

**MINISTRY OF EDUCATION & TRAINING
THAI NGUYEN UNIVERSITY**

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**THE REAL SITUATION OF OCCUPATIONAL SAFETY
AND HEALTH ON THAINGUYEN MEDICAL
PERSONAL EXPOSED TO IONIZING RADIATION
AND EFFECT OF INTERVENTIONS**

**Speciality: Social Hygiene and Health Organization
Code number: 62.72.01.64**

SUMMARY OF PhD DISSERTATION IN MEDICINE

Thai Nguyen - 2016

**The dissertation was completed in:
College of Medicine & Pharmacy, Thai Nguyen University**

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**The dissertation will be defended at the
Dissertation committee in National level
COLLEGE OF MEDICINE AND PHARMACY – TNU**

Timedate.....monthyear 2016

The dissertation can be found at:

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INTRODUCTION

Along with the huge benefits in diagnosis and treatment, however, ionizing radiation as well as potentially unsafe risks affect exposed people's health and environment. Owing to profession, so that health workers who have been exposed to prolonged radiation types during their clinical practice can be adversely affected. Radiation Safety (RS) is the implementation of measures to combat the harmful effects of radiation, prevent or minimize the problem of radiation effects on humans and the environment (according to the Atomic Energy Act). The studies on Radiation Safety (RS) evaluate the working conditions and the implementation of radiation safety in the health facilities, the effects of the working environment to health of health workers (HWs). No studies of interventions have been systematically conducted, so far.

Thai Nguyen is one of provinces where a medical network is relatively developed, with sufficiency of health levels, there are many techniques to use energy ionizing radiation sources (IRSs) in hospitals. Currently there has been a significant increase in the number of health facilities using IRSs, accompanied by an increase in the number of HWs exposed to radiation. The question arises in Thai Nguyen: what is radiation safety problem today ?, its impact to HWs and what is the relationship between health and radiation? And what measures are needed to ensure safety, improve working conditions of HWs exposed to IRSs ?. Starting from these questions, we conduct the project "The real Situation of occupational safety and health on Thainguyen medical personal exposed to ionizing radiation and effect of interventions", with the following objectives:

- 1. To assess the situation of radiation safety, health and illness of health workers exposed to ionizing radiation in Thai Nguyen in the year 2012.*

2. *To analyze the association between radiation safety and health of health workers at health facilities using ionizing radiation in Thai Nguyen.*

3. *To evaluate the efficacy of some interventions about ensuring radiation safety and health of health workers at health facilities using ionizing radiation in Thai Nguyen.*

NEW CONTRIBUTIONS OF THE DISSERTATION

1. The dissertation has identified: the situation of radiation safety in health facilities in Thai Nguyen is still a lot of shortcomings: The effective heat index exceeds the permitted limit (36%). The activity of radiation safety at the health facilities is not good, 34.8% of the health facilities have not made an assessment and annual reports about RS and 27.3% of the health facilities have not made the follow-up and the assessment of personal dosimeters. The rate of health workers participating into training courses on RS remains low (79.3%). Knowledge, attitudes and practices on RS is not high (33.2 to 60.2%). The health of radiation workers (RWs) in health facilities is generally not so good. The rate of poor health is still high (6.2%). Percentage of some complications, skin diseases of RWs is high (25.3%). The diseases in the neuropsychiatric logical system are still seen a lot (36.9%). The rate of RWs have abnormally high hemoglobin (66.1% for men), the rate of abnormal erythrocyte and leukocyte accounts for 36-39%.

Some risk factors related to health, illness of RWs in the health facilities in Thai Nguyen include: attitude, practices on RS the nature of the job exposed to IRSs.

To propose some intervention measures about RS and health of HWs has remarkably effectiveness:

Knowledge, attitudes, practice on RS and the prevention of exposure to IRSs of radiation workers are better. The Efficacy of interventions for

knowledge is 29.7%; The efficacy of interventions for the attitude is 30.1%; The efficacy of interventions for practice reaches 20%.

The intervention measures result in mitigating illness, skin diseases and abnormal rates of blood flow of HWs working in ionizing radiation environment.

Having organized and built the Steering Committee of Radiation Safety and the Board's activities are very effectively. The efficacy of interventions to improve the use of means of personal protection reaches 25.6%. Intervention models receive the support and cooperation of the community and it is able to be kept in the health facilities.

