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Developing the First Highly Specialized Neurosurgical Center of Excellence in Trujillo, Peru: Work in Progress—Results of the First Four Months

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■ BACKGROUND: Economic, cultural, and geographical reasons usually limit the access to specialized health centers in developing countries, especially in rural areas. Peruvian health system indicators still highlight significant unmet clinical need for neurosurgical patients. Our project is to develop the first highly specialized neurosurgical center in the EsSalud hospital of Trujillo, with the goal to improve the treatment of neurosurgical diseases in that region, thus optimizing their outcomes while decreasing expensive and risky patients transfer to the neurosurgical departments in the capital district.

■ METHODS: After an initial center evaluation, 2 neurosurgeons and 2 nurses from the Helsinki University Central Hospital provided the microneurosurgical training for the local team. Moreover, our team worked closely with the local staff to develop standardized protocols for surgical procedures and postoperative management.

■ RESULTS: From February to May 2016, 59 surgeries were performed in the new Neurosurgical Center, including cerebrovascular and skull-base cases that were never performed before in Trujillo. Moreover, the first “Cerebral Bypass and Vascular Microsurgery Live Course” was held in Trujillo in May 2016. After we left, the local team continued to work following the same protocols we introduced, and built up together.

■ CONCLUSIONS: An effective and adequate operative skill transfer to the local staff may be accomplished in a reasonable amount of time, thus guaranteeing a long-lasting improvement of neurosurgical care, while

minimizing expenditures on personnel and capital. We believe that this is possible following a general microsurgical philosophy that can be simplified as follows: “simple, clean, fast, and preserving normal anatomy.”

INTRODUCTION

Economic, cultural, and geographical reasons usually limit the access to specialized health centers in developing countries, especially in rural areas.¹⁻³ In Peru, the most developed neurosurgical centers, which belong to EsSalud (one of the 5 Peruvian health systems), are located mainly in Lima, the capital of the country.⁴

Even though there are some neurosurgical units belonging to EsSalud all around the country, there is still inefficiency, because only very few centers are able to manage the more complex neurosurgical pathologies. As a result, patients with such pathologies usually are referred to the most developed neurosurgical departments in the capital district.

Nonetheless, because the patient transfer system does not work effectively, the transport of any patient from 1500 km far inside the country to Lima implies delayed opportunities, a huge monetary investment, and may represent a high risk for the inpatient him/herself.

The creation of a center of excellence is a health program whose value is based on clinical outcomes and high levels of safety for the patient, comparable with the best references, and costs for the different diseases or health conditions that are highly competitive with the market.⁵⁻⁸ Hence, a center of excellence is built on high levels of evidence and uses protocols of management with a TEAM

Key words

- Developing countries
- Neurosurgical training
- Surgical missions
- Sustainable surgical care

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work concept. Our project is to develop the first highly specialized neurosurgical center in the High Complexity Hospital "Virgen de la Puerta" – EsSalud, located in Trujillo (La Libertad Region, Peru), with the goal to improve the treatment of neurosurgical patients in that region, thus optimizing their outcomes.

The first part of the project took place from February to May 2016, and consisted of a progressive microneurosurgical operative skills transfer to host neurosurgeons and nurses, to make access to neurosurgical care for the population of that region easier and safer. We present an analysis of the results achieved during the first 4 months.

MATERIALS AND METHODS

The first part of our project took place from February to May 2016. The aim of our Neurosurgical TEAM, led by the senior author (J.H.) was to develop a neurosurgical center of excellence. The EsSalud hospital of Trujillo, which has a neurosurgical theater and a critical care unit, was chosen as the center for our project.

An initial center evaluation was performed to assess the skill level of the local staff, facilities, and equipment.⁹⁻¹⁴ The administrative organization of the project comprised the following stages: preparation, implementation, performance, and certification.

Preparation

This stage started with the approval of the plan for the creation of a Neurosurgical Center of Excellence in EsSalud Trujillo Peru. The activities developed during this phase were as follows: 1) socialization of the project; 2) workshops to build the team of training and the local group to be trained; 3) start of the process of empowerment of the budget; 4) initial diagnosis of the center; 5) plan for the improvement; 6) training with the processes; and 7) final activation of the Center of Excellence.

Implementation

During this phase, our team worked closely with the local staff to 1) define specific areas to improve; 2) develop a standardized methodological guide; 3) formulate a local plan; 4) set protocols and guides for surgical procedures and postoperative management; and 5) monitor, and evaluate the results.

