was amazed by the lack of imaging equipment, the scarce local workforce, and the quality of life of patients suffering from burdensome neurological diseases. Fortunately, in what he called “the experience of a lifetime,” Dr. Bansal achieved to assist in spinal and head trauma surgeries, provided neurosurgical supplies in four national hospitals, and lectured about the impact of surgery as a curative option for epilepsy.<sup>[5]</sup>

### *Americare Neurosurgery International (AMCANI)*

In 2000, AMCANI was founded to promote modern neurosurgical care in the developing countries while respecting communities' worldviews. It has worked by providing neurosurgical training and developing appropriate resources, including physical therapy, rehabilitation skills, and nursing care.<sup>[1]</sup> Ms. Monica A. Gersner-Mosko and Dr. Gary Heit, AMCANI cofounders, realized that Peruvian children suffering from hydrocephalus often die due to a lack of shunting procedures, a relatively available resource in developed countries.<sup>[6]</sup> Hence, they decided to travel to Cusco in May 2002 to conduct their first mission in cooperation with Dr. Diomedes Arias Villena, a local physician.<sup>[6]</sup> The AMCANI team stayed for 10 days and performed 28 procedures on pediatric and adult patients, including reconstruction of complex spinal deformities, repair of pediatric skull fractures, and treatment of adult brain tumors.<sup>[6]</sup> Remarkably, the teamwork, excellence, and high performance of AMCANI surpassed the resource limitations of the local facilities.



**Figure 1:** Outreach map of neurosurgical missions across Peru. AMCANI: Americare Neurosurgery International. FIENS: Foundation for International Education in Neurological Surgery. HOPE: Health Opportunities for People Everywhere. INCA: International Neurosurgical Children's Association. NED: Neurosurgery, Education, and Development Foundation.

### *The Eagle Condor Humanitarian (ECH) Foundation*

ECH was founded in 2003 by a group of volunteer board directors committed to improving the quality of life for families and communities, alleviating generational poverty, and producing opportunities for self-reliance in South American countries (e.g., Peru, Ecuador, and Colombia). Its expeditions' goal has included assisting underprivileged people and training staff from local hospitals.<sup>[3,11]</sup> Since the first visit to Peru, its labor has been remarkable; ECH has performed 291 surgeries in collaboration with over 170 local and international surgeons, including the International Orthopaedic Neurological Foundation and the Innovasis Spine company. The foundation assisted in hospitals of Lima, Cusco, Junín, and Piura including "Hospital del Niño", "Hospital María Auxiliadora", "Hospital Central Fuerza Aérea del Perú", "Hospital Villa el Salvador", "Hospital Ramiro Prialé", "Hospital Antonio Lorena", and "Hospital Daniel Alcides Carrión."<sup>[12]</sup>

### *A well-organized program devoted to children's care*

In 2003, Dr. Rahul Jandial founded the International Neurosurgical Children's Association (INCA) in City of Hope, California.<sup>[15]</sup> Since then, INCA has provided modern brain surgery to poor children in Central America, South America, East Europe, and Africa. INCA educates neurosurgeons in charity hospitals in modern techniques, provides them with instruments to perform less invasive pediatric brain surgery, and empowers them to provide routine care. In Peru, its neurosurgical missions took place in Lima at "Hospital María Auxiliadora," where it performed numerous brain surgeries on children. Between 2004 and 2006, it provided training and equipment to create an educational program. Its training themes included microsurgical techniques, neuroendoscopy, and minimally invasive neurosurgery.<sup>[15]</sup> After just one year of missions, host neurosurgeons acquired proficiency in microsurgical techniques and neuroendoscopy.<sup>[15]</sup> A 5-year follow-up demonstrated the reduction of cerebrospinal fluid shunting on implementing neuroendoscopic surgeries

to treat hydrocephalus, a common pathology in Peruvian children.<sup>[10]</sup> During this period, 196 procedures were performed by locally trained neurosurgeons since the last INCA visit in 2006.<sup>[10]</sup> Moreover, a recent 15-year follow-up described the establishment of a new neuroendoscopy training program for residents, thus, exemplifying the sustainable outreach model of INCA in Peru.<sup>[20]</sup>

