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Original investigation

Evaluation of the Medical Chemical, Biological, Radiological, and Nuclear Awareness Level of Emergency Healthcare Professionals Serving on Different Centres

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ABSTRACT

Purpose: The aim of this study was to compare the medical chemical, biological, radiological, and nuclear (CBRN) awareness of emergency healthcare professionals from two different centres.

Methods: The survey was conducted among 67 healthcare professionals including physicians, nurses, emergency medical technicians, and paramedics from two emergency departments of two different cities. A questionnaire that was designed in order to evaluate demographic data (age, gender, job description, education level) and knowledge/experience about medical CBRN was filled by participants during the face-to-face interviews. All data were evaluated statistically in order to obtain mean awareness score (MAS) of participants and institutions.

Results: It was found that MAS of the whole participants is 7.62±3.92. There was a statistically significant difference observed between MAS of Training and Research Hospital (6.75±3.97) and State Hospital (8.64±3.65) ($p<0.05$).

Conclusion: It was concluded that emergency health professionals should be ready for CBRN incidents and awareness level of health professionals is the most objective indicator of medical CBRN preparedness of emergency departments just like in global COVID-19 outbreak response.

Keywords: CBRN, awareness, preparedness, emergency medicine.

INTRODUCTION

Chemical, biological, radiological, and nuclear (CBRN) incidents and attacks have disaster potential for modern communities, especially for healthcare system. CBRN agents are spread around as a result of an accident or intentional and malicious acts as can be seen in terrorist attacks. The contamination of foods or urban water infrastructure with CBRN agents or releasing of these agents directly to the atmosphere can be shown some ways of releasing (1, 2). Intentional use of CBRN agents poses a significant burden on life sources and medical resources as well as their direct impact on humans. Also, they can harm public health as it causes social concern (3). During the period when manufacturing of chemical or biological weapon was not possible without government support, Aum Shinrikyo doomsday cult which was known with its terrorist attacks in Japan after 1994 succeeded in producing many chemical and biological weapon prototypes, especially sarin, in a laboratory established with a cost of 30 million dollars (4). The fact that trade volume of toxic industrial chemicals globally is high today and biological warfare agents are often dealt with in government-controlled laboratories in many countries results in misusing the said trade and scientific researches especially by the non-state actors. For this reason, the debate is not whether a CBRN attack will occur or not, the debate is when it will occur.

The legal legislation in Turkey that specifies the measurements to be taken against the CBRN threats and basic details of the actions

to be taken by the government bodies is the "Regulation on the Chemical, Biological, Radiological and Nuclear Threats" published in May 3, 2012. The scope of this regulation is to put forward the precautions to be taken against the CBRN attacks made by state or non-state actors as well as measures to be taken by government bodies against CBRN agents that may leak due to an accident. Radioactive and nuclear agents also pose CBRN threats. Nuclear materials such as uranium and plutonium are stored safely and in a limited number in nuclear power plants and nuclear weapon production facilities under normal conditions. Because, stricter security culture and international protection mechanisms regulate the use and storage of these materials all over the world. However, it is detected that small scale nuclear agents have been taken from these facilities to utilize them out of designated purpose (5). Also, today, radiological resources are used in every part of the life, especially for diagnosis and treatment in medical facilities. According to estimations of US Nuclear Regulatory Commission, each day one licensed radioactive resource is lost in the U. S as an average (6). One of them was intentionally used as a threat to the general public in Moscow park in 1995 (7). It is a clear fact that potential results of any terrorist attack to be carried out in open public area by exploding one of the missing radioactive sources conventionally can be destructive both for the victims and system. In 2011, the explosion occurred following the accident in Fukushima Daiichi Nuclear Power Plant caused by the earthquake that triggered huge waves in Japan resulted in big environmental disaster like the Chernobyl catastrophe occurred in 1986, Ukraine (8).

Turkey acceded to the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction in April 29, 1997 (9). Moreover, chemical weapons used in Syrian civil war against the civilians pose a significant threat to Turkey. For the sake of avoidance of potential CBRN threats, healthcare personnel should have enough awareness, knowledge and equipment so as to respond such actions while providing healthcare to the people affected by CBRN attacks. It is strict requirement that corporate roles of the healthcare professionals should be clearly designated for the preparation, planning, organization, equipment, communication and training activities in case of CBRN attack (10).

