Professional Training Scheme to Answer National Demand Medical Physicists in Indonesia

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Abstract—**The recognition of medical physicist in Indonesia has been implemented in many aspects. In regulatory point of view, registered medical physicists has to be present during application of license for ionizing radiation-utilizing medical facilities in Nuclear Energy Regulatory Agency (*Badan Pengawas Tenaga Nuklir*, BAPETEN). Regulations also mandate diagnostic x-ray devices to be compliance-tested by BAPETEN-appointed companies prior to use—with certified personnel in these companies being mostly medical physicists. One of the major impacts of these policies is the significant increase in number of clinical medical physicists from 2016 to 2020, particularly for diagnostic radiology medical physicist (DRMP). In addition, the number of radiation oncology medical physicist (ROMP) is also increasing along with the increasing number of radiotherapy centers. Similarly, the incresing number of nuclear medicine medical physicists (NMMP) is also due to the the increasing number of nuclear medicine facilities in Indonesia. This situation has been made possible by the short-term policy of the medical physics professional society in collaboration with university and regulatory authority to develop the professional training scheme for medical physics. Two professional training programs to produce young medical physicists has been implemented in Indonesia since 2018. The result of the training is presented in this paper.**

Keywords — **medical physics, recognition, prefessional training, Indonesia.**

I. Introduction

Medical physicist as profession in Indonesia has been recognized by Ministry of Health in Decree No. 48/ 2007. The profession 'medical physicist' has also been mentioned in Government Regulation No. 36/2014, stated as medical professional under biomedical technology cluster with radiographer and biomedical engineer. By law, medical physicists have to be present in Radiotherapy, Diagnostic and Interventional Radiology, and Nuclear Medicine services as one of the prerequisites for medical devices to be licensed for clinical use. It is regulated by both the Nuclear Energy Regulatory Agency and Ministry of Health under separate decrees [1].

According to Government Regulation No. 12/2012 on higher education, medical physics education comprises of academic and professional training. [1] In line with international recommendations, the Clinically Qualified Medical Physicist (CQMP) has academic qualification of postgraduate level with minimum 2 years of additional clinical training at hospital [2].

II. Medical Physics Training Programme

2.1. Short-term Policy

Pawiro et al [1] mentioned that direct implementation of international recommendation on clinically qualified medical physicist training program faces a challenge concerning the geography, demography of population, and medical devices distribution in Indonesia.

Table 1. Radiation medicine facilities in Indonesia and the need of medical physicists

Province	DR	RT	NM	MP need
Aceh	14	-	-	11
North Sumatera	56	5	1	78
West Sumatera	11	2	- (1)	17
Riau	18	2	-	20
Jambi	5	-	-	7
South Sumatera	18	1	-	25
Bengkulu	4	-	-	5
Lampung	20	1	-	23
Bangka Belitung	4	-	-	5
Riau Island	11	-	-	10
Jakarta	95	12	6	207
West Java	134	3	2	289
Central Java	99	8	1	207
Yogyakarta	22	3(1)	1(1)	34
East Java	116	5	- (2)	213
Banten	39	1	-	104
Bali	30	3(1)	-	32
West Nusa Tenggara	8	1	-	12
East Nusa Tenggara	5	-	-	6
West Kalimantan	9	-	-	17
Central Kalimantan	6	-	-	5
South Kalimantan	11	1	-	16
East Kalimantan	15	2(1)	1	24
North Kalimantan	3	-	-	0
North Sulawesi	6	1	-	10
Central Sulawesi	8	-	-	6
South Sulawesi	36	3	-	52
South-East Sulawesi	5	-	-	16
Gorontalo	4	-	-	10
West Sulawesi	4	-	-	2
Maluku	3	(1)	-	1
North Maluku	2	-	-	3
Papua	7	-	-	3
West Papua	1	-	-	0
Total	839	56(4)	16(4)	1470

This is inline with quantity demand of medical physicists of around 1600 as calculated from the data of the Indonesian Nuclear Energy Regulatory Agency (*Badan Pengawas Tenaga Nuklir*, BAPETEN) [1]. This prediction is based on the data of radiation medical facilities as presented in Table 1.

Table 1 also illustrates the radiation medicine facilities distribution in Indonesia for diagnostic and interventional radiology, radiotherapy and nuclear medicine in each province in Indonesia. The number in brackets indicates the number of centers currently under development.

In order to answer the quantity demand of medical physicists in Indonesia, the medical physics professional society, *Aliansi Fisikawan Medik Indonesia* (AFISMI) decided on providing two levels of medical physicists which are Associate Medical Physicist (Assoc. Medphys) and Clinically Qualified Medical Physicist (CQMP). This leveling scheme is in line with the directives from Indonesian regulation according to Government Regulation No. 12/2012. The Associate Medical Physicist level falls on the category of Indonesian Qualification Framework (IQF) in Level 7, whereas Clinically Qualified Medical Physicist is categorized in IQF as Level 8. An Associate Medical Physicist essentially holds a bachelor's degree in Physics and completed the additional professional training for 6-12 months. Based on the Competence Standard of Medical Physicist developed by AFISMI and Ministry of Health, Associate Medical Physicists are dedicated to play limited role in physics service; i.e. related with simple equipment, techniques, and procedures for radiotherapy, diagnostic radiology, and nuclear medicine. For the use of advanced techniques and devices in radiotherapy, diagnostic and interventional radiology, and nuclear medicine, the Clinically Qualified Medical Physicist (CQMP) must be present. The Associate Medical Physicist also served as a bridge to match the current national capacity with the international qualification of medical physicist in the future [1].