STRUCTURE OF DISSERTATION

The key part of dissertation is 108 pages, including the following parts:

- Introduction: 2 pages
- Chapter 1. Literature review: 29 pages
- Chapter 2. Subjects and methods: 23 pages
- Chapter 3. Results: 28 pages
- Chapter 4. Discussion: 24 pages
- Conclusions and recommendations: 3 pages

The dissertation has 126 references, including 64 in Vietnamese and 62 documents in English. The dissertation includes 42 tables, 3 figures, 3 diagrams, 6 boxes for. The appendix includes 10 subappendices with 24 pages.

Chapter 1. LITERATURE REVIEW

1.1. Status of radiation safety, health and illness of health workers exposed to ionizing radiation

For those who received low doses of radiation but in the long time as the health workers working in radiology, radiotherapy and nuclear medicine can suffer damages both early and late effects caused by IRSs. In the world, many studies on the situation of radiation safety in the health facilities have been conducted. In Vietnam, as reported by Ministry of Science and Technology's the

Office of Radiation Safety in 2013, our country had 3577 health facilities using IRSs, had 6107 machines including X-ray machines and Computer scanners. According to the latest report of the Department of Science, Technology and Education, Ministry of Health (2015), by September 2015 there were 174 computer scanners, 51 magnetic resonance machines, 21 angiography machines, 23 radiotherapy facilities with 53 machines, in which 30 machines are placed in Hanoi and Ho Chi Minh City.

Nationwide there are hundreds of X-ray establishments and nearly 30 health facilities with the nuclear medicine Unit are operating. The high technology used in the nuclear medicine Unit also increased significantly, with 31 SPECT machines, 4 SPECT/CT machines, 8 machines PET/CT machines with 5 cyclotron in the country.

According to Nguyen Khac Hai (2004) and Ha Van Hoang (2011) showed that the situation of RS in health facilities still had a lot of shortcomings. Findings of the authors pointed out that many health facilities did not guarantee the machine room conditions, lack of collective and personal protection means, in many machine rooms, radiation rays go through protection walls exceeding permissible standards, So that the health of RWs in the health sector are not so good. To solve this problem, it is necessary to propose measures to well implement the regulations on radiation safety, to protect the health of RWs and prevention of exposure to IRSs.

1.2. State management on radiation safety and solutions of health care, disease prevention for health workers

Since radioactive substances and X-ray radiation source is applied for human benefits and due to the detection of unexpected benefits of radiation, the International Radiation Safety Committee, International Atomic Energy Agency and World Health Organization have offered the standards of radiation safety.

In Vietnam, according to Atomic law that the State makes ordinances for safety and radiation control. Since then the government issued decrees and circulars implementing the ordinances. Ministry of Science and Technology that is the State management Agency, is tasked to guarantee the radiation safety and radiation control for radiation facilities. Law stipulates two main problems: Promoting the application of atomic energy and ensure the safety, security and non-proliferation of nuclear weapons. Along with the Atomic Energy Act was issued, the bylaws as circulars, decrees on RS were issued, too aiming to guide implementation of the law.

Pursuant to the Atomic Energy Act, based on the standards of the International Atomic Energy Agency, Directorate for Standards, Metrology and Quality (STAMEQ), has developed standards of Vietnam on radiation safety and suggested approval of the Ministry of Science and Technology. 35 standards of Vietnam were issued and most of them still take into effects .

1.3. Solutions for health care, disease prevention for radiation workers in health facilities

In the world, there are many studies on RS to care for health, the illness prevention for RWs in the health facilities. The community-based researches to enhance knowledge, understanding the causes and improving health through intervention strategies and behavioral change, addressing environmental health issues of the community. Also there are many in-depth study under narrow specialization as shielding materials manufacturing, assessing individual absorbed doses to protect the health of health workers (HWs), patients and people exposed to IRSs.

In Vietnam, the intervention measures are done to protect the HWs working in an environment with IRSs, which the authors point out including solutions for protection and control solutions and the solutions

of health. To synchronously perform solutions mentioned above combined with health education and communication, training in radiation safety will help prevent better exposure.

Chapter 2. SUBJECTS AND METHOD

2.1. Study subjects

2.1.1. Environment of machine room

- Micro-climate conditions (temperature, humidity, wind flow velocity) at the Faculties with ionizing radiation sources.

- Radiation dose rate (natural background radiation, the dose rate at the location needs to be examined) in the engine room, a room containing radioactive sources.

- Conditions for the engine room, room containing radioactive sources.

- The personal protective equipment and health workers.

2.1.2. Leaders and people in charge of safety and radiation workers at the health facilities

- Leaders of health facilities and workers in charge of RS.

