Original Article

Patterns of Neurosurgical Conditions at a Major Government Hospital in Cambodia

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Abstract

Background: Low- and middle-income countries (LMICs) have a growing and largely unaddressed neurosurgical burden. Cambodia has been an understudied country regarding the neurosurgical pathologies and case volume. Rapid infrastructure development with noncompliance of safety regulations has led to increased numbers of traumatic injuries. This study examines the neurosurgical caseload and pathologies of a single government institution implementing the first residency program in an effort to understand the neurosurgical needs of this population. **Methods:** This is a longitudinal descriptive study of all neurosurgical admissions at the Department of Neurosurgery at Preah Kossamak Hospital (PKH), a major government hospital, in Phnom Penh, Cambodia, between September 2013 and June 2018. **Results:** 5490 patients were admitted to PKH requiring neurosurgical evaluation and care. Most of these admissions were cranial injuries related to road traffic accidents primarily involving young men compared to women by approximately 4:1 ratio. Spinal pathologies were more evenly distributed in age and gender, with younger demographics more commonly presenting with traumatic injuries, while the older with degenerative conditions. **Conclusions:** Despite increased attention and efforts over the past decade, Cambodia's neurosurgical burden mirrors that of other LMICs, with trauma affecting most patients either on the road or at the workplace. Currently, Cambodia has 34 neurosurgeons to address the growing burden of a country of 15 million with an increasing life expectancy of 69 years of age, stressing the importance of better public health policies and urgency for building capacity for safe and affordable neurosurgical care.

Keywords: *Cambodia, developing countries, epidemiology, global neurosurgery, low- and middle-income country*

Introduction

Low- and middle-income countries (LMICs) face unique struggles to address the neurosurgical burden of their populations. There is a gross lack of surgical access for LMICs in comparison to developed countries. Developed countries receive 75% of all surgical procedures for the top 30% of the population, while, in comparison, only 3.5% of surgical cases are performed on the 30% of the lowest income populations in LMICs.[1,2] With an estimated 5 billion individuals not having access to safe surgical care, the importance of addressing the surgical burden has become an area of growth in the global health landscape. In addition, the surgical and neurosurgical burden within LMICs has a more disparate distribution in terms of quality and availability of care.[3-5] Many studies have been done on the surgical burden of LMICs in Asia and Africa, however, only a few studies have specifically addressed the neurosurgical burden of Cambodia.

The population of Phnom Penh, the capital city of Cambodia, has grown remarkably from only 30,000 in 1978 to 2 million in 2019.[6] After the fall of the Khmer Rouge, only 21 physicians remained in the country, none of whom were trained neurosurgeons. This created an urgent need to rebuild the health-care system across the whole spectrum of specialties. A revival of neurosurgery in Cambodia has been underway through the assistance of the international neurosurgical community. Before the introduction of formal neurosurgical training, neurosurgical procedures were performed by general surgeons. The first formally trained Cambodian neurosurgeon began practicing in 1998 at Calmette Hospital.

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The first neurosurgical department was only established at the government-run Preah Kossamak Hospital (PKH) in 2011. Currently, there are 34 trained neurosurgeons in Cambodia to address the neurosurgical needs of a country with a population of over 15 million – roughly one for every 870,000, with a great majority of them working in the capital city of Phnom Penh. The PKH has 4 neurosurgeons, 2 fellows, 4 residents, and 10 nurses, and over the past decade, it has successfully built up an active neurosurgical ward, thanks in part to the diplomatic partnerships with individual volunteering neurosurgeons and numerous not-for-profit organizations from Korea, Japan, and the United States.

Given the nascent history of neurosurgery in Cambodia, very limited research has been done to describe the patient population and the scope and limitations of neurosurgical practices in the country. Indeed, despite the rapidly growing numbers of injuries, the supply and quality of neurosurgical care have remained largely unknown. In order to address this need, our study was performed to identify the gaps both in the knowledge and the practice of neurosurgery in Cambodia. Here, we present 58 months of longitudinal data from a single government hospital with the first neurosurgical training program in Cambodia.

