



# Nepal

Mahesh Chaudhary  
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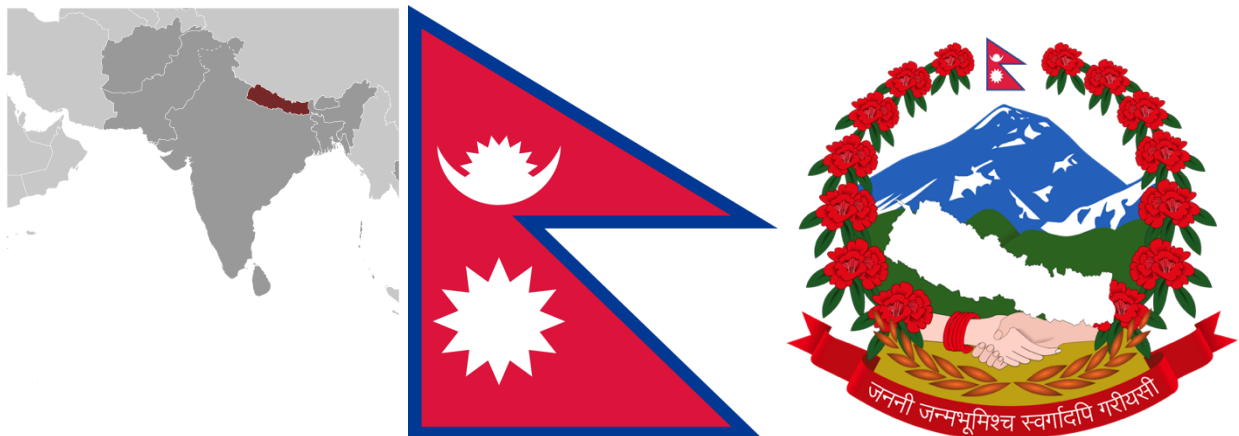
## **RAD-AID: Country Report of Nepal**

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**Mahesh Chaudhary, Carlin Ridpath**

**Correspondence: [maheshchaudhary@hotmail.com](mailto:maheshchaudhary@hotmail.com)**

## General Country Profile of Nepal:



Source: The world factbook and Constitution of Nepal 2015 (1 & 3).

### **Geography and Population:**

Nepal is a landlocked country sandwiched between two large countries, China in the north and India in the south, east, and west. The eastern and western border of Nepal is defined by two rivers, Mechi and Mahakali respectively. It is almost trapezoidal in shape and has an area of 147,181 square km. Geographically it lies between 26° and 31° N, and 80° and 89° E (1). Nepal is divided into three belts from north to south as Himalayas, Hills, and Terai (2). Hence, the climate varies according to the different belts. It can be a very cold winter to warm summer in the northern belt with mild winter and hot summer in the southern belt. Mount Everest (Sagarmatha in Nepali) which is the highest peak in the world measuring 8848 meters lies in the Himalayan region near the China border (3).

The total estimated population of Nepal is about 30,327,877 (July 2020), which accounts for 0.37% of the world population and ranks number 49 in the world (4). The current estimated growth rate is 0.98% in 2020 (1) compared to 1.15% in 2018. The population distribution is almost similar in the southern Terai and Hilly regions of Nepal. The rural population accounts for 44.73%. The population aged 25-29 years in rural areas is about 7.37% for males and 9.15% for females. Nepal is one of the least developed countries in the world. Out of the total population, nearly 25% are below the poverty line. The average life expectancy of Nepal is 70.5 years. Nearly 14.5% of males and 5.34% of females have completed post-secondary education (5).

### **History and Politics:**

Nepal was unified by Prithivi Narayan Shah, the king of Gorkha in the mid 18<sup>th</sup> century. He conquered the Kathmandu valley in 1769 after winning the battle against Kirtipur (6). Nepal has never been colonized by any invaders. Nepal has practiced an autocratic rule for

several hundred years. A caste system comprising 4 casts and 36 sub casts was developed on the basis of work division and Hindu practices in the mid 19<sup>th</sup> century. However, Nepal has multiethnic, multilingual, multiple cultures, and traditions. As per the data 2011, Hinduism is followed by 81.3% of the population: the rest of the country splits between Buddhism 9%, Muslim 4.4%, Kirant 3.1%, Christianity 1.4%, and others 0.5% (1). Nepal had a ceremonial monarchy till May 2008 A.D. where the country was governed by local and national assemblies were controlled by the palace (7). Nepali is the official language comprising of 44.6%, followed by Maithali 11.7%, Bhojpuri 6%, Tharu 5.8%, Tamang 5.1%, Newar 3.2%, Bajjika 3.0%, Magar 3%, Doteli 3%, Urdu 2.6%, Avadhi 1.9%, Limbu 1.3%, Gurung 1.2%, Baitadeli 1%, other 6.4%, unspecified 0.2%. It is reported that almost 123 languages are spoken inside the country where English is used by many institutions (1).

Democratic reforms began in 1950 with the ratification of a new constitution in 1959 and subsequently, a national assembly was elected. While King Mahendra ruled from 1955-1972 he took over the power of the nation by disbanding Congress and jailing most of the government. He then formulated a brand-new constitution that granted him most of the power (7). The general public mass movement occurred in 1990 for the restoration of democracy that ultimately led the king to implement a multiparty democracy (5). A Maoist insurgency began in 1996, ending with a massive communist victory in 2007 (4). Nepal was declared a federal democratic republic in 2008 and the monarchy was abolished (2). A massive 7.8 magnitude earthquake occurred in central Nepal on April 25, 2015, causing the death of 9,000 people, and nearly ten million were affected, which is one of the major disasters for Nepal (2).

### **Government and Legal System:**

The current government in Nepal is a Federal Democratic-Republican state. The executive branch includes the President, Prime Minister, and the cabinet. The President is indirectly elected by an electoral college of the Federal Parliament for a five-year term (8) and the President serves as chief of state and shall promote the unity of Nepal and protect the Constitution of Nepal (8). The prime minister is head of the government (1 & 3).

The Legislative Branch is a bicameral Federal Parliament consisting of the National Assembly (59 seats) and the House of Representatives (275 seats) (1 & 3). The Judicial branch consists of District Courts, High Court (Court of Appeal), and a Supreme Court (1 & 3). There is no distinction between the Criminal and Civil Court (8).