- RWs in the health facilities include doctors, engineers, assistant doctors, nurses, technicians, midwives working in Dpt of radiology, radiotherapy of cancer and facilities of nuclear medicine in Thai Nguyen province, where there is a potential irradiation at doses greater than 1 mSv / year, with the time of exposure to radiation ≥ 1 year.

2.1.3. Management profile of RWs and radiation equipment

The health records of RWs are archived at the health facilities; the management profile of follow-up of training courses on RS, results of personal dosimeters; the management profile of radiation equipment: historical machine, testing machines and the management profile of examination and inspection of medical radiation facilities.

2.2. Duration and settings

2.2.1. Duration

The study conducted between January, 2012 and October, 2014.

2.2.2. Settings

All 41 health facilities in Thai Nguyen using IRSs (including 21 government health facilities and 20 private health facilities).

2.3. Study method and design

2.3.1. Study method and design

In this study, we use the combined method:

- A cross-sectional descriptive study design, combining quantitative and qualitative research to identify the situation of RS, of health, illness, KAP of RWs and some related factors (to meet objective 1 and objective 2).

- An intervention study: the community-based interventions designed according to before-to-after intervention design with controls (to meet objective 3).

During the study, data collection, we always combine the qualitative and quantitative research in the specific case.

Method, qualitative research design:

The qualitative research is conducted with in-depth interviews and group discussions.

2.3.2. Sample size and sampling

2.3.2.1. Sample size and sampling for descriptive study

According to a cross-sectional survey in 2012, in Thai Nguyen, there were 41 health facilities with IRSs, so that we applied a purposive sampling (all 41 health facilities selected into the study).

+ *Sample size for studying on health, illness and related factors of radiation workers:* the sample size applied as a formula :

$$n = Z_{(1-\alpha/2)}^2 \frac{p \cdot q}{d^2}$$

Where:

α : Error of type I, choosing $\alpha = 0,05 \rightarrow Z_{1-\alpha/2} = 1,96$

$p = 0,7$; the rate of health related to ionizing radiation taken from studies by Vien Chinh Chien (2003) and Nguyen Ngoc Dien (2007).

$q = 1 - p = 0,3$.

d : absolute precision = 0,06

The sample size calculated = 225. (according to results of a cross-sectional survey in 2012, in these facilities, 241 persons included in the sample, so that we take all these persons into the study to prevent dropouts and ensuring a research ethics.

+ *Sample size and sampling for environment study:*

The sample size for the environment study used is similar to the sample size for studying on health, illness and related factors, it means that we take all 41 health facilities with departments and units using ionizing radiation sources into the study.

2.3.2.2. *Sample size and sampling for intervention study:*

The sample size for the intervention study used as formula:

$$n = (Z_{1-\alpha/2} + Z_{1-\beta})^2 \frac{p_1 q_1 + p_2 q_2}{(p_1 - p_2)^2}$$

Where

$Z_{1-\alpha/2} = 1,96$

$Z_{1-\beta} = 0,84$ (sample power is 80%)

p_1 : The rate of practice on safe protection of occupational health not meeting requirements during exposure to IRs before intervention, approximately 50% according to Nguyen Khac Hai (2004).

p_2 : The rate of practice on safe protection of occupational health not meeting requirements during exposure to IRs after intervention, approximately 30%.

Replacing data in the formula. n calculated = 91 persons. .
 During the study, to avoid sample loss and ensure a research ethical issues we chose an intervention 50% as the intervention group and 50% left as controls .

Sampling:

The health facilities were randomly selected by ballot into two groups: a intervention group and a control and two groups are similar to all aspects.

The sampling in the intervention group are conducted firstly and then selecting the control group with similarities in age, seniority and elated issues to the pairing, finally, a number persons in each group as follows:

- *A study group(intervention group):* 121 persons
- *A control group (no intervention group):* 120 persons

2.3.2.3. Sample size for qualitative research

- *Sample size for in-depht interviews includes 3 in-depht interviews:* 02 before intervention and 01 after intervention.

- *Sample size for group discussions includes 4 group discussions:* 02 before intervention and 02 after intervention.

2.3.4. Contents of intervention and diagram of intervention study

*** Organization**

Organizing and establishing the Steering Board of Radiation Safety (SBRS) is considered a prerequisite tasks to support the activities and ensure the implementation of the research given. At the Faculties and Offices, we recommend the establishment of a Steering Committee of radiation Safety aiming to maintain long-term performance with the participation of the community

** Contents of intervention:*

- + Training and communication of regulatory documents on radiation safety to improve knowledge, attitude and practice on radiation safety when exposing to IRSs for radiation workers.

