



## Comparison of the prevalence of darkroom disease and related factors between radiotechnologists and nurses in selected hospitals of Guilan University of Medical Sciences, Iran, in year 2016

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### Original Article

#### Abstract

**BACKGROUND:** Radiotechnologists are always in contact with chemicals during the process of confirmation and appearance of radiographs. This study evaluated the prevalence of darkroom disease among the radiotechnologists and nurses working in radiology centers of Guilan University of Medical Sciences, Iran.

**METHODS:** This cross-sectional study was conducted between two groups of radiotechnologists and nurses from selected hospitals of Guilan University of Medical Sciences, in year 2016, including 323 radiotechnologists (n = 140 people) and nurses (n = 183 people) working in educational therapy centers. The participants were selected through convenience sampling method. Total information on darkroom disease was collected using the standard Damases questionnaire, and analyzed using SPSS software at the significance level of  $P < 0.050$ .

**RESULTS:** The mean age of radiotechnologists was  $34.01 \pm 7.9$ , and the mean age of nurses was  $32.33 \pm 7.90$  years. Symptoms of nausea ( $P = 0.001$ ), runny nose ( $P = 0.001$ ), oral ulcer ( $P = 0.020$ ), burning mouth ( $P = 0.001$ ), skin rash ( $P = 0.001$ ), blurred vision ( $P = 0.002$ ) night sweats ( $P = 0.001$ ), chemical taste ( $P = 0.001$ ), and dysuria ( $P = 0.001$ ) were significantly more common in the radiotechnologists group. Regarding gender and symptoms of darkroom disease in each occupational group, nausea ( $P = 0.024$ ) and runny nose ( $P = 0.001$ ) among the radiotechnologists and chemical taste ( $P = 0.001$ ) among the nurses, had significant relationship with being woman.

**CONCLUSION:** The prevalence of darkroom disease was high among the radiotechnologists in Guilan Province, Iran. Therefore, it is recommended to improve the quality of services provided, as well as to promote the health and safety of radiology personnel through preparing and implementing modern digital equipment in radiology departments.

**KEYWORDS:** Radiography, X-Ray Film, Allergy, Chemically-Induced Disorders, Diagnostic Uses of Chemicals

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### Introduction

Chemicals have become part of human life,

especially in the prevention, treatment, and control of diseases. If used improperly, they put human health at risk, and have irreversible effects on the environment.<sup>1,2</sup>

Continuous exposure to chemicals has side

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effects such as asthma, skin inflammation, and allergies.<sup>3</sup> More than 200 known agents may cause asthma.<sup>4,5</sup> The most noteworthy cases of discomfort and complaint among radiotechnologists occur as the result of working with the processing device, the vapor caused by image processing and radiography film processing in the darkroom.<sup>5</sup> The widespread use of chemicals in the processing of radiology images has raised professional concerns about the darkroom disease.<sup>6-9</sup> Darkroom disease has various types of allergic reactions (headache, itchy skin, shortness of breath, mouth ulcers, arrhythmias, painful joints, runny nose/adenoid, and nausea),<sup>10,11</sup> which is similar to the symptoms reported by miners in exposure to SO<sub>2</sub>.<sup>1</sup> According to the American Society of Radiologic Technologists, the most common symptom is headache (among 39.4% of radiotechnologists).<sup>6,12</sup>

The chemicals used in the processing and forming steps are formaldehyde, sulfur dioxide and glutaraldehyde, hydroquinone, sodium sulfite, ammonium chloride, and silver compounds.<sup>13,14</sup> According to studies, very little inhalation of the vapor from glutaraldehyde causes possible respiratory problems.<sup>13</sup> In addition, hydroquinone and toxic vapors of SO<sub>2</sub> from the processor device are harmful to the health of the workers.<sup>15-17</sup>

In order to replace the processing and forming drug, to examine their qualitative status, to place the film in the processor device, and also to clean the internal components of the processor, radiotechnologists are forced to have direct contact with image processing and forming substance. At the same time, inhalation of chemical vapors, direct contact with processing and forming drug, and visual observation can cause various allergic diseases. In this regard, principles and rules have been adopted in several countries (including Zimbabwe and the United States) for people exposed to chemical agents.<sup>18</sup>

The symptoms mentioned in the study of

Spicer *et al.*, due to the lack of a control group, cannot be specific to those involved in the radiology department. However, Nallon *et al.* used the physiotherapists as the control group, and examined the prevalence of darkroom disease.<sup>10,19</sup> In the study of Al Zabadi and Nazzal, the symptoms reported in radiotechnologists were significantly higher than nurses (control group).<sup>20</sup> The study of Jalalvandi *et al.* in Kermanshah, Iran, showed a significant relationship between the darkroom disease and radiotechnologists.<sup>11</sup>

Radiology, as the first choice in diagnostic procedures, plays a very important role in patients' health. In addition, the workers' health will increase productivity and efficiency. The study of Al Zabadi and Nazzal in another country's cultural context,<sup>20</sup> as well as the study of Jalalvandi *et al.* in Iran,<sup>11</sup> using a researcher-made tool, investigated this important disease. However, its examination with standard and trusted instruments can identify all aspects of darkroom disease in radiotechnologists, and improve the safety and security of the radiology department staff.

