Level of radiation exposure in several hospitals in Indonesia

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Abstrak

Latar belakang: *Untuk menjaga keselamatan pekerja, Badan Pengawas Tenaga Nuklir Indonesia telah menentukan nilai batas dosis radiasi di antara pekerja yang terkena radiasi. Tujuan penelitian ini untuk mengetahui besar pajanan radiasi di tempat kerja di beberapa rumah sakit.*

Metode: *Studi potong lintang dilakukan dengan wawancara, observasi, serta pengukuran besar pajanan radiasi di tempat kerja. Besar pajanan radiasi dikelompokkan sesuai dengan tempat kerjanya yaitu bagian radiodiagnostik, radioterapi, dan kedokteran nuklir. Populasi penelitian ini adalah tenaga kesehatan yang terpajan radiasi di sembilan rumah sakit di enam provinsi.*

Hasil: *Jumlah responden dalam penelitian ini 103 orang dari 9 rumah sakit. Sebagian besar responden adalah laki-laki (51,3%) dan kelompok umur terbanyak 40-44 tahun (27%). Besarnya pajanan radiasi di tempat kerja yang paling tinggi ialah pada waktu dilakukan kateterisasi jantung (pajanan radiasi rata-rata 11,02 uSv/jam). Sedangkan di bagian radiodiagnostik lainnya (CT scan, fluoroskopi, dan C-arm) pajanan radiasi rata-rata 1,80 uSv/jam, di bagian kedokteran nuklir 5,33 uSv/jam, dan terendah di bagian radioterapi (1,05 uSv/jam).*

Kesimpulan: *Personil kateterisasi jantung menerima pajanan radiasi per jam tertinggi, sedangkan tenaga kerja yang lainnya menerima pajanan rendah.* ***(Health Science Indones 2012;1:15-8)***

Kata kunci: *pajanan radiasi, pekerja radiasi*

Abstract

Background: The Nuclear Energy Regulatory Agency of Indonesia formulated guidelines on the standard dose for workers exposed to radiation. The purpose of this study was to identify the degree of exposure to radiation of workers in several hospitals in Indonesia.

Methods: The data in this **c**ross-sectional study were collected by interview, observation, and measuring radiation exposure dose at several work places (radio-diagnostic, radio therapy, and nuclear medicine in nine purposively selected hospitals in six provinces in Indonesia

Results: The total respondents in this study were 103 technicians in 9 hospitals. There were more male (51.3%) than female technicians, and they were mostly 40-44 years old (27%). The highest exposure occurred in heart catheterization lab (the average dose was 11.02 uSv/hour). Meanwhile, in other radiodiagnostic laboratories (CT scan, fluoroscopy, and C-arm) the average radiation exposure was 1.80 uSv/hour, in radiotherapy 1.05 uSv/hour, and in nuclear medicine 5.33 uSv/hour.

Conclusion: Heart catheterization personnel received high radiation exposure per hour. Other radiologic technicians received less than the allowable radiation exposure per hour. ***(Health Science Indones 2012;1:15-8)***

Key words: radiation exposure, radiation technicians

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Radiation safety is an effort to protect an individual, his heirs, and the public in general from all biologically detrimental effects caused by radiation exposure. The effect is called somatic if it occurs to an individual and genetic if it occurs to his heirs. These effects can be either stochastic or nonstochastic. Stochastic effects occur by chance and need no threshold dose. Nonstochastic effects, on the other hand, are characterized by a threshold dose, below which an adverse effect cannot occur. In other words, nonstochastic effects have a clear relationship between exposure and effect. The degree of the effect is directly proportional to the size of the dose. Nonstochastic effects will result when workers are exposed to very large dosages of radiation in a short amount of time. Prevention of nonstochastic effects can be accomplished by keeping radiation exposure "as low as reasonably achievable" (ALARA) which means making every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as practical.

In 1960-1968, the United States Atomic Energy Commission reported that radioactive accidents were caused by several reasons: operator negligence (68%), procedural negligence (8%), logistic damaged (15%), and other reasons (9%). In detail, operator negligence was: absence of radiation survey (46%), did not follow the procedure (36%), did not use protection equipment (6%), human error (6%), and error in measuring radiation exposure (6%).