### ***A Peruvian-Canadian collaborative effort***

In 2008, the absence of a program for Epilepsy Surgery in Peru motivated a collaboration between the Partnering Epilepsy Centers in America; the North American Commission of the International League Against Epilepsy; the Western University in London, Canada; and “Hospital Nacional Edgardo Rebagliati” and “Instituto Nacional de Ciencias Neurológicas” in Lima, Peru. Numerous efforts, visits, and grants gave rise to the establishment of the first epilepsy program in the nation in 2011, where an interdisciplinary team between neurologists and neurosurgeons was able to help patients suffering from this detrimental illness. Notably, the strong partnership overcame diverse challenges such as the lack of personnel and infrastructure to provide continuous functioning of the video electroencephalography unit, and the patient idiosyncrasy about the disease’s nature.<sup>[36]</sup> Over the years, this collaboration has resulted in an integrated approach to epilepsy surgery and created opportunities for peruvian physicians to continue their professional development abroad.

### ***The Neurosurgery, Education, and Development (NED) Foundation***

The NED Foundation has promoted a neuroscience culture to improve technological development in health care, for instance, through the incorporation of mobile and portable systems for the endoscopic treatment of hydrocephalus. In November 2009, its global plan included visiting pediatric patients suffering from hydrocephalus and shunt complications in Lima. Thus, in alliance with FIENS and local Peruvian neurosurgeons, the NED Foundation organized conferences, short courses, and neuroendoscopic surgeries for children at “Hospital Daniel Alcides Carrión,” “Instituto Nacional de Salud del Niño,” and “Hospital Edgardo Rebagliati Martins.”<sup>[26]</sup>

### ***The C. Ehrnrooth Foundation***

Named after Göran Albert Casimir Ehrnrooth and conceived as part of the Luxembourg Foundation in 2008, the C. Ehrnrooth Foundation has promoted a philanthropic commitment to scientific research and holistic education to individuals, institutes, organizations, and universities.<sup>[13]</sup> Historically, its neurosurgical fellowship has provided international neurosurgeons the opportunity to receive qualified training at the Helsinki University

Central Hospital; for example, Dr. Luis Muñoz Gallegos and Dr. Joham Choque, two Peruvian neurosurgeons, have acquired essential skills in the treatment of pineal pathologies at the Finnish institution.<sup>[13,14]</sup> In 2016, under the leadership of Dr. Juha Hernesniemi, the foundation supported a neurosurgical mission to develop the first Neurosurgical Center of Excellence in Trujillo, Peru. This center was created in association with a local public health system and its plan to decentralize the specialized neurosurgical attention in locations across the country. In this mission, the C. Ehrnrooth Foundation performed 59 surgeries to treat brain aneurysms, cranial arteriovenous malformations, and skull base pathologies. Furthermore, in May 2016, it held the first Cerebral Bypass and Vascular Microsurgery Live Course.<sup>[7,18]</sup>

### ***”Treat, educate, and empower”***

Since 2011, the Mission Brain foundation has provided neurosurgical training and supplies in underserved areas; their volunteer team has allowed the delivery of specialized neurosurgical care, resources, and education to patients and trainees worldwide.<sup>[24]</sup> The founding team included health-care providers such as Dr. Alfredo Quiñones-Hinojosa, Dr. Michael T. Lawton, April M. Sabangan, Lisa T. Hannegan, and Will Aarsheim.

In February 2019, the Mission Brain team traveled to Lima to perform neurosurgery on two older women referred from Quillabamba, Cusco.<sup>[8]</sup> Interestingly, a unique moment occurred on the patient’s awakening. The surgical team felt blessed when the patients thanked them in their native language, Quechua. Another noticeable contribution during their visit included lecturing on the novel use of awake surgery and brain mapping.