- + To detect health problems, illness of RWs to timely treatment and rehabilitation for exposed workers.

- + Nutritional intervention through communication sessions includes providing menus and diets with acting to enhance the health, prevention of damage due to the effects of ionizing radiation.

- + Inspection and examination on RS at the health facilities.

The monitoring activities on the radiation safety are conducted regularly and not as planned.

2.3. Method of data collection and processing data

2.3.1. Method of data collection

- * Assessment of the work environment at the healthcare facilities: radiation dose rate at the locations and different distance and measuring workplace microclimate: temperature, humidity, wind speed; assessment of machinery equipment, sources of ionizing radiation and evaluation of the collective, personal protection means in RWs.

- * To directly interview study subjects about personal information, knowledge, attitudes, practices on RS and how to prevent the exposure to IRSs by a set of questionnaire (survey) designated by specialists in occupational medicine.

- * Physical examination by the physician with a high professional level, specialized doctors by using special examination tools. Diagnosis based on the criteria of the Ministry of Health according to Decision 1613 in 1997 and ICD 10. The evaluation is based on the following criteria: The morbidity rate of radiation

workers done through retrospective medical records; Clinical indicators evaluate the health of HWs (detecting signs and symptoms usually seen in people exposed to IRSs) and subclinical tests (peripheral blood tests).

* Evaluate the efficacy of some interventions: Assess the efficacy of interventions according to results of inspection and examination after 2 years of intervention. Evaluate the use of personal protection means, KAP of radiation workers; Assessment of health status, illness of RWs before and after intervention: Calculation of efficacy index and the efficacy of interventions. The ability to maintain and duplicate the model: the qualitative study.

* The qualitative study:

- In-depth interview: to directly interview study subjects by administered questionnaires according to the research objectives.

- Discussion group: according to the target group on understanding, regulations of radiation safety protection and preventive measures of exposure to ionizing radiation.

Analysis of qualitative data interpretation. Analyzing data according to the procedure both inductive interpretation and explaining to draw key issues.

2.3.2. Processing and analyzing data

Data are processed and analyzed by SPSS 18.0 software and statistical tests.

Chapter 3. STUDY RESULTS

3.1. Situation of radiation safety, health, illness of health workers exposed to ionizing radiation at Thai Nguyen

3.1.1. Characteristics of study subjects

Table 3.1. Distribution of radiation worker by areas of health care

<i>Area</i>	<i>State health</i>		<i>Private health</i>		<i>Total</i>	
	<i>n</i>	<i>(%)</i>	<i>n</i>	<i>(%)</i>	<i>n</i>	<i>(%)</i>
Male	190	91.3	31	93.9	221	91.7
Female	18	8.7	2	6.1	20	8.3
Total	208	86.3	33	13.7	241	100

The results showed that the State health activities in Thai Nguyen remained basically, RWs working in this field accounted for 86.3%. The proportion of men in the total number of RWs accounted for more than 90%

Table 3.2. Distribution of RWs by qualification level

<i>Area</i>	<i>State health</i>		<i>Private health</i>		<i>Total</i>	
	<i>n</i>	<i>(%)</i>	<i>n</i>	<i>(%)</i>	<i>n</i>	<i>(%)</i>
Postgraduate	66	31.7	7	21.2	73	30.3
University, college	89	42.8	12	36.4	101	41.9
Secondary	49	23.6	14	42.4	63	26.1
Primary, staff	4	1.9	0	0	4	1.7
Total	208	86.3	33	13.7	241	100

The number of RWs had the university, college degrees accounted for the highest rate (41.9%). followed by the post-graduate degree (30.3%).

**Table 3.4. Distribution of radiation workers by seniority
(years of exposure)**

<i>Years</i>	<i>State health</i>		<i>Private health</i>		<i>Total</i>	
	<i>SL</i>	<i>(%)</i>	<i>SL</i>	<i>%</i>	<i>SL</i>	<i>(%)</i>
< 5 years	104	50.0	17	51.5	121	50.2
5 - 9	43	20.7	8	24.2	51	21.2
10 - 14	31	14.9	1	3.0	32	13.3
15 – 19	4	1.9	3	9.1	7	2.9
20 - 24	14	6.7	0	0.0	14	5.8
25 - 29	7	3.4	0	0.0	7	2.9
≥ 30	5	2.4	4	12.1	9	3.7
Total	208	86.3	33	13.7	241	100

The percentage of RWs with seniority exposed to IRSs under 5 years in the 2 study areas were high (50.2%). The group of worker with exposure ≥ 20 years accounted for a low rate ranging from 2.9% to 5.8%.

