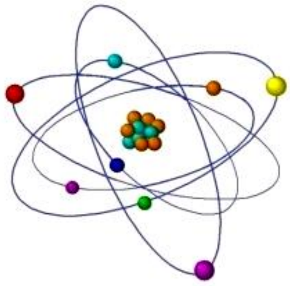
HYGIENIC ASSESSMENT OF THE WORKING ENVIRONMENT OF EMPLOYEES IN INTERVENTIONAL MEDICINE



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ABSTRACT: The study aimed to identify the peculiarities of the working conditions of the medical staff employed in specialized procedures in the cardiac catheterization laboratories of the specialized clinics.The study found that the catheterization laboratory: 25% of cases did not meet the standard requirements, the internal area was on average 41-43 m^2, instead of the minimum 47 m^2; the average height of the ceiling was 2.7 m, instead of 3 m; the walls and floor of the catheterization laboratory were not treated with X-ray-resistant material (in 7% of the clinics); 30% of the research facilities didn't have adequate lead sealing of the Procedure Room door; 7-8% of the surveyed facilities did not have a well-functioning ventilation system; In 17% of the surveyed cases the autonomous power source system of the coronary angiography was located so close to the laboratory that the noise level in the Control Room (in the remote control room) exceeded the maximum permissible noise level, which created discomfort during the operations.A study of the use of personal protective equipment (to reduce the dose of radiation) by medical personnel revealed that: the staff did't use protective glasses (98%); 7-8% did't use thyroid protection collar during the procedure;) 92% did't use small pelvic and gonad protective lead aprons; 67% did't attach the dosimeter to the body during the procedure; 98% of the staff did't use a special shield to reduce radiation in the procedure; 1-2% of the medical staff taking part in the procedure is in the usual medical uniform.

Conclusion: the profession of interventionists belongs to the group of tense and stressful work, but radiation safety requirements are not fully implemented in the workplace.

Key words: working environment, occupational hazard, hygienic essesment, catheterization laboratory

Noncommunicable diseases (NCDs) remain the number one challenge for world medical professionals. For years, diseases of the cardiovascular system have been at the top of the list of noncommunicable diseases in terms of frequency of development. Cardiovascular pathologies are one of the leading causes of lethal outcomes in all the countries of the world [2,4].

In a document developed by the World Health Organization WHO [3,5], premature (30-69 years) age-standardized mortality rates from cardiovascular diseases appear to have a leading position among other non-communicable diseases. According to WHO experts, ischemic and cerebrovascular diseases will be among the top ten causes of the disease burden in the world by 2030 [1], which will further increase the number of people involved in the management of this pathology and the number of people employed in this field. The latter in itself implies the identification of the working conditions of the employees and the management of the labor process and the importance of revealing possible health effects urgently. The share of circulatory system pathology in Georgia is 15.5% of all diseases registered in the country, and that of the new cases equals 8.6%. Hypertensive, ischemic, and cerebrovascular pathologies are characterized by high morbidity and mortality in this disease group. In 2000-2015, there is an increasing trend in the prevalence of circulatory pathologies (Diagram 1) [7].

Continuous development and modern advancementof medicine can significantly reduce the likelihood of developing diseases of the cardiovascular system, it is only necessary to detect the first signs of changes in time. According to statistics, 80% of surgeries performed due to pathologies of the cardiovascular system fall on men, and 20% - on women.

In recent years, interventional cardio therapy has achieved special development in the treatment of cardiovascular pathologies. The main achievement of interventional cardiotherapy is considered to be the reduction of the postoperative rehabilitation period and the maximum avoidance of postoperative discomfort, pain, and scar development. Interventional cardiotherapy is the "gold standard" for the treatment of acute myocardial pathology.

