Does the informal education training increase awareness of anaphylaxis among students of medicine? Before-after survey study.

Julia Leszkowicz

Gdańsk Medical University

Agata Pieńkowska

Gdańsk Medical University

Wojciech Nazar (✉ wojciech.nazar@gumed.edu.pl)

Gdańsk Medical University

Eliza Bogdan

Gdańsk Medical University

Natalia Kwaka

Gdańsk Medical University

Agnieszka Szlagatys-Sidorkiewicz

Gdańsk Medical University

Katarzyna Plata-Nazar

Gdańsk Medical University

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Abstract

Background

Allergies are among the most common chronic diseases in Europe. The most serious complication of allergies is anaphylactic shock. Most of cases occur outside the hospital, thus knowledge of symptoms and first aid is crucial. The aim of this study was to evaluate the level of knowledge about anaphylaxis and ability to use adrenaline auto-injectors among medical students and to determine an improvement after a training based on non-formal education.

Methods

The research was conducted among 365 medicine students from the Medical University of Gdańsk. The respondents completed a multiple-choice knowledge test, before theoretical and practical training on adrenaline auto-injector use was given, then they re-took the test. Descriptive statistics were used to reveal characteristics of students of different grades. T-test was used for statistical analysis.

Results

There was an increase in knowledge test scores (on average, 28.6%, $p=0.0168$) after training. The average test score increase questions for the whole study group was 2.29, varying between 4.96 and 7.25, out of 8. Almost all (99.4%) of the respondents after training believed that they would be able to use adrenaline auto-injector in an emergency.

Conclusions

Tested students didn't have sufficient knowledge to provide first aid in cases of anaphylaxis before schooling. The training based on non-formal education was effective. Using the subject-performed task method helps remembering stages of action in stressful situations. This type of training would increase self-efficacy among various social groups.

Background

Over 120 thousand people in Poland suffer anaphylaxis and almost 100 of them die every year as a result [1]. Most cases of anaphylactic shock happen outside the hospital, that's why knowledge of symptoms and first aid is crucial. Adrenaline injected intramuscularly is the most effective treatment for this serious condition [2,3]. Unfortunately, the majority of people have never seen the procedure of drug administration. That's why those who witness anaphylactic shock don't know how to react or simply call emergency services. As fast response time is the key in this condition, many patients do not receive help in a timely manner. Pediatric Scientific Circle from Medical University in Gdańsk has developed a project, whose aim is to educate the general public about anaphylactic shock and to show how to use adrenaline auto-injectors [4].

The project was based on non-formal education with subject-performed tasks. Non-formal education relies on committed volunteers (in this case medical students), who firstly acquire knowledge about given topic, then conscientiously prepare training program and share knowledge with their peers later. The advantage of this method is its accessibility, as training can take place anywhere. Furthermore, prepared topics are based on the needs of the target group and not on the overall curriculum, which often does not take into account the interests of the

individual. Moreover, projects like that provide a mutual benefit for both the students and the educators, who in this case had to consolidate the knowledge about anaphylaxis and adrenaline.

The project was divided into three stages. First, the medical students' knowledge on anaphylactic shock, first aid and how to administrate adrenaline with automatic injectors was evaluated. The second stage consisted of the training – the students obtained information about the topic and practiced their manual skills using adrenaline auto-injectors. In the third stage, a re-test of the knowledge was administrated to assess the improvement. There was an assumption, that medical students were potentially one of the best prepared group of general public to act properly in similar emergencies. Despite that fact, most of them had never had an opportunity to perform adrenaline injection. Even among medical students the training turned out to be necessary.

Introduction to the topic

Allergies are not only among the most common chronic diseases in Europe, but also affect an increasing number of patients [4]. The most serious complication of an allergy is anaphylactic shock, which can be life-threatening. Anaphylaxis is a severe, dynamically progressing, systemic hypersensitivity reaction to a given allergen [5]. The most common stimuli that cause anaphylactic shock are hymenoptera venom, food and medicines. The incidents of anaphylaxis had increased in number significantly over the past 20 years [6-7].