Performance

High-quality surgeries were done via the protocols and guides for surgical procedures and postoperative management.

Certification

As a part of the project evaluation, the certification will represent its final stage, and will need: 1) a local or international organization with high credibility that certifies the opening of the Center of Excellence; and 2) a continuous surveillance of the processes during the development of the Center of Excellence according to a standardized methodological guide.

During the process and after the approval of the project, strict work was done with the local staff to refine and progressively improve it.

Regarding the neurosurgical equipment, selective interventions were progressively made to have the following tools perfectly working: 1) a basic microsurgical set of 11 instruments (4 bipolar forceps

[longer and short, sharp, and blunt tipped], microdissector, straight microscissors, aneurysm clip applicator, straight blunt steel needle for irrigation, and 3 suction tubes [long, medium, and short]) plus some ring tip forceps for tumor surgery; 2) a highly mobile operating microscope, equipped with a mouth switch, and providing good magnification and illumination; 3) 4 high-speed drills with a craniotome blade, a cutting ball tip, and a diamond ball tip; and 4) a Sugita Head Frame, and a Mayfield Head Frame.

Two neurosurgeons and two nurses from the Helsinki University Central Hospital provided the microneurosurgical training for the local team. Our goal was to progressively enhance their confidence in dealing with more complex neurosurgical diseases,¹¹⁻¹⁷ such as the following:

- cerebrovascular diseases: cerebral revascularization surgery (brain bypass), brain aneurysms, arteriovenous malformations, Moyamoya disease and cerebrovascular occlusive disease;
- skull base diseases: tumors and vascular pathologies of the skull base;
- intracerebral lesions: gliomas, meningiomas or other intraparenchymal lesions, lesions of the third ventricle, fourth ventricle, and pineal region; and
- spinal diseases: spinal intradural tumors, vascular pathologies and spinal arteriovenous malformations, complex degenerative spinal diseases.

RESULTS

As a health development project in the neurosurgical field, we consider 2 aspects for its performance: 1) the administrative organization of the project; 2) medical activities.

1) All the administrative processing ended with the creation of the first Neurosurgical Center of Excellence in Trujillo, Peru (Figures 1 and 2). 2) Regarding medical activities, 59 surgeries were performed from February to May 2016 on 40 male patients (mean age at surgery, 49.55 years; standard deviation, 23.92

Figure 1. Plaque commemorating the creation of the highly specialized neurosurgical center in Trujillo, Peru.

Figure 2. Administrative staff from EsSalud-Peru and part of Juha Hernesniemi's TEAM during the opening ceremony of the Neurosurgical center.

years) and 19 female patients (mean, 52.05 years; standard deviation, 21.16 years). **Table 1** shows the distribution of the neurosurgical pathologies.

Most of the spinal cases and the less-complicated intracranial surgeries were performed by the local staff under our supervision. In contrast, our team performed all the more complex intracranial procedures, specifically cerebral aneurysms, tumors, and arteriovenous malformations. The outcome of all patients except 3 was very good. A patient with quadriplegia after a cervical trauma, another with a ruptured anterior communicating artery aneurysm, and a patient with a complex vestibular schwannoma died. Difficulties in the management of severe cerebral vasospasm,

Table 1. List of Neurosurgical Cases Performed in the EsSalud Neurosurgical Center of Trujillo, Peru, from February to May 2016

Surgical Operations	Number of Patients		
	Male	Female	Total
Cerebral aneurysm clipping	4	4	8
Brain tumor resection	12	4	16
Cerebral AVM resection	0	2	2
Spinal surgeries	11	5	16
Neuroendoscopic operations	2	1	3
Cranioplasty	1	0	1
Ventriculoperitoneal shunts	4	2	6
Tumor biopsies	2	0	2
Transsphenoidal surgery	1	0	1
Cerebral bypass for Moyamoya disease	1	0	1
Intracerebral hemorrhage evacuations	2	1	3
Total	40	19	59

AVM, arteriovenous malformation.

hydroelectrolytic imbalance, as well as of lung postoperative infection after the surgery were the main reasons for those results.

All the surgical cases were discussed accurately with the local team. Moreover, the entire local staff in training participated in the surgeries themselves. In addition, all the personnel inside the operation room (assistants, anesthesiologist, scrub nurses, technicians) could observe every step of the operations through monitors, thus enhancing teamwork and coordination.

