

A Prospective Emergency Department–Based Study of Pattern and Outcome of Neurologic and Neurosurgical Diseases in Haiti

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■ **OBJECTIVE:** To perform the first prospective survey of neurologic and neurosurgical emergency department (ED) admissions in Haiti.

■ **METHODS:** Data of all ED admissions at 3 Haitian hospitals for 90 consecutive days per site were collected prospectively. Patients who were given a diagnosis of a neurologic or neurosurgical disorder by the ED physician were entered in a deidentified database including demographics, presenting symptoms, brain imaging (when available), requests for neurosurgical consultation, and outcome.

■ **RESULTS:** Of the 7628 patients admitted to the ED during this study, 1243 patients had a neurologic disorder, yielding an ED-based neurologic disease prevalence of 16%. The 3 most common neurologic diseases were cerebrovascular disease (31%), neurotrauma (28%), and altered mental status (12%). Neurosurgical pathologies represented 19% of all neurologic admissions with a combined ED-based disease prevalence of 3%. Mortality rate was 9%. The most common neurosurgical disease was neurotrauma (87%), caused by motor vehicle accidents (59%), falls (20%), and assault (17%). Neurosurgical procedures were performed in 14 of 208 patients with a mortality rate of 33%.

■ **CONCLUSIONS:** This prospective survey represents the first study of neurosurgical or neurologic disease patterns in Haiti. The results suggest specific disease priorities for this population that can guide efforts to improve Haitian

health care and conduct more comprehensive epidemiologic studies in Haiti.

Even before the 2010 catastrophic earthquake and cholera epidemic, Haiti was the poorest and most pathologically burdened nation in the Western Hemisphere (1, 9, 34). Given such challenges, the surgical and medical management of neurologic disease in Haiti is likely to be suboptimal. Documentation of these diseases is poor, leaving many unanswered questions about Haitian disease patterns. To address adequately the medical needs of developing countries such as Haiti, it is imperative to define the local epidemiology (21).

Recognizing the growing awareness of the importance of nervous system disorders in the global burden of disease, the field of global neurosurgery seeks to identify and help address what is needed by applying the tools of public health to neurosurgical disorders (11, 13, 17, 31, 35). The aim of this study is to perform the first prospective survey of neurologic and neurosurgical emergency department (ED) admissions at 3 major Haitian hospitals to determine the disease patterns and outcome in these fields.

METHODS

Ethical Clearance

Ethical approval was obtained by the institutional review board of the Icahn School of Medicine at Mount Sinai, New York, New York, and by each of the 3 Haitian institutions participating in this research project.

Key words

- Brain injuries
- Cerebrovascular disorders
- Global health
- Haiti
- Neurologic diseases
- Neurosurgical procedures
- Outcome assessment

Abbreviations and Acronyms

- CDC:** Centers for Disease Control and Prevention
CT: Computed tomography
CVD: Cerebrovascular disease
ED: Emergency department
HBM: Hospital Bernard Mevs Project Medishare
HUEH: Hôpital de L'Université d'État d'Haïti
MVA: Motor vehicle accidents

TBI: Traumatic brain injury

WHO: World Health Organization



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Data Collection and Sites

For this prospective study, on-site data of all ED admissions for 9 months at 3 Haitian hospitals for the period August 2012 through May 2013 were collected. The 3 participating hospitals were Hospital Bernard Mevs Project Medishare (HBM), Hôpital de L'Université d'État d'Haïti (HUEH), and Hôpital Albert Schweitzer. These sites were selected to compare data from the only hospital with a computed tomography (CT) scanner (HBM) with another urban site without a CT scanner (HUEH) and with a rural hospital (Hôpital Albert Schweitzer).

HBM is a 50-bed trauma, critical care, and rehabilitation hospital in Port-au-Prince that was the only hospital with a working CT scanner and neurosurgery capabilities on site after the earthquake in 2010. Neurosurgery accounts for 10% of total surgical interventions performed at the hospital, with emphasis on elective treatment of hydrocephalus performed by local and visiting volunteer neurosurgeons (7, 18).

HUEH is a 700-bed university hospital in Port-au-Prince. It remains the country's largest tertiary care center despite the fact that it was significantly damaged by the 2010 earthquake. It treats >169,000 patients annually (23, 32).