Methods

This is a longitudinal descriptive study of patients admitted with a neurosurgical pathology to PKH, a major government hospital, in Phnom Penh, Cambodia, between September 2013 and June 2018.

There were 5490 patients admitted with neurosurgical conditions during the study period. Data collection was performed by a single dedicated hospital research assistant, who interviewed each patient and entered their data into an Excel database.

The population sample includes Cambodians living in Phnom Penh and the surrounding provinces. Patient demographics (age, sex, and residing province), mechanism and time of injury, helmet use, alcohol use, images taken (skull radiographs, computed tomography [CT], and magnetic resonance imaging [MRI]), Glasgow Coma Scale (GCS) on admission, diagnosis, and types of procedures were obtained from the patient records. Levels of injury for spinal data were counted per injury, not per patient. Individuals sustaining multiple levels of injury were grouped into each appropriate category. Basic descriptive statistics, such as linear regression, were performed on Excel. The statistical analyses and figures result from analyzing only the available data for each specific variable.

This study was approved by the Cambodia National Ethics Committee for Health Research, protocol #350 NECHR.

Results

Neurosurgical overview

Patients presented from 23 provinces, traveling across the country to seek care at PKH [Figure 1]. 32% of the patient admissions were directly from Phnom Penh, while the rest were referrals from regional hospitals with inadequate neurosurgical care. The number of patients from each area appears to correlate to the proximity to the capital. Over the 5-year period of data collection, the number of neurosurgical cases to PKH increased by an average of 2.2 patients/month, with a peak of 222 admissions in December of 2017 [Figure 2].

Admissions to PKH were broadly categorized into cranial and spinal pathologies, which were then subcategorized into traumatic and nontraumatic admissions. Cranial cases constituted 74% of the overall admissions, while spinal cases made up the remaining 26%. 89% of the cranial pathologies were of traumatic origin, while the remaining 11% had a nontraumatic origin. Among the spinal admissions, the breakdown was 47% traumatic and 53% nontraumatic. Approximately 1 in every 5 patients with cranial pathologies received surgical intervention (21% traumatic and 20% nontraumatic), while approximately 1 in every 2 spinal pathologies received surgical intervention (47% for traumatic and 56% for nontraumatic) [Figure 3a].

The majority of trauma cases for both cranial and spinal groups were males, who made up 78% of the traumatic cranial admissions and 72% of the traumatic spinal admissions. The male predominance was less markedly skewed among nontraumatic admissions (60% in nontraumatic cranial and 52% in nontraumatic spinal groups) [Figure 3b].

Among the patients with cranial pathologies, those in their 20s and 30s made up the highest proportions, 39% and 19%, respectively. Among those with spinal pathologies, those in their 30s made up the largest proportion at 20%,

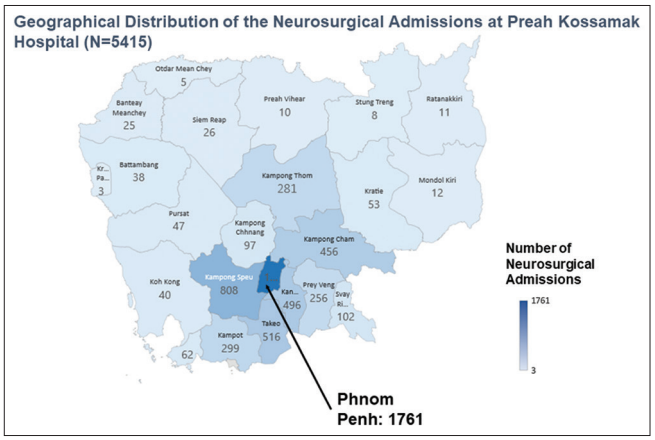

Figure 1: Provinces of Cambodia and distribution of neurosurgical patients admitted to Preah Kossamak Hospital

however, patients' ages were more evenly distributed compared to cranial cases [Figure 4a and b]. In terms of the time of injury, more injuries took place in the evening, reaching the peak between the hours of 6 PM and 7 PM [Figure 5].