Finally, the first "Cerebral Bypass and Vascular Microsurgery Live Course" was held in Trujillo in May 2016. Our team and internationally renowned neurosurgeons demonstrated and discussed different approaches and microsurgical techniques in live operations. A basilar artery bifurcation aneurysm in addition to complex arteriovenous malformations was treated surgically. Moreover, bypass procedures were performed in various cerebrovascular lesions, including Moyamoya disease and a giant internal carotid artery aneurysm.

The academic activities ended officially with the presentation of certificates to all participants who received the training during those 4 months; EsSalud and Braum-Aesculap from Peru guaranteed the validity of the course (**Figures 3–5**).

DISCUSSION

The Peruvian population comprises approximately 30 million people, and EsSalud (the Peruvian Social Security Health System) provides health care to approximately 11 million people (36.67%). Even though EsSalud has worked tirelessly to reduce the morbidity and mortality of the population due to neurosurgical diseases, health system indicators still highlight a significant unmet clinical need.¹⁸ The shortage of neurosurgeons, as well as of neurologists and neuroanesthesiologists, is one of the main reasons.

Moreover, an inefficient administration of the resources for neurosurgical care also plays a key role. Indeed, many neurosurgical theaters had no adequate organization. In addition, the limited number of neurosurgical beds (both in neurosurgical

Figure 3. Juha Hernesniemi's TEAM (surgeon, fellow, nurse) and Local TEAM (surgeon, anesthesiologist, and nurse) working together in the operating room, EsSalud Trujillo, Peru.

Figure 4. Presentation of the certificates during the closing ceremony of the training.

Cerebral Bypass and Vascular Microsurgery Live Course
16-20 MAY 2016
EsSalud Trujillo, Peru

SEDE:
Hospital de Alta Complejidad La Libertad
EsSalud Trujillo, Peru

Bypass case and Vascular surgery (AVM/Aneurysm/Cavernous malformation) with discussions on cases and microsurgical videos between and after the operations.

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 Lima, Peru

Participation fee:
 Peruvian Medical Resident
 \$500 valid until 30.04.16
 \$700 from 01.05.16
 Peruvian Neurosurgeon
 \$800 valid until 30.04.16
 \$1,000 from 01.05.16
 Foreign Neurosurgeon
 \$1,000 valid until 30.04.16
 \$1,200 from 01.05.16

Please register online at:
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Course organization and registration
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Figure 5. Advertisement for the first cerebral bypass and vascular microsurgery live course, Trujillo, Peru.

wards and in intensive care units) determines the extent of the surgical waitlist.

To January 31 2016, 401 Peruvian patients with neurosurgical diseases were waiting for surgery, and the longest waiting time for a patient was more than a thousand days.¹⁸ As mentioned previously, an analysis conducted by EsSalud revealed that most of the patients with neurosurgical diseases are transferred from the little local hospitals to the 3 highly specialized hospitals in the capital district (Lima and Callao). We observed the same trend in EsSalud Trujillo Hospital. Indeed, before the beginning of our project, no neurosurgical operation had been performed in Trujillo for a cerebral aneurysm, an arteriovenous malformation, or a skull base lesion.

As a consequence, too many patients are referred to very few hospitals that do not have enough resources to guarantee them an appropriate and well-timed clinical and surgical care. Moreover, the transfer of these patients from isolated interior towns to the capital district requires a lot of money and may put in jeopardy the inpatients themselves.

In 2013, EsSalud (the Peruvian Social Security Health System) started a crucial plan called "Plan Confianza," and then "Super Plan Confianza," with the aim of improving these aforementioned problems.¹⁹ This project promotes the development of specialized neurosurgical centers in the main strategic places all around the country to make feasible an optimal treatment of neurosurgical

patients. The creation of a highly specialized neurosurgical center of excellence in Trujillo represents the first step of this main project, and it will be followed by the development of other highly specialized neurosurgical centers in Arequipa, Cusco, Huancayo, and Tacna.

During the first 4 months of our project, our goal was to progressively transfer to the local staff our microneurosurgical operative skills and most of all our organization and our general philosophy of microneurosurgery. In this regard, we believe that, inside the operating room, teamwork (surgeon, assistant, nurses, anesthesiologist), as well as a judicious application of microsurgical principles (i.e., performing every microneurosurgical procedure in a simple, clean, and fast way while preserving normal anatomy), play a key role.¹¹⁻¹⁷ Indeed, this may allow that neurosurgical operations are completed in an efficient and safe manner, thereby optimizing the available resources and the chances of a good outcome for the patient. Again, this takes on utmost importance in resource-challenged environments. Moreover, the division of every microsurgical procedure in several steps, as well as the simplification of each of them, may allow to "speed up" the training, even for the more complex procedures.