Nowadays, Mission Brain continues empowering young generations through medical school chapters to share their mission globally.<sup>[24,37]</sup> Notably, the affiliated chapters across the globe are raising funds to cover the cost of underserved patients’ treatment.<sup>[4]</sup>

### ***The Heal International Medical Missions (HIMM) organization***

Working under a Christian belief of serving people, HIMM has visited impoverished locations to provide medical and surgical attention. In 2019, it aided people living in Cutervo, a rural and remote city without robust surgical workforce in the highlands of Peru. Dr. Juan M. Padilla, director of HIMM, has been very concerned about the consequences of living in those precarious conditions, where patients die traveling long distances to seek basic and complex neurosurgical care. Thankfully, HIMM has started a project in this underserved community to bring medical attention not only in neurosurgery but also in general surgery, internal medicine, family medicine, dentistry, among other specialties.<sup>[16]</sup>

### **An American Neurosurgery department and its role in Global Neurosurgery**

The Department of Neurosurgery at Vanderbilt University offers one of the few Global Neurosurgery curriculums in the United States, thus, allowing residents and faculty members to help patients with difficult access to routinely available procedures in North America. The neurosurgical department delivers outreach missions in Tanzania/Zanzibar, Uganda, Malawi, and Peru. Besides, it offers research mentorship to neurosurgeons in Bangladesh, Ethiopia, and Rwanda. For example, every year, a team led by Dr. Bonfield, in partnership with plastic surgeons and anesthesiologists from “Komedylast,” travels to Peru to perform craniofacial surgeries for complex craniosynostosis and skull deformities at “Instituto Nacional de Salud del Niño - San Borja” in Lima.<sup>[40]</sup>

## **DISCUSSION**

### **Geographical outreach, incipient efforts, and opportunities for collaboration**

During our chronicle, we noticed that most neurosurgical missions had been conducted on the coast or highlands of Peru and have spared the amazon area, a historically unattended area with difficult territorial access. However, we found that a local organization, the “Yantalo Peru Foundation,” has attended to the non-neurosurgical needs in this area for several years. Its facilities are part of a global health campus that collaborates with international institutions. Besides, the local community and organization committee have guided volunteers, including physicians and students, to find the accommodations, meals, and the most efficient route to reach the hospital during missions. As activities reinstate after the pandemic the future partnerships and the delivery of neurosurgical care for the first time might represent an excellent opportunity to direct efforts in the area (contact information can be found at <https://www.yantalo.org/home>).

On the other hand, our historical review revealed that few missions had focused their attention on preventing and treating neurotrauma [Table 1]. Nevertheless, an emerging program is being established by the “Sadanah Trauma and Surgical Initiative” in collaboration with the Ministry of Health of Peru, Universidad Peruana Cayetano Heredia, and “Fundación Meditech”. Their incipient project entitled “Peru Trauma Initiative” aims to characterize the surgical capacity at tertiary care centers and describe the basic epidemiology of traumatic brain injury.<sup>[34]</sup>

### **Sustainability and progress tracking**

Although the impact of neurosurgical missions is noticeable on patients and local trainees, the lack of measurable and standardized indicators limits the evaluation of progress tracking and sustainability over the years. Except for the

INCA organization, whose labor has been tracked for almost 15 years by measuring the number of procedures completed and neurosurgeons trained per year, most organizations had no available long-term information in this regard. Hence, the adoption of core indicators for monitoring universal access to safe, affordable surgical, and anesthesia may benefit the organizations’ goals during missions. For this purpose, the parameters suggested by the Lancet Commission in Global Surgery include access to timely essential surgery, specialist surgical workforce density, surgical volume, perioperative mortality, protection against impoverishing expenditure, and protection against catastrophic expenditure.<sup>[23]</sup>

### **Remote technological solutions to strengthen long-term partnerships**

With the advancement of technologies in neurosurgery, virtual platforms open for networking have demonstrated to potentiate and facilitate global collaborations. This is the case of “Intersurgeon,” an internet-based platform with almost 800 members worldwide that has contributed to transcend in-person neurosurgical missions and promote virtual collaborations based on augmented reality.<sup>[22]</sup> Because of its potential to allow more accessible communication between global surgery advocates, Intersurgeon could represent a favorable space for connecting international and local organizations in Peru.

