

## THE ASEAN DIAGNOSTIC REFERENCE LEVELS IN MEDICAL IMAGING

A. Krisanachinda<sup>1</sup>, S. Srimahachota<sup>1</sup>, I.D. McLean<sup>2</sup>, N. Jamal<sup>3</sup>, K. Matsubara<sup>4</sup>, F. Haryanto<sup>5</sup>, V. Ath<sup>6</sup>, C. Anam<sup>7</sup>, L.E. Lubis<sup>8</sup>, E. Kunarsih<sup>9</sup>, I.B.G. Putra Pratama<sup>9</sup>, V. Inphavong<sup>10</sup>, N M Ariffin<sup>11</sup>, T.T. Myint<sup>12</sup>, A. Peralta<sup>13</sup>, D. Arzabal<sup>14</sup>, V. Dalin<sup>14</sup>, JCL Lee<sup>15</sup>, S Somanesan<sup>15</sup>, Y M Kwok<sup>15</sup>, NT Chau<sup>16</sup>

<sup>1</sup>Chulalongkorn University, Bangkok, Thailand, <sup>2</sup>Canberra Hospital, Canberra, Australia,

<sup>3</sup>Platinum Radiation Sciences Consultancy Sdn Bhd Kuala Lumpur, Malaysia, <sup>4</sup>Kanazawa University, Japan

<sup>5</sup>Bandung Institute of Technology, Bandung, Indonesia, <sup>6</sup>National Institute of Science Technology and Innovation, Phnom Penh, Cambodia, <sup>7</sup>Diponegoro University, Semarang, Indonesia, <sup>8</sup>Universitas Indonesia, Depok, Indonesia, <sup>9</sup>Indonesian Nuclear Energy Regulatory Agency, Jakarta, Indonesia, <sup>10</sup>Mittabhab Hospital, Vientiane, Lao PDR, <sup>11</sup>Medical Radiation Surveillance Division, Ministry of Health, Putrajaya, Malaysia, <sup>12</sup>Yangon General Hospital, Yangon, Myanmar, <sup>13</sup>University of Santo Tomas Graduate School, Manila, Philippines, <sup>14</sup>Society of Medical Physicists in the Republic of the Philippines, <sup>15</sup>Singapore General Hospital, Singapore, <sup>16</sup>Cho Ray Hospital, HCM City Vietnam.

**Abstract**— The Association of South-East Asian Nations, ASEAN, was established on 8 August 1967 in Bangkok, Thailand, with the Bangkok Declaration signed by the Founders of ASEAN, namely Indonesia, Malaysia, Philippines, Singapore and Thailand. Brunei Darussalam, Viet Nam, Lao PDR and Myanmar, and Cambodia were later joined, making up what is today the ten Member States of ASEAN. In the year 2000 at the World Congress on Medical Physics and Bio-Medical Engineering, held in Chicago, Illinois USA, the South-East Asian Federation of Organizations for Medical Physics (SEAFOMP) was established. The Congress of SEAFOMP-SEACOMP, is annually organized at each member state. The congress program consists of John Cameron Memorial Lecture, medical physics in radiation oncology, nuclear medicine, and diagnostic radiology on research and development, education and clinical training of medical physicists and radiation protection of staff and patients. The concept of Diagnostic Reference Levels in Medical Imaging had been introduced to SEAFOMP in early 2021. In ASEAN, DRLs was firstly started in Philippines in 2005, Malaysia in 2007, Vietnam in 2014, Indonesia in 2015 and Thailand in 2017. Laos, Cambodia and Myanmar join SEAFOMP on DRLs in 2021.