The World Bank worldwide governance indicators (3 & 9) for Nepal are:

Parameters	Score (range in scale)	Percentile rank
Political Stability and Absence of Violence	-0.63 (-2.5 to 2.5)	23.81

Government Effectiveness- Governance	-0.90 (-2.5 to 2.5)	16.83
Individual voice and accountability Governance	-1.13 (-2.5 to 2.5)	39.41
Regulatory Quality - Governance	-0.75 (-2.5 to 2.5)	23.08
Rule of law - Governance	-0.48 (-2.5 to 2.5)	33.65
Control of Corruption - Governance score	-0.67 (-2.5 to 2.5)	27.40

### **Economy and Employment:**

Nepal is one of the least developed countries and ranks as a low-income country (3). Nepal's gross domestic product (GDP) per capita for 2018 was \$1,034 which is a 13.44% increase from 2017 (10). Nearly 30% of Nepal's GDP is contributed by remittances sent by persons working abroad(3). Agriculture is the primary occupation of Nepal but accounts for less than a third of the GDP whereas Service and industry, such as tourism, carpets, and textiles, make up 73% of the GDP (3). The gross domestic product on the purchasing power of Nepal dropped from a world ranking of 95 (in 2017) to 195 (in 2018) (3). The gross national income in 2018 was NRs. 27,201,708,172 and the net official development assistance received was US\$165.78 billion (5).

The unemployment rate for 2017 was 3%, country comparison to the world 36 (3). Labor force by occupation: agriculture 69%, Industry 12%, and Services 19%. The annual inflation rate for 2017 was 4.5%, country comparison to the world 168 (3).

The World Bank 2020 "Ease of doing Business" index for Nepal includes(3).

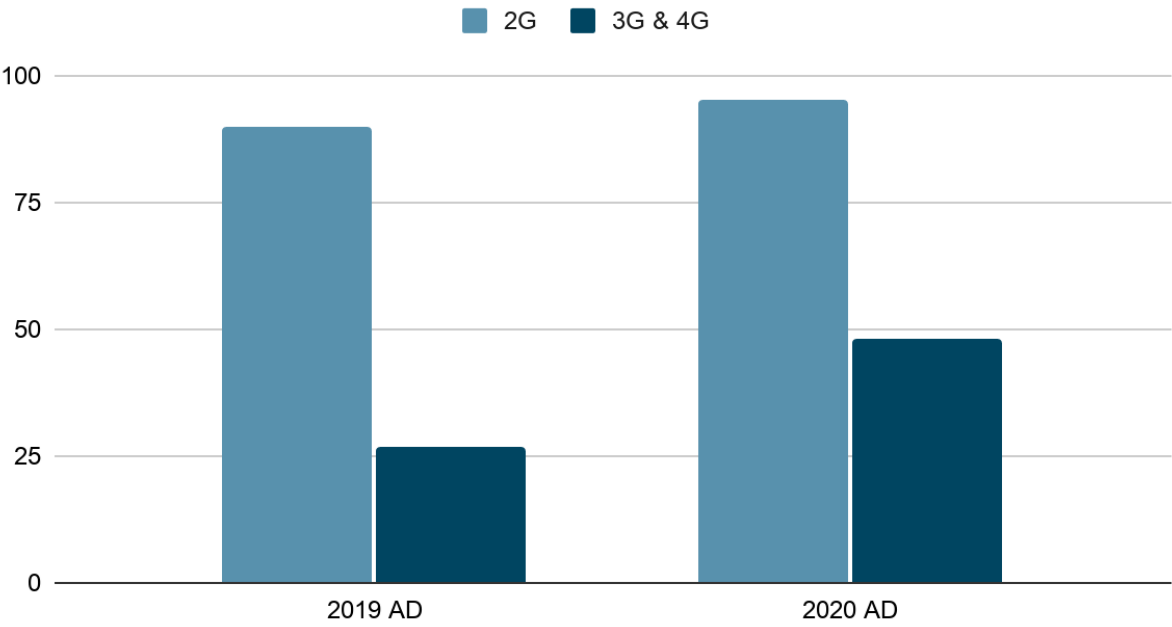
Parameters	Ease index
Ease of starting a business	81.7
Dealing with construction permits	67.3
Getting electricity	60.9

Registering Property	63.6
Getting Credit	75.0
Protecting minority investors	58.0
Paying taxes	47.1
Trading across borders	85.1
Enforcing contracts	46.0
Resolving Insolvency	47.2
Employing workers	47.2
Contracting with the government	47.2

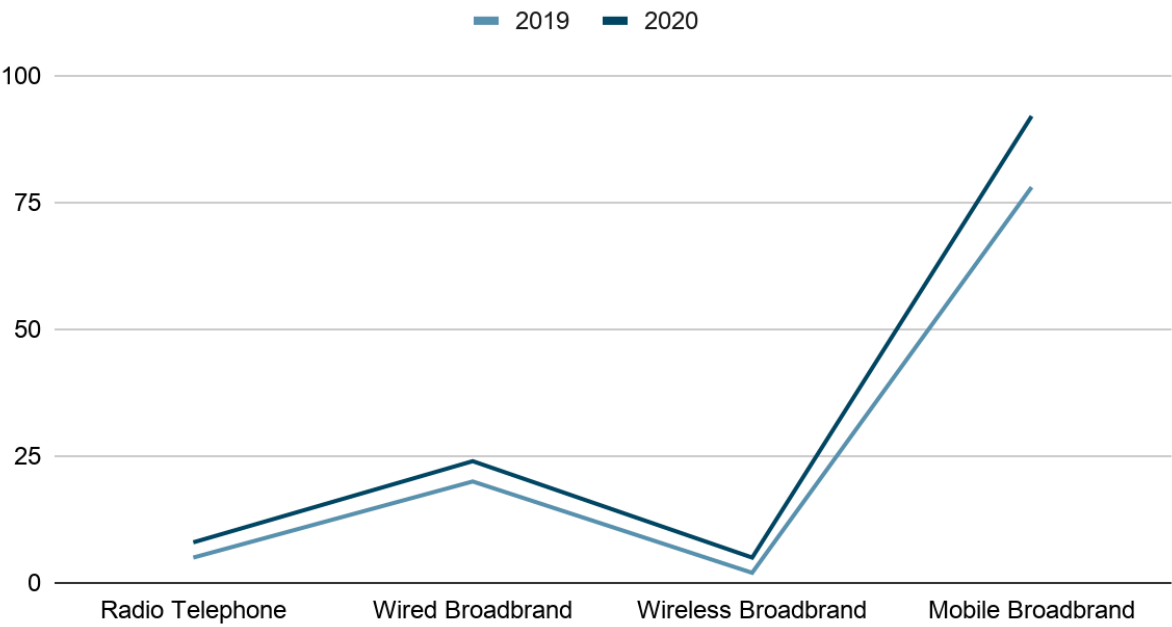
### **Physical and Technological Infrastructure:**

Nepal consists of one-third of the Hills and one-third of the Himalayas, which is the major obstacle to the development of the communication system (11). Mountainous topography hinders the development of telecom infrastructure, mobile and internet services (3).