The International Atomic Organization has lowered their standard dosage for exposed radiation workers from 50 mSv/year to 20 mSv/year, and the maximum standard was 50 mSv/year. While according to the International Commission on Radiological Protection (ICRP), who had discussed the recommendations and guidelines from all aspects of protection from radiation, stated that the standard dose for exposed worker was 20 mSv/year and the standard dose for the public was 1 mSv/year.

Regulation No.01/Ka-BAPETEN/V-99 from the head of the Nuclear Energy Regulatory Agency (BAPETEN) regarding occupational safety stated that the standard radiation dose for workers was less than 50 mSv/year and the standard radiation dose for the public was less than 5 mSv/year.

Considering the importance of keeping radiation exposure as low as possible, it is vital to determine the strength of workers exposed to radiation in the daily course of their work. The objective of this study was to determine the amount of radiation on workers exposed to radiation in various hospitals in Indonesia.

METHODS

This was a cross-sectional study, and the population was medical workers exposed to radiation in their workplaces.

At the start, there were 20 hospitals with radiodiagnostic and radiotherapy facilities. Of these 20, 13 hospitals had nuclear medicine facilities. Finally, from these 13 hospitals, only 9 hospitals participated in this study. The nine hospitals in six provinces were included in this study. The nine hospitals were the Dharmais Cancer Hospital in Jakarta, the Harapan Kita Hospital in Jakarta, the Hasan Sadikin Hospital in Bandung, the Kariadi Hospital in Semarang, the Moewardi Hospital in Solo, the Sarjito Hospital in Yogyakarta, the Saiful Anwar Hospital in Malang, the Sutomo Hospital in Surabaya, and the Sanglah Hospital in Denpasar.

Radiation exposure was measured in the radiodiagnostic division of the hospitals included in the study. The division consisted of the heart catheterization laboratory and the workers included cardiologists, nurses, and radiographers. Other radiodiagnostic laboratories included CT-scan, fluoroscopy, C-arm X-ray. In radiotherapy, those teletherapists working with cobalt 60, LINAC, simulator, and brachytherapy were tested, while in nuclear medicine the workers were involved in Myocard Perfusion Imaging, lung perfusion scanning, and thyroid scanning.

The inclusion criteria for the subjects were: (a) exposed health personnel who worked either in the radiology facilities, and (b) had been exposed to radiation in the workplace for more than one year. Exclusion criteria were: a) sick at the time of the study, and b) on leave. The duration of this study was 8 months in 2011.

Data were collected by interviews based on questionnaires to all exposed health personnel working in the 9 hospitals meeting the criteria of having radio-diagnostic facilities for heart catheterization, fluoroscopy, CT scan, and C-arm X ray, radio therapy, and nuclear medicine. Radiation exposure in the facilities was measured by using a survey-meter (Thermo Eberline ESM – FH 406). This instrument was calibrated and validated

before use. Radiation was measured during the time the doctors, nurses, and radiographers were with the patients. Measurements were done more than once to ensure accuracy.

RESULTS

There were 103 subjects from nine hospitals, mostly males (51.3%), in the 40-44 years age group (27%), and married (98.2%). Most of them had college education (44.3%) and were radiographers (59.1%). A good number (26.1%) had worked for 11 – 15 years in their last job.

The highest radiation exposure was in the catheterization lab where the average exposure was 11.02 μSv/hour, ranging from 5 until 32.50 μSv/h. In the radiodiagnostic facilities (CT scan, fluoroscopy, C-arm), the average exposure was 1.80 μSv/h, ranging from 0.20 until 10 μSv/h. In the radiotherapy facilities, it was 1.05 μSv/h and the range was between 0.11 until 10 μSv/h. In the nuclear medicine facilities, it was 5.33 μ Sv/h and the range was between 3 until 8 μ Sv/hour.