**Keywords**— ASEAN, SEAFOMP, Medical Imaging, NDRLs, optimization.



Figure 1: The map of ASEAN Region

### I. INTRODUCTION

The concept of Diagnostic Reference Levels has been introduced by ICRP, IAEA BSS, radiation protection of patients, RPOP, with the purpose of the optimization of the patient dose together with the adequate image quality. Furthermore, the College on Medical Physics organized the course on DRLs at Abdus Salam International Centre of Theoretical Physics co-host by IAEA, to the large number of participants from different regions at Trieste Italy. Those activities encouraged the optimization of the patient dose through the survey from frequent examinations with high patient dose such as CT, interventional radiology and other medical imaging. Several ASEAN members have no opportunity to start the survey according to the lack of medical physicist in medical imaging such as Brunei, Cambodia, Lao PDR, Myanmar, Singapore and Vietnam. Under the support from SEAFOMP President, Dr. Freddy Haryanto, Dr. Anchali Krisanachinda, President of Thai Medical Physicist Society had invited three distinguished consultants in early 2021 to initiate the national diagnostic reference levels and the regional diagnostic reference levels for ASEAN. Those are:

1. Dr. Donald McLean, Former IAEA Technical Officer, Human Health, IAEA Expert to Thailand, currently, Diagnostic Radiology Medical Physicist at Canberra Hospital, Australia.
2. Dr. Noriah Jamal from Malaysia, Former National Liaison Officer of Malaysia and Lead Country Coordinator on the IAEA Medical Physics Project
3. Professor Kosuke Matsubara, Kanazawa University, Japan, J-RIME committee on the establishment of Japan DRLs 2020.

The Consultants had paid the most important roles on giving lectures on DRLs, exchange their evidence and experience in establishing DRLs in their own countries and others, draft the excel file on the survey of patient data

related to dose quantities, patient indications and examinations, plan for national and regional DRLs activities, encourage the Member States to get along with the activities and contribute to the virtual meetings in 2021.

## II. VIRTUAL MEETINGS

According the COVID 19 pandemic, the virtual meeting had been planned and organized for SEAFOMP members. Four virtual meetings had been hosted by Chulalongkorn University (Zoom Chula), Bangkok Thailand in 2021 as following:

**First:** On May 27, 2021, three lectures titled

- *Concept of NDRLs, RDLs - NJ*
- *Templates for the regional data collection -DM*
- *Experience on Japan DRLs2020 -KM*
- *Country Reports-Member States*

**Second:** On July 21, 2021, three lectures titled

- *Survey on General Radiography -NJ*
- *Survey on Interventional Radiology -DM*
- *Survey on Computed Tomography -KM*
  - *Country Reports Member States*

**Third:** On September 9, 2021, four lectures titled

- *Survey on Dental Radiography -DM*
- *Survey on Fluoroscopy -KM*
- *Survey on Mammography -NJ*
- *Survey on Nuclear Medicine -AK*

**Fourth:** On December 23, 2021, three lectures titled

- *The 2015 Japan DRLs establishment -KM*
- *Proposed 2022 ADRLs Milestones -NJ*
- *Australian – UK DRLs -DM*
- *Country Reports on Milestone in 2022*

## III. COUNTRY REPORTS

### *Cambodia*

Mr. Ath Vannyat proposed the survey of CT, Interventional Radiology (IR) and General X-ray examinations. In the year 2018, the number of CT system in Cambodia was 58. Dose quantity is  $CTDI_{vol}$  (mGy) and DLP (mGy.cm). The CT examination includes brain, cervical spine, thorax and lumbar spine. The number of general X-ray system was 520, the dose quantity is KAP (mGy.cm<sup>2</sup>). X-ray examination includes Abdomen AP, Cervical Spine AP, LAT, Chest PA, LAT, Thoracic spine AP, LAT, Lumbo-sacral AP, LAT, Pelvis AP, Skull AP/PA, LAT. The number of X-ray systems in IR was 20. The patient size is weight (kg) and height (cm), dose quantity is KAP (mGy.cm<sup>2</sup>), and the examination includes biliary intervention and facet joint intervention.

### *Indonesia*

In May 2021, Indonesia established the national DRL (Indonesian Diagnostic Reference Level, IDRL) resulting from a series of coordination meetings among stakeholders over online-based data collection/survey initiated in 2015 by the Indonesian Nuclear Energy Regulatory Agency (BAPETEN). The established IDRL has been published and accessible at <https://idrl.bapeten.go.id/index.php/site/idrl>. Currently, it provides national DRL values for general radiography and CT for a typical adult patient. The indicated dose quantities were Entrance Surface Air Kerma, ESAK (mGy) and Incident Air Kerma, IAK (mGy) for general radiography as well as  $CTDI_{vol}$  (mGy) and DLP (mGy.cm) for CT.