Cranial pathologies

Characteristics

Of the 4139 cranial admissions, 89% were traumatic in etiology. Consistent with patterns of injury in other LMICs, the top three mechanisms of head injuries were road traffic accidents (RTAs; 79.4%, n = 2928), fall from height greater than standing (8.5%, n = 314), and assault (7.2%, n = 264). Among the RTAs, helmet use in this current study was found to be only 13.7%, while alcohol involvement was found to be 38.8% [Table 1].

Diagnostic evaluation and management

At PKH, X-ray and CT imaging modalities are available, however, there are no MRI capabilities on-site. 94.7% of all cranial admissions underwent CT imaging (n = 3920), while 37% received plain skull X-ray (n = 1535). Only 2.5% of cranial cases underwent MRI evaluation at outside hospitals (n = 104) [Table 1].

Among the traumatic cranial pathologies, the three most common diagnoses were concussion (30.7%, n = 1138), contusion (19%, n = 705), and skull fracture (12.6%, n = 468). Epidural hematoma and subdural hematoma made up 12.3% and 11.3% of the diagnoses in the cranial admissions, making them the fourth and fifth most common cranial diagnoses at PKH. Nontraumatic cranial diagnoses included stroke and tumors, accounting for 39.4% and 18.8%, respectively [Table 2]. Without stroke intervention capabilities, endovascular interventions were not performed at PKH.

Patients were clinically categorized at the time of admission into mild (GCS 13–15), moderate (GCS 9–12), or severe brain injury (GCS 3–8), with records available for 3686 of the patients. 71% of these patients had a mild brain injury, while 16% and 10% of these patients presented with moderate and severe brain injury, respectively [Figure 6].

In terms of surgical intervention, the most commonly performed procedures were craniotomy, craniectomy, and bone fragment elevation among traumatic cranial admissions, and for nontraumatic cranial admissions, they were craniectomy, burr hole, and extirpation [Table 2].

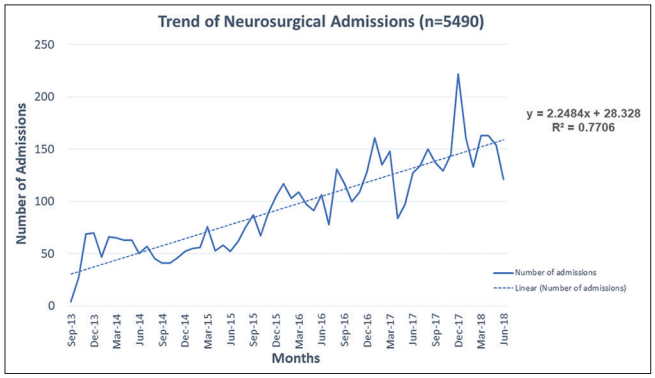

Figure 2: Monthly admissions to Neurosurgery Department at Preah Kossamak Hospital from September 2013 to June 2018

Spinal pathologies

Characteristics

Spinal admissions were less skewed toward traumatic etiologies compared to cranial admissions. 47% of the 1459 spinal admissions were of traumatic etiology were of traumatic etiology, with the most common mechanisms of injury being falls (51.7%, n = 354), RTAs (38%, n = 260), and being struck by falling objects (5.4%, n = 34). This may reflect the fact that, with the developing infrastructure, more Cambodian citizens are using motorcycles, cars, and bicycles, severely congesting the roadways. Despite the newly instated helmet law in 2016 that mandates all motorbike riders and passengers to wear helmets, of the patients with spinal injury from RTAs, only 12.8% were noted to be wearing a helmet at the time of the accident, and 12% also reporting alcohol use before the accident [Table 3].

