Although neurology originated in Africa, there is little modern African contribution to the advancement of knowledge in this field. We present the African neurologic service and scientific productivity indices and suggest a development plan. We conducted PubMed and EMBASE searches for articles about neurologic services in Africa. To assess scientific productivity, we determined the number of publications of African origin in journals with high impact. The neurologist-population ratio in African countries varies from 1 per 162,885 persons to none in 11 countries, compared with 1 per 29,200 persons in the United States. There are few African publications in high-impact international journals of neurology. Africa faces a heavy burden of communicable diseases and increasing noncommunicable diseases, with few workers, poor equipment, and little research effort to bear it. There is a need for African neuroscientists to discover areas of research unique to the continent in order to advance the frontiers of knowledge for all neurologists. International collaboration and support are required to improve the number of workers, resources, and research productivity.

Methods

We conducted a literature search for articles about neurologic services in Africa using the PubMed and EMBASE databases. We used the search terms neurology in Africa, neurologic services in Africa, and neurological services in Africa. More than 600 articles were identified and examined for relevance to the stated objectives. We reviewed key articles to retrieve linked pertinent articles. We also included relevant literature in our personal files. To evaluate scientific productivity, we...
determined the number of publications from African sources in 1995 and 2005 in clinical journals of (general) neurology with an impact factor greater than 4 (ie, *Annals of Neurology, Brain, Neurology, and Archives of Neurology*).

**RESULTS**

**NEUROLOGIC DEMAND**

There is scant current epidemiological data that directly address the precise burden of neurologic diseases in the countries of Africa. Incidence and prevalence data on neurologic diseases in Africa are lacking as a result of a scarcity of community-based epidemiological studies. For example, in the Global Burden of Disease Study, direct data from the internet and neurologic literature, as well as insufficient equipment. Even where equipment is available, it is not uniformly affordable and accessible. To our knowledge, there are no direct data in the literature on the availability of facilities in Africa for neurogenetics, neuroimmunology, and interventional radiology.

There is insufficient information on neurology training programs in Africa. In the World Federation of Neurology survey, only 4 African countries were represented. Only 26 neurology residencies were documented in one survey, the nations of Africa were divided into 4 groups on the basis of the number of neurologists per country. Only 11 countries had more than 10 neurologists per country. The highest neurologist density was recorded in Tunisia, with a ratio of 1 neurologist to 422 885 persons. This is far from the ratio of 1:100 000 recommended by the World Health Organization (WHO). Five countries had 5 to 10 neurologists per country, averaging 1 612 039 population per neurologist. Twenty-three countries had 1 to 4 neurologists per country, averaging 5 099 908 population per neurologist. Eleven countries with a total population of about 26 million had no neurologists.

According to the *Atlas: Country Resources for Neurological Disorders 2004* (hereinafter, the WHO Neurology Atlas; WHO, Geneva, Switzerland), the median number of neurologists per 100 000 population was 4.84 in Europe compared with 0.32 in the eastern Mediterranean, including some countries in northern Africa, and 0.03 in the rest of Africa. Thus, even within Africa there is variation, with sub-Saharan Africa having the lowest density of neurologists worldwide. Most are located in cities and practice general medicine, psychiatry, or both. Therefore, the total time devoted to the absolute practice of neurology by neurologists in Africa is further compromised, and the majority of the population who reside in rural areas have limited access to neurologists.

Despite the meager neurologic workforce in Africa, there is a migration of professionals to the industrialized countries that is fueled by inadequate remuneration, lack of required infrastructure and facilities with which to work, and foreign training. There is a lack of equipment with which to perform studies such as magnetic resonance imaging, computed tomography, electroencephalography, and electromyelography, and dozens of countries have no such equipment. Even where equipment is available, it is not uniformly affordable and accessible. To our knowledge, there are no direct data in the literature on the availability of facilities in Africa for neurogenetics, neuroimmunology, and interventional radiology.

There is insufficient information on neurology training programs in Africa. In the World Federation of Neurology survey, only 4 African countries were represented. Only 26 neurology residencies were documented in Africa compared with 117 in the United States. Where they were present, most had inadequate access to the Internet and neurologic literature, as well as insufficient training in neuroradiology, neurophysiology, psychiatry, and neuropathology. It was concluded that there were few or no neurology training programs in developing countries, the very regions of the world where they are needed most owing to the overwhelming burden of neurologic disorders. These facts are reinforced by figures from the WHO Neurology Atlas that show that postgraduate training programs were rarest in Africa, with
an infinitesimal number of new neurologists per year per 100 000 population.21

As a result of the limited local training programs, there is a predominance of foreign training, with 28 countries reporting training in Europe.1 The listed demerits of foreign training include questionable suitability to local pathology, equipment, and circumstances; high cost; and increased “brain drain.”1,10,21,23

The problem of inadequate current hard and electronic literature is daunting. This is compounded by the digital divide as illustrated by the poor Digital Opportunity Index and Internet access in Africa.15,24 The Digital Opportunity Index is a measure of opportunities, infrastructures, and use of information and communications technology worldwide.24

Scientific productivity is often practically measured by its contribution to the body of knowledge as represented by scientific publications. Although not necessarily an indicator of impact on evidence-based and patient-centered practice, the journal impact factor is one measure of scientific impact that is based on citation rate.25 The journal impact factor was used in this study to select the journals for analysis.26 The results given in Table 1 demonstrate infinitesimal contribution from Africa to the frontiers of neurology and neuroscience despite its overwhelming burden of neurologic disorders. A similar work by Gureje et al25 buttresses this finding.