For general radiography, IDRL covers several of anatomy-based procedures, namely abdomen AP, ankle joint AP, antebrachial AP, BNO (*Blass Nier Oversich*) AP, chest (AP and PA), cervical (AP and lateral), femur AP, genu (AP and lateral), lumbar spine (AP and lateral), manus AP, pedis AP, pelvis AP, shoulder, skull (AP and lateral), GR-Cruris/Tibia Fibula, wrist joint AP, and waters. For CT, the established DRL covers the following anatomy-based procedures; abdomen (contrast and non-contrast), abdomino-pelvis (contrast and non-contrast), cardiac studies (contrast), chest (contrast and non-contrast), head (contrast and non-contrast), neck (contrast), and urology (non-contrast).

The data used to establish IDRL is obtained from data reported online by hospitals or clinics to the integrated national system for patient dose data registry (Si-INTAN, <https://idrl.bapeten.go.id>). The data collection process has been ongoing since 2015 until present, that includes data on examination of patients with CT (available since 2015), interventional radiology (available since 2016), diagnostic nuclear medicine (available since 2017), general radiography (available since 2017), dental radiography (available since 2018), and mammography modalities (available since 2018).

From 2015 to 2020, the availability of adequate data to determine IDRL is data for examining patients using CT and general radiography. In 2021, the IDRL value for CT and general radiography has been established. In 2022, it is planned to determine IDRL values for interventional radiology and diagnostic nuclear medicine, and in 2023 for dental radiography and mammography.

The dosimetric calculation system used in Si-INTAN to determine the patient dose value is the radiation output data for each modality obtained from compliance test results. The unique radiation output value for each x-ray modality will be used to calculate the patient dose, namely IAK, ESAK, and DAP. While for CT modalities, using the  $CTDI_{vol}$  and DLP dose indicators on the monitor console that have been validated through compliance test, which has an error of less

than 20%. Another aspect considered for determining IDRL of adult patients is using the Indonesian adult patient weight standard ( $60 \pm 10$  kg), which was obtained from the analysis of body weight data from Si-INTAN for the period 2015 - 2018 and updated in 2019 - 2020. Dose indicators used in determining the IDRL value in Indonesia is enlisted in Table 1. (From the website www.idrl.bapeten.go.id):

Table 1 Dose quantities used in determining Indonesian Diagnostic Reference Level (IDRL)

No.	Modality	Dose Quantity	Derivative Indicators
1.	General radiography	ESD (mGy) or DAP or KAP ( $\text{mGy.m}^2$ )	Effective dose (mSv)
2.	Mammography	IAK (mGy)	Mean Glandular Dose (mGy)
3.	Fluoroscopy/ image-guided interventional	DAP or KAP ( $\text{mGy.m}^2$ ) or Peak Skin Dose (mGy) or Air Kerma Rate ( $\text{mGy/s}$ )	Effective dose (mSv)
4.	CT	$\text{CTDI}_{\text{vol}}$ (mGy) or DLP ( $\text{mGy.cm}$ )	Effective dose (mSv)
5.	Intraoral dental	ESD (mGy)	Effective dose (mSv)
6.	Panoramic dental	DAP or KAP ( $\text{mGy.m}^2$ )	Effective dose (mSv)
7.	Nuclear medicine	Administered Activity (MBq)	Effective dose (mSv)

The establishment of IDRL is a mandate from the Government Regulation Number 33 Year 2007 on the Safety of Ionizing Radiation and the Security of Radioactive Sources. Furthermore, in 2020, BAPETEN Regulation Number 4 of 2020 was issued concerning Radiation Safety in the Use of X-Ray Equipment in Diagnostic and Interventional Radiology, which requires the licensee to submit patient dose records online through the national information system for patient radiation dose. According to the regulations, recording and reporting patient radiation dose data to Si-INTAN is one of the tasks of medical physicists. Therefore, it is necessary to encourage the participation of medical physicists to be active in the mechanism for collecting, reporting, and analyzing patient dose data to Si-INTAN, so that the national program in determining and implementing IDRL is easily realized.