While there are few international studies evaluating the awareness and knowledge level of healthcare professionals in terms of their approaches to CBRN cases, no study dealt with this issue in Turkey. Even if it is very hard and challenging method to evaluate the efficiency of the hospitals and their personnel in an appropriate way, various methods have been developed to evaluate the structural and functional features of the hospitals, implementation level of disaster plans and readiness level of the personnel (11, 12). The aim of this sectional and descriptive study based on the available studies in the literature is to evaluate the medical CBRN-related knowledge and awareness level of the healthcare professionals working in the emergency departments of two different health institutions.

METHODS

A questionnaire was drafted by the health professionals working in the Department of Medical CBRN within the University of Health Sciences with a view to detecting the awareness and knowledge level of health professionals at emergency services. The draft questionnaire was voluntarily responded by 33 health professionals working in Ankara in August 2018. By doing so, the suitability and reliability of the questions were tested and then questions were reviewed based on the preliminary feedbacks. The updated questionnaire was conducted face-to-face in September 2018 to the health professionals (n=67) working in the emergency services of two hospitals including a Training and Research Hospital (TRH) and a State-run Hospital (SH). This study enabled to collect data and information on hospitals disaster plan, risk perception and evaluation of the personnel for CBRN, state of the decontamination units of the hospitals, use of personnel protective equipment, antidote applications, previous CBRN trainings of the personnel as well as demographical information regarding the health professionals who responding the questionnaire voluntarily.

The questionnaire form compiled from the current literature includes 27 questions. In the first section of questionnaire, respondents are requested to answer the questions relating to their socio-economic status such as age, gender, profession, educational background. 16 questions were raised to measure the knowledge level of responders on CBRN in the second section. For the second section, a score was given to each correct answer (minimum 0, maximum 16 points) and a scoring scale was developed.

This study was conducted after receiving the approval of the Gulhane Ethics Committee of University of Health Sciences.

Statistical Analysis

Statistical Package for Social Sciences (SPSS) 18 Program was used for analysing the data. Statistical assessments were conducted based on percentage, average, standard deviation, Ki-square, Kruskal Wallis and Mann Whitney U tests.

RESULTS

While there is no significant difference between the respondents from TRH and SH in terms of age, gender and education ($p>0.05$), significant difference was detected for the occupational groups ($p=0.041$) (Table 1).

It was detected that 83.8% of the ones who received CBRN training in TRH is above 28 ($p<0.05$), 53.3% of the ones who received CBRN training in SH was below 27 ($p>0.05$). It was also detected that (i) women, (ii) emergency resident and nurse, (iii) people with bachelor's degree account for 53.8%, 77.0%, 46.2% of the ones who received CBRN training in TRH, respectively ($p>0.05$); while the (i) men, (ii) general practitioner (GP), (iii) people with bachelor's degree account for 60.0%, 46.7%, 40.0% of the ones who received CBRN training in SH, respectively ($p>0.05$) (Table 2).

While the CBRN knowledge scoring average of total 67 respondents is 7.62±3.92, scoring average of SH personnel (8.64±3.65) is higher

Table 1. Comparison of the responders in terms of socio-demographic variables

		TRH n (%)	SH n (%)	Total n (%)	p
Age	18–27	17 (47.2%)	20 (64.5%)	37 (55.2%)	0.365*
	28–37	14 (38.9%)	8 (25.8%)	22 (32.8%)	
	38–47	5 (13.9%)	3 (9.7%)	8 (11.9%)	
Gender	Male	17 (47.2%)	17 (54.8%)	34 (50.7%)	0.534*
	Female	19 (52.8%)	14 (45.2%)	33 (49.3%)	
Occupation	Emergency Medicine Specialist	5 (13.9%)	4 (12.9%)	9 (13.4%)	0.041*
	Emergency Medicine Resident	11 (30.6%)	1 (3.2%)	12 (17.9%)	
	Practitioner	6 (16.7%)	10 (32.3%)	16 (23.9%)	
	Nurse	12 (33.3%)	10 (32.3%)	22 (32.8%)	
	EMT	2 (5.6%)	5 (16.1%)	7 (10.4%)	
	Paramedic	0 (00.0%)	1 (3.2%)	1 (1.5%)	
Education Level	Doctor's Degree	6 (16.7%)	3 (9.7%)	9 (13.4%)	0.093*
	Master Degree	12 (33.3%)	5 (16.1%)	17 (25.4%)	
	Bachelor's Degree	15 (41.7%)	13 (41.9%)	28 (41.8%)	
	Associate Degree	3 (8.3%)	8 (25.8%)	11 (16.4%)	
	High School	0 (00.0%)	2 (6.5%)	2 (3.0%)	
	Total	36 (100.0%)	31 (100.0%)	67 (100.0%)	