To perform microneurosurgery in a new center with a different environment obviously can be difficult. At the beginning, inefficient coordination between our team and the local staff resulted in

start time delays in operating room that we could use for elective cases only 3 days a week. A member of our team was fluent in Spanish, which allowed us to overcome the language barriers, which could act as an important limitation for our cooperative work with the local staff.

Initially, the adopted methods for patient transportation to the operating room, and, after a surgery, from the operating room to the postanesthetic care unit were time consuming. As a result, it was difficult to perform more than 2 cases a day. Moreover, even though some neurosurgical procedures were performed routinely in Trujillo Hospital previously, the complexity of the cases performed during our project was not understood completely at first glance by hospital administrators, as well as by medical and paramedical staff. Hence, sometimes, in the beginning, the surgical schedule was planned without taking into account the real difficulty of the operations, and we were asked to start some complex elective case late in the afternoon/evening.

These issues were resolved progressively after a careful review with the local staff. In addition, a gradual improvement of the neuroanesthesiologic support allowed us to increase the complexity of the cases we performed. Furthermore, during the first weeks, we were confronted with the shortage of the neurosurgical equipment. At the beginning, the microscope had no mouth switch, and video angiography could not be used. In addition, the Sugita frame was not always available, the craniotome did not have diamond drills, and the sterilization system for surgical instruments worked only in the mornings. Finally, neuromonitoring was not always available while we performed vestibular schwannoma resections.

Regarding postoperative care, the shortage of neurosurgical beds in the intensive care unit (only 3–4 beds most of the time) limited the number of very complex operations we could perform. Indeed, postoperative neuromonitoring and hemodynamic support play a major role in determining the final outcome of patients with arteriovenous malformations, ruptured cerebral aneurysms, sellar region tumors, and skull base lesions. Moreover, it was not so easy to perform immediate postoperative computed tomography scans on a regular basis.

After we left, the local team continued to work following the same protocols we introduced and built together in Trujillo. Moreover, the local team is continuing to perform, in addition to neurotrauma and spinal procedures, cerebrovascular, neuro-oncology, and skull base cases.

Obviously, the true impact of our mission can be evaluated only in the years to come. We already have planned new short visits to work together again with the neurosurgical staff of Trujillo, thus contributing to further improve the neurosurgical cares in that region; however, this start is surely encouraging.

Many studies reported different strategies to improve the quality of medical services around the world, especially in developing countries.^{20–32} Economic, cultural, and geographical reasons usually limit the access to specialized health centers in developing countries, especially in rural areas.^{1–3} In addition, most of the developing countries have a very centralized health system that concentrates a high number of patients in few hospitals.

The Study on Surgical Services for the United States report from 1977 proposed to centralize the neurosurgical services according to a 1:100 000 neurosurgeon to population ratio as the optimal

density.³³ More recently, the analysis carried out by Rosman et al.³⁴ invalidated the aforementioned 1:100 000 ratio and underlined that a shortage of neurosurgeons may be defined by patient demand, by hospital and practice market (i.e., recruitment) demand, or by other factors that may vary in different regions.

Although we recognize that a hub-a-spoke model may make the healthcare system more effective in developing countries, we also believe that highly specialized health workers also must be present in remote areas to guarantee an opportune clinical and surgical care to the entire population, in particular for urgent cases, while reducing the transfer to other centers.

Certainly, the benefits of centralized systems comprise a more simple protocol for the management of neurosurgical patients. Few neurosurgical centers assemble the best technological resources, as well as highly specialized surgical and diagnostic skills. The resulting high volume of specialty procedures in few centers makes the training of doctors easier and quicker, thus improving the quality of neurosurgical care. Obviously, centralized systems require an impeccable patient transfer.