Hôpital Albert Schweitzer is located in the rural region of Artibonite in Deschappelles. It has a 130-bed capacity for inpatients and observation and serves a population of >340,000 individuals living in the surrounding mountains of central Haiti. There is no neurosurgical service at this hospital (12, 28).

Definitions and Data Entry

All ED admissions were recorded. Patients given a diagnosis of a neurologic or neurosurgical disorder by the ED physician were entered in a deidentified database that included demographics, presenting symptoms, brain imaging (when available), and requests for neurosurgical consultation at sites with neurosurgical capacity. Each patient's outcome, with or without neurosurgical intervention until discharge from the hospital, was also recorded.

Neurologic Disease Categories

Patients with diagnoses of neurologic disorders were divided into the following categories.

Altered Mental Status. All patients presenting with confusion, disorientation, or signs of depressed consciousness or receiving a diagnosis of "altered mental status" were placed in this category. Patients with seizure, infection, or signs of cerebrovascular disease (CVD), such as stroke or malignant hypertension, were excluded from this group.

Brain Tumors. Patients with a diagnosis of tumor of the brain or spine were placed in this category.

Cerebrovascular. Patients with a diagnosis of stroke or subarachnoid hemorrhage or presenting with malignant hypertension associated with headache, altered mental status, or neurologic deficit were placed in this category.

Congenital Anomalies. Pediatric patients presenting with hydrocephalus, spina bifida, or encephalocele or pediatric patients for whom the cause of admission was a nervous system anomaly were placed in this category.

Headache. Patients receiving a diagnosis of "headache" or "migraine" and without malignant hypertension were placed in this category.

Meningitis or Central Nervous System Infection. All patients with a diagnosis of meningitis confirmed by lumbar cerebrospinal fluid analysis and patients with altered mental status or neurologic deficit caused by abscesses or other infection of the central nervous system were placed in this category. Patients presenting with seizure were excluded.

Neurologic Deficit. Patients presenting with nontraumatic focal neurologic deficit, such as unilateral weakness or bilateral extremity paralysis, but who were not given a diagnosis of either CVD or infection were placed in this category.

Neurotrauma. Traumatic injury caused by external force applied to the skull, spine, or central nervous system was classified as neurotrauma. Lacerations to the scalp with no loss of consciousness or other sign of injury to the skull or brain did not count as neurotrauma. For patients with head trauma, a Glasgow Coma Scale (GCS) score was recorded in all cases in which the attending physician or surgeon assigned a GCS score to the patient.

Neurosurgical Disease. All neurologic patients for whom the attending physician requested a neurosurgical consultation, regardless of whether an intervention was performed, were categorized as having "neurosurgical disease."

Peripheral Nervous System Disorders. Patients with a diagnosis of "neck pain," "back pain," or neuropathy of the extremities in the absence of trauma, focal neurologic deficit, or other neurologic symptoms were placed in this category.

Seizure. All patients presenting with seizure or receiving an initial diagnosis of "seizure" or "epilepsy" were placed into this category. Patients from this group whose final diagnosis might otherwise fit into another category, such as "meningitis," were retained in the "seizure" category.

Statistical Analysis

Data were analyzed with one-way analysis of variance using StatPlus:mac LE:2009 (AnalystSoft, Inc., Vancouver, British Columbia, Canada) or Student unpaired t test using Microsoft Excel for Mac 2011 (Microsoft Corporation, Redmond, Washington, USA), as indicated, and are presented as mean \pm standard deviation. A probability value <0.05 was considered significant.

RESULTS

During this study, 7628 patients were admitted to the ED. Of 7628 patients, 1243 had a neurologic disorder, yielding an ED-based neurologic disease prevalence of 16% (Table 1). The most common categories of neurologic disease observed at the 3 sites were CVD (388 cases; 31%), neurotrauma (353 cases; 28%) and altered mental status (151 cases; 12%) (Figure 1A), with a significantly higher volume of CVD observed at HUEH (Figure 1B). Differences in disease pattern were not statistically significant among hospitals for the other categories.

