



COUNTRY REPORT

Imaging in the Khmer's Land: Cambodia Country Report

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Introduction

CAMBODIA is located in Southeast Asia on the Indochina Peninsula and borders Vietnam, Laos, Thailand and the Gulf of Thailand (Figure 1). With a total area of 69,898 square miles and population of 15,458,332, Cambodia's population density has steadily increased since 1980. The country's annual rate of urbanization is 2.65%. As of 2014, 20.5% of the population lives in an urban setting. The estimated population growth rate is 1.63% (1). The capital of Cambodia is Phnom Penh, which is located in the southern part of the country. Other major cities include Battambang and Siem Reap, both of which have populations over 150,000. There are officially 24 provinces and one municipality (Phnom Penh). However, many consider Phnom Penh to be its own province. As a result, some research puts the number of Cambodian provinces at 25.

The climate is tropical with two seasons: monsoon season (May to November) and dry season (December to April). Temperatures range from approximately 70 to 95°F. Cambodia's economy largely depends on the garment industry, tourism, construction, real estate and agriculture. Cambodia gained independence from France in 1953 and was first ruled by a constitutional monarchy under King Norodom Sihanouk. After a five-year struggle starting in 1970, the Khmer Rouge captured Phnom Penh in 1975. Pol Pot, the leader of the Khmer Rouge, oversaw a brutal regime that, through executions and forced labor, was responsible for the deaths of at least 1.5 million Cambodians. The Vietnamese drove out the Khmer Rouge in 1979. After years of Vietnamese occupation, the 1991 Paris Peace Accords established a ceasefire and a democratic framework for the country. By 1993 elections established a new coalition government; yet, political instability and violence persisted throughout the 1990s. Cambodia most recently held elections in 2013, as a multiparty democracy under a constitutional monarchy.

The devastation caused by the Khmer Rouge has had long-lasting negative effects on Cambodia's political and economic systems, as well as to its infrastructure, and public health. Despite this, Cambodia has made measurable improvements. At the end of Khmer Rouge rule in 1980, life expectancy was 30 years (1). Political stabilization,

economic improvement and a growing healthcare system improved the life expectancy to 63.78 years by 2015 (2). The physician density remains low, at 0.17 physicians per 1,000 people (2). As of 2012, there were eight national hospitals and three levels of referral hospitals in the public sector. Referral hospitals are categorized by three levels of Complementary Package of Activity (CPA): 1) CPA-1 hospitals do not perform surgery; 2) CPA-2 hospitals perform surgeries but with more limited specialized services; and 3) CPA-3 hospitals perform surgery with more specialized services. There are 26 CPA-3 hospitals in Cambodia (3). As of 2011 there were 2,391 doctors, 8,433 nurses and 3,748 midwives (3). There are also NGOs that run hospitals throughout Cambodia, as well as private sector health care facilities.

The radiology environment

Radiologists in Cambodia

The exact number of radiologists in Cambodia is unknown, but informal numbers range from 20 to 60 radiologists nationwide. Due to the lack of formal organization within the Cambodian radiology community, it is extremely difficult to estimate the exact number of radiologists.

The total number of specialist medical practitioners in all fields in 2011 was estimated to be 351 (4); the percentage of radiologists from the specialist sector is not specified. Cambodian specialists must complete six years of medical school to receive a Bachelor of Medical Sciences (BMedSc), followed by 3-4 years of specialized training, for a total of 9-10 years of training. After completion of their training students are awarded a Degree of Specialized Doctor (MD-D.E.S). Much of the radiology training is structured like an apprenticeship. There is no standardized radiology curriculum or licensing exam, nor is there any known continuing medical education curriculum for radiologists. Since the vast majority of the radiology equipment in Cambodia is located in major cities, where most radiologists are found in urban areas.

Technologists in Cambodia

University of Health Sciences (UHS) is the only institution in Cambodia that trains radiology technologists (4). The total length of training is

Figure 1. Cambodia Map No. 3660 Rev. 4.



United Nations, Department of Peacekeeping Operations, Cartographic Section. January 2004. Retrieved from <http://www.un.org/Depts/Cartographic/map/profile/cambodia.pdf>.

three years and costs \$800 US per year.

According to the Cambodia Ministry of Health (MOH), from 2013-2014 there were 115 students at UHS pursuing a degree in radiology technology. At the start of the academic year the university matriculated sixty students: six on scholarships and 54 who were self-funded.