Etiology and pathogenesis

Anaphylaxis occurs due to the release of inflammatory mediators and cytokines from mast cells and basophils. It may be caused by the IgE-dependent mechanism (e.g., food, drugs), IgE-independent mechanism (e.g. contrasting agents used in radiology, NSAIDs, biological agents) or by and non-immunological reactions that result from direct mast cell activation (e.g. physical effort, alcohol) [8]. Anaphylaxis typically presents many different symptoms over minutes or hours [3]. The most common areas affected include: skin (80–90%), respiratory (70%), gastrointestinal (30–45%), heart and vasculature (10–45%), and central nervous system (10–15%). There are usually two or more systems involved [3].

Diagnosis

Anaphylaxis is diagnosed with classification based on person's signs and symptoms [5,9]. Diagnostic criteria include:

- 1) Involvement of the skin or mucosal tissue plus either respiratory difficulty or a low blood pressure
- 2) Two or more of the following symptoms after contact with an allergen:
 - a. Involvement of the skin or mucosa
 - b. Respiratory difficulties
 - c. Low blood pressure
 - d. Gastrointestinal symptoms
- 3) Low blood pressure after exposure to a known allergen

- Infants and children - low systolic pressure (depending on age) or more than a 30% decrease in systolic pressure
- Adults - systolic blood pressure <90 mmHg or more than 30% of baseline

The patient's history and symptoms are crucial for the diagnosis of anaphylaxis. Additional tests are used to determine what type of an allergic reaction has occurred and to evaluate mast cell involvement [5,10].

Treatment

After the onset of symptoms, the most important thing is to terminate contact with the allergen, e.g. stopping the drug admission or removing the sting. First-line drug is adrenaline, which should be used at a dose of 0.5 mg in adults, and in children 0.01 mg / kg body weight (max 0.3-0.5 mg). It is administered intramuscularly, preferably in the lateral surface of the quadriceps femoris muscle [2,3]. Research shows that anaphylactic shock occurs mostly in public spaces and at home. In such situations, adrenaline autoinjectors should be used, as they offer a fast and easy way to administer the drug by a person without specific first aid training [11].

The aim of this study was to evaluate the level of knowledge about anaphylaxis and ability to use adrenaline auto-injectors among medical students and to determine an improvement after a training based on non-formal education.

Methods

The study consisted of three steps: asking respondents to fill in an anonymous questionnaire evaluating their initial knowledge regarding anaphylaxis, then giving them a brief informative training about it, and lastly asking them to fill in the same questionnaire (Supplementary Material).

The questionnaire was designed by the students of medicine, members of the Pediatric Student Scientific Circle and was based on a poster entitled "Anaphylaxis - an algorithm for emergency care" which was published on the official website of the *World Allergy Organization* [9]. The bioethical commission had given its approval to carry out the study among medical students of the Medical University of Gdańsk (no: NKBBN/148/2018). All methods were performed in accordance with the relevant guidelines and regulations of the Bioethics Committee of the Medical University of Gdańsk. The research was conducted through April-May 2019 and involved 365 students from years 1 to 5 of the courses of schooling. The questionnaire consisted of 12 questions divided into 3 sections. In the first part of the survey, the respondents were asked to specify the year of schooling, whether they had been diagnosed with allergies, and if they had experienced an anaphylactic shock in the past. This part in the test was designed to divide the respondents into smaller groups and see if those variables correlated with the respondents' knowledge of anaphylaxis. The next 3 questions evaluated general knowledge about anaphylactic shock, its symptoms and triggers. Further detailed questions concerned treatment of anaphylactic shock including drug doses and its routes of administration. At the end, respondents were asked about the correct first aid in case of the anaphylactic shock and how they assessed their ability to administer the treatment.

The second stage comprised training on theoretical knowledge of anaphylaxis and a practical part focused on learning how to properly use an adrenaline autoinjector. The training scheme was always the same. Due to use of the adrenaline autoinjector demonstrators, each participant could practice administration of the drug in case of shock, either on himself or the colleagues.

After the training, the respondents were re-tested, using a questionnaire with 13 questions. 12 out of the 13 were identical to the first questionnaire, and the last question measured the respondents' opinion about the usefulness of the training. Students used their own phones to complete the survey created using the Google platform (Google Forms) and the results were automatically saved. That eliminated the human error in data entry. Unfortunately, due to technical difficulties, the training could not be carried out at the same time of the day in each group, which could potentially affect the cognitive abilities and focus of the participants.