3.1.2. Situation of radiation safety at health facilities at Thai Nguyen

Table 3.10. Effective heat index (Webb index)

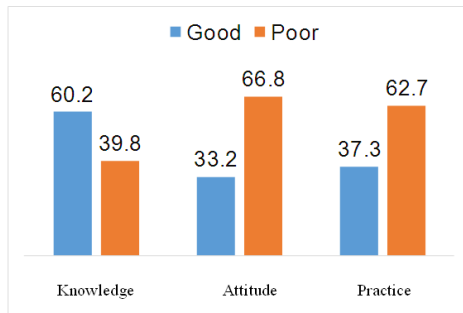
<i>Effective heat</i> <i>Location measured</i>	<i>No.</i> <i>sample</i>	<i>Not meeting permitted standards</i> <i>(Viet nam standards 5508-2009)</i>	
		<i>SL</i>	<i>%</i>
Engine room	61	22	36.1
Control room	60	17	28.3
Worker's duty room	41	15	36.5
Administrative offices	61	11	18.0
Corridor/ lounge	61	7	11.5
Outdoor	41	5	12.2

Rooms with IRSs had a number of samples that not reaching standards such as the effective temperature accounted for the highest proportion (36%).

Table 3.17. Practice of radiation safety at health facility

<i>Content of assessment</i>	<i>Practice</i>		<i>Reaching requirement</i>	
	<i>SL</i>	<i>%</i>	<i>SL</i>	<i>%</i>
Using personal protective equipment regularly	187	77.6		
Closing the engine room when the source is active	237	98.3		
Wearing personal dosimeters when working	187	77.6		
Periodic health examination	148	61.4		

Only 61.4% of RWs were periodically examined. 77.6% of RWs used the personal protective equipment regularly.

**Figure 3.2. General evaluation on KAP of radiation workers about radiation safety**

39.8% of RWs had not a good knowledge on radiation safety. 66.8% had not a good attitude on RS and 62.7% had not a good practice on RS.

3.1.3. Situation of health, illness of radiation workers at health facilities in Thai Nguyen

Table 3.18. Classification of health of radiation workers

<i>Health Unit</i>	<i>Type 1 & 2</i>		<i>Type 3</i>		<i>Type 4 & 5</i>		<i>Total SL</i>
	<i>SL</i>	<i>%</i>	<i>SL</i>	<i>%</i>	<i>SL</i>	<i>%</i>	
<i>State health</i>	157	75.5	42	20.2	9	4.3	208
<i>Private health</i>	18	54.5	9	27.3	6	18.2	33
Total	175	72.6	51	21.2	15	6.2	241

A number of RWs had a health type 1 and type 2 was 72.6%. Percentage of RWs with the type 4 and 5 accounted for 6.2%.

Table 3.19. Percent of some symptoms, diseases of radiation workers

<i>Area</i> <i>Symptome.</i> <i>Disease</i>	<i>Public health</i> <i>(n=208)</i>		<i>Private health</i> <i>(SL=33)</i>		<i>Total</i> <i>(n=241)</i>	
	<i>n</i>	<i>(%)</i>	<i>n</i>	<i>(%)</i>	<i>n</i>	<i>(%)</i>
<i>Eye diseases</i>	35	16.8	7	21.2	42	17.4
<i>ENT diseases</i>	43	20.6	8	24.2	51	21.2
<i>Teeth- Jaw- face diseases</i>	7	3.4	2	6.1	9	3.7
<i>Neuropsychiatric disorders</i>	76	36.5	13	39.3	89	36.9
<i>Diseases in Circulatory system</i>	44	21.1	9	27.2	53	21.9
<i>Diseases in respiratory system</i>	10	4.8	2	6.1	12	4.9
<i>Diseases in Digestive system</i>	25	12	11	33.3	36	14.9
<i>Diseases in urinary-genital system</i>	17	8.2	8	24.2	25	10.4
<i>Diseases in musculoskeletal system</i>	59	28.3	10	30.3	69	28.6
<i>Skin-Dermatology</i>	53	25.4	8	24.2	61	25.3
<i>Diseases in Endocrine-metabolic</i>	11	5.3	3	9.1	14	5.8
<i>Types of tumors</i>	5	2.1	1	3.0	6	2.5

Symptomes and diseases in the neuropsychiatric system were most seen (36.9%), followed by in musculoskeletal system(28.6%). Diseases in skin were 25.3%.

