COMPETENCE OF FAMILY PHYSICIANS TO TREAT
THE VICTIMS OF RADIOLOGICAL TERRORISM

Kompetencje lekarzy rodzinnych w leczeniu ofiar terroryzmu radiologicznego

Vili Slavchev Zaharievi, Nikolai Milenov Hristov

STRESZCZENIE

Cel: Optymalizacja opieki lekarskiej na wypadek terroryzmu radiologicznego poprzez ba-
danie i analizę wiedzy i umiejętności lekarzy rodzinnych w mieście Sofii, w celu ich udziału
w zabezpieczeniu usług medycznych dla ofiar radiologicznego terroryzmu. Metody: przeprowa-
dzono pojedyncze badanie przekrojowe w celu zebrania danych i analizy przygotowania lekarzy
pierwszego kontaktu. Badanie zostało przeprowadzone we wrześniu 2011 roku. Względny
udział badanej grupy 400 lekarzy rodzinnych wynosi 45% (z ogólnej liczby 890) przy standar-
dowym błędzie 2,5% i 95% CI – (40,1% ÷ 49,9%). Wyniki: prawie wszyscy respondenci określili
swoją wiedzę jako „niewystarczającą” i „wysoce niewystarczającą” – 97,3% (CI = 95,19% ÷ 98,65%).

Wnioski: wiedza i umiejętności lekarzy rodzinnych są fragmentaryczne i powierzchowne,
brak jest jakiegokolwiek praktycznego doświadczenia w świadczeniu opieki medycznej dla osób
z obrażeniami popromiennymi. W rzeczywistości lekarze rodzinni pozostają poza systemem
reagowania na terroryzm radiologiczny i wypadki radiologiczne. Praktycznie wszyscy uczestnicy
badania uznają za konieczne przeprowadzenie dodatkowych szkoleń z zakresu świadczenia opieki
medycznej dla ofiar z obrażeniami popromiennymi.

Słowa kluczowe: terroryzm radiologiczny, lekarz rodzinny, obrażenia popromienne

Key words: radiological terrorism, family physicians, radiation injuries.

INTRODUCTION

Terrorism has turned into an inseparable part of modern life. The main weapon of
terrorists is violence aimed to instill fear. Contemporary living conditions present the
terrorists excellent opportunities to generate fear through violence –media multiply the
psychological effects of the terrorist act; developments in science and technology
allow achieving a maximum devastation effect with little resources. Of all forms of
terrorism radiological, chemical and biological present the gravest threats. Radiological
terrorism deserves special attention (20, 22, and 23). Due to the radiophobia present
among the population, the usage of sources of ionizing radiation (SIR) would generate
an enormous psychological effect. Potentiating of effects – because of fear of terrorism and
fear of radiation, makes the perspective of implementing radiological terrorism very
feasible (4, 15). According to some “the risk of terrorists using nuclear weapons is
significantly higher than the risk of them using chemical or biological weapons
(almost twice as higher), as demonstrated by the tendency of increase in this risk (from
25-27.1% to 40%) in the next 10 years (27). The most probable scenario would be the
dissemination of radioactive material (dirty bomb) in the central parts of a large city (6,
16, 19, 22, and 23). In this case we can expect the highest number of affected and most serious
problems with the elimination of radioactive contamination from the environment.
Keeping in mind that the specific activity of radioactive materials would not be high, we should not expect serious deterministic effects, but owing to the massive decontamination procedures to be anticipated and the pre-existing radiophobia, the psychological effect would be tremendous. Analysis of experience so far makes us believe that in the event of radiological terrorism a significant number of affected with Multiple Idiopathic Physical Symptoms (MIPS), would head to family physicians (7). More serious injured would represent a smaller share and would be directed to hospitals, thereby additionally increasing psychological tension among the population and medical personnel. Bearing in mind that ionizing radiation is an inadequate irritant for the human, it is not impossible that radioactive contamination be found with a certain delay (12, 13). This would lead to additional problems related to the admission of affected to hospitals unprepared to treat radioactively contaminated patients (3, 21). All this necessitates the establishment of dedicated protection and medical care provision structures, especially in large urban areas. A key position in the provision of medical care for the population provides the family physician.