In this study, the principles of non-formal education were used [12]: voluntary participation, training occurring after regular classes, during free time; training method adapted to the needs of the trainees; learning by practice; partner relations with educators. The main advantages of this method are: firstly - learning by practicing and secondly - the educator could deepen the knowledge in one field of science by repeating the same information every time. The educators also drew upon the subject performed task method (SPT) [13] while creating the training program. The SPT method consists of educators giving short commands, which are repeated by students using a tangible item. According to research projects, students will memorize better, if information is provided non-verbally. Using an item (in this case AAI) during training makes it easier to remember subsequent stages of action even under stress, which is crucial in life-threatening situations.

Mean and cohort-specific percentages of correct answers for each survey question were calculated. In addition to that, mean, median, mode and its frequency, minimum and maximum test score for each group of students classified by year of study were analyzed. Moreover, answers of the respondents were analyzed in the following question-based groups: "I have allergy to something: yes/no" and "I have seen anaphylaxis before: yes/no". Where possible, a Wilcoxon signed-rank test was applied (data not tabulated). The threshold of statistical significance was set at $p \leq 0.05$.

Results

709 non-paired questionnaires were collected, with 364 pre-tests and 345 post-tests (Table 1). Women comprised 60% of the sample. For test questions (4-11), a mean 28.6% increase in the percentage of correct answers was observed. Before the training, questions (Q) that had the highest percentage of correct answers were the Q10 (94.0%), Q5 (82.7%) and Q6 (73.4%) (Table 2). After practical exercises: Q10 (97.7%), Q9 (96.5%) and Q7 (95.7%) were the best-answered questions. The greatest increase was noticed for the Q11 (73.1%), Q8 (60.3%) and Q9 (34.2%).

TABLE 1. Test scores by year of study, descriptive statistics

Pre-test									
Year of study	n	Mean	Median	Mode	Frequency of the mode	Minimum	Maksimum	Standard deviation	
1 st	93	4.06	4.00	4.00	28.00	1.00	8.00	1.52	
2 nd	108	4.71	5.00	4.00	28.00	1.00	7.00	1.37	
3 rd	58	5.50	6.00	6.00	26.00	2.00	7.00	0.98	
4 th	55	5.62	6.00	6.00	27.00	3.00	8.00	1.01	
5 th	50	5.84	6.00	6.00	20.00	3.00	8.00	1.00	
Whole cohort	364	4.96	5.00	6.00	107.00	1.00	8.00	1.42	
Post-test									
Year of study	n	Mean	Median	Mode	Frequency of the mode	Minimum	Maksimum	Standard deviation	
1 st	94	6.69	7.00	7.00	34.00	4.00	8.00	1.27	
2 nd	101	7.18	8.00	8.00	53.00	4.00	8.00	1.04	
3 rd	56	7.64	8.00	8.00	38.00	6.00	8.00	0.55	
4 th	48	7.79	8.00	8.00	42.00	5.00	8.00	0.62	
5 th	46	7.52	8.00	8.00	36.00	4.00	8.00	1.05	
Whole cohort	345	7.25	8.00	8.00	198.00	4.00	8.00	1.08	
Pre-post test difference									
Year of study	n	Mean	Median	Mode	Frequency of the mode	Minimum	Maksimum	Standard deviation	
1 st	1	2.63	3.00	3.00	6.00	3.00	0.00	-0.25	
2 nd	-7	2.47	3.00	4.00	25.00	3.00	1.00	-0.33	
3 rd	-2	2.14	2.00	2.00	12.00	4.00	1.00	-0.42	
4 th	-7	2.17	2.00	2.00	15.00	2.00	0.00	-0.39	
5 th	-4	1.68	2.00	2.00	16.00	1.00	0.00	0.05	
Whole cohort	-19	2.29	3.00	2.00	91.00	3.00	0.00	-0.35	

TABLE 2. Pre-test and post-test percentages of correct answers to test-questions.