Table 1. Demographics of Emergency Department–Based Admissions

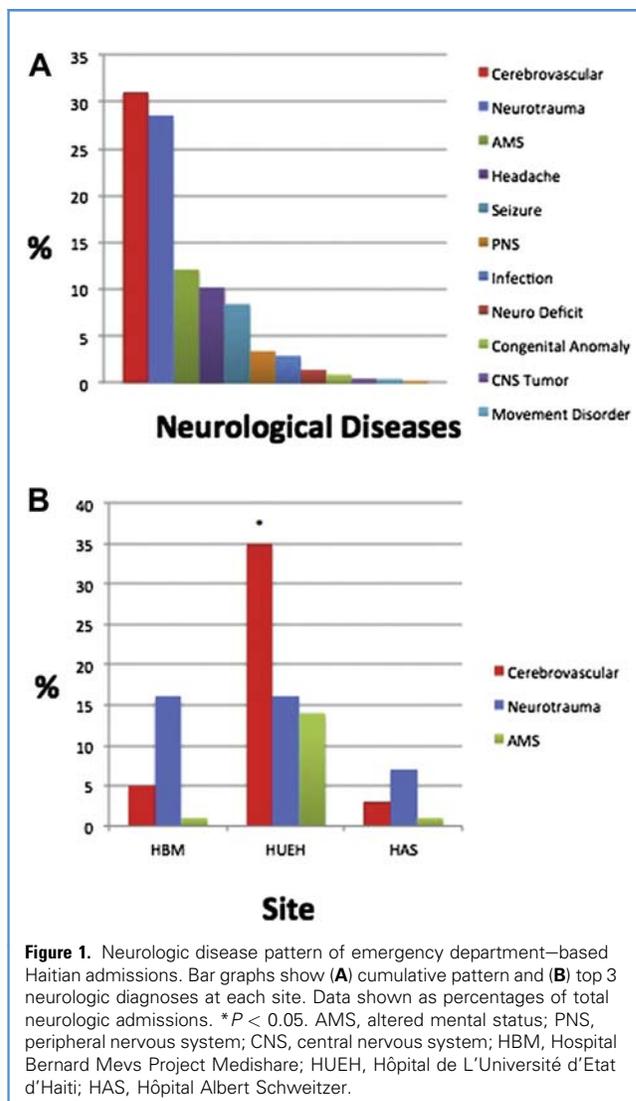
Characteristic	Total	HBM	HUEH	HAS
Total emergency department admissions	7628	2502	4070	1056
Neurologic admissions (%)	1243 (16)	314 (13)	792 (19)	137 (13)
Female gender (%)	54	42	60	42
Age (years)	39 ± 23	26 ± 22	43 ± 21	47 ± 23

HBM, Hospital Bernard Mevs Project Medishare; HUEH, Hôpital de L'Université d'État d'Haiti; HAS, Hôpital Albert Schweitzer.

At the 2 sites with neurosurgical services (HBM and HUEH), 1106 neurologic patients were seen out of 6572 ED admissions, yielding a neurologic disease prevalence of 17% for the 2 sites. A neurosurgical consultation was requested for 208 patients, which represented 19% of all neurologic admissions and a combined ED-based neurosurgical disease prevalence of 3%. The most common neurosurgical disease was neurotrauma, which triggered 181 (87%) of the 208 consultations. The most common causes of neurotrauma were motor vehicle accidents (MVAs) (59%), falls (20%), assault without a firearm (12%), gunshot wounds (5%), and falling objects (4%) (Figure 2A). Neurosurgical disease patterns for conditions other than neurotrauma, representing the remaining 27 consultations (13%), are summarized in Figure 2B. Table 2 summarizes the outcome of patients with a neurologic disease; 90% were successfully discharged home. Mortality was 9%. There was no statistically significant difference in patient outcome between sites. Neurosurgical procedures were performed in 14 of 208 patients (0.7%) with neurosurgical disorders; mortality rate was 33% (Table 3).