Likewise, incorporating remote software for neurosurgical assistance and education may constitute an important step for its broad application during missions. For instance, “Virtual interactive presence and augmented reality (VIPAR)” and “Proximie” software may represent a game-changer in continuing long-term partnerships and improving sustainability.<sup>[17]</sup> VIPAR, an iPad-based application, has provided remote guidance during endoscopic third ventriculostomy and training in carotid endarterectomy and craniotomies. This is an appealing solution for conducting remote missions in Peru because of the prevalent focus on pediatrics and hydrocephalus treatment.<sup>[9,35]</sup> Besides, “Proximie” has allowed live remote preceptorship and proctorship from computers, representing a solution to the limited number of attendees in an operating room-since participants can join live surgeries from anywhere and watch them anytime.<sup>[30]</sup> Importantly, these efforts should be accompanied by national initiatives to guarantee the access and quality of internet connection in rural areas. Thus, an ambitious goal of incorporating 5G connection must be undertaken to facilitate telesurgery in the near future.<sup>[27,33]</sup>

## **CONCLUSION**

Neurosurgical missions have represented a strategy to close the disparity in education and treatment in Peru. However,

additional efforts must be conducted to improve long-term partnership and sustainability, such as adopting standardized indicators for progress tracking, incorporating remote technologies for continuous training and communication, and expanding partnerships in less attended areas.

### Disclosures

The authors are affiliated with the Mission Brain Foundation as part of their medical school chapter at Universidad Peruana Cayetano Heredia. Also, this review was accepted as an abstract at the 2022 Congress of Neurological Surgeons Annual Meeting in San Francisco, California.

### Acknowledgments

We thank Dr. Juan Padilla and Dr. Luis Vásquez for providing information about Heal International Medical Missions (HIMM) and the Yantalo Peru Foundation, respectively.

### Declaration of patient consent

Patient's consent not required as there are no patients in this study.

### Financial support and sponsorship

Publication of this article was made possible by the James I. and Carolyn R. Ausman Educational Foundation.

### Conflicts of interest

There are no conflicts of interest.