Correct answers to the test-questions [%]	Question										
	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Mean Q4-Q11
Pre-test	77.75	82.69	73.35	67.86	26.37	62.36	93.96	12.09	66.21	-	62.05
Post-test	87.83	95.07	80.58	95.65	86.67	96.52	97.68	85.22	100.00	98.55	90.65
Pre-post test difference	10.08	12.38	7.23	27.80	60.29	34.16	3.73	73.13	33.79	-	28.60

The mean increase in the test score for the whole sample was equal to 2.29 ($p \leq 0.05$), from pre-test 4.96 to post-test 7.25, out of 8 (Table 1). The greatest improvement in the test score was achieved by the students of the 1st (2.6, $p \leq 0.05$) and 2nd (2.5, $p \leq 0.05$) years, followed by the 4th (2.2, $p \leq 0.05$), 3rd (2.1, $p \leq 0.05$) and 5th (1.7, $p \leq 0.05$) year students. Also, after the training, no one scored less than 4. In addition to that, the test scores' medians as well as modes and their frequencies increased in all year-of-study-dependent cohorts.

Only minor differences between the test scores of students diagnosed with allergy versus the non-allergic ones were observed. When comparing students who had seen anaphylaxis with those who had not, the pre-training test scores obtained by students who had seen anaphylaxis were lower at 4.53 from the scores of students who had not seen anaphylaxis at 5.01. After the training this relation has changed. The training scores were 7.30 and 6.76, respectively (Table 3).

TABLE 3. Mean test scores by allergy-related variables.

Criterion	Pre-test	Post-test	Mean test score Pre-test	Mean test score post-test	Pre-post test difference
	n	n			
Allergic	118	111	5.00	7.28	2.28
Non-allergic	246	234	4.89	7.19	2.30
Have seen an anaphylaxis	32	29	5.01	6.76	1.75
Have not seen an anaphylaxis	332	316	4.53	7.30	2.77

What is more, the percentage of positive answers to Q12 increased from 66.2% to 100.0% after training, while 98.6% of the respondents answered "yes" to Q13, asked only after the training (Table 2).

Discussion

Most incidents of anaphylactic shock occur outside the hospital (mostly by coming into contact with food or venom) [7]. The problem with managing anaphylaxis at schools in Poland is lack of legislation and not respecting the European law [22]. There are no school or national programs to educate on management of anaphylaxis. It implies insufficient knowledge on this subject and lack of abilities to help in case of emergency. This project was

carried out to bring attention to this problem and start discussion on the lack of education regarding early treatment of anaphylaxis. There is evidence that delayed use of adrenaline can lead to increased cases of hospitalization and potentially is a factor contributing to fatalities [14].

Collected data reveals that the training provided during the project was effective. After the presentation students knew significantly more about anaphylactic shock (Table 1, Table 2) and each trainee obtained the minimum of 50% score after the training. These results correspond with other studies, in which respondents also obtained very good results after receiving training in the management of food allergy and anaphylaxis [15-18].

Before the training, questions with the highest rate of good answers concerned the general knowledge about anaphylactic shock. After the training, the questions with the highest proportion of correct answers were the ones concerning the treatment (medication and routes of administration) (Table 1), as reported elsewhere (Table 1, Table 2) [16].

When looking at specific question results, the biggest improvement was seen for Q8, Q9 and Q11, which referred to practical aspects of administering adrenaline by AAI. Moreover, nearly 100% rate of good answers to the question: "Do you think the training was useful?" indicates that the program is efficient and it emphasizes the need for training. Similar results were observed in other studies [15,16]. All respondents correctly answered at least 50% of the test questions after the training. Also, 100% of respondents stated they would be able to use AAI, similarly to participants of other studies [15].

33% of the study population reported being diagnosed with allergies. Based on other studies, 40% of the members of the general Polish population state that they suffer from allergies [19]. The level of knowledge about anaphylactic shock among allergy sufferers was not significantly higher than among non-allergy sufferers before the training, despite the fact that allergy sufferers are more susceptible to anaphylactic shock than non-allergy sufferers (Table 3). There were also no statistically significant differences in total scores of good answers between these two groups after the training. However, people who had seen anaphylactic shock achieved significantly higher scores than people who had not seen anaphylactic shock. It indicates that witnesses of anaphylactic shock know that this is a dangerous situation and have a desire to acquire knowledge on how to provide help [17].

The results demonstrate that first and second year students achieved the greatest improvements in the test score after training. The initial years do not provide many practical classes, more of theoretical and general knowledge concerning anatomy and physiology. Those results indicate that short training might significantly improve knowledge of people who are not during medical training or are not healthcare providers. The students of the third, fourth and fifth year had achieved better general results, but smaller improvements to first and second year after the training. It is also implied by the learning program in Poland, which concerns the subject of anaphylaxis during those years [20-21], which might be the factor of knowledge retention comparing initial and subsequent years.