DISCUSSION

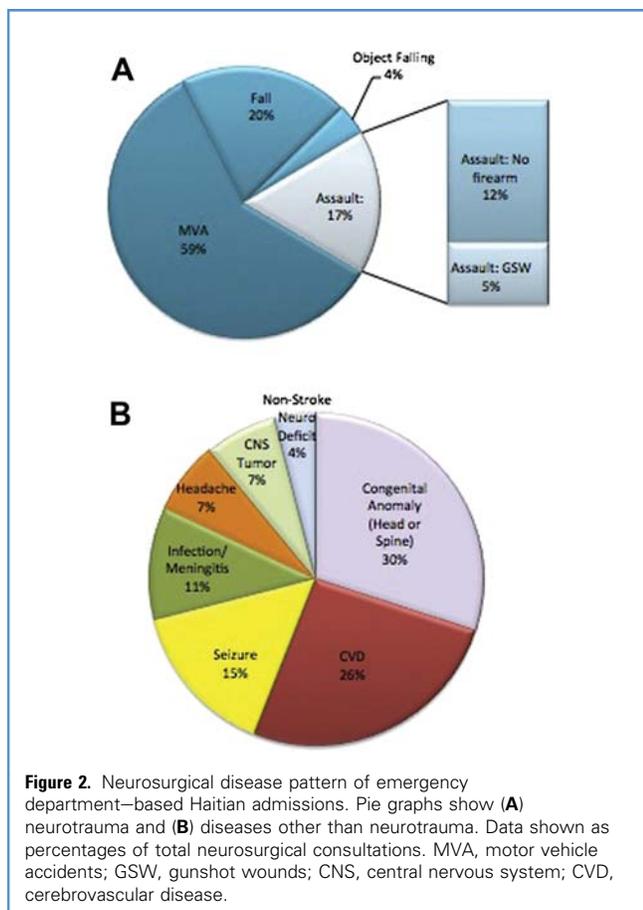
Our prospective study reveals that the 2 main causes of ED-based neurologic disease in Haiti are CVD and neurologic trauma. According to a report by the World Health Organization (WHO), CVD accounts for 3.46% of the global disease burden and is the principal cause of neurologic disease burden as measured by disability-adjusted life years, accounting for 55% of all neurologic disease categories (35). Neurologic injuries are estimated by the WHO to account for >33% of the world's neurologic disease burden as measured by years lived with disability (35). In the United States, CVD and neurotrauma are known public health concerns. The U.S. Centers for Disease Control and Prevention (CDC) estimates for ED visits in 2007 show CVD as the fourth most common hospital discharge diagnosis group, representing 3% of all ED visits and exceeded by only 3 nonneurologic disease categories: heart disease (6.3%), chest pain (5.7%), and pneumonia (3.5%) (25). The CDC estimates also show that from 2002–2006, traumatic brain injury (TBI) was responsible for 1.4% of all ED visits. Falls were the most common cause of TBI during this time period; however, MVA was the second leading cause of TBI (17.3%) and the most common cause of TBI-related death (31.8%) (14). Collectively, the WHO and U.S. patterns of CVD and



neurotrauma are very similar to our data showing an ED-based disease prevalence of 5.07% for CVD and 4.6% for trauma. Similarly, the leading causes for neurotrauma in our study were MVA and falls.

The predominant focus of international public health in developing nations such as Haiti has long been on communicable diseases that are not treated surgically, inspiring health care providers to dub surgical specialties such as neurosurgery the “neglected stepchild of global health” (4, 8, 18, 26). However, our results demonstrate that noncommunicable and surgical diseases such as stroke and neurotrauma are conditions contributing significantly to the Haitian disease burden (5, 8).

Our findings suggest that the United States and Haiti have similar neurologic disease trends, despite being at opposite ends of the economic spectrum with 2011 gross domestic product estimates of \$14.99 trillion (United States) and \$7.35 billion (Haiti) (33). These 2 countries significantly differ in the number of specialized providers



available to care for these patient populations. With only 5 local neurosurgeons and 1 local neurologist available to care for the entire population (2013 estimate 9,893,934), the number of such providers is 0.05/100,000 and 0.01/100,000, respectively (9). By comparison, the WHO estimated in 2004 that there were >1 neurosurgeon/100,000 and 5 neurologists/100,000 in the United States (30).

Table 2. Neurologic Outcome

Outcome	Total n = 1210	P = 0.560		
		HBM n = 313	HUEH n = 760	HAS n = 137
Discharged/transferred (%)	1083 (90)	286 (91)	672 (89)	125 (91)
AMA* (%)	30 (2)	5 (2)	24 (3)	1 (1)
Died (%)	97 (8)	22 (7)	64 (8)	11 (8)

HBM, Hospital Bernard Mevs Project Medishare; HUEH, Hôpital de L'Université d'État d'Haïti; HAS, Hôpital Albert Schweitzer.
*Left against medical advice (AMA).