So far a case of radiological terrorism, save for a few unrealized threats, has not been registered (22, 23). According to some authors during the last 50 years two cases may be considered terrorist crime acts (2, 16). This means that we can rely on some previous experience when planning medical care provision in emergency situations. In its essence and consequences the radiological terrorism act is a factual accident, albeit deliberately induced. In this respect the Goiania accident is very informative (11, 14). Population effects and medical care provision activities can be elucidated on the basis of past accidents experience and this is the exact approach of most institutions and organizations specialized in radiation protection (1, 15, and 23). Thorough analysis of information from past accidents shows that family physicians are most often the first to offer medical care to victims (17, 28). The main reason for the prolonged misdiagnosis of radiation injuries is the inadequate knowledge of ionizing radiation exposure consequences and their clinical signs. This leads to improper and in some cases outright incorrect treatment of victims in the first hours following the accident. Thus the deterioration of the victims’ condition continues simultaneously limiting the possibilities for ensuing effective treatment (10, 11, 25, and 26). This poses the necessity to provide family physicians with updated information on the best course of action in cases of radiation terrorism and radiation injuries. Family physicians should ideally be able to perform initial diagnosing, treatment and certain administrative measures if necessary.

The topicality and great significance of radiological terrorism justifies the assessment of hospitals’ and emergency wards’ preparedness (3). Unfortunately the role and place of family physicians in post-exposure medical provision is underestimated. Insofar a study of the competence of family physicians to participate in such medical provision has not yet been conducted, we proceeded to perform the present study.

**OBJECTIVE:**

Optimization of medical care in case of radiological terrorism through study and analysis of the knowledge and skills of family physicians in the city of Sofia, Bulgaria, to participate in the medical services provision for survivors according to the recommendations of leading international organizations in the field.

**METHODS:**

We performed a single cross-sectional study in order to collect data and analyse the preparedness of general practitioners. The study was performed in September 2011. We used direct individual inquiry “face to face” using a questionnaire developed by us on the basis of document analysis. We made a simple random sample using a generator of random numbers and based on the register general practitioners in Sofia. The relative
share of the studied group of 400 GPs is 45% (out of a total of 890) with a standard error of 2.5% and 95% CI – (40.1% ÷ 49.9%). The dropout percentage in the course of the study is 10%. We processed data using SPSS ver. 19.0. The adopted level of significance in the testing of $H_0$ was $\alpha = 0.05$ in guaranteed probability 95%. In order to validate results from the performed analyses we used the following statistical methods: descriptive analysis; tests for interdependence between descriptive data – $\chi^2$ Pearson, Exact test, coefficient of contingency of Cramer (V) – for orientation estimation of the degree of manifestation of the dependence found by the $\chi^2$– method; tests for comparing relative shares – $Z$ test.

**RESULTS:**

Data used to analyze the competence of family physicians in the field of radiation medicine was obtained via several groups of questions directed towards the following main directions: diagnosis; prevention and treatment of radiation injuries; values and units; decontamination, decorporation, and overcoming of psychological effects. To the question: “Do you know what adverse health effects can result from radiation terrorism?” we obtained the following results: 83% responded with “yes” and “more like yes”, and 17% with “no” and “more like no”. The distribution in percentages of the answers is shown on Fig. 1.