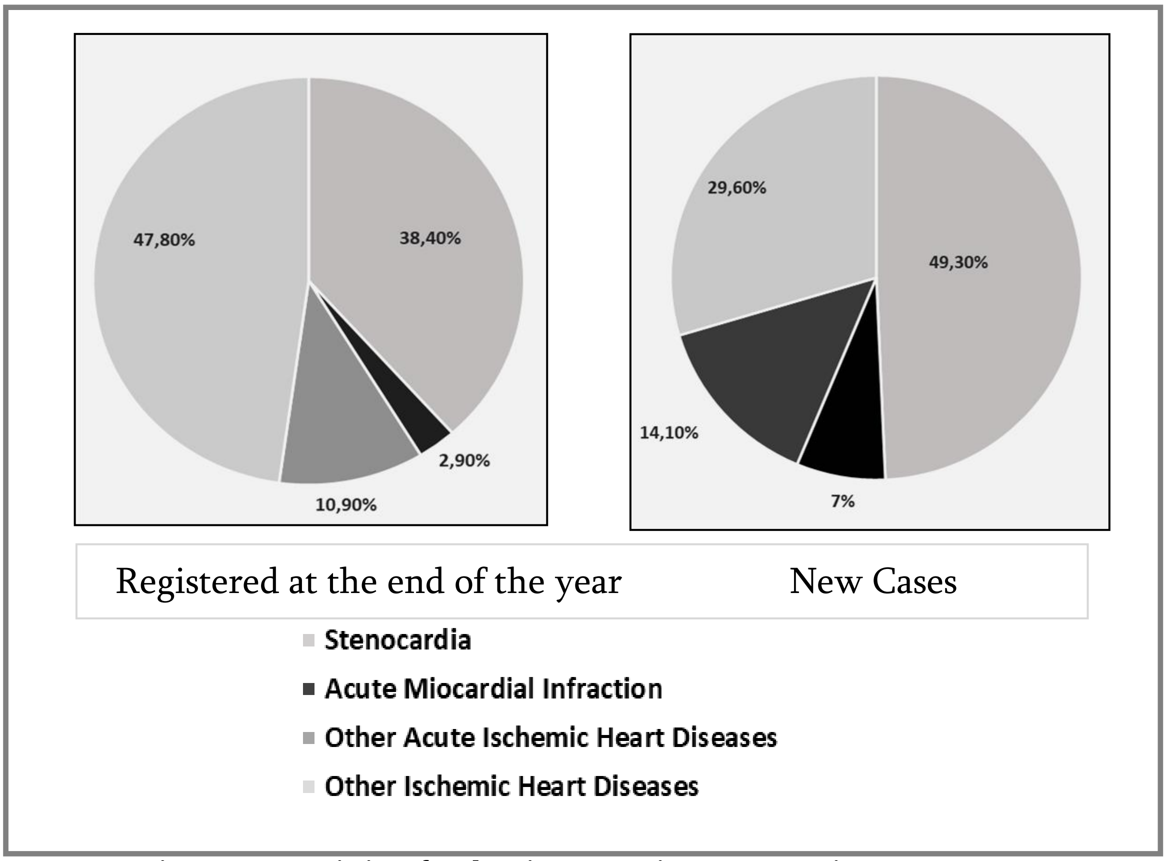


Diagram 1. Statistics of Ischemic Heart Diseases, Georgia 2013

According to the recommendation of the World Health Organization, coronary artery angiography is recommended in patients with coronary heart disease (CHD) to prevent myocardial infarction and lethal outcome of ischemic heart disease and to reduce their number.

With the refinement of cardiac catheterization techniques (better radiographic equipment, less adverse effectsof contrast agents) and the introduction of effective methods of treating coronary artery diseases (stenting, aortocoronary shunting), diagnostic coronary angiography has become one of the most important components of cardiac catheterization.

An appropriate working environment and special equipment are required for the implementation of this procedure.

In a modern catheterization laboratory (Figure 1) there is an X-ray machine that allows different angulation of the X-ray beam and directs this beam at different angles to the patient. The patient lies on a special table (4) that allows the x-ray beam to go through smoothly. The table can be moved up and down, as well as to the right and left. Under the table is placed the source of X-ray radiation and, consequently, above the table - the image receiving device.