# Mobile Services



# Internet Services



As of the 2018 estimate, broadband fixed subscriptions were 791 961, with a country comparison to the world at 75. The number of current internet users is approximately 5,716,419, with a country comparison to the world at 69 (3). The mobile voice telephony and the broadband market are dominated by two telecommunications companies, the state-owned Nepal Telecom (55%) and the private multinational, Ncell (40%). A smart cell is one of the upcoming CDMA services. Nepal Telecommunication Authority reported the voice telephony subscription rate as 2.70% of the total population for fixed phones and 138.59% for mobile; 98% of all voice telephony was through mobile phones in the year 2019. Out of 21% of fixed broadband internet service, around 25% was owned by Nepal Telecom, while the rest was owned by private Internet Service Providers (12). In the year 2019, Nepal operated 3 Television stations, national and regional radio stations (short and medium waves); 117 television channels were licensed, among those 71 are cable television channels, three were distributed through Direct-To-Home (DTH) system, and four were digital terrestrial; 736 FM radio stations were licensed and 314 of those radio stations were community radio stations (3).

According to (the reference), in 2016 the total population having access to electricity was 90.7% of which urban and rural areas electrification is 94.5% and 85.2% respectively. As hills and mountains impose a great challenge, an alternative source of energy has been thought of in which solar panels come into major play. However, less than half of the Nepalese have access to the national electric grid. In remote areas of Nepal mini and micro-hydro plants generate enough to meet the needs of modestly living rural communities (13). Nepal produces almost 4.244 billion kWh of electricity, which ranks 125 positions in the world. Electricity consumption is estimated at 4.983 kWh, with a country comparison to the world at 124. The majority of electricity comes from hydroelectric plants, which ranks the world at 10 (4). Nepal has good potential to utilize hydropower as a major source of energy, but a small portion has been only used by the country (13).

According to (the reference), in 2016 there is a total of 27 990 kilometers of road in Nepal, where 11 890km of it are paved and 16,100km unpaved, which ranks at 98 in the world comparison. There are 47 airports of which 11 are paved and 36 are unpaved. The total number of registered air carriers as per 2015 data is 4, inventory of registered aircraft operated by air carriers: 15. Hence annual passenger traffic on registered air carriers is 510,341 and annual freight traffic on registered air carriers is 4,536,371 mt-km (3). The total railways cover 59 km (2018) in Nepal which connects it with part of India and makes a country comparison to the world as 131 (3). The key perquisites for the promotion of public health, quality of life, as well as strong indicators of human development standards include the provision of safe drinking water, sanitation, and hygiene (WASH). A cross-sectional study conducted by Wang et.al showed that the percentage of households having access to an improved toilet (5.6% in 1996 vs. 40.5% in 2016) and water (19.3% in 1996 vs. 27% in 2016). Households in the Far Western and Mountain regions were geographically disadvantaged in terms of having access to improved water and sanitation facilities (14).

### **National Health Care Profile:**

### **National Health Care Structure:**



Until 1950, there were only a few doctors in Nepal to treat the millions of citizens. In 1956, the General Health Plan was introduced and was aimed at providing basic health services to all citizens. More recently, private health care institutions have been founded including hospitals, medical college teaching hospitals, and nursing homes(16). The current (as per 2018) average life expectancy of Nepalese is around 70.5 years where males and females are 69 years and 72 years respectively. The crude birth rate is 19.8 and the crude death rate is 6.4 per 1000 people. The infant mortality rate (IMR) is 26.7 per 1000 live births. The maternal mortality rate as of 2017 is 186 per 100,000 live births. The immunization with DPT, measles, and hepatitis B is 91% as per the 2018 data (17).

According to the study of the global burden of disease 2017, the eight leading causes of morbidity (illness) and mortality (death) in Nepal are Neonatal disorder (9.97%), Ischemic Heart disease 7.55%, chronic obstructive pulmonary disease (COPD) 5.35%, lower respiratory tract infection 5.15%, road injury 3.56% (18), diarrheal disease 3.42%, stroke 3.49% and diabetes 2.35% (19). Many children die of easily preventable and treatable diseases such as diarrhea and/or dysentery (61%) and acute respiratory infections each year (16). In order to reduce diarrheal disease-related morbidity and mortality, 120,000 schoolteachers have been trained in oral rehydration therapy (ORT). There is a poor sanitary/sewerage system including waste disposal in the rural part of Nepal. The latrines in rural areas range from 0-25% (20, 21). Micro-nutrients deficiency is a common problem for low- and medium-income countries (LMICs) with almost 50% of pregnant women and children under five, as well as 35% of women of reproductive age, being anemic. Only 24% of children consume iron-rich food, 24% of children meet a minimally acceptable diet, and only 50% of pregnant women take recommended iron supplementation during pregnancy. Additionally, open defecation (44%) has contributed to poor sanitation and the common practice of Nepal (22). The main cause of maternal mortality in Nepal is hemorrhage (either anti-partum, post-partum or abortion-related) and birth trauma by the ruptured uterus or cephalo-pelvic disproportion (23). The majority (27.6%) of children 6 – 59 months have iron-deficiency anemia (IDA) followed by non-pregnant women aged 15-49 years and adolescent girls 10-19 years with 18.7% and 18.0% respectively (24). The main cause of death due to cancer is attributed to tobacco (25). Nepal ranked 177 among 180 countries in terms of air quality (Kathmandu Post 2016). Air pollution might be another contributing factor. Stomach cancer is increasing every year due to dietary habits. Cervical cancer is a potential threat among females due to a lack of health education and information (26). Premenopausal, as well as young women, have a higher incidence of breast cancer (27, 28). Due to this high incidence of a public health program regarding health education, awareness programs have been given priority.