The next question was open and aimed at checking the knowledge of respondents: “If the answer is “yes” indicate the types of injuries”. Most of the physicians having responded to this question – 197, indicated “cancer” and 9 indicated “bone tumors”. We think that these answers point to an associative connection between ionizing radiation and the carcinogenic process and are an expression of pronounced radiophobia. A surprisingly large number have responded with “skin lesions” – 102, which is an indication of a drastic lack of knowledge in radiation pathology. “Thyroid injuries” are listed by 93 respondents. The answer “radiation sickness” was provided by 32 respondents. Only 7 have indicated “genetic transformations”, and 3 – “gastro-enteric impairments”. Of certain interest are answers like: “anemia” – 10, “hair loss” – 48, “gum bleeding” – 33, and “internal bleeding” – 32. A large proportion of physicians – 124, have given no answer. These data indicate insufficient, superficial and fragmented knowledge on the matter. The percentage distribution of answers is presented on Table 1.

![Fig. 1. Do you know what adverse health effects can result from radiation terrorism?](image-url)
The question: “Do you believe you can diagnose radiation injury?” aimed to obtain the physicians’ self-esteem regarding their skill to diagnose correctly. Categorically with “yes” responded only 3%, with “probably” – 55.5%, and with “probably not” – 36.5%. Only 5% responded with “no”.

At this stage diagnosing is hard because radiation injury has no specific symptoms. According to the International Atomic Energy Agency (IAEA) one of the key issues is the competence of physicians (12, 13). Taking into account the maximum sampling error we can say with greater accuracy that no less than 26.02% and no more than 35.27% of all respondents think that this type of injury has no specific symptoms. Also of interest is the crossing of this question with the preceding one – see Table 2. Applying the Exact test of Fischer we demonstrated that there exists a statistically significant correlation between them – $\chi^2 = 83.1, p < 0.0001$, which is weakly expressed – $V = 0.33$. All physicians believing that they can diagnose correctly are at the same convinced that radiation injury has specific symptoms. Of the physicians having responded with “probably”, 64.3% also believe the same.