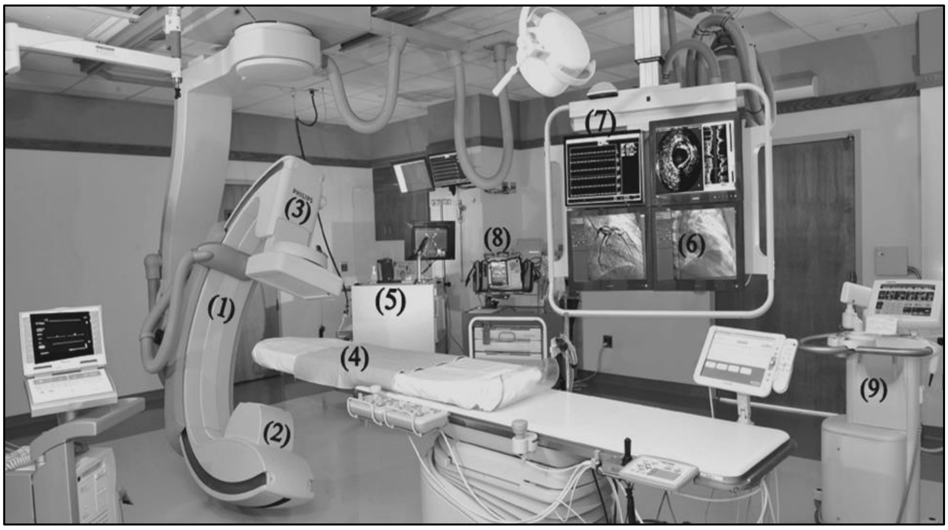


Figure 1.Catheterization laboratory

In a catheterization laboratory, there are the following items: 1. a mechanical part of an x-ray machine that hangs from the ceiling. At its lower end is an X-ray source (2), and at the top is an imaging device,an image detection system (3). X-rays fall on it, which pass through the patient, it converts these rays into a television signal and transmits them to monitors (6). The mechanical part of the X-ray machine (1) allows the X-ray source (2) and the image receiving device (3) to be positioned at different angles in different directions. Two monitors, which also hang from the ceiling, are designed to visualize angiographic images. The left monitor shows the situation in real-time, while the bottom right shows special monitors (7) that are used during the electrophysiological examination. The catheterization laboratory is equipped with a defibrillator (8), an artificial ventilator; a high-pressure input device, the so-called, contrast injector. A clinic has two catheterization laboratories to continue the procedure through the second equipment in case of failure of one. It is also necessary to have an autonomous power supply. If a clinic has one catheterization laboratory, a second portable device is necessary (5). The described system is a typical single-plane system [8]. There are also dual-plane devices (Figure 2). A dual-plane X-ray device is an integrated X-ray machine with two independent radiation sources and an independent television system - one on the floor and the other on the ceiling. Using this device, less contrast agent is expended, since two different planes are recorded with a single input of contrast substance.

Figure 2. Biplane angiography

The classic imaging procedure chain looks like this:
Generator - Cineangiography Pulse System - Imaging Receiver - Optical Distributor - TV Camera - Digital Recorder - Monitor. In this chain of images, it is possible to receive and view a direct real-time fluoroscopy image.

According to modern standards, the area of the catheterization laboratory is at least 47 m2. Ceiling height in the room - 3 m. The interior- walls, ceiling, and floor are treated with X-ray-resistant material, and the doors are hermetically sealed with lead material. The catheterization room and the remote control unit should be connected in such a way that verbal communicationamong the staff members is easily possible.

The generator of the equipment converts three-phase 480 volts to 70-120 volts and 300-800 milliamperes. The device required for cardiological purposes should have an alternating current output combined with a cineangiography pulse system that emits 4-6 ms long impulses. The voltage of the X-ray tube should be 80-100 kV. The image receiving device (so-called intensifier) should preferably be 5.7 and 9 inches in diameter. An X-ray tube should be able to emit 25-30 pulses per minute to obtain high-quality cineangiographic images. Images are taken as short films and stored digitally. They are exchanged between clinics by recording in DICOM (Digital Imaging Communications in Medicine) mode.