**Table 3.21. Laboratory results of peripheral blood cells of RWs
(n = 241)**

<i>Indicator</i>		<i>Value</i> $\bar{X} \pm SD$	<i>Constant</i>	<i>No. abnormal sample</i>	
				<i>n</i>	<i>%</i>
Erythrocyte count ($\times 10^{12}/l$)	<i>Male</i>	4.39 \pm 0.74	4.0 - 5.8	86	38.9
	<i>Female</i>	4.44 \pm 0.73	3.9 - 5.4	0	0.0
Hb (g/l)	<i>Male</i>	136.88 \pm 11.4	140 - 160	146	66.1
	<i>Female</i>	131.75 \pm 10.1	125 - 142	2	10.0
Leukocytes count ($\times 10^9/l$)		5.53 \pm 2.57	4 - 10	87	36.1
Platelets count ($\times 10^9/l$)		226.4 \pm 78.01	150 - 400	7	2.9

The prevalence rate of anemia in RWs was relatively high(a number of abnormal sample in male worker accounted for 66.1%, 38.9% of the cases in men had an abnormal red blood count). The number of cases with abnormal white blood cells count was 36.1%.

**Table 3.22. Laboratory results of WBC of radiation workers
(n = 241)**

<i>Chỉ số</i>	<i>Value</i> $\bar{X} \pm SD$	<i>Constant</i>	<i>No. abnormal sample</i>	
			<i>SL</i>	<i>%</i>
<i>Neutrophils</i>	52.9 \pm 20.21	55 - 75	171	71.0
<i>Eosinophils</i>	4.06 \pm 3.16	2 - 6	83	34.4
<i>Basophils,</i>	0.16 \pm 0.47	0 - 2	0	0.0
<i>Lymphocyte</i>	44.1 \pm 13.1	20 - 40	134	55.6
<i>Monocyte</i>	4.04 \pm 3.55	0 - 1	173	71.8

The proportion of abnormal polymorphonuclear leukocytes and monocyte was similarly high (71%). followed by abnormal lymphocytes (55.6%) and Eosinophils (34.4%) and no abnormal Basophils.

3.2. Relationship between RS and health of radiation workers

Table 3.30. Relationship between abnormality of blood cell flow and attitude on RS of radiation workers

<i>Abnormality of blood cells</i>	<i>No.sample</i>	<i>Yes</i>		<i>No</i>	
		<i>SL</i>	<i>%</i>	<i>SL</i>	<i>%</i>
<i>Attitude</i>					
<i>Poor</i>	161	90	55.9	71	44.1
<i>Good</i>	80	34	42.5	46	57.5
<i>p</i>	< 0.05				

The statistically significant association between disorders of blood cell flows and attitude on RS of health workers in the health sector was found ($p < 0.05$).

Table 3.31. Relationship between practice of RS and blood cell disorders

<i>Abnormality of blood cells</i>	<i>No. sample</i>	<i>Yes</i>		<i>No</i>	
		<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>
<i>Practice</i>					
<i>Poor</i>	151	88	58.3	63	41.7
<i>Good</i>	90	36	40.0	54	60.0
<i>p</i>	< 0.05				

Practice on a poor radiation safety resulted in the increase in the rate of RWs with peripheral blood cells. The significant association between abnormal blood cells and the practice on RS in people were tested ($p < 0.05$).

Table 3.33. Relationship between Abnormality of blood cells and exposure to ionizing radiation

<i>Exposure classification</i>		<i>Abnormality of blood cells</i>		<i>Total</i>	<i>p</i>
		<i>Yes</i>	<i>No</i>		
<i>Direct</i>	n	91	69	160	< 0.05
	%	56.87	43.13	100.0	
<i>Indirect</i>	n	33	48	81	
	%	40.74	59.26	100.0	
<i>General</i>	n	124	117	241	
	%	51.5	48.5	100.0	

There was an association between abnormal blood cell flows in radiation workers with a direct and indirect exposure to ionizing radiation with $p < 0.05$.

3.3. Effectiveness of some interventions on ensuring radiation safety and health of radiation workers

Table 3.34. Results of inspection and examination of radiation safety at health facilities

<i>Year</i>	<i>Unit</i>	<i>Intervention</i>		<i>No intervention^p</i>			
		<i>No.</i>	<i>No. not reaching</i>	<i>No.</i>	<i>No. not reaching</i>		
			<i>n</i>		<i>%</i>	<i>n</i>	<i>%</i>
2012		12	9	75.0	6	2	33.3
2014		14	5	35.7	15	4	26.7
<i>p</i>		< 0.05			> 0.05		

The percentage of RS in intervention health facilities was better after 2 years of intervention and the difference was statistically significant ($p < 0.05$).