#### Lao PDR

Ms.Viphaphone Inphavong proposed the survey for the local diagnostic reference levels, LDRLs, at Mittaphab Hospital, Vientiane Lao PDR. The survey includes CT and General X-ray examinations. The patient selection was at 18-70 years old, the weight range was 45-75 kg. The CT examination includes Brain with contrast (2-phase) /without contrast, Chest with contrast (2-phase) /without contrast, Abdomen with contrast (3-4 -phase), CT TAP (thorax-abdomen- pelvis) (3-phase). Dose quantity is  $\text{CTDI}_{\text{vol}}$  (mGy), total DLP ( $\text{mGy.cm}$ ). The median and the third

quartile of the patient dose quantity were calculated from 289 cases. The General X-ray examination includes Sinus/Skull, Chest PA, Abdomen AP, Pelvis AP, Lumbar spine AP/ LAT. The dose quantity is KAP ( $\mu\text{Gy.m}^2$ ), the median and the third quartile of the patient dose quantity were calculated from 178 cases.

#### Malaysia

Ms.Nurmazaina Md.Ariffin proposed the survey of CT, General X-rays, Fluoroscopy, and Interventional Radiology. 277 CT systems, 2,457 X-ray systems, 718 Fluoroscopy systems, and 170 IR systems are in the country inventory. The range of patient weight is 40-80 kg. The dose quantity for CT is  $\text{CTDI}_{\text{vol}}$  (mGy) and DLP ( $\text{mGy.cm}$ ), the examination consists of Abdomen, Brain, Cardiac, Chest, Pelvis, Spine/ Musculo- Skeletal, Thorax. The dose quantity of general X-rays is Air KERMA (mGy) and KAP ( $\text{mGy.cm}^2$ ). The examination consists of Abdomen (KUB) AP, Cervical Spine AP/LAT, Chest PA/ LAT, Extremity upper/lower, Lumbo-sacral AP/LAT, Pelvis AP, Skull AP/PA, Skull LAT, Thoracic spine AP /LAT. The dose quantity of fluoroscopy is the Cumulated Air KERMA (mGy), KAP ( $\text{Gy.cm}^2$ ). The examination consists of ERCP, GI upper, GI Lower. The IR examination consists of cerebral, ESWL and vascular.

#### Myanmar

Ms. Thinn Thinn Myint proposed the survey of Nuclear Medicine, planar imaging, SPECT /CT, and PET/CT. There are six nuclear medicine centers, four are public centers and two are private centers. There are six SPECT/CT, two PET/CT systems, and one cyclotron. Nuclear Medicine examinations are planar and tomographic studies. Planar imaging is Thyroid, Parathyroid, Renal DTPA, Renal DMSA, Liver/Spleen, Hepatobiliary, and Bone. SPECT/CT imaging is Myocardial Perfusion (Rest and Stress), Parathyroid and Bone. PET/CT is an oncology study of F-18 FDG. At the public hospital, the patient injected activity has been recorded the fixed activity for individual examinations that based on the range of activity, i.e. Myocardial Perfusion (Rest and Stress), Tc-99m MIBI 8-10 mCi. PET/CT examination 18F-FDG 0.12 mCi/kg. At the private hospital, all injected activities had been recorded. Six nuclear medicine systems were proposed for NDRLs, those are Cardiac, Endocrine, Genitourinary, Haematological, Skeleton, Oncology systems. The survey will be started in 2022 when the delivery of the radiopharmaceuticals is available. Two centers will be in the survey. Those are Yangon General Hospital (Public) and Pinlon Hospital (Private).