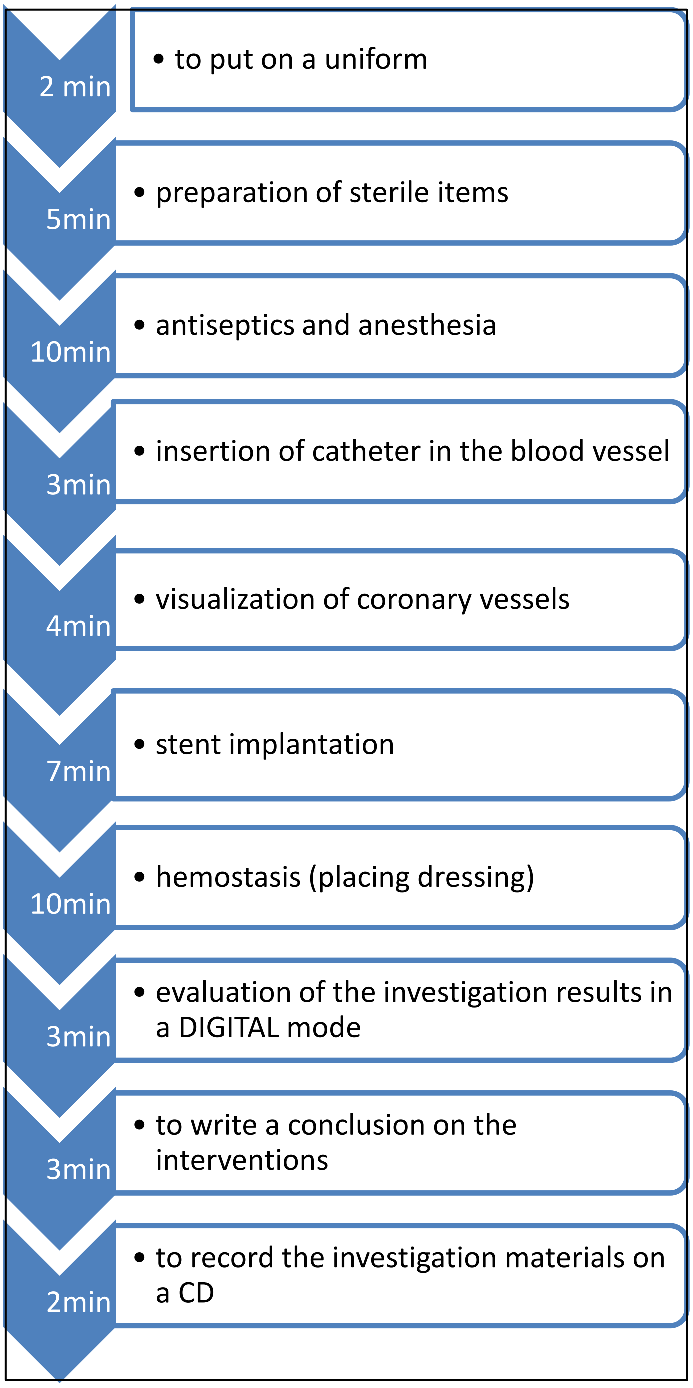
To protect against radiation, personnel are required to wear special protective clothing and neck protection shield to protect the neck and thyroid and X-ray goggles to protect the eyes. During coronary angiography and angioplasty, laboratory medical staff should have a personal dosimeter. If the dosimeter reading is close to the upper limit, a special X-ray shield should be used to reduce the radiation dose.

The studyaimed to identify the peculiarities of the working conditions of the medical staff employed in specialized procedures (in interventional cardiologyfor Coronary Artery Disease), for which the working conditions of the medical staff in the cardiac catheterization laboratories of the specialized clinics were studied. Adequate selection of medical centers was carried out at the initial stage. Criteria for inclusion of clinics in the study were: Existence of the Department of Interventional Cardiology for Coronary Diseases, smooth operation of the above-mentioned departments for the last 3 years, involvement in the Universal Healthcare (UHC) program with the component of emergency inpatient services.

Based on the listed criteria, 14 medical centers were selected for the study (9 of them were multi-profile and 5 were mono-profile), where the sanitary technical and sanitation and hygiene indicators were evaluated, which were compared to the relevant normative acts.