### REFERENCES

1. AMCANI. American Neurosurgery International. Available from: <https://www.amcani.org> [Last accessed on 2021 Dec 27].
2. Bernardo A. Humanitarian Work. Available from: <https://www.antoniobernardomd.com/humanitarian-work.html> [Last accessed on 2021 Dec 30].
3. Bell B. Annual Report 2019. United States: Eagle Condor Humanitarian; 2019. Available from: <https://irpcdn.multiscreensite.com/62d1fe59/files/uploaded/ECH%20Annual%20Report%202019.pdf> [Last accessed on 2021 Dec 09].
4. Bocanegra-Becerra JE, Castillo-Huerta NM, Vilca-Salas MI. Letter to the editor: The establishment of a new chapter in the neurosurgical care of patients with limited resources in Peru. *World Neurosurg* 2022;158:316-7.
5. Cheatham M. Profiles in volunteerism: From India to Peru as a neurosurgeon volunteer. *Surg Neurol* 2009;72:87-8.
6. Cheatham M. Profiles in volunteerism Gary Heit, MD, PhD, and Americare Neurosurgery International. *Surg Neurol* 2008;69:544-5.
7. Choque-Velasquez J, Colasanti R, Baffigo-Torre V, Sacieta-Carbajo L, Olivari-Heredia J, Falcon-Lizaraso Y, *et al.* Developing the first highly specialized neurosurgical center of excellence in Trujillo, Peru: Work in progress-results of the first four months. *World Neurosurg* 2017;102:334-9.
8. Clínica Delgado Noticias. Visita de Reconocidos Especialistas de Mayo Clinic a Clínica Delgado. Available from: <https://clinicadelgado.pe/noticia/visita-de-reconocidos-especialistas-de-mayo-clinic-a-clinica-delgado> [Last accessed on 2021 Dec 28].
9. Davis MC, Can DD, Pindrik J, Rocque BG, Johnston JM. Virtual interactive presence in global surgical education: International collaboration through augmented reality. *World Neurosurg* 2016;86:103-11.
10. Duenas V, Hahn E, Aryan H, Levy M, Jandial R. Targeted neurosurgical outreach: 5-year follow-up of operative skill transfer and sustainable care in Lima, Peru. *Childs Nerv Syst* 2012;28:1227-31.
11. Eagle Condor Humanitarian. Who We Are Our Mission. Available from: <https://www.eaglecondor.org/who-we-are-our-mission> [Last accessed on 2021 Dec 09].
12. Eagle Condor Humanitarian. Foundation Documents. Available from: <https://www.eaglecondor.org/foundation-documents> [Last accessed on 2021 Dec 09].
13. Fondation de Luxembourg. Origins. Available from: <https://www.fdlux.lu/en/page/origins> [Last accessed on 2021 Dec 11].
14. Fondation de Luxembourg. The Ehrnrooth Fellowship. Available from: <https://www.fdlux.lu/en/project/ehrnrooth-fellowship> [Last accessed on 2021 Dec 11].
15. Hayden MG, Hughes S, Hahn EJ, Aryan HE, Levy ML, Jandial R. Maria Auxiliadora Hospital in Lima, Peru as a model for neurosurgical outreach to international charity hospitals. *Childs Nerv Syst* 2011;27:145-8.
16. Heal International Medical Missions. Bringing Healing to Hurting Bodies and Souls. Available from: <https://www.himmonline.org> [Last accessed on 2021 Dec 30].
17. Higginbotham G. Virtual connections: Improving global neurosurgery through immersive technologies. *Front Surg* 2021;8:629963.
18. Hirdman T. Philanthropy Letter. Fondation de Luxembourg; 2017. Available from: [https://www.oecd.org/site/netfwd/Philanthropy\\_Letter\\_winter2017.pdf](https://www.oecd.org/site/netfwd/Philanthropy_Letter_winter2017.pdf) [Last accessed on 2021 Dec 11].
19. Howe J. Fifty years of HOPE: 2007 Annual Report of Project Hope. Washington, D.C., United States: Project Hope; 2008. Available from: <https://www.projecthope.org/wp-content/uploads/2018/08/2007ProjectHOPEAnnualReport.pdf> [Last accessed on 2021 Dec 09].
20. Jandial R, Narang P, Brun JD, Levy M. Optimizing international neurosurgical outreach missions: 15-year appraisal of operative skill transfer in Lima, Peru. *Surg Neurol Int* 2021;12:425.
21. Kooiman EP. The Bulletin of the Project HOPE Alumni Association. Washington, D.C., United States: Project Hope; 2012. Available from: [https://www.projecthope.org/wp-content/uploads/2018/08/ALUMNI-NEWSLETTER\\_SPRING-2012-copy.pdf](https://www.projecthope.org/wp-content/uploads/2018/08/ALUMNI-NEWSLETTER_SPRING-2012-copy.pdf) [Last accessed on 2021 Dec 09].
22. Maleknia P, Shlobin NA, Johnston JM, Rosseau G. Establishing collaborations in global neurosurgery: The role of InterSurgeon. *J Clin Neurosci* 2022;100:164-8.