*The Philippines*

The Food and Drug Administration and the Philippine Nuclear Research Institute, the two radiation regulatory bodies for ionizing radiation, are leading the establishment of National Diagnostic Reference Levels for the Philippines. The national policy for the establishment of DRLs is currently being finalized. Implementation and data gathering shall follow once the policy has been formally issued. The goal is to establish the DRL for CT, Fluoroscopy, IR, General Radiology, Mammography, and General Nuclear Medicine. There are 354 facilities with CT systems; 30 CT systems will be included in the survey from 30 CT facilities. The range of body weight is from 50 to 70 kg. The dose quantities to be determined for CT are the  $CTDI_{vol}$  (mGy) and the DLP (mGy.cm). The CT examination based on clinical indication will consist of Head (Acute Stroke), Chest (Lung Cancer), Chest (High Res), Abdomen (Liver Metastasis), Abdomen and Pelvis (Abscess), Chest Abdomen Pelvis (cancer), CT-Stonogram, and Head (Trauma). The number of general radiology facilities is 2593 of which 30 are to be included in the survey. The dose quantity to be measured is the Air KERMA (mGy). General X-ray examinations to be covered are Chest/Thorax (PA), Cervical Spine, Thoracic Spine, Lumbar Spine/LSJ, Abdomen, Pelvis and Hip, Skull (AP/PA, LAT), Pediatric - Chest (Lung), Pelvis, Abdomen, Skull (AP/PA, LAT), and Babygram. There are 109 facilities doing Fluoroscopy examinations of which 30 are to be included in the survey. The fluoroscopy examinations to be covered are Barium Meal, Barium Enema, Barium Follow Through, Intravenous Urography, and ERCP. There are 49 facilities doing IR of which 20 are to be included in the survey. The IR examinations to be covered are Coronary Angiography, Percutaneous Coronary Intervention, CA and PCI. There are 137 mammography centers, and 30 centers are to be included in the survey. The range of patient weight is 45- 65 kg. The dose quantity to be determined is the Mean Glandular Dose (MGD, mGy), and the examination to be covered is the screening mammogram.

*Singapore*

Mr.Kwok Yew Mun and Mr.Somanasen S proposed the survey of CT, IR and General Nuclear Medicine. The number of CT systems is 120, the number of department with CT is 20. The number of CT system in the survey is 8. The range of patient weight is 55-75 kg. The CT examination consists of Brain, Abdomen and Pelvis, Chest HRCT, Liver, multi-phase, KUB, CTA Circle of Willis. The number of IR X-ray systems is 78 from 10 departments; the data from 5 systems at a department is in the survey. The dose quantity is Cumulated Air KERMA (Gy) and KAP (Gy.cm<sup>2</sup>). The IR examination consists of AVF Angioplasty, AVG Thrombolysis/Thrombectomy, CVC Tunnelled (Dialysis/pheresis), ERCP (Fluoroscopy only),

Percutaneous Change of Catheter, Peripherally Inserted Central Catheter. There are 10 nuclear medicine departments and one department is in the survey. The dose quantity is the administered activity (MBq, mCi) and administered activity/body weight (MBq/kg).

*Thailand*

Prior to the survey of the patient dose from medical imaging, the Section of Radiation and Medical Devices, arranges the training program to radiology and related staffs from Department of Medical Science on dosimetry based on IAEA TRS 457 and the concept of optimization of protection in the medical exposure of patients for diagnostic and interventional procedures. Radiology equipment and dosimeters in Thailand are calibrated annually and certified by Department of Medical Sciences, Ministry of Public Health. Under Certification, the radiology equipment is eligible for clinical service.

The survey was started in 2017 on General radiology and Dental radiography, 2018 on Computed Tomography, 2019 on Screen Film and Digital Mammography, 2020 on Fluoroscopy, Interventional Radiology and Cardiology. General Nuclear Medicine, SPECT/CT and PET/CT are surveyed by Nuclear Medicine Society of Thailand. In 2021, Department of Medical Science announced the establishment of Thailand DRLs 2021. The milestone in 2022 will be the survey on panoramic radiography and Cephalometric radiography, 2023 – Cone Beam CT for dental radiograph, 2024- Digital Mammography and Digital Breast Tomosynthesis.

The survey of interventional cardiology based on clinical indication, is performed by the Cardiovascular Intervention Association of Thailand. Number of intervention cardiology PCI cases was 22,737 from 76 X-ray systems in 38 departments, 18- month survey with registry. The patient BMI, mean  $\pm$  SD is recorded. Dose quantity is Cumulated Air KERMA (mGy) and KAP (Gy.cm<sup>2</sup>). The examinations consist of Coronary Angiography (CAG), Percutaneous Coronary Intervention (PCI), Permanent Pacemaker (PPM), Chronic Total Occlusion (CTO) and non CTO.