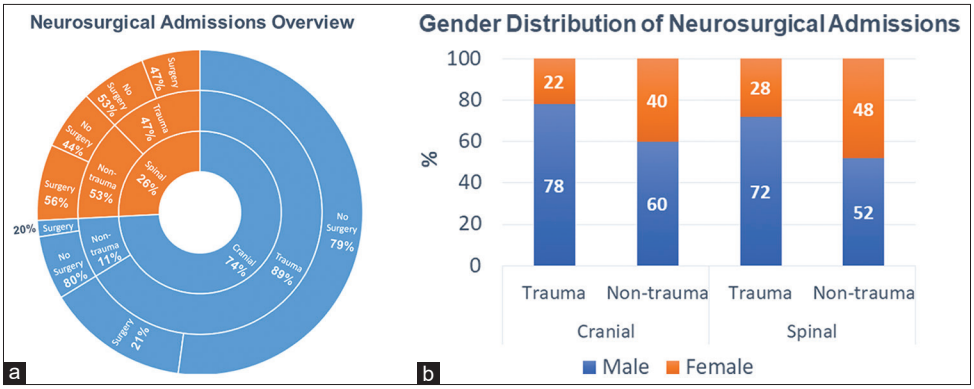

Figure 3: (a) Overview of neurosurgical admissions to Preah Kossamak Hospital categorized into spinal and cranial cases with further subcategorization by admission type and surgical intervention. (b) Gender distribution among the subcategories

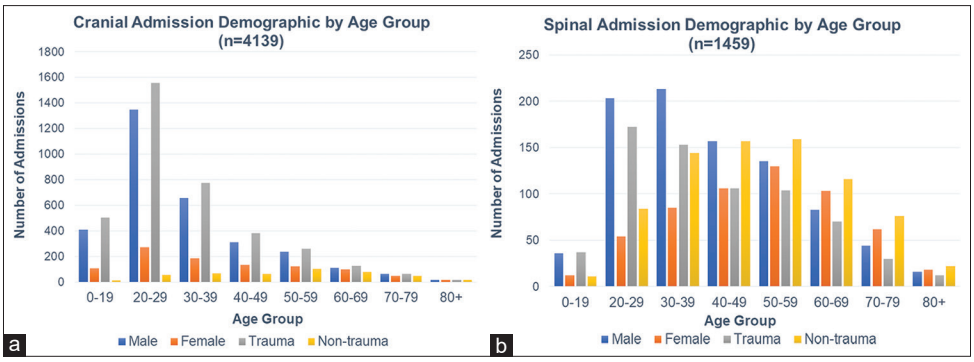

Figure 4: (a) Age and gender distribution of cranial admissions. (b) Age and gender distribution of spinal admissions

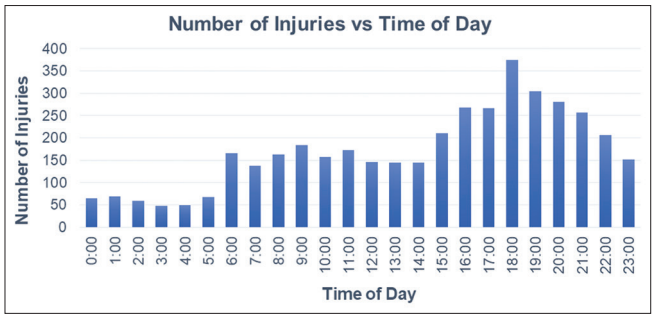

Figure 5: The time of injury sustained for the overall neurosurgical admissions

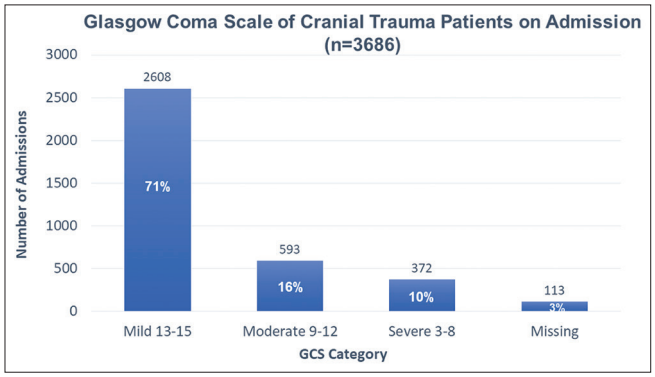

Figure 6: Glasgow Coma Scale of traumatic cranial patients on admission

Diagnostic evaluation and management

As in the case of cranial admissions, patients with spinal pathology (traumatic and nontraumatic) underwent basic radiographic studies. 1212 patients out of the 1459 spinal admissions received X-ray of their spine (83%), while CT and MRI were performed on 803 (55%) and 551 (38%) spinal patients, respectively. Patients undergoing MR studies were sent to off-site facilities for their imaging.