Table 3. Neurosurgical Interventions and Outcomes

Case Number	Intervention	Patient Outcome
1	Craniotomy/evacuation of empyema	Death
2	Encephalocele repair	Death
3	Myelomeningocele repair	Discharge
4	Myelomeningocele repair/VP shunt	Discharge
5	Laminectomy/trauma	Discharge
6	Craniotomy/elevation of depressed skull fracture	Discharge
7	Craniotomy (epidural hematoma)	Discharge
8	Craniotomy (frontal fracture, intracranial hemorrhage)	Death
9	Laminectomy (cauda equina)/completion of wound closure	Discharge
10	Craniotomy (right parietal epidural vs. subdural)	Discharge
11	Craniotomy (hemorrhagic brainstem CVA)	Death
12	Encephalocele repair	Death
13	Craniotomy (epidural hematoma)	Discharge
14	Craniotomy (subdural hematoma)	Discharge

VP, ventriculoperitoneal; CVA, cerebrovascular accident.

Prevention of CVD and neurotrauma is essential. In this survey, 33% of patients with CVD presented with neurologic manifestations of hypertensive emergency, whereas the remaining patients presented with stroke. Hypertension is the most important modifiable risk factor for both ischemic and hemorrhagic stroke, with blood pressure control correlating with a 30%–40% reduction in stroke risk (16). The patterns of hypertension-related CVD emergencies identified by this study agree with other studies reporting a high prevalence of hypertensive disease among Haitians and point to the need for prevention (20, 29). Regarding the neurotrauma patterns identified among Haitian patients in this study, the finding of MVAs as the principal cause of TBI is consistent with road traffic injury being a known global public health problem (27). Promotion of helmet use for motorcyclists is a potentially cost-effective intervention that would significantly reduce the Haitian neurologic disease burden and alleviate the Haitian economy of a significant drain (6).

In addition to direct efforts to prevent neurologic diseases, resources and training for effective management of CVD and TBI are needed to reduce the morbidity and mortality caused by these disorders (2, 3, 24). CT brain imaging was available at only 1 of the 3 sites in this study (HBM). The absence of CT brain imaging at the other sites is a direct barrier to the appropriate management of stroke and head trauma. Affordable access to a CT scanner at major referral centers in Haiti could provide for significant improvement in neurosurgical and neurologic care (19, 22). Another important initiative would be appropriate training of first responders and local physicians and surgeons to recognize and

manage the 2 most common conditions identified in this study. This training could be a first step toward creating specific educational programs to train more neurologists and neurosurgeons.

Using the 2002–2006 CDC data, TBI results in 51,538 deaths annually in the United States with an annual estimate of 1,364,797 TBI cases treated and released from U.S. EDs; for every TBI fatality in the United States, there are approximately 26 ED visits (14). Our combined data for all sites in Haiti found 24 total TBI fatalities in 314 cases of TBI admitted to the ED, resulting in 1 TBI fatality per 13 ED visits. The stark disparity between the United States and Haiti in terms of neurosurgical and neurologic resources could contribute to a near doubling of TBI fatality rates in Haiti. Similarly, among the 264 patients with stroke in our survey for whom discharge status was known, we observed a mortality rate of 19% compared with the 7% rate reported by the CDC data from 195 hospitals in 4 states in the United States from 2005–2007 (15). A previous study demonstrated an association between higher density of specialist neuroscience providers and fewer deaths from stroke (10). The elevated stroke mortality found in our own study can similarly be attributed to a lack of specialist neuroscience providers in Haiti.

This study has limitations. First, we acknowledge that the burden of neurosurgical and neurologic disease was most likely underestimated because of lack of neurologic expertise and brain imaging resources at our sites. Second, the study period was

limited to 90 consecutive days of ED admissions at each site, excluding potential variability in admission patterns that might be seen year round or more longitudinal patient follow-up that might alter the data for patient outcome. Third, this survey focused on ED admissions only and did not take into account neurologic and neurosurgical disease patterns in a nonemergent hospital population or in the general Haitian population.

CONCLUSIONS

To our knowledge, this prospective survey is the first study of neurosurgical or neurologic disease patterns in Haiti. Haiti has a significant neurologic disease burden consisting primarily of CVD and neurotrauma. We hope that further studies can stem from this preliminary work. Additionally, we hope that the findings of our study will provide useful input to global health policies and study of global disease burden, to Haitian public health officials and educators involved in the training of Haitian physicians, and to humanitarian organizations that aim to improve Haitian health care.

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