Table 3.36. Efficacy of intervention changing knowledge on RS of radiation workers

<i>Knowledge</i> <i>Group</i>	<i>Before intervention</i> <i>(Not reaching)</i>	<i>After intervention</i> <i>(Not reaching)</i>	<i>Efficacy index(%)</i>
<i>Intervention</i> <i>(n = 121)</i>	45 (37.2%)	29 (24.0%)	35.5
<i>Control</i> <i>(n = 120)</i>	51 (42.5%)	48 (40%)	5.8
<i>Efficacy of intervention</i>	29.7%		

After intervention, knowledge on RS of health workers reduced significantly. . Efficacy index in the intervention group was 35.5%. The efficacy of intervention was 29.7%.

Table 3.37. Efficacy of intervention changing attitude on RS of radiation workers

<i>Attitude</i> <i>Group</i>	<i>Before intervention</i> <i>(Not reaching)</i>	<i>After intervention</i> <i>(Not reaching)</i>	<i>Efficacy index(%)</i>
<i>Intervention</i> <i>(n = 121)</i>	86 (71.1%)	59 (48.8%)	31.4
<i>Control</i> <i>(n = 120)</i>	75 (62.5%)	74 (61.7%)	1.3
<i>Efficacy of intervention</i>	30.1%		

After interventions, the attitude on RS of health workers dropped. Efficacy index in the intervention group was 31.4%, the efficacy of intervention was 30.1%.

Table 3.38. Efficacy of intervention changing practice on RS of radiation workers

<i>Practice</i> Group	<i>Before intervention</i> (Not reaching)	<i>After intervention</i> (Not reaching)	<i>Efficacy index(%)</i>
<i>Intervention</i> (n = 121)	75(62%)	59 (48.8%)	21.3
<i>Control</i> (n = 120)	76 (63.3%)	75 (62.5%)	1.3
<i>Efficacy of intervention</i>	20%		

After intervention, the rate of practice on RS not reached. Efficacy index in the intervention group was 21.3%. The efficacy of intervention was 20%.

Table 3.39. Efficacy of intervention changing rates of symptoms and diseases in skin of radiation workers

<i>Symptome, skin diseases</i> Group	<i>Before intervention</i> (Diseased)	<i>After intervention</i> (Diseased)	<i>Efficacy index(%)</i>
<i>Intervention</i> (n = 121)	35 (28.9%)	18 (14.9%)	48.6
<i>Control</i> (n = 120)	26 (21.7%)	23 (19.2%)	11.5
<i>Efficacy of intervention</i>	37.1%		

Efficacy of intervention for symptoms and skin diseases was very clear. After intervention. The rate of symptoms and skin diseases dropped significantly (efficacy index = 48.6%). The efficacy of intervention reached 37.1%.

Table 3.41. Efficacy of intervention to increase health type of RWs

<i>Health type 1&2</i> <i>Group</i>	<i>Before</i> <i>intervention</i> <i>(%)</i>	<i>After</i> <i>intervention</i> <i>(%)</i>	<i>Efficacy</i> <i>index(%)</i>
<i>Intervention</i> <i>(n = 121)</i>	88 (72.7%)	97 (80.2%)	10.3
<i>Control</i> <i>(n = 120)</i>	87 (72.5%)	88 (73.3%)	1.1
<i>Efficacy of</i> <i>intervention</i>	9.2%		

The efficacy of intervention increased, health type 1 and 2 is not high, reaching 9.2% in which efficacy index in the intervention group reached 10.3% and the control group was 1.1%.

Table 3.42. Result of personal dosimeters after intervention

<i>Indicator</i>	<i>Time</i>	<i>Result of</i> <i>measurement</i> <i>(mSv/tháng)</i>	<i>Greater than</i> <i>permitted</i> <i>standards</i>		<i>Permitted</i> <i>standards</i> <i>(Viet nam</i> <i>standard</i> <i>6561)</i>	<i>p</i>
			<i>SL</i>	<i>%</i>		
Hp(10)	<i>Before</i> <i>intervention</i>	0.01 - 12.34	6	2.48	1.67	> 0.05
	<i>After</i> <i>intervention</i>	0.03 - 4.17	2	0.82		
Hs(0.07)	<i>Before</i> <i>intervention</i>	0.03 - 31.17	9	3.73	mSv/month	> 0.05
	<i>After</i> <i>intervention</i>	0.03 - 12.50	7	2.90		