There were 722 CT systems in Thailand in 2018 and 135 CT systems were in the survey. The size indicators were weight (kg), height (cm) and body thickness (cm). The range of body weight is 45-75 kg. The CT examinations were Brain without contrast media, Brain with contrast media, Chest without contrast media, Chest with contrast media, Whole abdomen without contrast media, Whole abdomen with contrast media.

546 from 8225 dental radiography systems were in the survey from 15 dental departments. Dose quantities were Incident Air KERMA, Entrance Surface Dose, Air KERMA at Isocenter (mGy), KAP (mGy.cm<sup>2</sup>). The examinations of

Maxillary/Mandibular were Incisor, Canine/premolar, Molar.

250 from 22,275 General X-ray systems were surveyed on Chest PA, Lumbar spine AP, Lumbar spine LAT, Pelvis AP, Abdomen AP, Skull AP/PA, Skull LAT examinations.

1846 Fluoroscopy systems were in the survey of Barium swallow, Upper gastrointestinal fluoroscopy with contrast, Long GI, Barium enema and HSG examinations. 135 from 251 IR equipment were surveyed on TACE 2D, TACE 3D, PTBD, GI Bleeding, Diagnostic cerebral, Embolization of intracranial aneurysm, Embolization of brain AVM, Embolization of intracranial Dural AVF, Embolization of head & neck tumor.

166 from 456 mammographic systems were surveyed on screening and diagnostic mammogram on CC, MLO views of both breasts. Dose indicators were MGD and ESAK (mGy).

There are 32 nuclear medicine centers, 25 centers were in the survey of general nuclear medicine, Planar Imaging, SPECT/CT and PET/CT imaging. Planar imaging examination were Cardiology, Endocrine, Genitourinary, Gastrointestinal, Infection, Lymphatic, Oncology and Skeletal Imaging. Dose quantity was injected activity, mCi and mCi/kg. 34 SPECT/CT and 13 PET/CT were in the survey of Myocardial Perfusion, Cardiovascular, Lymphatic (Breast Ca), Neurological, Pulmonary and skeletal examination. PET Imaging is on Neurology, Oncology and Whole Body scan of F-18 PSMA, F-18 FDG, Ga-68 DOTA-TATE, Ga-68 PSMA. CT DRLs were estimated and reported in CTDI<sub>vol</sub> (mGy) and DLP (mGy.cm) on the hybrid systems.

Table 2 The NDRLs Thailand on 10 examinations

General Radiography	ESD mGy	Intra Oral Radiography	Ki, mGy
Chest PA	0.3	Maxillary Incisor	2.3
Abdomen AP	3.8	Canine/premolar	3.1
Pelvis AP	3.1	Molar	4.0
LS AP	3.8	Mandibular Incisor	1.9
LS Lat	9.8	Canine/premolar	2.4
Skull AP/PA	2.6	Molar	3.1
Skull Lat	2.1		
Computed Tomography	CTDI <sub>vol</sub> mGy	DLP mGy cm	
Brain without CM	1028	62	
Brain with CM	935	52	
Chest without CM	417	18	
Chest with CM	665	18	
Whole abdomen without CM	717	18	
Whole abdomen with CM	717	20	
Mammography	D <sub>G</sub> mGy		
MGD at 45 mm PMMA	2.50		
2D MGD	2.04		
ESAK	9.70		
Interventional Body Radiology	KAP Gy.cm <sup>2</sup>		
TACE CBCT)3D(	226		
TACE)2D(	141		
PTBD	13		
GI bleeding	151		