In contrast, as other experiences demonstrate,^{30–32} we believe that an effective decentralization of major specialty services, together with an efficient use of the available resources, may allow the improvement of healthcare systems in developing countries. In fact, a wise decentralization could help to distribute and retain highly specialized health workers in remote areas, thus ameliorating treatment outcomes of rural populations. As a result, this could make possible a straightforward management of most of the neurosurgical cases, and of all emergencies, while decreasing/limiting the transfer of the patients to other centers just to the more complex and nonurgent cases. In addition, this could allow a reduction in the wait list for elective cases while offering to the entire population an appropriate and well-timed clinical and surgical care. Moreover, telemedicine, as well as the implementation and the constant improvement of neurosurgical training programs, could play a great role to enhance healthcare systems in developing countries.^{21,23,24,28,29}

As mentioned, Peru, a country with 30 million people and approximately 300 neurosurgeons actively working in private and public centers, has their main complex neurosurgical services in the capital of the country. Sixty percent of all neurosurgeons work in Lima with 1 neurosurgeon per 66,000 population ratio, and the remaining 40% of neurosurgical specialists work outside the capital district with 1 neurosurgeon per 184,000 population ratio.³⁵ Even though the distribution of neurosurgeons shows big differences between the capital and the rest of the country, highly specialized neurosurgeons are practically nonexistent outside Lima. Hence, as aforementioned, there is a serious deficit in the management of neurosurgical patients in Peru, particularly in remote geographic places. This deficit is even more dramatic for the treatment of complex tumors, as well as of vascular and complex spinal pathologies. In this regard, we believe that a combined strategy, according to a hub-and-spoke model that includes both a wise decentralization of neurosurgical centers in strategic places around the country and an improvement of transfer system to large regional centers, would absolutely benefit patients with complex neurosurgical pathologies.

CONCLUSIONS

We are confident that the development of highly specialized neurosurgical centers in the main strategic places of the country may make feasible the optimal treatment of neurosurgical patients. An effective and adequate operative skill transfer to the local staff may be accomplished in a reasonable amount of time, thus guaranteeing a long-lasting improvement of neurosurgical care, while minimizing expenditures on personnel and capital. We believe that this is possible thanks to a constant dedication and

following a general microsurgical philosophy that can be simplified as follows: “simple, clean, fast, and preserving normal anatomy.”