The need of medical physicists as presented in Table 1 is calculated based on BAPETEN's current regulation which obliges healthcare facilities equipped with fluoroscopy, computerized tomography, and/or mamography devices to hire medical physicists. In addition, the need of radiotherapy medical physicists is calculated based on the IAEA recommendation related with number of patients, whereas each nuclear medicine centers has to present at least one medical physicist.

Pawiro et al [1,3] explained that the number of member of society increased from 298 to 381 with clinical physicists from 161 to 202 in 2016 and 2017, respectively.

Table 2 shows the current number of clinical physicists in March 2020. Compared to the same data in previous works [1,3] the number is increased to 438 out of 597 professional society members of AFISMI. From the data, the number of clinical physicist in diagnostic radiology (DRMP) increased significantly compared to clinical physicists in radiotherapy and nuclear medicine. It is caused by BAPETEN's regulation mentioning that medical physicist being one of the requirements to get operational license for fluoroscopy, computerized tomography, and mamography machines. This number is in correlation with big number radiology facilities in Indonesia.

In addition, the increasing number of clinical physicists of radiotherapy (ROMP) is around 10% and is directly related with the development of new centers and radiotherapy machines in the country. Furthermore, the number of clinical physicist in nuclear (NMMP) is also increasing along with the increasing number of nuclear medicine centers.

The rest of AFISMI members are bureaucrats at Ministry of Health and BAPETEN, academics, researchers at government institutes, and other professionals at manufacturers and their representatives.

Table 2. Number of Existing Medical Physicists

Province	**ROMP**	**DRMP**	**NMMP**
Aceh	-	5	-
North Sumatera	10	19	1
West Sumatera	4	8	1
Riau	3	5	-
Jambi	-	2	-
South Sumatera	2	4	-
Bengkulu	-	2	-
Lampung	2	3	-
Bangka Belitung	-	2	-
Riau Island	-	1	-
Jakarta	31	45	6
West Java	5	42	2
Central Java	16	51	2
Yogyakarta	10	9	2
East Java	11	27	2
Banten	2	8	-
Bali	8	6	-
West Nusa Tenggara	2	4	-
East Nusa Tenggara	-	4	-
West Kalimantan	-	1	-
Central Kalimantan	-	3	-
South Kalimantan	2	1	-
East Kalimantan	3	5	2
North Kalimantan	-	1	-
North Sulawesi	-	5	-
Central Sulawesi	-	5	-
South Sulawesi	5	24	-
South-East Sulawesi	-	8	-
Gorontalo	-	1	-
West Sulawesi	-	3	-
Maluku	-	1	-
North Maluku	-	1	-
Papua	-	1	-
West Papua	-	0	-
Total	114	306	18

2.2. Curriculum of Training

The training scheme of Associate Medical Physicist was developed to produce the large number of junior physicist who can play role as junior physicist in three specialities under senior physicists or Clinically Qualified Medical Physicist. The curriculum of this scheme will train the candidate to understand the role of medical physicist in simple diagnostic radiology (general x-ray, dental and fluoroscopy), radiotherapy (teletherapy machines with 3D and brachytherapy 2D capabilities), and nuclear medicine (gamma camera and single photon emision computerized tomography, SPECT). Therefore, the 6 to 12 months training for Associate Medical Physicists will cover the basic competency of medical physicist in three specialities. The curriculum of associate medical physicist is decribed in Table 3.

Table 3. Curriculum of associate medical physicist training scheme

No	Module	Length of training (hours)
1	Ethics of medical physicist in clinic and research	16
2	Acceptance and ommissioning of equipment	24
3	Quality Assurance of Equipment	32
4	Radiotherapy planning	28
5	Dose Audit	
6	Radiation protection and radiation safety	68
7	Clinical rotation in Diagnostic Radiology	160
8	Clinical Rotation in Radiotherapy	160
9	Clinical Rotation in Nuclear Medicine	80

In addition to the Associate Medical Physicist training scheme, we also run international standard of clinical residency program following the IAEA Training Course Series (TCS) publication 37, 47, and 50 [1,2].

2.3 Intake of participants

As consensus at the professional society (www.afismi.org) and the Indonesian Association of Higher Education in Medical Physics (AIPFMI, www.aipfmi.org), the educational background to enroll to the Associate Medical Physics training is described. Participants must only graduate from undergraduate program of physics or nuclear engineering with major in medical physics. The candidate has to proof with their academic transcript and completed the specified subjects; anatomy and physiology, radiological physics and dosimetry, imaging physics, radiotherapy physics, and nuclear medicine physics. If the candidates come from other theoretical and applied physics program, they must complete the matriculation on the aforementioned core subjects in medical physics.