23. Meara JG, Leather AJ, Hagander L, Alkire BC, Alonso N, Ameh EA, *et al.* Global Surgery 2030: Evidence and solutions for achieving health, welfare, and economic development. *Lancet* 2015;386:569-624.
24. Mission: Brain. Treat. Educate. Empower. Available from: <https://www.missionbrain.org> [Last accessed on 2021 Dec 28].
25. Mount LA. Peru and neurosurgery on project hope. *J Neurosurg* 1963;20:512-4.
26. NED. Neurocirugía, Educación y Desarrollo. Available from: <https://nedfundacion.org/?lang=en> [Last accessed on 2021 Dec 09].
27. Penn JW, Marcus HJ, Uff CE. Fifth generation cellular networks and neurosurgery: A narrative review. *World Neurosurg* 2021;156:96-102.
28. Project HOPE. Learn about Project HOPE. Available from: <https://www.projecthope.org/about-us> [Last accessed on 2021 Dec 09].
29. Project HOPE. National Volunteer Week Meet Dr. Gregorio Delgado. Available from: <https://www.projecthope.org/national-volunteer-week-meet-dr-gregorio-delgado/04/2012> [Last accessed on 2021 Dec 09].
30. Proximie-Saving Lives by Sharing the World's Best Clinical Practice; 2022. Available from: <https://www.proximie.com> [Last accessed on 2022 Mar 31].
31. Punchak M, Mukhopadhyay S, Sachdev S, Hung Y, Peeters S, Rattani A, *et al.* Neurosurgical care: availability and access in low-income and middle-income countries. *World Neurosurg* 2018;112:e240-54.
32. Punchak M, Lazareff J. Cost-effectiveness of short-term neurosurgical missions relative to other surgical specialties. *Surg Neurol Int* 2017;8:37.
33. Ravindra VM, Kraus KL, Riva-Cambrin JK, Kestle JR. The need for cost-effective neurosurgical innovation--a global surgery initiative. *World Neurosurg* 2015;84:1458-61.
34. Sadanah Trauma and Surgical Initiative. Peru Trauma Initiative STSI. Available from: <https://www.stsiglobal.org/peruvian-trauma-initiative> [Last accessed on 2022 Mar 27].
35. Shenai MB, Dillavou M, Shum C, Ross D, Tubbs R, Shih A, *et al.* Virtual interactive presence and augmented reality (VIPAR) for remote surgical assistance. *Neurosurgery* 2011;68(1 Suppl Operative):200-7; discussion 207.
36. Steven DA, Vasquez CM, Delgado JC, Zapata-Luyo W, Becerra A, Barreto E, *et al.* Establishment of epilepsy surgery in Peru. *Neurology* 2018;91:368-70.
37. Tesen F. Alfredo Quiñones: "El cerebro es complejo y nuestro entendimiento aún es prehistórico". *Diario Correo*; 2018. Available from: <https://diariocorreo.pe/salud/alfredo-quinones-cerebro-complejo-nuestro-entendimiento-es-prehistorico-808828> [Last accessed on 2021 Dec 28].
38. The Foundation for International Education in Neurological Surgery FIENS. Available from: <https://www.fiens.org> [Last accessed on 2021 Dec 30].
39. The Spine Practice of J. Patrick Johnson. Available from: <https://spine-practice.com> [Last accessed on 2021 Dec 28].
40. Vanderbilt University Medical Center. Global Neurosurgery Department of Neurological Surgery. Available from: <https://www.vumc.org/neurosurgerydept/global-neurosurgery> [Last accessed on 2021 Dec 30].
41. Weill Cornell Medicine. Surgical Innovations Laboratory Neurological Surgery. Available from: <https://neurosurgery.weill.cornell.edu/education/surgical-innovations-laboratory> [Last accessed on 2021 Dec 30].

**How to cite this article:** Bocanegra-Becerra JE, Castillo-Huerta NM, Ludeña-Esquivel A, Torres-García ON, Vilca-Salas MI, Bermudez-Pelaez ME. The humanitarian aid of neurosurgical missions in Peru: A chronicle and future perspectives. *Surg Neurol Int* 2022;13:545.

## Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Journal or its management. The information contained in this article should not be considered to be medical advice; patients should consult their own physicians for advice as to their specific medical needs.