### **National Health Care Structure:**

#### **Health Structure and Policy:**

The present health care facilities and the organizational structure of the Ministry of Health Department of Health Services in Nepal are shown in Figure 1, which constitute Central and Regional Hospitals as tertiary care centers. The Zonal and District Hospitals serve as the secondary level of the health care system in Nepal. Primary health care is delivered through

Primary Health Care centers (PHCC), Health Centers (HC), Health Posts (HP), and Sub Health Posts (SHP) at the Electoral Constituency and VDC level (31).

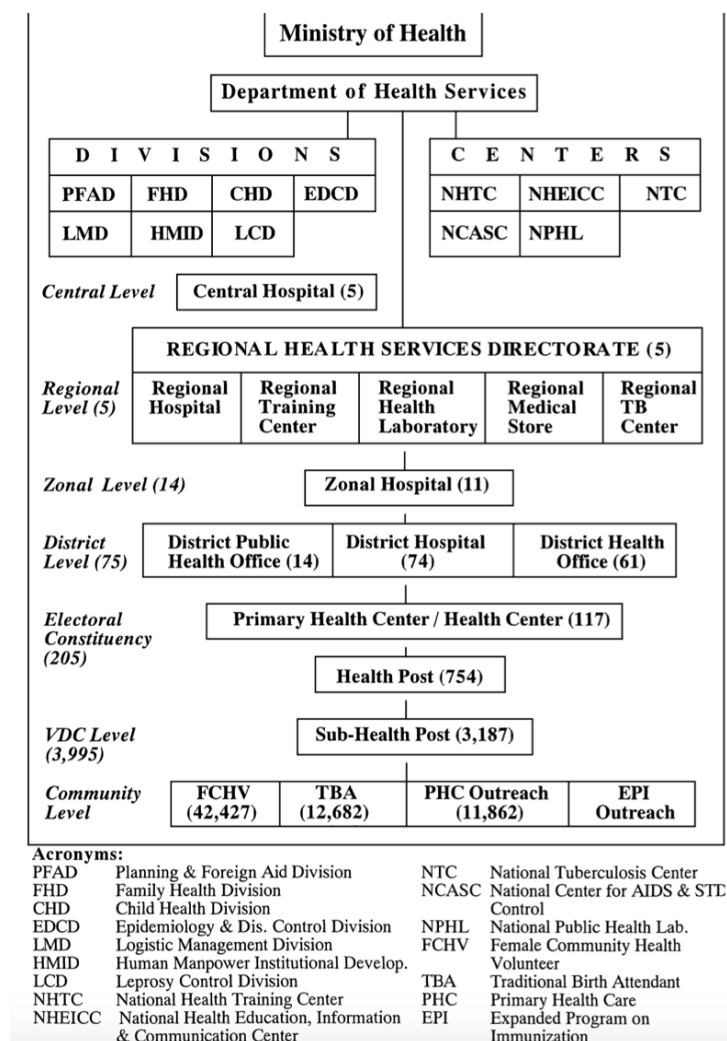


Figure 1. The organizational structure of the Health care system of Nepal.

Health services are delivered mainly by public institutions, private organizations, and non-governmental organizations (NGOs) in Nepal (29) despite failing to meet the international standards of the World Health Organization (30). There are 125 public hospitals, 198 primary health care centers (PHCs), 3808 health posts (HPs), and 1822 nonpublic health facility providers in Nepal (31). Despite the existence of a formal referral system for secondary health care, Nepal is still having problems implementing it effectively. Generally, the referral tends to be those centers that are closest by distance to the hospital where appropriate medical facilities are available. A study concludes that the majority (86%) of referrals were found to be appropriate. However, geographical and transportation continues to be a great barrier in Nepal (32). Many national and international

non-governmental organizations (NGOs and INGOs) work for family planning, safe abortion, delivery by skilled birth attendants (SBA), and encouraging immediate breastfeeding (33).

Nepal's Interim Constitution of 2007 addresses health as a fundamental right, stating that every citizen has the right to basic health services free of cost. However, only 61.8% have access to health facilities within 30 min, with a significant discrepancy among urban (85.9%) and rural (59%) areas. Social Health Security Development was formed to increase access to health services to the poor and the marginalized, but finance is still an issue to be addressed (34). Hence, the majority of Nepalese patients are bound to pay totally out-of-pocket costs. Many private insurance companies have recently established the policies of health care but due to lack of standard protocol by the government, the implementation for the same is a major challenge.

### **Health Service Coverage:**

The Ministry of Health and Population (MoHP) provides guidance to Department of Health Services (DoHS) as well as provincial- and local-level governments to deliver promotional, preventive, diagnostic, curative, and palliative health care services and carries out the related policy, planning, human resource, financial management, and monitoring and evaluation functions. In a newly restructured MoHP organogram (Figure 2), it has five divisions: The Policy, Planning & Monitoring Division; the Health Coordination Division; the Quality Assurance & Regulation Division; the Population Management Division, and the Administration Division. In addition, the six professional councils: Nepal Medical Council, Nepal Nursing Council, Nepal Ayurvedic Medical Council, Nepal Health Professional Council, Nepal Pharmacy Council, and Nepal Health Research Council) accredit health-related schools and training centers and regulate care providers. The Department of Health Services (DoHS), the Department of Ayurveda and Alternative Medicine (DAA), and the Department of Drug Administration (DDA) come under MoHP. These three departments are responsible for formulating and implementing programs, the use of financial resources and accountability, and monitoring and evaluation. DDA is the regulatory authority for assuring the quality and regulating the import, export, production, sale, and distribution of drugs. The Department of Ayurveda and Alternative Medicine is responsible to care for Ayurvedic services and implements health promotional activities (Figure 2). Nearly 30% of the health care services are provided by non-public facilities which include private hospitals, clinics, NGOs, and INGOs (31).