After intervention, results of reading personal dosimeters reduced but not statistically significant with $p > 0.05$

CONCLUSIONS

1. Situation of radiation safety, health and illness of radiation workers exposed to ionizing radiation at Thai Nguyen remains a lot of shortcomings

- Some health facilities are not safe on the room area. old machines. The effective temperature index exceeds the permitted limit (36%).
- The activities of RS at the health facilities are not good. Up to 34.8% of the health facilities did not carry out the assessment and annual reports and 27.3% of the health facilities do not make the follow-up and assess personal dosimeters.
- The rate of RWs participating into training courses on radiation safety remains low (79.3% of RWs participating into training courses). Knowledge, attitudes and practices meeting the requirements of radiation safety is not high (33.2 to 60.2%).
- The percentage of RWs with health type 1 and type 2 accounts for only 72.6%. The rate of RWs with health type 4 and 5 is 6.2%.
- The percentage of some symptoms, skin diseases of RWs is still high. A number of RWs have pathological manifestations on the skin accounts for 25.3%.
- Diseases in neuropsychiatric system seen a lot (36.9%).
- The percentage of RWs with anemia is high (Haemoglobin in radiation male workers: abnormality of 6.1%, in radiation female workers: abnormality of 10%), the rate of decreased erythrocyte count is 38.9% in men and the general rate of abnormal white blood cell count in men and women is 36.1%.
- The percentage of abnormal reticulocyte is high (63.5%). Some samples with abnormality of minimum tensile strength of RBC is 14.1% and maximum was 76.8%.
- The activities of radiation safety and prevention have been paid special attentions to by leaders and boss of all the health facilities but incomplete and remains shortcomings. Many the health facilities have not met requirements of RS and health care for RWs . The monitoring activities have not been regularly done, roles and

responsibilities of the radiation safety officers at the health facilities do not meet practical requirements. The training activities and communication was not good (results from in-depth interviews and focus group discussions).

2. Some related factors between RS and health of RWs

- There is a relationship between attitude and practice and the rate of abnormal peripheral blood flows in RWs responsible for the radiation safety in the health facilities
- There is a relationship between the nature of work and the rate of abnormal peripheral blood flows in RWs. The workers who contacts directly with IRSs have the rate of abnormal blood flows higher than the workers contact indirectly with IRSs.

3. Some intervention measures of radiation safety and health promotion of radiation workers

- Having organized and built the Steering Committee of Radiation Safety at the health facilities and its activity is very effective.
- The results of inspection and examination on RS at the intervention health facilities were better than before, the difference was statistical significant ($p < 0.05$).
- The intervention improving a use of personal protection means of RWs clearly effective (Efficacy of intervention reached 25.6%).
- After intervention, knowledge, attitude and practice on RS in health workers were remarkably improved (Efficacy of intervention reached 20-30%).
- The intervention measures resulted in reducing the proportion of symptoms, skin diseases and the rate of abnormal blood cell flows significantly. Efficacy reached more than 30%.
- The results of intervention of RS of the Steering Board together the help of the study team has changed the perception of heads in all health facilities, people responsible on RS and health workers exposed to IRSs. The desire of the health facilities is to be helped and continuously supported.

RECOMMENDATIONS

1. Strengthening health communication, education combined with inspecting and examining the radiation safety in health facilities. especially the private health facilities.

2. To organize periodically health examination, occupational health examination at least 2 times / year as prescribed for early detection and timely treatment of pathological signs related to RWs, especially diseases of the blood and skin.

3. The health facilities should strictly implement building infrastructure as standards prescribed, equipped with modern machines and providing personal protection means adequately for the curative healthcare, at the same time also ensuring the safety for RWs.

4. It is necessary to maintain a technical assistance with a broader and more comprehensive intervention on the basis of solutions already implemented effectively.

PAPERS PUBLISHED RELATED TO DISSERTATION

1. Nguyen Xuan Hoa, Do Ham (2015), “Status of knowledge, attitudes and practices in occupational safety and health of workers exposed to ionizing radiation in the medical facilities of Thai Nguyen”, *Journal of Labor Protection*, No. 1 +2/2015, pp. 87-90.

2. Nguyen Xuan Hoa, Do Ham (2015), “Efficacy of interventions to minimize the effects of ionizing radiation for health workers in Thai Nguyen”, *Vietnam Journal of Medicine*, May 7, No. 1/2015, Medical Publishing House, Ha Noi, pp. 15-18.