### Table 1. Nature of radiation injuries according to the respondents

<table>
<thead>
<tr>
<th>№</th>
<th>Answer</th>
<th>Answers Number</th>
<th>Percentage</th>
<th>Percentage of cases</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>No answer</td>
<td>124</td>
<td>15,9%</td>
<td>32,2%</td>
<td>27,56% + 37,12%</td>
</tr>
<tr>
<td>2.</td>
<td>Cancer</td>
<td>197</td>
<td>25,3%</td>
<td>51,1%</td>
<td>45,98% + 56,19%</td>
</tr>
<tr>
<td>3.</td>
<td>Anemia</td>
<td>10</td>
<td>1,3%</td>
<td>2,6%</td>
<td>1,25% + 4,73%</td>
</tr>
<tr>
<td>4.</td>
<td>Bone tumor</td>
<td>9</td>
<td>1,2%</td>
<td>2,3%</td>
<td>1,05% + 4,34%</td>
</tr>
<tr>
<td>5.</td>
<td>Thyroid injury</td>
<td>93</td>
<td>11,9%</td>
<td>24,2%</td>
<td>20,01% + 28,79%</td>
</tr>
<tr>
<td>6.</td>
<td>Internal bleeding</td>
<td>32</td>
<td>4,1%</td>
<td>8,3%</td>
<td>5,74% + 11,52%</td>
</tr>
<tr>
<td>7.</td>
<td>Skin lesions</td>
<td>102</td>
<td>13,1%</td>
<td>26,5%</td>
<td>22,16% + 31,21%</td>
</tr>
<tr>
<td>8.</td>
<td>Blood count changes</td>
<td>30</td>
<td>3,9%</td>
<td>7,8%</td>
<td>5,32% + 10,95%</td>
</tr>
<tr>
<td>9.</td>
<td>Hair loss</td>
<td>48</td>
<td>6,2%</td>
<td>12,5%</td>
<td>9,37% + 16,22%</td>
</tr>
<tr>
<td>10.</td>
<td>Vomiting</td>
<td>11</td>
<td>1,4%</td>
<td>2,9%</td>
<td>1,46% + 5,11%</td>
</tr>
<tr>
<td>11.</td>
<td>Gum bleeding</td>
<td>33</td>
<td>4,2%</td>
<td>8,6%</td>
<td>5,99% + 11,86%</td>
</tr>
<tr>
<td>12.</td>
<td>Radiation sickness</td>
<td>32</td>
<td>4,1%</td>
<td>8,3%</td>
<td>5,74% + 11,52%</td>
</tr>
<tr>
<td>13.</td>
<td>Burns</td>
<td>13</td>
<td>1,7%</td>
<td>3,4%</td>
<td>1,83% + 5,73%</td>
</tr>
<tr>
<td>14.</td>
<td>Impotence</td>
<td>12</td>
<td>1,5%</td>
<td>3,1%</td>
<td>1,61% + 5,36%</td>
</tr>
<tr>
<td>15.</td>
<td>Nervous system injury</td>
<td>7</td>
<td>0,9%</td>
<td>1,8%</td>
<td>0,72% + 3,69%</td>
</tr>
<tr>
<td>16.</td>
<td>Hematologic diseases</td>
<td>10</td>
<td>1,3%</td>
<td>2,6%</td>
<td>1,25% + 4,73%</td>
</tr>
<tr>
<td>17.</td>
<td>Gastro-enteric impairments</td>
<td>3</td>
<td>0,4%</td>
<td>0,8%</td>
<td>0,17% + 2,29%</td>
</tr>
<tr>
<td>18.</td>
<td>Genetic transformation</td>
<td>7</td>
<td>0,9%</td>
<td>1,8%</td>
<td>0,72% + 3,69%</td>
</tr>
<tr>
<td>19.</td>
<td>Dependent on stage</td>
<td>6</td>
<td>0,8%</td>
<td>1,6%</td>
<td>0,59% + 3,42%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>779</td>
<td>100,0%</td>
<td>202,3%</td>
<td></td>
</tr>
</tbody>
</table>
Of significance regarding the knowledge and skills of family physicians is the following question: “Do you believe that providing medical care to victims with external exposure carries risk to the physician?” The “no” answers represent only 31.8% of all respondents. The relative share of “yes” answers is 42.7%, which proves the alternative hypothesis (H1) for a significant difference in the compared relative shares – Z = 4.40, p<0.0001. Responses “I am unsure”, represent 25.5% of the total.

Again all having responded that they can diagnose correctly are convinced that patients undergone external exposure present a risk to the physician. Of the responded with “probably”, 45.9% think the same. Between the two questions there exists a very weakly expressed statistically significant difference – $\chi^2 (6) = 29.5, p < 0.0001, V = 0.19$. This relation is presented on Table 3.

Table 2. Correlation between the diagnostic process and knowing of symptoms

<table>
<thead>
<tr>
<th>Do you believe you can diagnose radiation injury?</th>
<th>Yes</th>
<th>No</th>
<th>I am unsure</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Probably</td>
<td>142</td>
<td>63</td>
<td>16</td>
<td>221</td>
</tr>
<tr>
<td>Probably not</td>
<td>43</td>
<td>57</td>
<td>40</td>
<td>140</td>
</tr>
<tr>
<td>No</td>
<td>8</td>
<td>0</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>205</td>
<td>120</td>
<td>68</td>
<td>393</td>
</tr>
</tbody>
</table>

Of significance regarding the knowledge and skills of family physicians is the following question: “Do you believe that providing medical care to victims with external exposure carries risk to the physician?” The “no” answers represent only 31.8% of all respondents. The relative share of “yes” answers is 42.7%, which proves the alternative hypothesis (H1) for a significant difference in the compared relative shares – Z = 4.40, p<0.0001. Responses “I am unsure”, represent 25.5% of the total.