Among the traumatic spinal admissions, the most common pathologies included compression fracture (n = 129), burst fracture (n = 84), and complete/incomplete spinal cord injury (n = 63). There were also 310 patients who had unspecified types of spinal fracture injury. Among the nontraumatic spinal admissions, the most common pathologies were herniated lumbar disc (47.7%, n = 337),

Table 1: Cranial admission characteristics (n=4139)

Characteristic	Value (%)
Type of admission	
Trauma	3686 (89.1)
Nontrauma	443 (10.7)
Missing data	10 (0.2)
Mechanism of trauma	
RTA	2928 (79.4)
Fall	314 (8.5)
Assault	264 (7.2)
Object to head	77 (2.1)
Others	103 (2.8)
RTA helmet/alcohol use	
RTA helmet use	13.7
RTA alcohol involvement	38.8
Imaging	
X-ray	1535 (37)
CT	3920 (94.7)
MRI	104 (2.5)
Missing data	33 (0.8)

RTA – Road traffic accident; CT – Computed tomography; MRI – Magnetic resonance imaging

Pott's disease (11.6%, n = 82), and tumors involving the spinal regions (10.5%, n = 74) [Table 4].

The lumbar spine was the most commonly involved level of injury, accounting for 40% of the levels identified, followed by cervical spine and thoracic spine injuries [Figure 7].

In terms of operative management, the most common procedures were posterior spinal fusion and anterior cervical discectomy and fusion for traumatic spinal admissions and discectomy, laminectomy, and laminoforaminotomy for nontraumatic spinal admissions [Table 4].

Discussion

Neurosurgical admissions have increased steadily between 2013 and 2018 at PKH, with notable periodicity between the dry (November–January) and rainy (April–May) seasons. This seasonal variability likely reflects the changes in road conditions as well as fewer motorized

Table 2: Top primary cranial diagnoses and procedures

Characteristic	Value (%)
Top primary cranial trauma diagnoses	
Concussion	1138 (30.7)
Contusion	705 (19)
Skull fracture	468 (12.6)
EDH	457 (12.3)
SDH	420 (11.3)
Top primary cranial nontrauma diagnoses	
Stroke	155 (39.4)
Tumor	74 (18.8)
ICH	59 (15)
SDH	23 (5.9)
Brain abscess	10 (2.5)
Top primary cranial trauma procedure	
Craniotomy	310 (39.5)
Craniectomy	308 (39.2)
Bone fragment elevation	67 (8.5)
Burr hole	16 (2.0)
Posterior spinal fusion	13 (1.7)
Top primary cranial nontrauma procedure	
Craniectomy	32 (35.6)
Burr hole	16 (17.8)
Extirpation	8 (8.9)
Craniotomy	7 (7.8)
VP shunt formation	6 (6.7)

EDH – Epidural hematoma; SDH – Subdural hematoma; ICH – Intracranial hemorrhage; VP – Ventriculoperitoneal

Table 3: Spinal admission characteristics (*n*=1459)

Characteristic	Value (%)
Type of admission	
Trauma	685 (46.9)
Nontrauma	770 (52.8)
Missing data	4 (0.3)
Mechanism of trauma	
Fall	354 (51.7)
RTA	260 (38.0)
Hit by falling object	37 (5.4)
Assault	11 (1.6)
Others	9 (1.3)
Missing data	14 (2.0)
RTA helmet/alcohol use	
RTA helmet use	12.8
RTA alcohol involvement	12
Imaging	
X-ray	1212 (83.1)
CT	803 (55)
MRI	551 (37.8)
Missing data	22 (1.5)

RTA – Road traffic accident; CT – Computed tomography; MRI – Magnetic resonance imaging

vehicles on the roads during the rainy season, when poor weather conditions and flooding may be prohibitive for transportation.