Survey Results: The entrance to the inpatient catheterization laboratory of the medical facility was connected to the intensive care unit via a corridor. There were isolated spaces in the catheterization block: - the entrance to the cath lab room, where the patients underwent the procedure; - the preparation space for the catheterization laboratory staff to prepare for the procedure; - the space for autonomous power supply of the catheterization laboratory equipment; - the operating room, where invasive manipulations were performed to the patients; - the Control Room (a remote control room), where additional observation took place on the course of the procedure.

The study found that the catheterization laboratory:



1) 25% of cases did not meet the standard requirements, the internal area was on average 41-43 m^2, instead of the minimum 47 m^2;

2) the average height of the ceiling was 2.7 m, instead of 3 m;

3) In 7% of the clinics, the walls and floor of the catheterization laboratory were not treated with X-ray-resistant material;

4) 30% of the research facilities didn't have adequate lead sealing of the Procedure Room door;

5) 7-8% of the surveyed facilities did not have a well-functioning ventilation system;

6) In 17% of the surveyed cases the autonomous power source system of the coronary angiography was located so close to the laboratory that the noise level in the ControlRoom (in the remote control room) exceeded the maximum permissible noise level, which created discomfort during the operations.

Timeline of Cardiovascular Interventionist Activities:

The activities of the medical staff included the following stages: Based on the timeline of the cardiovascularinterventionist activities, it was revealed that one cycle of the intervention lasted 45 min. The maximum 10 min ofeach surgical operation was spent on antiseptics and anesthesia, as well as treating hemostasis, which accounted for 22.2-22.2% of the total work cycle. The mean duration of coronary angiography was 20 min and that of stenting was 30 min (the duration of the procedure depended on the anatomical features of the patient's coronary arteries and the number of stents required for implantation). On average, 7 procedures were performed during a day: 4 coronary angiographies and 3 stentings. Implantation of a pacemaker and cardioverter-defibrillator (ICD) took 2 hours, and the average number of procedures per month was 3-5 (often the patients refrained from such interference due to economic problems).

Cases ofcalling an interventionist for the procedure at night were 5-6 times during the month.

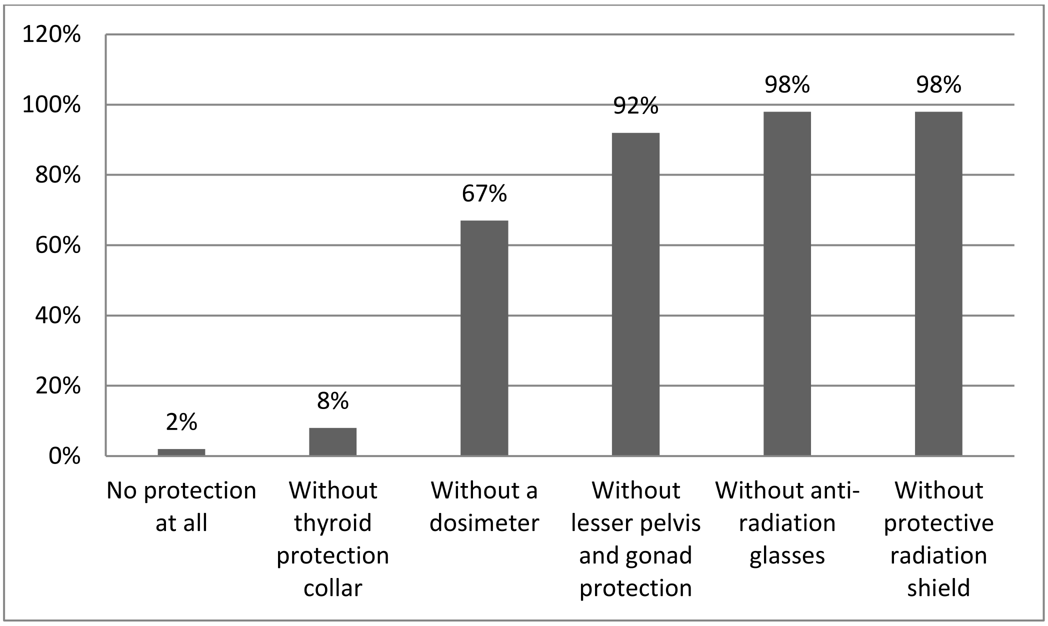


Diagram 2. Data about non-usage of the means of personal protection during the procedures