Table 3. Correlation between the diagnostic process and the risk in external exposure

<table>
<thead>
<tr>
<th>Do you believe you can diagnose radiation injury?</th>
<th>Yes</th>
<th>No</th>
<th>I am unsure</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Probably</td>
<td>101</td>
<td>63</td>
<td>56</td>
<td>220</td>
</tr>
<tr>
<td>Probably not</td>
<td>45</td>
<td>55</td>
<td>44</td>
<td>144</td>
</tr>
<tr>
<td>No</td>
<td>11</td>
<td>8</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>169</td>
<td>126</td>
<td>101</td>
<td>396</td>
</tr>
</tbody>
</table>
Due to the absence of specific clinical symptomatic differential diagnosis is of the utmost importance (13). To the question: “Can you make a differential diagnosis of radiation injury?” we received the following answers: 8.2% responded with “yes”, which share does not differ significantly from the share of “no” answers – 6.3% – $Z = 1.56, p = 0.1178$ and fails to reject the null hypothesis ($H_0$). The relative share of “probably” answers represents 38.7% of the respondents. This relative share differs significantly from the “probably not” answers – 46.8% – $Z = 3.25, p = 0.0012$.

The high sensitivity to radiation of lymphocytes is well known from classic radiobiology. The dose dependent reduction of their absolute count in the first 24 hours and the easily performed automated counting makes them a suitable marker for biologic dose metering, highly recommended by most international organizations (12, 23, and 24). The question: “According to you, which blood fraction can serve the purpose of biologic dose metering?” aimed to check the knowledge of family physicians. The largest share of answers was “lymphocytes” – 71.3% of the respondents. Alerting is a smaller share of the answers: 26.5% have pointed to the most resistant fraction: “erythrocytes”.

A matter of special importance in the competence of family physicians is the diagnosing and treatment of the most significant effect in exposure – the acute radiation syndrome (ARS) (5, 8, and 9). To the question: “According to you, to what would lead an acute whole body exposure to 30 Gy?”, only 1.5% have given the answer “fatal outcome in the course of several days” – Fig. 2. This relative share is statistically significant from the relative share of answers “no effect” and “ARS with a favorable outcome” – 16.6% – $Z = 8.12, p<0.0001$. The largest share has the answer “I am unable to judge” – 73.8%. These answers clearly demonstrate the insufficient knowledge of radiation pathology and the need of family physicians to have at their disposal relevant information on the required course of action in cases of radiation terrorism and radiation injuries.

Important in the aftermath of radiation terrorism would be the external contamination and the incorporation of radioactive substances in the human organism. IAEA, the International Commission on Radiological Protection (ICRP), the National Council on Radiation Protection and Measurements (NCRP) and the Radiation Emergency Assistance Center (REAC) pay specific attention to the decontamination and decorporation of the

Fig. 2. According to you, to what would lead a whole-body exposure to a dose of 30 Gy?
following radionuclides: Cesium-137, Cobalt-60, Plutonium-239, Polonium-210, Strontium-90, Uranium-238, Radium-226 and Iridium-192 (1, 12, 15, 21, 23, and 24). The ensuing group of questions aimed to obtain information on the competence of physicians in this direction. To the question: “Do you know how to perform primary individual deactivation?” only 4.1% (CI = 2.38% ÷ 6.54%) answered with “yes”.

We obtained similar results with the question: “Do you know with what means to perform a decontamination of a victim?” Only 2% (CI = 0.87% ÷ 3.9%) have responded with the categorical “yes”.

These answers speak of rather superficial knowledge on radio-toxicology. Our conclusion was confirmed with the concrete question: “According to you, in the case of internal contamination with what radionuclide, is Prussian blue applied?” where only 16.8% replied with “Cesium-137”. This share significantly differs from the relative share for the answers “Strontium-90”, “Polonium -210”, “Plutonium -239”, and “Iodine-131” – 30.4% – Z = 5.91, p<0.0001. The largest share had the answer “I am unable to judge” – 52.8% of the respondents.