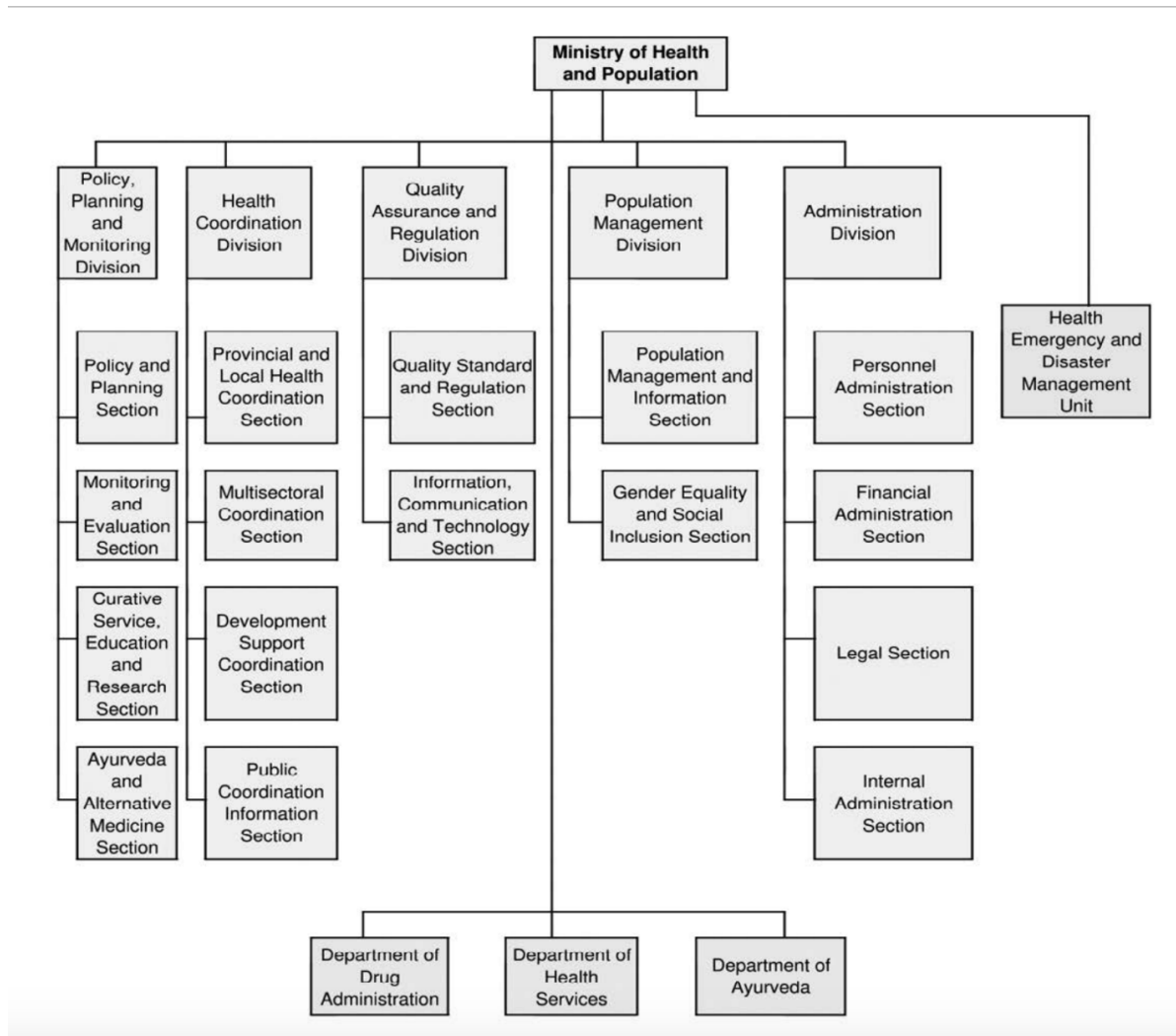


Figure 2. Organogram of the Ministry of Health and Population.

### Health Care Expenditures:

According to the world bank 2017, the health care expenditure of Nepal was 5.55% of the Gross Domestic Product (GDP) which accounts for \$48 as shown in figure 3 (35). Government health expenditure as a percentage of GDP for Fiscal year (FY) 2017/18 is 1.9% compared to 1.8% in FY 2016/17. There has been a 0.5% increase compared to the baseline year and a 0.3% increase compared to the Nepal Health Sector Strategy (NHSS) target. The Government of Nepal (GoN) has rolled out several social protection schemes to reduce out-of-pocket expenditure in health. The GoN had expanded the coverage of the health insurance programs in 36 districts by the end of 2017/18. The cumulative number of people enrolled in the social health insurance had increased to 1.1 million by the end of FY 2016/17 and more than 1.3 million by the end of Nov 2018, which is 8.3 % of the catchment population in the implemented districts (17). The health care system of Nepal is financed as per Figure. 4 (36). Private health care is dependent on the out-of-pocket cost for the patients.