The degree granted by UHS is called an Associated Degree in Radiological Technology (ADRT). However, many radiology technologists practice without an official degree. For example, radiology technologists at Angkor Hospital for Children took an unspecified 3- or 6-month course before starting work. There is no known continuing medical education curriculum for radiology technologists in Cambodia.

Diagnostic and interventional skills

- **X-ray**
No x-ray limitations.
- **Computed tomography**
No CT limitations. Due to the limited number of CTs, patients must be referred to hospitals that have scanners for appropriate treatment.
- **Ultrasound**
Ultrasound is widely used by all specialists. FAST scans are

particularly important for medical, surgical and pediatric specialists. Ultrasound is also used by radiologists for a variety of pathologies ranging from abscess localization to ocular sonography. In June of 2015, China donated 200 ultrasound machines. However, ultrasound-guided procedures are still limited.

- **MRI**

There is only one MRI in the public sector according to the World Health Organization (WHO). Traditional diagnostic MRI is performed. The number of interventional procedures is unknown. Other informal reports suggest that there may be additional MRIs in the country.

- **Angiography**

Angiography is limited, but is available at Sen Sok International University Hospital in Phnom Penh. A cardiologist conducts these procedures.

- **Fluoroscopy**

Fluoroscopy is available at select hospitals.

- **Other interventions**

Surgeons conduct interventional procedures more commonly than radiologists.

Power supply

As of 2013, Cambodia consumed 3.553 billion kWh and only produced 1.77 billion kWh (2). The production of electricity is derived from hydroelectric plants (57.4%), fossil fuels (32.7%) and other renewable sources (10%) (2). Approximately 22.47% of Cambodians have electricity, including 54% of urban households and 14% of rural households (6). The Electricite Du Cambodge, a government enterprise that generates and distributes electricity, hopes to provide electrification to all villages by 2020 (6).

The cost of electricity is relatively high in Cambodia. As of 2012, the price has ranged between US \$0.16 - \$0.40 per kWh (7). Compared to other nations, such as the US, where, as of April 2015, electricity was \$0.10 kWh (8). Radiologists' dependence on technology that requires electricity is a challenge. Cambodia typically experiences six days of outages a month, lasting approximately 1.4 hours (9). Due to this volatility, many small business owners use diesel generators to generate power. (7).

Radiology equipment in Cambodia

The majority of diagnostic equipment is found in the major cities, especially Phnom Penh. Access to radiology is limited in rural communities and patients must travel great distances to access more developed healthcare (see Table 1).

PACS

PACS is available but not necessarily in wide use. For example, at Angkor Hospital for Children, radiologists use a web-based system. X-rays can be directly uploaded to the system, but ultrasound images are transferred via a USB stick.

MRI

WHO recorded one MRI in the public sector, which is located in Phnom Penh. According to the Ministry of Economy and Finance, Calmette Hospital has a 1.5T MRI that was installed in April 2015.

Computed tomography

There are six CT scanners in the public sector and 12 in the private sector (10).

Fluoroscopy

The exact number of fluoroscopes in Cambodia is unknown. However, they are available at various hospitals throughout the country. Sen Sok International University Hospital, a major teaching hospital in the capital city of Phnom Penh, is able to conduct fluoroscopy. Sihanouk Hospital Center of HOPE, which is located two hours outside of the capital, also owns a fluoroscope, as does Kantha Cophu IV Children's Hospital.

X-ray

The number of X-rays is unknown. X-rays are not only found

in the clinical setting, but also as portable screening devices for tuberculosis. For example, under the directly observed treatment, short-course (DOTS) strategy, patients with TB are closely and directly followed. Mobile X-rays are used by the National Centre for Tuberculosis and Leprosy (CENAT) as part of a screening program (11).

Service

Servicing radiology equipment is a challenge in Cambodia. Much of the equipment is donated, which in many cases means the warranty has expired. Accessing repair service is a challenge. The MOH published a report in 2011 regarding the acceptance of second-hand medical equipment. Pre-conditions for receiving donated equipment that must be met, including analysis of the needs for the equipment, contact with local agents, and providing basic information regarding the equipment. A Memorandum of Understanding must also be signed (12). Nonetheless, many pieces of radiology equipment remain broken and sit unused in hospitals, a problem not unique to Cambodia.