The third main direction for analyzing the competence of family physicians was dosimetry of ionizing radiation – in particular the used values and units. Only 17 respondents, amounting to a relative share of 4.3%, thought they were familiar with them. Significantly more – 33.8% of the respondents presumed that they are “most likely” to be familiar with them. The relative share of physicians thinking that they are “most likely” unfamiliar with them was the largest – 42.6%. A relatively large number of physicians – 76, stated explicitly that they do not possess any relevant knowledge.

The special publications of the National Council on Radiation Protection – NCPR Report No 138 and Report No 165, dedicated to protection from terrorist threats, recommend a very pragmatic approach to as action according to three boundaries – green, yellow and red, defined by the easiest to measure indicator – the power of the ambient equivalent dose in the respective region (18, 23). Of considerable interest to us here was the question: “Do you believe that a power of the ambient dose in the magnitude of 0.1 Sv/h constitutes a health threat?” Only 2.5% of the respondents answered with “yes”.

The question: “Can you operate a dosimeter?” aimed to check the practical preparedness of family physicians. The “yes” answers amounted to only 10% of all respondents.

The fourth main direction for analysis was preparedness for overcoming the psychological effects of radiological terrorism. Especially with the pre-existing radiophobia among the population the usage of ionizing radiation sources would surely generate a strong psychological effect which is in fact a goal in itself of terrorism – the spreading of mass panic and mistrust of the population with authorities. Therefore the question: “Do you know how to offer psychological support to victims of radiological terrorism?” was quite significant. Only 18.7% responded with “yes”. On the other hand 10.8% responded with straight “no”. The largest share occupied the “most likely” answers – 46.5% of all respondents.

An important part of our study formed the ensuing self-assessment questions with which we aimed to compare our findings with the opinions of physicians themselves. Almost all respondents rated their knowledge as “insufficient” and “extremely insufficient” – 97.3% (CI = 95.19% ÷ 98.65%). The relative share of “sufficient” answers was only 2.7% (CI = 1.35% ÷ 4.8%), which very categorically proves the alternative hypothesis (H1) for a significant difference between the compared relative shares – Z = 116.73, p<0.0001. The percentage distribution of answers is presented on Fig. 3.
In support of the necessity for new knowledge and skills came the results from the question: “How would you rate your practical skills to provide care in radiological terrorism?” Considering the maximum sampling error we can state with 95% accuracy that no less than 97.18% and no more than 99.62% of the respondents rated their skills as “insufficient” and “extremely insufficient”.

When comparing this relative share with the relative share of physicians having rated their skills as “sufficient”, a bare 1.2% (CI = 0.38% ÷ 2.82%), we observed a significant difference – Z = 179.27, p<0.0001. The percentage distribution of answers is presented on Fig. 4.

Fig. 3. How would you rate your knowledge on the course of action in case of radiological terrorism?

Fig. 4. How would you rate your skills in responding to radiological terrorism?
Almost all participants in the study think they need additional training on providing medical care in radiation terrorism – 85.5% (CI = 81.66% ÷ 88.8%) of the respondents. Only 14.5% (CI = 11.19% ÷ 18.34%) think they don’t need such training. These data are presented on Fig. 5.

CONCLUSIONS:

Analyzing the information obtained from our inquiry we came to the following conclusions:

1. The knowledge and skills of family physicians are fragmented and superficial, and any practical experience in the provision of medical care for survivors of radiation accidents is missing.

2. In practice family physicians are left outside the system for preparedness in radiological protection. Almost all participants in the study find it necessary to receive additional training in the provision of medical care for survivors of radiation accidents.

3. It is necessary to establish an algorithm of family physicians’ activities in the events of radiological terrorism or ionizing radiation injuries with particular attention to diagnostics, prevention, therapy of radiation injuries, and the overcoming of psychological effects.

4. A complete program for the training of family physicians should be established alongside criteria for the ensuing medical monitoring of survivors.

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