Considering the small number of studies conducted in this regard in Iran, and the lack of documented information in Guilan province, the prevalence of this disease and its related factors, the present study was conducted to determine the prevalence of darkroom disease among the radiotechnologists working in hospitals affiliated to Guilan University of Medical Sciences.

## Materials and Methods

In this cross-sectional study, 323 participants (140 radiotechnologists and 183 nurses) in educational hospitals of Guilan University of Medical Sciences in 2016, were enrolled using convenience sampling method. In a preliminary study on 30 people of target groups, the proportion of the symptoms of darkroom disease was 50% and 70% for nurses and radiotechnologists, respectively, and the

difference between them was 20%. With assumptions ( $\alpha = 0.05$ ,  $\beta-1 = 0.9$ ,  $P1-P2 = 0.02$ , and 95% of confidence interval), the steps were loaded into the PASS sampling software (NCSS, LLC, East Kaysville, UT, USA) and were evaluated (Power = 0.9003,  $N1 = 110$ ,  $N2 = 143$ ). Considering 20% sample dropping, 140 people were calculated for radiotechnologists group and 183 people for the nursing group.

One of the criteria for selecting hospitals was an active darkroom in the radiology departments of the hospital. Nurses, who did not have a history of working with chemicals used for radiographic processing and forming, were selected. Hospitals were selected at two levels of provincial capital and cities, in order to measure the performance of the devices and the amount of X-ray request (workload). Having at least an academic degree in radiology technology or nursing, and willingness to complete the questionnaire were the criteria for entering the study.

The used data gathering tool was Damases standard questionnaire,<sup>21</sup> whose validity and reliability is desirable, and has been used in various studies in Iran and other countries in regard with darkroom disease.<sup>11,12,20-22</sup> This questionnaire consists of 50 questions and includes 3 sections: 1. Demographic characteristics (age, height, level of education, place of residence, and work experience); 2. Information related to the history of allergy and respiratory diseases; and 3. Symptoms of diseases similar to darkroom disease (such as headache, allergies, asthma, skin inflammation, burning eyes, and throat irritation) during the shift work. The method of scoring in this questionnaire is based on the Likert and Gutman scaling. Considering the fact that this tool was designed to investigate the darkroom disease, after getting the permission to use it, the steps of the study were evaluated in a preliminary study with 30 people of the target group in order to assess the reliability of the questionnaire. The internal

consistency of the items were calculated to determine the reliability of the history of allergic diseases with Cronbach's alpha of 0.84 and 0.86 for the area related to the symptoms of darkroom disease. The coefficient alpha of the tool was also evaluated, and was still at the optimal level of 0.84.

In order to maintain ethics in the research, the anonymity of the questionnaires, and the voluntary participation of the research units were among the cases considered as ethical principles; and the participants were assured that the data collected to conduct the scientific article was only available to researchers, and they could withdraw from the partnership at any time.

After data collection, data was entered into SPSS software (version 19, SPSS Inc., Chicago, IL, USA). In order to analyze the data, the Kolmogorov-Smirnov test was used to examine the normal distribution of variables. Descriptive and analytical statistics such as chi-square test in agreement tables, independent t, and Pearson tests were also used. The significance level in all tests was considered as lower than 0.05.

## Results

The mean age of radiotechnologists and nurses was  $34.01 \pm 7.9$  and  $32.33 \pm 7.90$  years, respectively; which was statistically different between the groups ( $P = 0.104$ ). 31.58% of the samples were single, and the rest were married. More than 82% of radiotechnologists and 92% nurses had bachelor's degree. More than 94% of the samples were resident of the city. 95% of radiotechnologists stated that they prepared more than 15 X-ray images in one work shift, and also spent over 90 minutes (47.9%) of their work shift in the darkroom and in the vicinity of the processor device (Table 1).