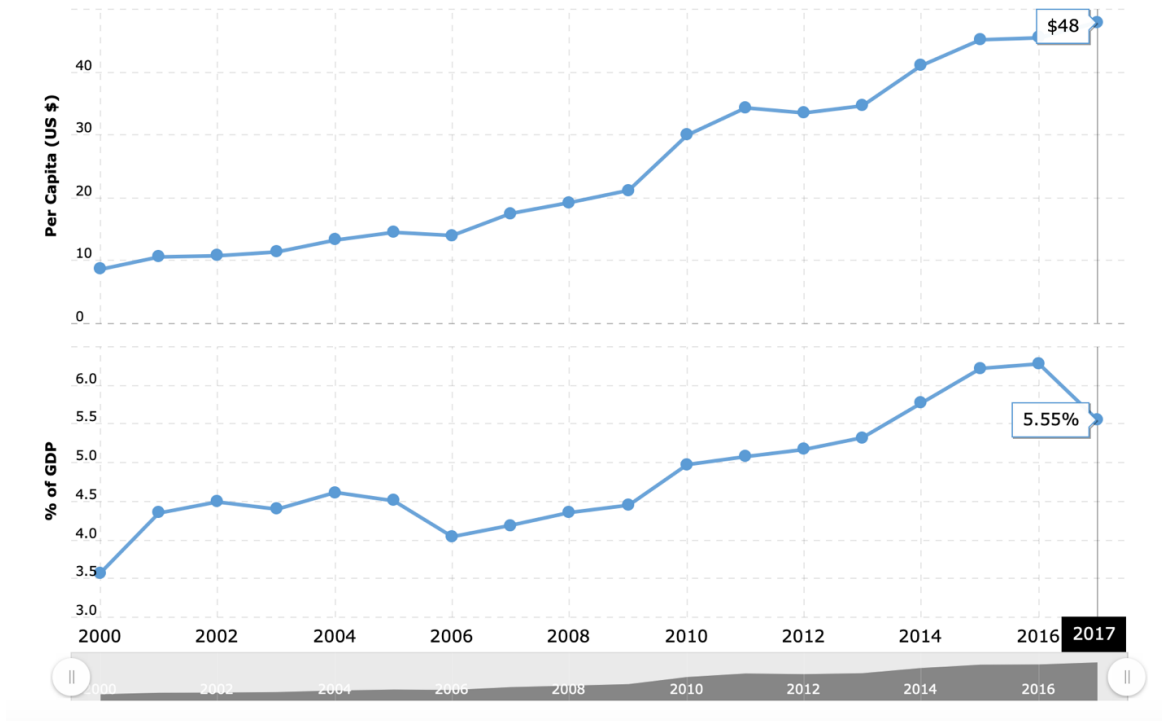


Figure 3. Nepal Health care expenditure 2000 to 2017.

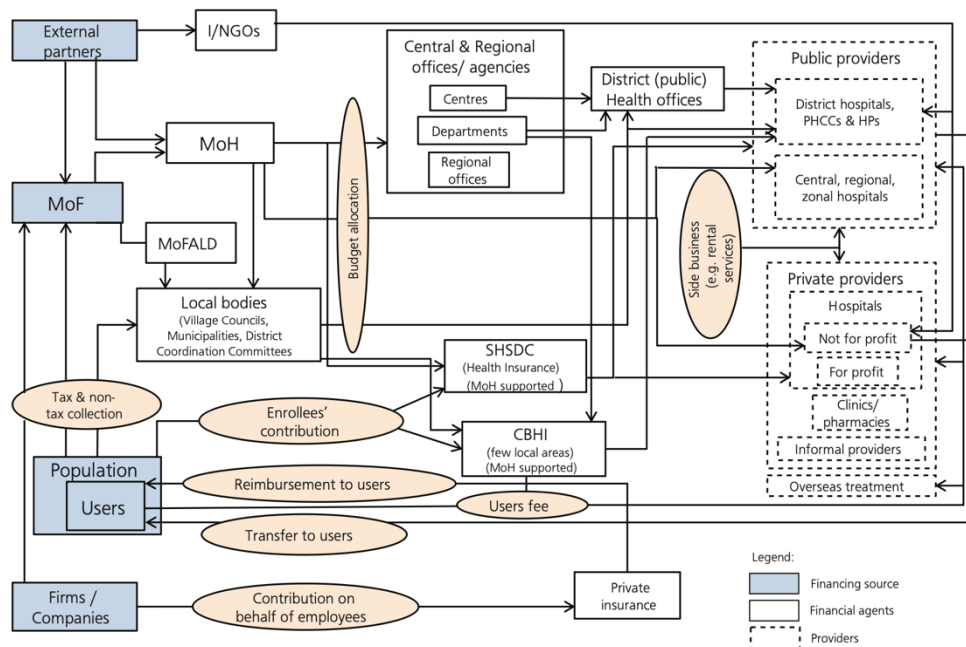


Figure 4. Health financing flow adapted from the WHO Southeast Asia Region.

## **Health Workforce and Infrastructure:**

As per the data published by the World Bank, International Bank for Reconstruction and Development (IBRD), the rate of hospital beds is 0.30 per 1000 people (35). The doctor to population ratio for the whole country is 1:1724. Similar to most developing nations, doctors are geographically mal- distributed in Nepal. The Kathmandu Valley has one doctor for 850 people but in rural areas, the number is one doctor for every 150000 people (37). The nurses and midwives are 3.11 per 1000 people (35). The ratio of doctors to pharmacists is 1:0.072 and the ratio of doctors to nurses and midwifery personnel is 1:3.03 (38, 39, 40).

In Nepal, the Ministry of Health and Population (MoHP) has implemented a compulsory two-year rural service for all the scholarship holders of the Ministry of Education. The consideration provided to these students for postgraduate seats at the National Academy of Medical Sciences (NAMS) is a strong motivating factor for rural service (41).

In collaboration with the ministry of finance (MOF), the MoHP contributes to the direct effect in the health care system of Nepal. In Nepal, 6% of external aid is spent on health. The biggest donors at the moment in the health sector are Japan and the UK, together contributing for nearly half the external aid, while the United Nations Children's Fund (UNICEF), World Health Organization (WHO), United Nations Population Fund (UNFPA), Germany, the United States (USA), and Switzerland making up most of the remainder (42).

## **National Radiology Profile:**

### **Radiology Workforce and Training and Professional Representation:**

The hierarchy for clinics and hospitals in Nepal is labeled as sub-health post, health post-primary care center, district hospital, regional hospital, central hospital; the majority of Radiological services are limited to the district, regional and central regions only. Healthcare including radiological services is provided by both public and private entities, with resources mostly located in the capital (43). There were about 150 radiologists practicing in Nepal in the year 2012 and by the year 2020 it reached 547, as reported by one of the executive members of the Nepal Radiologists Association (44).

Radiology residency programs in Nepal are offered at fourteen medical colleges and hospitals out of which five are centered inside Kathmandu Valley. The different colleges that are certified for Radiology Residency programs are BP Koirala Institute of Health Sciences in Dharan; Nobel Medical College, Biratnagar; Institute of Medicine, Tribhuvan University Teaching Hospital, Kathmandu; National Academy of Medical Sciences, Kathmandu; Nepalese Army Institute of Health Sciences, Kathmandu; Patan Academy of Health Sciences, Lalitpur; Nepal Medical College & Hospital, Jorpati; Kathmandu University Medical Sciences, Dhulikhel; College of Medical Sciences, Bharatpur; Chitwan Medical College, Chitwan; Manipal College of Medical Sciences, Pokhara; National Medical College, Birgunj; Nepalgunj Medical College, Nepalgunj; and Universal College of Medical Sciences in Bhairahawa. Currently, there are 21 medical colleges in Nepal including both the Governmental and Private sectors. Most of these are affiliated with Tribhuvan University



and Kathmandu University (45). There are a few other institutes that are autonomous universities such as B. P. Koirala Institute of Health Sciences (BPKIHS), Patan Academy of Health Sciences (PAHS), and National Academy of Medical Sciences (NAMS). To become a radiologist in Nepal, one must hold a Bachelor of Medicine and Bachelor of Surgery (MBBS) degree and then attain a Doctor of Medicine (MD) in Radiology. Students who have passed the high secondary school (10+2 examination) or any other equivalent examination with a science background having a biology major are eligible to apply for admission into medical colleges in Nepal. After completing 4.5 years of Bachelor of Medicine and Bachelor of Surgery (MBBS) program with one-year compulsory internship training, a medical student is eligible to become registered as a legally practicing physician after passing Nepal Medical Licensing Examination (NMCLE) conducted by Nepal Medical Council (NMC). The yearly intake of radiology residents is around 1-3 students per year per institution after the approval from Nepal Medical Council (NMC) on minimum criteria for both academic and administrative infrastructure (46).