General Electric (General Electric, Schenectady, New York, USA) has been working with the Ministry of Health since 2009. GE has an office in Phnom Penh that can provide repair services. However, many hospitals use in-house staff to work on the machines. These are often general repair technicians who lack specialized training, often ordering replacement parts through e-commerce websites like eBay (eBay, San Jose, California, USA).

Job opportunities

Radiologists

Specialist medical practitioners in Cambodia were paid US \$153 per month as of 2011 (5). However, the annual recruitment in the public sector was low, at just five specialists per year (5).

Technologists

Radiology technologists in Cambodia are paid US \$79 per month. The annual recruitment in public sector from 2010–2011 was 24 radiology technologists.

Economics and imaging

Readiness for radiology entrepreneurship

Cambodia's economy has blossomed in the last decade. The real GDP growth of Cambodia was 7.0% in 2014 (13). This economic growth is attributed to a combination of tourism, garment production, construction, real estate and agriculture. Although Cambodia is one of the poorer countries in Asia, poverty rates declined to 17.7% in 2012. The GDP per capita was US \$1,084.40 in 2014. (14)

As discussed previously with relation to radiology entrepreneurship, the GINI index is a useful tool for assessing

Table 1. Radiology equipment in Cambodia, 2014. Source: Global atlas of medical devices 2014: Cambodia

Equipment	Public sector	Private Sector	Total	Density per 1,000,000 population
Magnetic Resonance Imaging	1	0	1	.066
Computerized Tomography Scanner	6	12	18	1.189
Ultrasound	n/a	n/a	n/a	n/a
X-Ray	n/a	n/a	n/a	n/a
Positron Emission Tomography Scanner	0	0	0	0
Nuclear medicine	0	0	0	0
Mammograph	n/a	n/a	n/a	n/a

income distribution and inequality (15). Based on a scale of 0 (no inequality) to 100 (very unequal), a higher number indicates greater inequality. As of 2008, Cambodia's GINI coefficient was 37.9, which was more equal when compared to the United States at 45 (2).

The World Bank and Asian Development Bank conducted the Investment Climate Assessment for Cambodia in 2014 (16). Of note, Cambodia is located geographically at the center of the Association of Southeast Asian Nations, giving the country a strategic advantage. The World Bank uses the Logistics Performance Index (LPI) to measure a country's perceived ability to conduct international trade. Cambodia has also greatly improved on the World Bank's LPI worldwide ranking from 129 in 2010 to 83 in 2014. With a growing and diversifying economy, Cambodia is attractive for foreign investment. However, investors face challenges such as high costs, unreliability of electricity, anti-competitive practices and endemic conditions. For radiology entrepreneurship, the high cost of electricity is particularly burdensome.

Radiology market and service capacity

According to a WHO survey of medical devices, there are a total of 18 CT scanners: six in the public sector and 12 in the private sector. Thus, the density of CT scanners per 1 million people is 1.189 (see Table 1), which is significantly lower than in developed nations.

With a very low density of radiology equipment for such a populous country, the MOH has included technology as a central goal for their 2008-2015 Health Strategic Plan. Specifically, the MOH seeks to "increase competency and skills of health workforce to deal with increased demand for accountability and high quality care, including through strengthening allied technical skills and advanced technology through increased quality practice of training, career development, right incentives and good working environment" (13, 17).

In addition to government support, NGOs play an important role in the growth of radiology services in Cambodia. For example, in February 2015 the Japan Anti-Tuberculosis Association (JATA) funded a US \$240,000 project to combat tuberculosis. One phase of the project involves training radiologists and providing technical support (18).

The potential for the radiology market is also demonstrated by the Medical & Pharmaceutical Equipment & Supplies Exhibition hosted by CamboMed. The exhibition was most recently held August 15-18, 2014 in Phnom Penh, and drew 9,320 trade visitors who sought to attract investments to medical technology in Cambodia, including radiology services (19).

Radiology volunteerism

There are ample opportunities for radiologists to volunteer in Cambodia, with continuing education being the main focus for radiology volunteers. Radiologists from high-income countries can travel to Cambodia to work with radiologists and non-radiologists there to improve interpretation skills, specifically for X-rays and ultrasound imaging. Many volunteer positions are listed online, including on the websites of the American College of Radiology, local Cambodian hospitals and various online forums. Volunteer openings exist at a variety of hospitals in cities including Phnom Penh, Siem Reap, Kampot and Battambang.