When interpreting the results of this study, some limitations have to be discussed. Every training session differed slightly from others, because it was performed by a group which consisted of various educators. A single group of educators, that were trained, or created a video together, would deliver more consistent training and thus also a more reliable and valid research results.

Another problem which could not be eliminated during trainings was delivering the training at different times of day. Some groups of students were trained in the morning before classes, another around 12 p.m. or after classes around 5 p.m. That is why there could be differences in the level of concentration and fatigue affecting learning

both theoretical knowledge and practical skills. Delivering all training at the same time of day would have eliminated this issue. However, establishing one time suitable for all participants as well as educators was an impractical task, due to varying schedules, and would have led to a significantly smaller number of participants. Not all questionnaire results were analyzed, because not every survey was filled.

Compared with other studies about management of anaphylaxis, this project varied in a few aspects. Every other study the authors are familiar with, involved teachers or school workers, not medical students [15-17]. The training sessions were delivered by physicians or psychologists and were longer, whereas in this case self-educated students delivered less time-consuming training. Despite those differences, a similar increase of knowledge was observed. This suggests that training based on non-formal education is as effective as training conducted by professionals.

Another positive aspect of our study is using the subject-performed task method, which helps remembering subsequent stages of action in stressful situations.

Conclusions

The knowledge about anaphylaxis among medical students is insufficient, despite the fact that this group should be prepared to deal with this kind of emergency. However, the training based on non-formal education was effective. Using the SPT method made it possible to deliver training in any place and at any time, while, more importantly, the opportunity to practice the use of auto-injectors provided a unique way to learn.

The survey shows that 33% of study population was at risk of anaphylactic shock, as they were allergy sufferers. Frequency of this chronic disease is undeniable and it is extremely important for society to understand the symptoms and know how to administer adrenaline quickly and effectively. Our study has demonstrated that acquiring skills needed to use adrenaline auto-injectors is quick and relatively easy. This means that lay members of the society without medical training could acquire these vital life-saving skills fairly easily.

Collected data proves that performed training can significantly improve knowledge and practical skills. This model of education might be successfully implemented in schools or other public facilities to help people overcome the fear in stressful situations like anaphylactic shock.

Polish program of education at schools includes procedures and protocols in case of bites but does not specifically concern anaphylaxis and administration of adrenaline [22]. However, schools or first-aid classes at universities focus on CPR in case of a cardiac arrest, which could be an effect of an anaphylactic shock. The results of the project indicate that it would be valuable to introduce similar training programs in schools, to educate young people and teachers on anaphylaxis and its treatment. If adrenaline in easy-to-use form of auto-injectors was introduced to every school and university or public facility (as a part of first-aid kit), training about anaphylactic shock would be obligatory. This would also contribute to propagation and increase of the awareness of those issues among the general public and improve the safety of those at risk of anaphylactic shock. If the knowledge of CPR is common, and training in delivering CPR widespread, why shouldn't anaphylaxis education program be?

Abbreviations

Immunoglobulin E (IgE)

Nonsteroidal anti-inflammatory drugs (NSAIDS)

Subject performed task method (SPT)

adrenaline auto-injectors (AAI)

Cardiopulmonary resuscitation (CPR)

Declarations

Ethics approval and consent to participate

All participants had to read a written consent form for purposes of this study before fulfilment of the survey. Fulfilment of the survey by the participant was an equivalent to his or her consent to take part in this study. Also, a word informed consents were obtained. The Bioethics Committee of the Medical University of Gdańsk had given its approval to carry out this study. Bioethics Committee of the Medical University of Gdańsk approval number: NK BBN/148/2018.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

JL wrote the discussion section and helped in survey development. AP created the survey, wrote abstract and introduction section and applied for approval of the Bioethics Committee of the Medical University of Gdańsk. WN analysed the data statistically and wrote results. EB wrote the discussion section and helped in survey development. NK wrote the methods section and helped in survey development. KPN developed the study concept and substantively reviewed the manuscript. AS substantively reviewed the manuscript. All authors read and approved the final manuscript.

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