A study of the use of personal protective equipment (to reduce the dose of radiation) by medical personnel revealed that:
1) 98% of the staff of the catheterization laboratory do not use protective glasses;
2) 7-8% of the staff do not use thyroid protection collar during the procedure;
3) 92% do not use small pelvic and gonad protective lead aprons;
4) 67% of medical staff do not attach the dosimeter to the body during the procedure;
5) In most cases, it is not possible to determine if the environment meets the upper permissible limit of radiation during the day and, consequently, 98% of the staff does not use a special shield to reduce radiation in the procedure;
6) 1-2% of the medical staff taking part in the procedure is without mandatory protective equipment for the catheterization laboratory.

In 75% of the clinics surveyed, the use of a dosimeter has a formal use. At the end of the working day, the medical staff does not check what radiation dose each of them had received. Due to this situation, it became impossible to obtain a record of radiation doses for the interventionist and medical support staff, although, at the end of each procedure, an angiographer writes down the patient's radiation dose, which is written in the relevant medicalrecords book of the clinic. A review of the records book data found that the duration of the procedures was standardized for all patients and therefore the radiation rate was always the same and within the norm (meaning that no patients have been found to have relatively complex coronary anatomy for the last 2 years).

During investigating the timeline, it has been found that coronary angiography takes 20-40 minutes, while stenting takes 40-50 minutes. But the duration of the procedures is recordedwith a reduced period in the relevant protocols. This means that incorrect data on irradiation and the duration of the procedure are recorded in the medical records book.

It is known that medical personnel (unprotected parts of the body) are exposed to 0.05% of a patient's radiation dose when he or she is wearing a protective uniform. The dosimeter, inside the lead coat, identifies an additional 0.05% to 10%. The interventionist assistant and medical support staff receive 30% of the amount of the operator's radiation [9].

According to the radiation doses of the patient, the radiation rate of the medical staff was calculated: according to the official data of the clinic, during the coronary angiographic examination, which lasts 20 minutes, the patient is irradiated for 4 minutes - 800 mGy, and the operator - 800 mGy - 0.05% = 0.4 mGy. In fact, during a coronary angiography lasting 30 minutes, the patient is irradiated for 6 minutes - 1200 mGy, and the operator - (1200 mGy - 0.05%) = 0.6 mGy. Angioplasty with implantation of 1 stent lasts for 30 minutes and the patient is irradiated for 13 minutes - 2700 mGy, and the operator - (2700 mGy - 0.05%) = 1.35 mGy. In fact, angioplasty with implantation of 1 stent lasts for 40 minutes and the patient is irradiated in 17.3 minutes - 3593 mGy, and the operator (3593 mGy - 0.05%) = 1.8 mGy. Angioplasty with implantation of 2 drug-coated stents lasts for 35 minutes and the patient is irradiated for 16 minutes - 3050 mGy, and the operator (3050 mGy - 0.05%) = 1.52 mGy. Angioplasty with implantation of a drug-coated stent takes 42 minutes and the patient is irradiated for 19.2 minutes with 3660 mGy, and the operator (3660 mGy for 0.05%) = 1.83 mGy.

The annual dose of staff irradiation was calculated according to the patient's irradiation dose per procedure and the average monthly number of procedures:

During the year, on average, the catheterization laboratory emits 2348 mGy of radiation, 41% of the medical staff's body area is covered with protective clothing. Accordingly, the exposed parts of the operator's body radiate 962.68 mGy. Covered 59% - with 1385.32 mGy; 10% of the radiation penetrates the lead coat, i.e. 138.53 mGy. Accordingly, during the year the interventionist is irradiated with 1101.21 mGy, and the support staff of the catheterization laboratory, since theyare irradiated with 30% of the radiation dose of the interventionist, are irradiated with 330.3 mGy.

Based on the results of the research, we can conclude that the profession of interventionists belongs to the group of tense and stressful work, but radiation safety requirements are not implemented in the workplace: there is no special recording book in the workplace, which would describe radiation rates at the end of each working day.

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