Radiology volunteers can also learn from their fellow healthcare providers in Cambodia. The diverse pathologies presented, including dengue fever and Japanese encephalitis, provide a learning opportunity for foreign volunteers.

Internet access

Smart (Smart Axiata Company Limited, Phnom Penh, Cambodia), one of the leading telecom operators in Cambodia, provides 2G, 3G and 4G LTE network coverage. Approximately 98% of Cambodia has access to 2G. Smart has recently expanded

4G LTE coverage to cover all 25 provinces, thereby providing access to approximately 4 million people (20).

There has been a steady increase in Internet use in Cambodia. Up to 12% of Cambodians reported using the Internet in 2014, compared to just 4.9% in 2012. The vast majority (89.2%) use mobile devices to connect to the Internet, as opposed to desktop (18.5%), laptop (15.2%) or tablet (7.6%). The majority of Internet use is clustered in urban population centers (21). There are over 20 Internet service providers in Cambodia. Ezeecom (Ezeecom, Phnom Penh, Cambodia) is the largest provider in Cambodia with corporate packages that range from 1 mbps (US \$59 per month) to 5 mbps (US \$285 per month).

Disease profile and differentiating demographic and cultural factors

During the rule of the Khmer Rouge and the political instability that followed, the general health of Cambodians suffered greatly. Cambodia struggled with high infant and maternal mortality rates, as well as deaths due to AIDS and malaria. In the last 25 years, Cambodia has made great strides in improving the well-being of its citizens. From 1990 to 2013, the under-five mortality rate per 1,000 live births decreased from 119 to 28. Maternal mortality ratio per 100,000 live births also decreased from 1,200 to 170. From 2000 to 2012, the number of deaths due to HIV/AIDS per 100,000 decreased from 29 to 17.1. In that same period, deaths due to malaria per 100,000 decreased from 166 to 66 (22). In addition to these encouraging public health statistics, the government has continued to increase the national budget for health financing. In 2008, the government approved US \$404,803.80 to go to healthcare. Then in 2013 the budget more than doubled to US \$901,500.80 (5).

The top ten causes of death in Cambodia are, in descending order, ischemic heart disease, tuberculosis, stroke, lower respiratory infections, HIV/AIDS, road injury, preterm birth complications, liver cancer, birth asphyxia/ birth trauma, and congenital anomalies (21). In calculating the burden of disease, WHO uses disability-adjusted life years, which is the average years of lost life due to premature mortality added to the average years of healthy life lost due to disability. The major burden of disease is due to maternal, neonatal and nutritional causes (22). Thus, much of the focus of improving the health of Cambodians has been on maternal and pediatric health.

One problem that continues to plague healthcare providers on the frontlines is the delay in receiving treatment. By the time patients make it through the referral system and/or travel from rural areas, they present to health care workers at urban hospitals with advanced diseases. Patients will travel hundreds of kilometers to reach hospitals, such as Angkor Hospital for Children, in order to receive free care.

Culture and tourism overview

Cultural attractions, languages spoken

Cambodia has grown into a popular tourist destination. In 2014, 4.5 million tourists visited the country (2). The two most visited destinations are the bustling capital cities of Phnom Penh and Siem Reap, which are home to many famous temples. Tourists flock to explore the vast array of ancient temples in and around Siem Reap, including the UNESCO World Heritage Site Angkor Wat. There are also many other popular temples including Bayon, Ta Prom and Banteay Srei.

There is a wide range of recreational options for visitors, ranging from wildlife and bird watching to zip-lining through the rainforest or trekking through the countryside.

However, the terror of the Khmer Rouge is not forgotten. The Cambodian Landmine Museum and School offers insights into Cambodia's violent past, as does the War Museum in Siem Reap. Tour guides at the museums are often victims of landmines and other violence from this era. Cambodians pay respect to those killed by the Khmer Rouge every May 20th on Day of Remembrance, a national holiday.

The official national language of Cambodia is Khmer, though many Cambodians speak English and/or French. Although Khmer script differs greatly from Latin script, one can easily navigate the city with its many English signs. In addition, tour guides at many cultural sites are available in a wide range of languages.