The three-year MD Radiodiagnosis program has a rigorous schedule. Sonographers do not exist in Nepal, so by design, all sonography is completed by the first-year residents, six days per week for the entire first year. They generate a Microsoft Word report, print and sign it as final and after the nurse documents the exam as final in the logbook, the report is given to the patient, thus completing their visit with their provider which is similar to the system for laboratory exams (47). Training during Post Graduate Year (PGY) 2 & PGY 3 includes “on-call” arrangement during their postings which is supervised by the radiologist; rotations in nuclear medicine, pediatrics radiology, obstetrics & gynecology radiology, neuroradiology, and interventional radiology. In addition, these residents must be trained in CT, Ultrasound, MRI, and angiography; perform reporting, fluoroscopy, plain radiography, and IVU with less supervision. Residents are encouraged to attend clinical radiological meetings and conferences and participate in all teaching activities, give talks and other presentations; and gain a sound knowledge of pathology, particularly in relation to current imaging modalities. The course curriculum of the trainees is focused on anatomy and techniques in reference to CNS including the skull, Respiratory system, Cardiovascular system, Abdomen, Genitourinary tract system, Musculoskeletal system, Breast imaging, Obstetrics & Gynecology, Neonatology and Pediatrics, and Lymphatic System. Postgraduate Radiology examinations consist of Theory papers, Clinical/Practical and Oral examinations, and a thesis. The methods of assessment for Postgraduate residents include Logbook, Formative assessment, Summative assessment, and Thesis. At the end of the radiology residency program, the resident is expected to be clinically sound, skilled, creative, and competent to independently perform and interpret all kinds of radiological investigation and imaging studies; fully aware of the radiological hazards, and competent enough to minimize and prevent the risk associated with conducting radiological investigations and imaging studies; and capable of providing leadership in the field radiology(46).

The inception of Radiology started with the approval of a Diploma in Medical Radio Diagnosis (DMRD) course in 1988 and a few Doctor in Medicine (MD) Radiology and Imaging. However, Nepal faced a shortage of Radiologists. Thereafter in the year 2000, the availability and use of radiological services have increased tremendously requiring radiologists of the highest caliber to provide quality services to the patients. Moreover, the Institute of Medicine and the Ministry of Health are giving great importance to radiologists with a postgraduate degree, (MD) to fulfill the future needs of the country. The main thrust of

the training program is to develop the trainee's competence in clinical radiology and understanding of the principles of radiological sciences and technology. At the end of basic training, the trainee is expected to take the MD (Diagnostic Radiology) examinations, and to enter the subsequent advanced specialty training program (48). Radiologists are trained locally or abroad, such as in India and the Philippines, and practice in larger and urban hospitals. Technologists are specifically trained in a chosen modality in dedicated programs for 3 to 12 months within Nepal (43). The Government of Nepal has called for the provision of basic health services to all. In this regard, the Council for Technical Education and Vocational Training (CTEVT) has been contributing to the development of the different levels of health personnel. In the field of Radiography and imaging, CTEVT has been running a program to produce middle-level radiography and imaging service providers. The Certificate in Diagnostic Radiography graduates is able to perform routine works related to technology in different levels of hospitals, health institutions, and imaging centers. This program is of three academic years where the first-year course focuses on basic science and foundation subjects, the second-year course focuses on basic radiography and imaging-related subjects, and the third year is given to the application of learned skills and knowledge within the comprehensive practical settings in hospitals, health institutions, and imaging center recognized by the ministry of health and population or concerned authority (49).

In Nepal, the Primary Care Physicians or Medical Specialist (either Physician or Surgeons) requests a Radiologist for the relevant type of radiological examination necessary for the patients as per the presenting illness. The radiologist and the technologist thoroughly screen all requests in order to avoid unnecessary radiations. All radiological exams are expected to follow a standard protocol to limit the area of exposure as much as possible and the responsible radiologist should use radiation parameters (kVp, mAs, pitch) to deliver the lowest radiation dose necessary to answer the clinical question i.e. ALARA (As Low as Reasonably Achievable) (50). The radiologists are expected to interpret images for patient care, perform procedures under image guidance, and for operating imaging hardware to transmit images to radiologists (51). Radiation oncologists work closely with a multidisciplinary team of oncologists and radiation therapy staff to treat mostly cancer (and some benign conditions) using ionizing radiation. At the time of consultation, a radiation oncologist assesses the need for additional diagnostic evaluation or clinical interventions. Then, they integrate their knowledge of the patient's diagnosis, diagnostic studies, the natural history of the disease, and general medical conditions with their understanding of medical physics, radiobiology, and radiation safety to answer the following questions to guide therapy (52). Many tertiary hospitals of Nepal have made their best effort to implement this standard protocol; however, there has been a communication gap between the Primary Care Physicians (PCPs) and the Radiologists. In most cases, the Radiologists are unaware of the chief complaint, relevant physical findings of patients nor do they have ideas about the kind of information a physician is trying to get from the images interpreted by the Radiologist. The nurses manage patient safety and perform procedures on patients that require imaging exams despite having no special training related to Radiology and Radiation Therapy. The physicists and radiation safety officers manage the safety (radiation dose) of imaging hardware, manage quality (resolution, calibrations) of imaging hardware and software, monitor continuing safety and quality of all equipment (51). Research is a vital role of physicists; their fields of study include but are not limited to the application of new technology, high-energy machines, and the development of new methods of treatment