* Chi-square test

Table 2. Comparison of responders for being trained on CBRN, age, gender, education and occupations in terms of socio-demographic variables

		Question 1 (Have you received CBRN training?)									
		TRH n (%)					SH n (%)				
		Yes	No	No idea	Total	p	Yes	No	No idea	Total	p
Age	18–27	2 (15.4%)	10 (62.5%)	5 (71.4%)	17 (47.2%)	0.041*	8 (53.3%)	10 (71.4%)	2 (100.0%)	20 (64.5%)	0.694*
	28–37	7 (53.8%)	5 (31.3%)	2 (28.6%)	14 (38.9%)		5 (33.3%)	3 (21.4%)	0 (00.0%)	8 (25.8%)	
	38–47	4 (30.8%)	1 (6.3%)	0 (00.0%)	5 (13.9%)		2 (13.3%)	1 (7.1%)	0 (00.0%)	3 (9.7%)	
Gender	Female	7 (53.8%)	6 (37.5%)	4 (57.1%)	17 (47.2%)	0.573*	6 (40.0%)	9 (64.3%)	2 (100.0%)	17 (54.8%)	0.175*
	Male	6 (46.2%)	10 (62.5%)	3 (42.9%)	19 (52.8%)		9 (60.0%)	5 (35.7%)	0 (00.0%)	14 (45.2%)	
Occupation	Emergency Medicine Specialist	3 (23.1%)	2 (12.5%)	0 (00.0%)	5 (13.9%)	0.266*	1 (6.7%)	0 (00.0%)	0 (00.0%)	1 (3.2%)	0.327*
	Emergency Medicine Resident	5 (38.5%)	4 (25.0%)	2 (28.6%)	11 (30.6%)		1 (6.7%)	8 (57.1%)	1 (50.0%)	10 (32.3%)	
	Practitioner	0 (00.0%)	3 (18.8%)	3 (42.9%)	6 (16.7%)		7 (46.7%)	2 (14.3%)	1 (50.0%)	10 (32.3%)	
	Nurse	5 (38.5%)	5 (31.3%)	2 (28.6%)	12 (33.3%)		3 (20.0%)	2 (14.3%)	0 (00.0%)	5 (16.1%)	
	EMT	0 (00.0%)	2 (12.5%)	0 (00.0%)	2 (5.6%)		1 (6.7%)	0 (00.0%)	0 (00.0%)	1 (3.2%)	
	Paramedic	0 (00.0%)	0 (00.0%)	0 (00.0%)	0 (00.0%)		1 (6.7%)	0 (00.0%)	0 (00.0%)	1 (3.2%)	
Education Level	Doctor's Degree	5 (38.5%)	1 (6.3%)	0 (00.0%)	6 (16.7%)	0.055*	2 (13.3%)	1 (7.1%)	0 (00.0%)	3 (9.7%)	0.680*
	Master Degree	2 (15.4%)	6 (37.5%)	4 (57.1%)	12 (33.3%)		1 (6.7%)	3 (21.4%)	1 (50.0%)	5 (16.1%)	
	Bachelor's Degree	6 (46.2%)	6 (37.5%)	3 (42.9%)	15 (41.7%)		6 (40.0%)	7 (50.0%)	0 (00.0%)	13 (41.9%)	
	Associate Degree	0 (00.0%)	3 (18.8%)	0 (00.0%)	3 (8.3%)		5 (33.3%)	2 (14.3%)	1 (50.0%)	8 (25.8%)	
	High School	0 (00.0%)	0 (00.0%)	0 (00.0%)	0 (00.0%)		1 (6.7%)	1 (7.1%)	0 (00.0%)	2 (6.5%)	

* Chi-square test

than TRH personnel (6.75±3.97) and there is statistically significant difference (p<0.05). Based on the scoring results, it was detected that 76.9% of the ones who have no CBRN awareness (n=10) are working at TRH, 75% of the ones who have enough awareness (n=6) are working at SH (p<0.05). While 61.1% of the personnel working at TRH have lack of CBRN awareness, this ratio is 45.2% at SH. Generally, it was detected that 11.9% of all respondents have sufficient (in terms of knowledge) CBRN awareness (Table 3).