The training is initiated and conducted by the Center for Medical Physics and Biophysics, Institute of Applied Sciences, Faculty of Mathematics and Natural Sciences, Universitas Indonesia (CMPB UI), with participants coming from other universities throughout Indonesia. The first batch of this training started in February 2018.

According to the data from batch 1 to batch 5, the training administrator must select participants based on admission test scores and also geographical distribution aspects. The selected participants for the Associate Medical Physics training can be seen in Table 4.

Table 4. Professional training program for Associate Medical Physicist

Batch	Number of participants	Graduated	Job position secured
Batch 1	49	47	44
Batch 2	34	33	23
Batch 3	32	32	26
Batch 4	29	29	12
Batch 5*	33	-	-
Total	177	141	105

• On-going

International Atomic Energy Agency (IAEA) through the Regional Technical Cooperation project in Asia Pacific conducted the pilot project to initiate the Clinically Qualified Medical Physics residency program in Indonesia in 2016. The pilot ROMP and DRMP has been started as described in Tabel 5 under the IAEA project RAS6077 followed the IAEA Training Coure Series, and it was translated to e-learning system called the Advanced Medical Physics Learning Environment (AMPLE). This e-learning system provides the possibility for residents to submit their work and the supervisor to grade their work [1]. Table 5 shows the paticipant of CQMP residency program in Indonesia which is registered by CMPB UI. The requirement of candidate is graduated form master of medical physics with background education in physics or nuclear engineering and have to completed associate medical physics training scheme before the candidate started the training. Up to now, this program is a voluntary program.

For ROMP program, three residents have graduated from based on asessment in April 2019 which was performed by external expert of IAEA and local medical physcists. Two residents of ROMP batch 1 still doing additional assignment to pass the program. The second batch will be asessed and evaluated in 2020. The first and second batch is trial program for 2 years flexible program depending on the clinical environment. The third batch has been started with fixed program for mandatory module in one year and then continue with internship for 6 months.

The DRMP program is started with remote residency program which is supervised by clinically qualified medical physicist from Australia. Up to now, we only have

one resident who still struggling to finish the program. In addition, the NMMP program is finally started under the project IAEA RAS6087 with 2 residents in June 2020.

Furthermore, the Table 5 indicated that ROMP batch 3 and NMMP batch 1 will be started with 4 residents and 2 residents, respectively.

Table 5. clinical qualified medical physics residency program

Specialities*, Batch	Number Participants	Graduated	Job position secured
ROMP 1	5	3	5
ROMP 2	4	-	4
ROMP 3	4	-	-
DRMP 1	1	-	1
NMMP 1	2	-	-
Total	16	3	10

*ROMP (Radiation Oncology Medical Physics), DRMP (Diagnostic Radiology Medical Physics), NMMP (Nuclear Medicine Medical Physics). The first batch ROMP and DRMP is under IAEA RAS6077 project, wheras first batch of NMMP is under IAEA RAS087 project

After completion of the professional training in both schemes, medical physicist has to be registered in the Indonesian Health Professional Council (*Konsil Tenaga Kesehatan Indonesia*, KTKI), Ministry of Health. The council will issue the registration certificate. This medical physicist registration certificate is a prerequisite document for radiation medicine facilities license application under BAPETEN's authority.

2.4 Placement of the alumnae

As above mentioned, two professional training schemes is developed to answer national demand of medical physicists in Indonesia. Tables 4 and 5 indicated the placement of alumnae of professional training of associate medical physicist and clinically qualified medical physicist, respectively.

Table 4 shows that more than 95% of participant have graduated from AMP training program and around 75% of them have each secured a job position. Participants having not secured any job position is because they are also master students who prefer to finish their study prior to seeking a job. Since Batch 4 has just graduated in March 2020, that the unemployment rate of alumnae of the training for batch 1 to batch 3 is less than 10 %.

For the survey, around 80% of the alumnae from batch 1 to 4 work in Java island, while the rest are being distributed in other islands. This distribution of alumnae is another issue of the job placement, so the admission requirement of participants have changed for batch 5, where we prioritize to select participants from outside Java island. It is expected that a more proportional distribution to take place within two years in the future.

In addition, Table 5 shows that all participants of the clinically qualified medical physicist training already have a job before their completion the program for batch 1 and batch 2.

Based on the distribution of placement, the participants and alumnae of the CQMP training of ROMP have occupied jobs in Java and Sumatera Island at new centers with advanced technology. This has been made possible thanks to our cooperation with Indonesian Radiation Oncologist Society (IROS) and BAPETEN. The aforementioned parties have recommended new centers with advance technology to recruit new medical physicist with master's degree in Physics or Medical Physics and with on going or graduated from CQMP training.

III. Conclusions

The recognition of medical physics profession in Indonesia has been established. The number of members and clinical medical physicists is increasing rapidly especially in diagnostic radiology. There are still homeworks to increase their competency through the continuing medical physics education which can be conducted by collaboration Ministry of Health, AFISMI, and Universities.

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