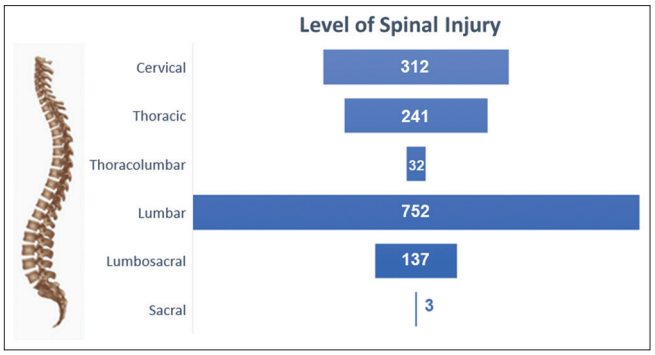

Figure 7: Level of spinal injury

Traumatic brain injuries and spine injuries generate most of the neurosurgical admissions and operative procedures at PKH. The relative paucity of elective neurosurgical conditions, such as degenerative spine, tumors, and vascular lesions, may not reflect the true incidence and prevalence of these conditions but rather underdiagnosis due to a lack of familiarity or available resources in treating these conditions. As the neurosurgical expertise and capacity continue to expand with more training and exposure, more elective neurosurgical cases can be identified to receive intervention.

The proportion of men among traumatic brain injuries far outnumbered that among traumatic spinal cases. While there are no published data analyzing the gender discrepancy among Cambodian drivers, it is possible that the ratio of male to female admissions may be skewed due to there being more men traveling on the roads. Estimates from the World Bank's Gender Database from 2016 also demonstrated that Cambodian men make up a higher percentage of the labor force for low, middle, and high-income brackets, compared to women.[7] This gender distribution in economic opportunities, in addition to the greater number of men on the road, may have led to the phenomenon we observed in our study.

Cambodia's unique road infrastructure and driving practices are important factors when considering its neurosurgical burden. These include extremely congested roads, lack of proper lane divisions, poor helmet compliance, and inadequately policed driving practices. These characteristics, along with the dramatic increase in the number of registered vehicles over the past few decades, likely contributed to the high RTA volume seen in this article. This also resembles the trends seen in other developing nations such as Nepal, Papua New Guinea, and Uganda, which have also reported large increases in head trauma cases.[8-10] They have also shown, as seen in this article, that young men in their 20s and 30s sustaining RTA-induced injuries are the demographic that contribute the most to the nations' neurosurgical burden.[11-16]

Conversely, nontraumatic spinal admissions at PKH more commonly involved older patients presenting with disc

Table 4: Top primary spinal diagnoses and procedures

Characteristic	Value (%)
Top primary spinal trauma diagnoses	
Fracture (unspecified)	310 (43.2)
Compression fracture	129 (18.0)
Burst fracture	84 (11.7)
Complete spinal cord injury	36 (5.0)
Incomplete spinal cord injury	27 (3.8)
Top primary spinal nontrauma diagnosis	
Herniated lumbar disc	337 (47.7)
Pott's disease	82 (11.6)
Tumor	74 (10.5)
Lumbar stenosis	61 (8.6)
Foraminal stenosis	35 (5.0)
Top primary spinal trauma procedure	
Posterior spinal fusion	212 (65.6)
ACDF	67 (20.7)
Discectomy	9 (2.8)
Laminectomy	8 (2.5)
Laminoplasty	5 (1.5)
Top primary spinal nontrauma procedure	
Discectomy	176 (42.7)
Laminectomy	71 (17.2)
Laminoforaminotomy	42 (10.2)
Hemilaminectomy and discectomy	36 (8.7)
Extirpation	13 (3.2)

ACDF – Anterior cervical discectomy and fusion

herniations, infectious causes, and degenerative changes like spinal stenosis. This pattern may be a consequence of the increasing life expectancy in Cambodia. Indeed, the nation's life expectancy increased from 67 in 2012 to 69 in 2017, according to the World Bank.[7] The aging population, arising from the recent advancements in health care, may have contributed to the appreciable prevalence of elective spinal cases for age-related neurological pathologies.