Travel access, currency, local accommodations

There are three international airports in Cambodia, located in Phnom Penh, Siem Reap and Sihanouk. A number of major airlines fly into Cambodia's international airports. Coming from North America or Europe, most travelers must connect through another major Asian international airport, such as those in Bangkok, Tokyo or Shanghai. Travelers can also travel to Cambodia from neighboring countries via bus or car. The tuk tuk, a type of rickshaw pulled by motorbike, is one of the most common types of transportation for exploring Cambodia's cities.

Visa requirements differ by country. The Ministry of Foreign Affairs now offers an easy online visa ("e-visa") that takes three days to process. The visa costs US \$37 via Visa or Mastercard. Once approved, one can print out the e-visa and simply present it upon arrival at the port of entry. The e-visa option is available for citizens of most countries. Citizens of Laos, Malaysia, Philippines, Singapore, Vietnam, Thailand and Indonesia are exempt. E-visas are not allowed for citizens of Afghanistan, Algeria, Saudi Arabia, Bangladesh, Iran, Iraq, Pakistan, Sri Lanka, Sudan and Nigeria; citizens of these countries must check with their nearest embassy. Tourists can also apply for a visa upon arrival at their port of entry.

In the major urban centers there is a wide range of options for accommodations, from guesthouses as low as US \$15 per night to five-star hotels for nightly rates of US \$500 and up. Hotels are often teeming with tourists from nearby countries such as China or Malaysia. Since the Cambodian economy relies heavily on tourism, customer service quality at hotels tends to be excellent. Food served at hotels, both Western and Cambodian, is of high quality. Outside of hotels, tourists may choose from a wide variety of restaurants ranging from street stalls selling pork rice to Western bistros offering high-class French cuisine. Cambodian food draws on the flavors of locally grown produce, such as cardamom, basil, kaffir lime, tamarind, lemongrass, ginger, galangal and star anise. Rice is the staple starch and is served at virtually every meal. Tourists can also enjoy traditional noodle soups or stir-fry dishes made with a choice of meats.

Although the Cambodian riel is the official currency of Cambodia, most service providers use the US dollar. In general, accommodations, food, cultural attractions and other services are quite affordable. It is advised to bring plenty of small bills, especially to provide tips.

Local security and safety situation

Cambodia is generally a safe country for tourists to visit. The most common concern for tourists is petty theft. Although uncommon, there have been reports of armed robberies, even in crowded tourists locations. The more common "snatch-and-grab" robberies occur while a tourist is sitting in a tuk tuk. Tourists are advised to keep their valuables out of sight.

One major concern for tourists is land mines. Various warning factories planted approximately 4-6 million land mines during the 1970s and 1980s. The US Embassy recommends that citizens avoid travel along the Cambodian-Thai border due to the presence of undetonated landmines. Travelers should only explore these areas with a trained guide. In the event that one finds anything that resembles a landmine, it should immediately be reported to the Cambodia Mine Action Center.

Another concern for tourist safety is road accidents. Road injury is the sixth leading cause of death in Cambodia (23). The WHO estimates that 70% of deaths are due to motorcycles, with pedestrians as the next most common victim (24). Visitors are advised not to drive at night. Although many major roadways are paved, the conditions of roads can vary greatly, especially during

monsoon season.

Although the opposing party disputed national elections in 2013, Cambodia remains politically stable at the time of writing.

Health advisories

At the time of writing this article, travelers are recommended to receive routine vaccines, as well as vaccines for hepatitis A and typhoid. Depending on the location of one's travels, vaccines for hepatitis B, Japanese encephalitis, malaria, rabies and yellow fever are also recommended. There are currently no travel health notices for Cambodia.

Visitors should only drink bottled water, as tap water is not potable in Cambodia. Eating only cooked food reduces the risk of gastrointestinal illness. To avoid mosquito borne-diseases, it is advised to use insect repellent with greater than 20% DEET, as well as to cover exposed skin. Rabies continues to be a problem in Cambodia and tourists should avoid handling animals.

When to visit

Although Cambodia is warm year-round, the most popular time to visit is during the dry season, which runs from October to April. In addition to avoiding heavy downpours, traveling to Cambodia during dry season provides better views of temples like Angkor Wat, particularly at sunrise and sunset. The peak tourist season occurs during the cooler months of dry season, from November to January.

While the weather is more comfortable during dry season, Cambodia can be enjoyed any time of year. The wet season, which runs May to October, offers a more relaxed atmosphere since fewer tourists are crowding public places. In addition, the heavy rains give rise to a lush green landscape. □

Conflict of interest

The authors report no conflict of interest.

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