Articles submitted from the developing countries, including Africa, have methodological inadequacies owing to infrastructural deficiencies, prompting rejection by high-impact journals.19 This leads to reduced funding for further research. A vicious cycle then develops. Poor research infrastructure leads to lower quality of scientific work, leading to a poor publication rate, reduced funding, and further deterioration in the research infrastructure. The end result is a lack of information for the worldwide neurologic community about the problems faced by the developing world.

### Table 1. Publications With African Author or Coauthor in High-Impact Journals of General Clinical Neurology

<table>
<thead>
<tr>
<th>Journal, JIF, 25</th>
<th>No. of Articles With African Authors (Country)</th>
<th>No. of Articles</th>
<th>No. of Articles With African Authors (Country)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annals of Neurology, 8.6</td>
<td>311 2 (Nigeria)</td>
<td>342 1 (Morocco)</td>
<td></td>
</tr>
<tr>
<td>Brain, 7.1</td>
<td>120 0</td>
<td>256 1 (Morocco)</td>
<td></td>
</tr>
<tr>
<td>Neurology, 5.3</td>
<td>445 1 (South Africa)</td>
<td>756 5 (South Africa, Egypt, Ethiopia, and Nigeria)</td>
<td></td>
</tr>
<tr>
<td>Archives of Neurology, 4.3</td>
<td>132 0</td>
<td>205 0</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviation: JIF, journal impact factor.

It is crucial to set strategic goals in training, research, funding, service delivery, and reducing the burden of disease.27,28 The achievement of such broad goals and specific targets should be monitored by measurable indicators that should be assessed from time to time.

Fulfilling the millennium development goals and implementing the report of former British Prime Minister Tony Blair’s commission for Africa will improve neurologic services in Africa.8,22,29 Specifically, this includes addressing general health and health-related issues such as trauma, poverty, infections, and malnutrition. Support is needed from the wealthier countries because we now live in a global village in which the health of one’s immediate or remote neighbor can also determine one’s own health.30

The best way to reduce the burden of neurologic diseases is through primary prevention, itself best achieved through community education and primary health care.31 A crucial aspect is the creation of professional and public awareness of neurologic disorders.8 The governments of African countries must commit themselves through their ministries of health to educating their populations about the major risk factors for neurologic diseases with the purpose of disease prevention, lifestyle modifications, and screening, early detection, and control of disease. Furthermore, similar to the public health needs in the developed world, the existing systems of primary health care must be strengthened in the developing world to provide services for persons with brain disorders including diagnosis, cost-effective interventions, treatment, and rehabilitation. It is equally necessary for neurologists to be involved in training primary physicians and other primary health care providers to offer these services, which cannot always be provided by neurologists because of their small number.1,8,9,32

To meet some of the infrastructural challenges, equipment for diagnosis, treatment, and research is required. It will be the responsibility of the local neurologists to identify these needs. Donation and subsequent adaptation and calibration of equipment for neuroradiology, neurooncology, and neurophysiology from industrialized countries will greatly help. A database of the specific requirements of individual countries may assist donors to channel their donations efficiently.

To fulfill the workforce requirement is even more daunting. Training must be community-driven and patient-centered. Neurology residency programs targeting the African population should emphasize the prevention and treatment of and research into diseases that are particularly prevalent in Africa such as stroke, neuro-AIDS, and epilepsy. While domestic training will ensure relevance to local circumstances, foreign training would improve skills and foster support and collaboration. Local programs can be strengthened by visiting tutorship programs and provision of current literature and Internet access. Travel sti-
pends should be granted to African neurologists to enable them to participate in international meetings.1

Neurology journals and resources for continuing medical education such as the American Academy of Neurology’s CONTINUUM and Lifelong Learning in Neurology could be made free to resource-poor countries, including Africa, through collaboration between the publishers and WHO.13,14 The Health InterNetwork Access to Research Initiative is commendable in this regard and should be strengthened and extended. The local journal, African Journal of Neurological Sciences, would benefit from international support to improve its impact.

To convert brain drain to brain gain, provision of equipment as well as attractive and better remuneration can encourage African neurologists to return home to practice. Protected time for clinical research should be provided to facilitate quick progress.1,6,8,27,35,36 Those who choose to remain abroad can serve as an external resource base for those practicing at home. A database of African neurologists in Diaspora (http://www.uiowa.edu/-commstdud/resources/bordercrossings/diaspora.html) should be established to facilitate linkages, networks, and collaborations among those at home and abroad.

To make cutting-edge contributions to neurologic research, African neuroscientists must discover areas of unique needs or comparative advantage. Neuroepidemiology, neurologic manifestations of HIV/AIDS and cerebral malaria, and holistic and complementary medicine are some of the areas in which substantial contributions can be made. National centers and institutes of excellence for research and training in brain disorders should be established across Africa. Cooperation with neuroscientists from the industrialized world is crucial in improving the African research infrastructure. The importance of Internet services, telemedicine, electronic contact, and networking in training, research, and mentoring cannot be overemphasized. To accomplish this, the Pan-African Association of Neurological Sciences should collaborate with WHO and the other organizations given in Table 2.33 It is also encouraging that the World Federation of Neurology has created a roadmap for developing neurology in Africa.37 This should help to improve research.

After improving the quality of the data, high-impact international journals would then be more likely to publish the resulting scientific papers. Information on the needs of African patients with neurologic diseases would, thus, be widely disseminated to the global neurologic community.

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