Interventional Neuroradiology	KAP Gy.cm <sup>2</sup>		
Cerebral angiogram	108		
Embolization of intracranial aneurysm	209		
Embolization of brain AVM	187		
Embolization of brain AVF	261		
Embolization of Head & Neck tumor	230		
Embolization of spinal AVM or tumor	210		
Interventional Cardiology	KAP Gy.cm <sup>2</sup>		
Angiography coronary arteries CAG	28		
Percutaneous coronary intervention PCI	99		
Permanent pacemaker PPM	8		
Nuclear Medicine System (SPECT)	Radiopharm	Activity mCi	Activity/BW mCi.kg <sup>-1</sup>
Skeletal, Bone Marrow	Tc-99m MDP	21	0.44
	Tc-99m MIBI (rest)	10	0.35
	Tc-99m MIBI (stress)	26	0.51
	Tc-99m PYP	20	0.30
	Tc-99m RBC (MUGA)	21	0.63
Cardiovascular	Tl-201	3	0.05
	Ga-67 Citrate	5	0.09
	I-131	3	0.11
	I-131 MIBG	1	0.07
	Tc-99m MAA	5	0.11
Oncology	Tc-99m MIBI	20	0.40
	Tc-99m Octreotide	20	0.25
SPECT/CT Part of CT	Radiopharm	CTDI <sub>vol</sub> mGy	DLP (mGy.cm)
Cardiovascular	Tc-99m RBC (MUGA)	2	200
Myocardial Perfusion	Tc-99m MIBI	2	200
Neurology	Tc-99m ECD	60	100
Oncology	Tc-99m Octreotide	12	400
PET System	Radiopharm	Activity, mCi	Activity/BW mCi.kg <sup>-1</sup>
Neurology	F-18 DOPA	10	0.14
	F-18 FBB (amyloid)	11	0.19
	F-18 FDG	7	0.15
	F-18 FDG	9	0.21
Oncology	F-18 PSMA	6	0.12
	Ga-68 DOTA-TATE	5	0.07
	Ga-68 PSMA	5	0.09
PET/CT Part of CT	Radiopharm	Activity, mCi	Activity/BW mCi.kg <sup>-1</sup>
Neurology	F-18 FDG	36	688
Oncology	F-18 FDG	11	500
	F-18 PSMA	13	500

Vietnam

There are more than 6000 X-ray facilities for General X-rays, Fluoroscopy, Dental, Mammography Intervention Radiology, and CT examinations. About 30 nuclear medicine centers are serviced in Vietnam.

At Cho Ray hospital, Ho Chi Minh City, further from general x-rays, there are 8 CT scanners, 2 PET/CT, 2 SPECT and SPECT/CT.

In 2022, the survey of common CT and Nuclear Medicine examinations will be started for local diagnostic reference level, LDRLs, such as CT Head, CT Abdomen, three phase liver, and etc. The dose quantity for CT protocol is DLP (mGy.cm). For Nuclear Medicine, the dose quantity is the injected activity in mCi for planar and tomographic imaging. PET/CT imaging, the dose quantity is administered activity per patient body weight at 0.12 mCi/kg of <sup>18</sup>F-FDG. For each examination, the data collection is at least 30 patients per examination.

### CONCLUSION

Even though the European Union started the RDRLs in 1997, the regional diagnostic reference levels in ASEAN had just been started in 2021 with large variation in the survey. The major problems are from the lack of knowledge and experience of the personnel in medical imaging especially the medical physicist. The lack of nuclear medicine and the interventional services in Lao PDR resulting in the Lao patients cross Mae Kong River to obtain the service in Thailand. Such the culture on the neighbor supportive has been extended to the education, clinical training to be sustainable in the future. The national and regional diagnostic reference levels are on the voluntary basis, the encouragement and the recognition on the optimization of radiation protection in medical imaging are emphasized by the consultants. There may be a lot of pitfalls in the first RDRLs of ASEAN – ADRLs, but the lesson learned can improve the next survey of ADRLs in the standards of the ASEAN surveys especially the inclusion of the clinical indication in the survey.

### REFERENCES

1. International Commission on Radiological Protection (ICRP), 2017. Diagnostic reference levels in medical imaging. ICRP Publication 135. Ann. ICRP 46(1) [https://www.icrp.org/publication.asp?id=ICRPPublication 135](https://www.icrp.org/publication.asp?id=ICRPPublication%20135) (last accessed 24 July 2020)
2. Japan Network for Research and Information on Medical Exposure (J-RIME). National Diagnostic Reference Levels in Japan (2020). 2020:1-22. Physics World. 34 (2):28-33.
3. Japan Network for Research and Information on Medical Exposures (J-RIME). Diagnostic Reference Levels Based on Latest Surveys in Japan. 2015:1-17.

Contacts of the Corresponding Author:

Author: Anchali Krisanachinda  
 Institute: Chulalongkorn University  
 Street: Rama IV Road  
 City: Bangkok  
 Country: Thailand  
 Email: anchali.kris@gmail.com