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REFERENCES

- Behrman JR, Behrman JA, Perez NM. Out of sync? Demographic and other social science research on health conditions in developing countries. *Demogr Res.* 2011;24:45-78.
- Camacho AV, Castro MD, Kaufman R. Cultural aspects related to the health of Andean women in Latin America: a key issue for progress toward the attainment of the Millennium Development Goals. *Int J Gynaecol Obstet.* 2006;94:357-363.
- Larme AC. Health care allocation and selective neglect in rural Peru. *Soc Sci Med.* 1997;44:1711-1723.
- Alcalde-Rabanal JE, Lazo-González O, Nigenda G. Health system of Peru. *Salud Pública México.* 2011; 53:s243-s254.
- Castaño RA. Centers of excellence: quality, efficiency and competitiveness to export services. *Salud.* 2005;33:8-17.
- Porter ME, Teisberg EO. Redefining competition in health care. *Harv Bus Rev.* 2004;82:64-76, 136.
- Centro de Gestión Hospitalaria, Centers of Excellence. *Via Salud.* 2006;38:2-3.
- Centro de Gestión Hospitalaria, Frequently asked questions about the Centers of Excellence and the Circle of Centers of Excellence. *Via Salud.* 2009;48: 35-37.
- Krayenbühl H, Yasargil MG. The use of binocular microscopes in neurosurgery. *Wien Z Nervenheilkd Grenzgeb.* 1967;25:268-277 [in German].
- Yaşargil MG. Intracranial microsurgery. *Clin Neurosurg.* 1970;17:250-256.
- Hernesniemi J. Mechanisms to improve treatment standards in neurosurgery, cerebral aneurysm surgery as example. *Acta Neurochir Suppl.* 2001;78:127-134.
- Hernesniemi J, Niemelä M, Dashti R, Karatas A, Kivipelto L, Ishii K, et al. Principles of micro-neurosurgery for safe and fast surgery. *Surg Technol Int.* 2006;15:305-310.
- Hernesniemi J, Niemelä M, Karatas A, Kivipelto L, Ishii K, Rinne J, et al. Some collected principles of microneurosurgery: simple and fast, while preserving normal anatomy: a review. *Surg Neurol.* 2005;64:195-200.
- Velasquez JC, Lau J, Kozyrev D, Sharafeddin F, Colasanti R, Luostarinen T, et al. Clean, fast and preserving normal anatomy: “the Helsinki revolution” in microneurosurgery. *J Neurosurg Sci.* 2016;60:44-53.
- Choque-Velasquez J, Colasanti R, Fotakopoulos G, Elera-Florez H, Hernesniemi J. Seven cerebral aneurysms: a challenging case from the Andean slopes managed with one-stage surgery. *World Neurosurg.* 2017;97:565-570.
- Choque-Velasquez J, Colasanti R, Jahromi BR, Rafei A, Sharafeddin F, Hernesniemi J. Short burst bipolar coagulation for repairing of partially damaged brain arteries preserving their flow: technical note. *World Neurosurg.* 2016;93:324-329.
- Choque-Velasquez J, Colasanti R, Jahromi BR, Hernesniemi J. The “squeeze maneuver” assisted by indocyanine green videoangiography: a simple technique to “resuscitate” partially occluded bridging veins during microneurosurgical operations. *World Neurosurg.* 2017;97:225-230.
- EsSalud. Estadística Institucional. Available at: <http://www.essalud.gob.pe/estadistica-institucional/>. Accessed October 29, 2016.
- EsSalud. ¿Qué es el Plan Confianza?. Available at: <http://www.essalud.gob.pe/que-es-el-plan-confianza/>. Accessed October 29, 2016.
- Youngkong S, Kaporiri L, Baltussen R. Setting priorities for health interventions in developing countries: a review of empirical studies. *Trop Med Int Health.* 2009;14:930-939.
- Ozgediz D, Roayaie K, Debas H, Schecter W, Farmer D. Surgery in developing countries: essential training in residency. *Arch Surg.* 2005;140: 795-800.
- Scott RA, Lhatoo SD, Sander JW. The treatment of epilepsy in developing countries: where do we go from here? *Bull World Health Organ.* 2001;79: 344-351.
- Wootton R. Telemedicine and developing countries—successful implementation will require a shared approach. *J Telemed Telecare.* 2001;7(suppl 1):1-6.
- Dadlani R, Mani S, A U J G, Mohan D, Rajgopalan N, Thakar S, et al. The impact of telemedicine in the postoperative care of the neurosurgery patient in an outpatient clinic: a unique perspective of this valuable resource in the developing world—an experience of more than 3000 teleconsultations. *World Neurosurg.* 2014;82:270-283.
- Rahimi-Movaghgar V, Sayyah MK, Akbari H, Khorramirouz R, Rasouli MR, Moradi-Lakeh M, et al. Epidemiology of traumatic spinal cord injury in developing countries: a systematic review. *Neuroepidemiology.* 2013;41:65-85.
- Patel A, Pfaff M, Clune JE, Mirensky T, Katona LB, Geiling J, et al. Disseminating surgery effectively and efficiently in Haiti. *J Craniofac Surg.* 2013;24: 1244-1247.
- Weil AG, Fallah A, Bhatia S, Ragheb J. Pediatric neurosurgery in the developing World: the Haiti experience. *J Craniofac Surg.* 2015;26:1061-1065.
- Piquer J, Qureshi MM, Young PH, Dempsey RJ. Neurosurgery education and development program to treat hydrocephalus and to develop neurosurgery in Africa using mobile neuroendoscopic training. *J Neurosurg Pediatr.* 2015;15:552-559.
- Warf BC. Educate one to save a few. Educate a few to save many. *World Neurosurg.* 2013;79(2 suppl): S15.e15-S15.e18.
- Adeleye AO, Fasunla JA, Young PH. Skull base surgery in a large, resource-poor, developing country with few neurosurgeons: prospects, challenges, and needs. *World Neurosurg.* 2012;78:35-43.
- Wahba MY, Kelly ME. The high cost of endovascular neurosurgery therapies and the need to sustain quality on limited resources. *World Neurosurg.* 2014;82:7-8.
- Davis MC, Than KD, Garton HJ. Cost effectiveness of a short-term pediatric neurosurgical brigade to Guatemala. *World Neurosurg.* 2014;82:974-979.
- Zuidema GD. The SOSSUS report and its impact on neurosurgery. *J Neurosurg.* 1977;46:135-144.
- Rosman J, Slane S, Dery B, Vogelbaum MA, Cohen-Gadol AA, Couldwell WT. Is there a shortage of neurosurgeons in the United States? *Neurosurgery.* 2013;73:354-355, 366.
- Doctoralia - Encuentra tu médico - Agendar cita médica. Doctoralia. Available at: <http://www.doctoralia.pe/>. Accessed January 11, 2017.

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