The prevalence of the symptoms of nausea ( $P = 0.001$ ), runny nose ( $P = 0.001$ ), oral ulcers ( $P = 0.020$ ), oral burns ( $P = 0.001$ ), skin rash ( $P = 0.001$ ), blurry vision ( $P = 0.002$ ), night

**Table 1. Demographic information of the two studied groups of nurses and radiotechnologists**

Demographic information	Radiotechnologists (n = 140)		Nurses (n = 183)		P
Gender	Men	47 (33.6)	11 (6.0)		< 0.001
	Women	93 (66.4)	171 (94.0)		
Marital status	Single	52 (37.1)	50 (28.4)		0.099
	Married	88 (62.9)	126 (71.6)		
Education	Associate Degree	20 (14.3)	4 (2.2)		< 0.001
	Bachelor's degree	116 (82.9)	165 (92.2)		
	Master's degree	4 (2.9)	10 (5.6)		
Smoking		7 (5.0)	1 (0.5)		< 0.001
Second job		14 (10.0)	17 (9.3)		0.280
Interested in changing the job		17 (12.3)	21 (11.7)		0.874
Living in the factory environment		0 (0)	11 (6.0)		0.668
Place of residence	City	131 (93.6)	171 (95.0)		0.584
	Village	9 (6.4)	9 (5.0)		
Time spent in darkroom per work shift	1-30 minutes	53 (37.9)	-		-
	31-60 minutes	12 (8.6)			
	61-90 minutes	8 (5.7)			
	> 90 minutes	67 (47.9)			

The amounts are as number (percent).

sweats ( $P = 0.001$ ), chemical taste, ( $P = 0.001$ ) and dysuria ( $P = 0.001$ ) was statistically significant between the two groups of nurses and radiotechnologists, and these symptoms were observed more in radiotechnologists group. Unexplained fatigue ( $P = 0.001$ ) was observed in nurses, while no case reported it in

radiotechnologists (Table 2). In studying the gender and symptoms of darkroom disease in each occupational group, nausea ( $P = 0.024$ ) and runny nose ( $P = 0.001$ ) in radiotechnologists, and chemical taste ( $P = 0.001$ ) in nurses had significant relationship.

**Table 2. An overview of information related to darkroom disease among the two groups of nurses and radiotechnologists**

Symptom	Radiotechnologists (n = 140)		Nurses (n = 183)		P (between the groups)
	n (%)	P (with gender)	n (%)	P (with gender)	
Headache	71 (50.71)	0.261	108 (59.1)	0.111	0.137
Nausea	34 (24.28)	0.024	17 (9.29)	0.275	0.001
Runny nose	54 (38.57)	0.001	23 (12.57)	0.571	0.001
Pharyngitis	40 (28.57)	0.071	36 (19.67)	0.522	0.062
Unexplained fatigue	0 (0)	0.440	2 (1.10)	0.865	0.001
Tinnitus	28 (20.00)	0.790	23 (12.57)	0.571	0.070
Mouth ulcers	19 (13.57)	0.748	6 (1.10)	0.530	0.001
Abnormal heart rate	52 (37.14)	0.593	62 (33.88)	0.994	0.842
Unusual anesthesia	43 (30.71)	0.828	44 (24.04)	0.806	0.181
Skin rash	18 (12.85)	0.299	4 (2.20)	0.109	0.001
Stomachache	23 (16.43)	0.274	23 (12.57)	0.571	0.325
Blurry vision	26 (18.57)	0.212	13 (7.10)	0.345	0.002
Dizziness	46 (32.85)	0.586	47 (25.68)	0.193	0.158
Sneeze	33 (23.57)	0.221	30 (16.4)	0.876	0.107
Night sweats	24 (17.14)	0.979	8 (4.37)	0.466	0.001
Chemical taste	19 (13.57)	0.475	4 (2.20)	0.001	0.001
Dysuria	17 (12.14)	0.353	5 (2.73)	0.567	0.001

## Discussion

Occupational diseases and providing prevention protocols has been among the important issues of increasing productivity and improving the quality of services in recent decades. The aim of this study was to investigate the prevalence of darkroom disease among radiotechnologists (target group) and nurses (control group) working in Guilan health centers. Symptoms of nausea, runny nose, mouth ulcers, tongue ulcers, skin rash, blurry vision, night sweats, chemical taste, and dysuria were more common in radiotechnologists than nurses, and a significant difference was reported between the two groups. In contrast, unexplained fatigue was observed more in nurses and a meaningful difference was observed. The results of this study could be due to the proximity and exposure to high concentrations of chemicals in the darkroom.<sup>11</sup> 47.9% of radiotechnologists spend more than 90 minutes per shift in darkroom. This statistic is important; because it will be repeated in subsequent shifts on the same day. Excessive radiography in each work shift for each person is due to the lack of adequate staff allocation to the radiology departments, and the administration of unnecessary radiographies.

The study showed that regarding the prevalence of darkroom diseases in radiotechnologists, headache, abnormal heart rate, runny nose, unusual anesthesia, pharyngitis, and dizziness were more than other symptoms. In the study of Jalalvandi *et al.*,<sup>11</sup> headache, joint pain, unexplained fatigue, and burning eyes were the most frequent symptoms; whereas no case of unexplained fatigue was reported in the present study. In Majonga *et al.* study,<sup>23</sup> chemical taste was the most frequent, which did not match with the results of the present study.