When compared the knowledge level of the 67 responders (based on the average scores) in terms of socio-demographical variables, it was detected that scores indicating the knowledge level increase significantly for statistical interpretation in parallel to the age (p<0.05), there is no difference in terms of gender and emergency service professionals and personnel with PhD have higher scores compared to ones with other professions and education level (p<0.05) (Table 4).

Table 3. Comparison of CBRN knowledge level scores according to qualification status in the health institutions where the study is conducted

		TRH	SH	Total	*p*
No awareness (0–4 points)	n	10	3	13	0.037*
	Line%	76.9%	23.1%	100.0%	
	Column%	27.8%	9.7%	19.4%	
Lack of awareness (5–8 points)	n	12	11	23	
	Line%	52.2%	47.8%	100.0%	
	Column%	33.3%	35.5%	34.3%	
Awareness should be developed (9–12 points)	n	12	11	23	
	Line%	52.2%	47.8%	100.0%	
	Column%	33.3%	35.5%	34.3%	
Awareness available and sufficient (13 points and over)	n	2	6	8	
	Line%	25.0%	75.0%	100.0%	
	Column%	5.6%	19.4%	11.9%	
Total	n	36	31	67	
	Line%	53.7%	46.3%	100.0%	
	Column%	100.0%	100.0%	100.0%	

*Chi-square test (linear-by-linear association)

Table 4. Comparison of the mean scores of CBRN knowledge of the responders who joined previously any training, course, CBRN case, etc. with the persons who have not

		CBRN Knowledge Level Points (Ort ± Ss)	p
Question 1 (Have you received CBRN training?)	Yes	11.07±1.84	<0.001*
	No	5.63±3.14	
	No idea	3.55±2.07	
Question 2 (I know what CBRN stands for)	Yes	8.97±3.57	<0.001*
	No	4.80±3.08	
	No idea	4.10±2.77	
Question 3 (Right/wrong answers for the definition of CBRN)	Right	9.00±3.70	<0.001**
	Wrong	5.46±3.26	
Question 4 (I have attended at least one medical CBRN practice so far.)	Yes	10.43±2.28	0.001*
	No	7.02±3.86	
	No idea	2.33±1.52	
Question 5 (I have witnessed a CBRN case)	Yes	10.07±3.42	0.006*
	No	7.50±3.63	
	No idea	4.37±4.03	
Question 6 (Do you know the places hot zone, warm zone and cold zone in a CBRN case?)	Yes	11.50±1.47	<0.001*
	No	5.58±2.77	
	No idea	4.16±2.85	

* Kruskal-Wallis test (post hoc Mann-Whitney U test)
** Mann-Whitney U test

DISCUSSION

It is of great importance for Turkey to be prepared against CBRN incidents and attacks as because it is among the most advanced twenty economies of the world, it locates at the intersection of important energy corridors and it is a neighbour country to Middle East where chemical weapons are highly used against civilians. Following the possible CBRN case, emergency service personnel will provide healthcare to the affected people arrived to hospitals with their own means or by the ambulance. In that context, it can be possible to create long-term medical awareness for emergency service personnel as a result of continuous training program including the theoretical and practical information for medical applications to the injured people by CBRN attack

Dynamic risk assessment, communication, planning, organization and equipment preparation, training and drills are the factors that have vital importance to obtain effective and quick CBRN respond. The requirement of such factors can be better understood as a result of this study.

In our study, we basically investigated medical CBRN awareness of emergency health professionals and it was found that mean awareness score (MAS) of the whole participants is 7.62±3.92. In

mean of MAS of TRH (6.75±3.97) and SH (8.64±3.65), statistically significant difference was observed between two centres/hospitals ($p<0.05$). It was indicated that only 11.9% out of all responders have full awareness and there was not a statistically significant difference in MAS when education levels of participants were compared ($p>0.05$).