delivery and radiation measurements (53, 54). The radiology educators help to utilize innovative teaching methodologies and communications advancements to increase human capacity development. Online learning management systems (LMS) have significantly facilitated distance-virtual learning, which is an appealing attribute for global education initiatives. These systems possess the versatility of course assignments, case presentations, quizzes with ease for grading, and discussion forums for in-depth analysis of topics while allowing learners to move at their own pace with monitored progress and the added benefit of cost savings (55, 56). Although the standard protocol states that the engineering staff ensures that all equipment (machines, computers, software) are functioning optimally and is compliant with international/national standards, this particular job is performed by either the technicians or Radiologists themselves in almost every hospitals. The accurate measurements of radiation output from radiation treatment machines as well as output from radioactive sources used during therapy are determined by Radiation Oncologist or Medical Oncologist, confirming that the planned dose is actually delivered to the planned target during treatment (57). These general principles of Radiation Oncology are practiced to their maximum extent by Physicians themselves in Nepal rather than Physicists. Hence, many centers are running in a compromised state due to a lack of trained health professionals and infrastructures.

Nepal Radiologists' Association (NRA) is the parent organization of all registered radiologists practicing in Nepal. Nepalese Society of Vascular and Interventional Radiology (NSVIR), Breast and Thyroid Society of Nepal, and Ultrasound Society of Nepal are associated with NRA. Nepalese Journal of Radiology is an official publication of NRA which is listed on the HINARI portal. Nepal Radiological Society (NRS) is a non-governmental national professional organization of Radiography/Radiologic professionals (viz. technologists, nurses, physicists, and biomedical engineers) of Nepal (58).

### **Equipment Inventory, Distribution, and Rules and Regulations:**

In 2012, approximately 1,200 x-ray, 800 ultrasonographic, 30 CT, 10 MRI, and 11 mammographic units were available in Nepal including both government and private sectors. Most of the CT scanners are older versions, and the MRI units operate at low magnetic field strengths (0.2-0.5 T). There are only 5 multidetector CT scanners and 1 MRI scanner operating at 1.5 T. In radiotherapy, only 1 intensity-modulated radiation therapy machine, 4 telecobalt machines, 4 linear accelerators, 3 radiotherapy simulators, 3 high-dose-rate brachytherapy machines, and 1 gamma camera are available. Radiography and ultrasound are available up to district level hospitals, and these technologies remain the primary diagnostic tools in the absence of CT and MRI (59). Nuclear medicine and digital subtraction angiography are available in few tertiary care hospitals only. By the year 2019, the Ministry of Health and Population (MoHP) was able to purchase 1600 units of Digital Xray films while the target was 1200 units, which shows an improvement of 133% (60). The majority of hospitals in Kathmandu are equipped with radiography, fluoroscopy, and ultrasonography. The rural hospitals and clinics have small x-ray units powered by electric generators and manual film development (61). All modalities are printed and there is no PACS system. After plain radiographs are printed, they are given to the patient to bring to their provider. Very rarely the provider asks the radiologist for a final report. If a CT is performed, the images are printed and given to the provider and a report will be generated in the morning. Handwritten radiology reports are still in use (47).

The most commonly requested examination of plain radiography is a chest x-ray followed by a musculoskeletal x-ray. Transabdominal ultrasound for the whole abdomen is most frequently followed by obstetric ultrasound. The fluoroscopy services are mainly focused on Intravenous Urography (IVU) and barium studies of the gastrointestinal tract. The mammogram is another frequently requested examination. CT and MRI of the head account for the majority of exams in cross-sectional imaging. Vascular and Interventional Radiology services are limited to tertiary care hospitals at Kathmandu Valley. In the private sector, almost all similar services are provided; however, the price for imaging services is high. Few private sectors at Kathmandu provide Nuclear Imaging Services. There are no local manufacturing companies for radiological equipment. Hence, it is either imported or donated from high-income countries with the help of local suppliers and vendors. Maintenance is done by the same local representatives of the international companies. The quality assurance and Regulation division which is under the MoHP is responsible for the procurement of quality medical equipment.

### **On-site Assessment:**

RAD-AID International performed a radiology-readiness assessment (RRA) in 2014 in collaboration with Tribhuvan University Teaching Hospital (TUTH) in Kathmandu. When an earthquake struck Nepal in April 2015, RAD-AID provided assistance in May 2015 to six hospitals on providing care for trauma patients, implementation of trauma radiology protocols, radiology-infrastructure damage assessments, and helping to create a reconstruction plan. RAD-AID sent a team consisting of 2 radiologists and 4 technologists and partnered with TUTH, the WHO, and other global NGOs. In 2017, RAD-AID sent a team of sonographers, IT specialists, and radiologists to Kathmandu and Dhangadhi. A team of four volunteers, two ultrasonographers, one IT specialist, and one Radiologist traveled to Kathmandu and Dhangadhi for two weeks in October 2017. In Kathmandu, we provided lectures on PACS and general and emergency ultrasound at National Trauma Center and Chirayu Hospital. In 2018, RAD-AID gave a workshop on MSK ultrasound at several hospitals. RRA was conducted at the Hospital and Rehabilitation for Disabled Children (HRDC). Since there is no PACS RAD-AID is in the process of installing PACS at TUTH in the near future. Currently, the radiology residents in Kathmandu are taking advantage of our learning center with access to cardiothoracic and abdominal lectures.

Under the leadership of Carlin Ridpath, RAD-AID International strives to improve radiology information systems, radiology professionals' education, and rural health care. From 2019 and into the present, Dr. Ridpath is working with colleagues in Nepal to advance topics of ultrasound education, specifically with MSK and pediatric focus, and to advance informatics infrastructure in Kathmandu (61).

### **Conclusion:**

Nepal belongs to one of the low medium-income countries with an impoverished health care system. Total health care expenditures of the country account for only 5.55% of the

government's budget. Despite huge advances worldwide, Nepal is still struggling to improve and manage even conventional radiology facilities in rural areas. However, radiology has achieved steady progress in Nepal in urban areas. Consequently, there are enormous shortages of human resources and technology. Although Nepal lacks sufficient teaching faculties and facilities, radiology education is gradually developing. Nepal is one of the most welcoming countries for many NGOs and INGOs which are involved in the development of the country including the health sector. The establishment of regional RAD-AID International chapters or liaison centers at different medical colleges of Nepal can be the right direction for getting people involved in this particular work for humanity.

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