In this study, there was no significant relationship between the work history of the research units and the darkroom

complications, indicating that it was not effective. In addition, Jazayeri Gharebagh and Abaszadeh Ghanavati reported that shallow breathing in men ( $P = 0.045$ ) and the whole group ( $P = 0.013$ ), and nausea ( $P = 0.049$ ) in the radiology group was significantly different from the control group. There was also the possibility of the relationship between the presence of skin inflammation and the history of this disease.<sup>22</sup> Murty and Rao stated that symptoms such as headache and skin irritation were observed in radiotechnologists when working with the processor device.<sup>24</sup>

In a comparative study between the radiotechnologists and physiotherapists in India, Tarlo *et al.* reported the darkroom disease symptoms in 7.8% (1483) of radiotechnologists and 1.8% (1545) of physiotherapists. In their research, in both occupations, the relationship between the psychosocial responses and the darkroom disease was observed. In addition, that darkroom disease had a significant relationship with the duration of proximity to chemical agents in the processor device ( $P = 0.001$ ).<sup>25</sup>

Moreover, in a cross-sectional study in Palestine using purposeful and non-random sampling on 330 men radiotechnologists (study group) and 242 men nurses (control group), Al Zabadi and Nazzal stated that the symptoms were more prevalent in radiotechnologists compared to nurses ( $P < 0.001$ ). Furthermore, based on the reported linear regression, staying more than thirty minutes in the darkroom in each shift had a significant effect on mean reported symptoms ( $P < 0.001$ ). Moreover, the presence of ventilation in darkroom had a strong negative correlation with mean reported symptoms ( $P < 0.001$ ).<sup>20</sup>

Previous studies indicate that there is a relationship between unexplained fatigue and darkroom disease,<sup>11,20,23</sup> which was not found in this study. In addition, the lack of significance of gender differences in the nurse

group was due to the low number of men in the nurse group.

One of the important findings in this study was abnormal heartbeat, which was more than 33% in both groups. Nevertheless, nurses and radiotechnologists often have to be employed in two or more hospitals, or even have other jobs due to the low salaries and benefits that are actually implemented in the health system, and the lack of labor rights and standards. Therefore, they do not observe the maximum working hours, and use drugs such as caffeine, ephedrine, or other performance-enhancing drugs, and are exposed to stress and severe occupational anxiety, all of which are the causes and factors that increase the risk of abnormal heartbeat.<sup>17,26,27</sup> Moreover, the effect of X-ray on the thyroid gland and unbalance in the basic conditions of the thyroid mechanism can be a major risk factor for this complication.<sup>28-30</sup>

Sulfur dioxide, a secondary product of the film-forming process, can lead to unpleasant metallic taste [a type of taste deficiency (dysgeusia)], and bad breath that requires special monitoring.<sup>11,16</sup> In nurses, this may be due to low quality food in healthcare facilities due to longer shifts, insomnia, and vitamin D deficiency due to working in closed environments and environmental chemicals (including benzene, hydrazine, gasoline, lacquers, chromate, and cobalt) that should be inhaled for a long period.<sup>31-34</sup>

According to the results of a study by Jazayeri Gharebagh and Abaszadeh Ghanavati, the prevalence of darkroom disease was reported to be more in morning shift.<sup>22</sup> This may be due to the replacement of medications in the morning before the department opens in the morning or at night. The factors that increase the prevalence darkroom disease in morning shift include more severe vapors of the new drug, more damaging smell of the drug in the morning, the accumulation of chemical vapors around the device due to the shutting down of the

darkroom ventilation system at night, and not opening the door of the darkroom during the night.

In most countries of the world, as well as in the densely populated centers of Iran, the use of digital devices, such as cassette reader and printers has replaced the old darkroom system, and the introduction of computed and digital radiography devices have somehow controlled the syndrome of darkroom disease; but these effects are still observed in many radiotechnologists in Guilan province and in different countries.

Darkroom disease, along with occupational musculoskeletal disorders,<sup>35</sup> and the effects of ionizing on the body and next generations,<sup>36</sup> are occupational hazards among the radiotechnologists. Issues such as unhealthy competition in the work environment, higher wages for more work, and the inappropriate nature of certain occupational standards and environmental conditions may increase the chance of darkroom disease. In this case, reducing job inconvenience, modifying the environment, and supplying modern equipment can increase the quality of services and the status of personnel health. Obviously, lack of timely modifications would be harmful for people health in due time.<sup>37-39</sup>

## Conclusion

Darkroom disease is of occupational hazards among the radiotechnologists. In order to provide a safe working environment, provide quality service to patients, and update imaging and film-forming processes in accordance with new standards and achievements in the world, more appropriate policies should be adopted by the health organization of Iran.

## Conflict of Interests

Authors have no conflict of interests.

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