Table 1. Radiation exposure in various workplaces

	n	Radiation measurement in various workplaces (uSv/ hours)				Maximum radiation dose for worker*
		Mean	SD	Min	Max	Per hour
Radiodiagnostic						
Heart catheterization	16	11.02	6.96	5.00	32.5	25 uSv
Others (CT-Scan, Fluoros-copy, C-arm X-ray)	39	1.80	2.69	0.20	10	25 uSv
Radiotherapy	45	1.59	3.90	0.11	25	25 uSv
Nuclear-medicine	3	5.33	2.52	3.00	8	25 uSv

*Based on the Indonesian Nuclear Energy Regulatory Agency on occupational radiation security

In the radiotherapy division of Saiful Anwar Hospital, Malang, one worker was found to have a high radiation exposure of 25 μSv/h. This was due to doubling as a medical physicist and as a technician, repairing the radiological equipment.

DISCUSSION

The limitation of this study was on the hospitals included as sample. Not all hospitals matching the criteria of having radiodiagnostic, radiotherapy, and nuclear medicine facilities could be included. In addition, the hospitals included were all only government hospitals.

According to Regulation No.01/Ka-BAPETEN/V-99 from the head of the Nuclear Energy Regulatory Agency (BAPETEN) the radiation exposure was limited to less than 50 mSv/year. When calculated to the hour, the result was 25 μSv/h. The limit set by The International Commission on Radiological Protection (ICRP) is lower, at 20 mSv/year or 10 μSv/h.

Radiation exposure was found to be highest in health personnel working in the catheterization lab, ranging from 5 to 32.5 μSv/h. Exposure to doctors and cardiologists were the highest, followed by the nurses and radiographers. This was probably due to the proximity of the examining physicians to the source of radiation.[5]

The amount of radiation received by the cardiologists was 32.5 μSv/h, higher than the 25 μSv/h limit set by regulation No.01/Ka-BAPETEN/V-99 of the Nuclear Energy Regulatory Agency (BAPETEN).

Nowadays, cath lab has grown to become a frequently used diagnostic laboratory and a means for interventional therapy. The duration of radiation exposure, therefore has increased due to amount of time needed in interventional therapy at the cath lab. Meanwhile radiation exposure to ventriculography and coronary angiography is 300 times conventional thorax x-ray, coronary stent procedure is 1000 times, peripheral artery intervention is 1500 – 2500 times, and ablation is 900 – 1500 times.[6]

Other studies have mentioned that radiation dosages received in many examinations was highest for heart catheterization (450 mSv), barium enema (80.0 mSv), mammography (15.0 mSv), and thorax radiography (0.22 mSv).[7]

Exposure of radiation from x-ray equipment received by the medical personnel in the Radiology Unit of the Sarjito Hospital, Yogyakarta, from year 2000 until 2007 was 119.5 mrem/year (1.195 mSv/year).[8] This was less than radiation exposure received by the cath lab personnel.

This increasing exposure to radiation by medical personnel may cause a rise in somatic DNA defects and may lead to cancer. Data in the United States showed that the risk of cancer due to radiation exposure was about 20%.[6]

Radiation exposure received by medical personnel in the interventional radiology facilities was higher than other radiological examinations. Therefore special

precautions should be taken, such as, closely monitoring hazards of the workplace and continuously checking the medical workers' health for stochastic effects of radiation. Preventive efforts can be achieved if the radiation exposure can be made as low as reasonably achievable (ALARA) for every worker and the dose limited to the normal range.[4,6]

Government Regulation of The Republic of Indonesia No. 33 of 2007 regarding ionizing radiation security and safety of radioactive resources and Decree of Head of BAPETEN No. 6 of 2010 regarding health monitoring for radiation workers have to be implemented regularly at least once a year in an effort to monitor health monitoring for early detection of any health problems.[9,10]

Epidemiological data on cancer risks from eight cohorts of over 270,000 radiologists and technologists in various countries have been reviewed. The most consistent finding was increased mortality due to leukemia among early workers employed before 1950, when radiation exposure was high.[11] Early detection for leukemia need complete hematology and peripheral blood smear.[12,13] For this reason, blood tests, that was not included in the Regulation No. 6 of 2010 of BAPETEN, should be included.

In conclusion, heart catheterization personnel received high radiation exposure per hour. Other radiologic technicians received less than the allowable radiation exposure per hour.

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