While Cambodia is making strides toward improving its health-care system and the field of neurosurgery, it still has multiple shortcomings in its current state. Notably, there is a lack of an extensive health-care data infrastructure and inadequate means for communication with patients for follow-up. Without the availability of a reliable medical record system at PKH, a thorough retrospective chart review was unable to be performed. This, in effect, was a major limitation for this current article, as its database relied on manual recording of data only during the time of inpatient hospitalization. Families often travel with patient records and films to the hospital, and often, they were unable to return for follow-up evaluation. Follow-up via phone calls was also limited as many patients and their families did not have a mobile device. Given these limitations with data management and postdischarge communication, many early entries of the database were deemed incomplete during our analysis.

Furthermore, as a retrospective study of a single government hospital, this article provides only a glimpse of the overall neurosurgical burden of Cambodia as a whole and therefore has limited generalizability. For example, there is great variability of resources, even among different hospitals within Phnom Penh. For example, Calmette Hospital, with support from the French and Cambodian governments and other private institutions, is better equipped in terms of diagnostic capabilities (such as an on-site MRI machine) and pre- and postoperative care. Similarly, Royal Phnom Penh Hospital, established in 2014 and affiliated with Thailand's Bangkok Dusit Medical Services Group, boasts state-of-the-art technology, 14-intensive care unit beds, and 5 operative rooms. Further descriptive studies from these and other hospitals with neurosurgical capacities would be necessary for more in-depth understanding of the case volumes and neurosurgical capacity in Cambodia.

Finally, the gaps in the insurance coverage are another ongoing issue that affects many Cambodian patients. In Cambodia, civil servants and formally employed workers are covered by the National Social Security Fund (NSSF) under the Ministry of Labor, and the poorest of the poor receive nearly free access to health care through a program known as the Health Equity Fund. However, these groups constitute only 40% of Cambodia's population, and even their insurance plans have limitations. For example, during the time of this study, Health Equity Fund (HEF) patients coming to PKH had to pay out of pocket for CT imaging, as the machine was leased by a private company. It has also been a commonplace for those covered by the NSSF to pay out of pocket for the cost of the emergency operations (including neurosurgical operations on trauma cases), requiring many of these patients to sell their properties or ask relatives for help. The remaining 60% of Cambodian citizens, the "informal sector," has also had numerous barriers to getting access to health insurance and receiving care. With the help of several international advisory entities, such as the Japanese International Cooperation Agency, the Cambodian government has recently developed a National Social Protection Policy Framework 2016–2025 both to reduce the widening economic disparity and to expand coverage for quality health care to its citizens over the 10-year period.[17] These policy efforts, combined with future epidemiological studies on the quality of surgical practices throughout Cambodia, could one day provide evidencebased recommendations for improved neurosurgical practices and assure that those that need surgery can and will receive the necessary treatments.

Conclusions

Our study at PKH in Phnom Penh was performed to provide a window into the neurosurgical caseload and burden in the most populous city of Cambodia. As reported in previous studies that looked at cranial and spinal injuries in developing nations, our findings also revealed multiple interesting trends that uniquely reflect the economic and cultural state of Cambodia. Our study

showed that young men in their 20s and 30s dominate cases for both cranial and spinal admissions. Given that the limited number of neurosurgeons in Cambodia is mostly in Phnom Penh, the access to neurosurgical care is limited both by geography and limited data and telehealth infrastructure. Our findings call for an urgent need to implement policies to comprehensively manage head and spine injuries in Cambodia. These policies should include the entire spectrum of head and spine injury management from surveillance, prevention strategies, prehospital care, surgical service delivery, and rehabilitation.[18] Finally, the study also revealed a great need to develop a robust electronic medical record infrastructure for the Cambodian health-care system, not only to provide more extensive analyses on outcomes and follow-up data but also to demonstrate a more complete picture on the neurosurgical burden affecting Cambodia as a whole.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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