The five questions in the first section of the questionnaire intended to obtain age, profession, educational background etc. information of the responders. The six questions in the second section of the questionnaire aim to detect the familiarity of responders with CBRN terminology and statistically meaningful results were obtained on CBRN awareness because yes/no distribution ratio of these six questions are similar. For example, the ratio of the ones whom are aware of the hot, warm and cold zone concepts and the ones who already received CBRN training is approximately 10%. Also, difference between the responses given to fourth (attendance to CBRN drill) and fifth (previous experience with CBRN case) questions as because CBRN cases are not categorized the cases that medical professionals experience frequently. The 10th, 14th and 15th questions in the second section aimed to measure awareness and knowledge level of the participants on "decontamination" which is an important component of the medical CBRN response. However, it was detected that half of the responders is not aware of the fact that main technique to treat the injured ones after CBRN attack is medical decontamination. It was also evaluated that responders are able to recognize the difference between chemical and biological warfare agents but they do not have sufficient knowledge on treatment of the ones which are subjected to these agents. For this reason, it was evaluated that repeating the CBRN training are of importance and organization of brief and to the point trainings and drills for enhancing the awareness on CBRN will be beneficial. It is also required to highlight that responders are relatively less informed about the radiation and nuclear-related issues compared to the awareness and knowledge level on chemical and biological weapons which seems also insufficient. Chaput et al. obtained a similar result from their study and they found that responders give correct answers on response to chemical and biological cases compared to radiation and nuclear cases (13).

Davidson et al. analysed the desk-based exercises, in which medical personnel working at health institutions and ambulances are included to practice nerve agent (sarin) scenarios, and they found that health institutions are major shortcomings in terms of organization and response due to the lack of CBRN awareness (14). It is a reality that CBRN awareness has not been sufficiently evaluated in the healthcare system. When a search is made in "PubMed" database by entering the keywords "CBRN Awareness" only ten papers are listed. The literature review study conducted by Kako et al. in eight health-based databases on CBRN training of health personnel, it was found that only 43 papers out of 619 relevant ones deal with the components of CBRN responses and interventions (15).

Another study conducted by Mortelmans et al. revealed that hospitals in the Netherlands have major shortcomings in terms of CBRN preparedness and despite the availability of large amounts of atropine in their inventories, specific preparations such as hydroxocobalamine, thiosulphate, Prussian blue and oxime are missing elements (16). Likewise, our study shows that there is lack of knowledge and training on CBRN cases based on the feedbacks of the respondents.

Timo et. al evaluated that a more positive feedback was received by the personnel working at university hospitals compared to ones working at city hospitals in terms of CBRN preparedness and awareness (17). Our study evaluated the CBRN awareness level of two groups of emergency service personnel as TRH and SH and when looked at the results, contrary to the findings of Timo et al, it was evaluated that healthcare personnel working at SH is more informed and higher CBRN awareness compared to TRH. It was concluded that healthcare professionals of SH kept their knowledge and skills updated and act as one of the members of organizational memory in their institutions as the main role of SH was just diagnosis and treatment. On the other hand, TRH personnel mainly focused on their professional training schedule. Besides, massive personnel circulation of TRH did not let the institution and personnel preparing themselves for CBRN incidents.

Medical response in the exposure of a chemical warfare agent is a multi-component and complex process that includes the detection, diagnosis, first aid and decontamination stages of illness and injury and all-round mitigation activities (18). The workload and mental traumas faced by healthcare professionals who encounter with the injured people in a CBRN case can be much higher than predictions. Therefore, CBRN interventions in hospitals require a preparatory integrity with personnel, equipment, distribution of duties and necessary legal regulations. Considering that the result of this survey study we conducted can be generalized, it is seen that there is a serious lack of training in terms of CBRN in both Training and Research Hospitals and State-run Hospitals under the current legal regulations. In this context, it is considered that it would be appropriate to give short-term training to the health personnel working in these health institutions in relation to training, research and development studies against CBRN threats and dangers, especially the reference CBRN hospitals in each province, primarily to increase the CBRN awareness.

Our study is one of the rare studies carried out in our country regarding the measurement of CBRN awareness level of health personnel working in hospital emergency services. In a similar study carried out by Chaput et al; a questionnaire of 11 questions was applied to 1010 first aid personnel known to have received CBRN training (13). In this context, limited number of participants is the major limitation of our study. For the next step of the current study, we consider that it will be beneficial to increase the number of participants by including more Training and Research Hospitals and State-run Hospitals, as well as to investigate awareness and preparedness for mass disasters and outbreaks.

CONCLUSION

Our study can be used as a tool to evaluate the training and awareness levels of hospital staff in order to respond to CBRN cases in a timely and quick manner and to obtain efficient results.

Emergency health professionals should be ready for CBRN incidents and awareness is the most objective indicator of medical CBRN preparedness of emergency departments. The whole world is now realizing the importance of medical CBRN preparedness after the COVID-19 outbreak.

Compliance with Ethical Standards: University of Health Sciences, Non-interventional Research Ethical Committee (No:2018/15, Date: 18.12.2018)

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