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Comparison of the effectiveness of training methods for medical practitioners in Ukraine regarding anaphylaxis

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Abstract. The incidence of anaphylaxis is increasing worldwide. Therefore, it is crucial for medical practitioners to be aware of anaphylaxis symptoms and respond effectively. The purpose of this study was to assess the level of Ukrainian doctors' knowledge regarding anaphylaxis, ability to recognise variable presentations of anaphylaxis, and knowledge of adrenaline administration depending on their form of training. A cross-sectional study was conducted between May 2023 and June 2023, involving physicians from different specialities, medical paramedics, medical students, and interns in Ukraine. A standardised anonymous questionnaire based on the European Academy of Allergy and Clinical Immunology guidelines for anaphylaxis (2021 update) was used to evaluate knowledge of clinical criteria for diagnosing and managing anaphylaxis. The study compared two groups: one with completed European Resuscitation Council courses in simulation centres (Group 1) and the other without such practical reinforcement (Group 2). Respondents primarily acquired knowledge about anaphylaxis during university studies and from Ukrainian guidelines, with only a minority referring to international guidelines. Approximately half of the participants completed European Resuscitation Council courses in simulation centres, suggesting the potential positive impact of practical reinforcement of theoretical knowledge. Group 1 demonstrated a higher percentage of recognising anaphylaxis in scenarios that combined symptoms of the respiratory and gastrointestinal systems without involving mucosal tissue and skin manifestations after exposure to a potential allergen, and they also provided more accurate responses regarding the route of adrenaline administration. Nonetheless, there was also a tendency for overdiagnosis by respondents in Group 1. The study revealed differences in the diagnosis and management of anaphylaxis among medical practitioners, with an advantage for those who completed European Resuscitation Council courses. Continuous education and simulation-based training are crucial for reducing anaphylaxis mortality and improving treatment outcomes

Keywords: anaphylaxis; knowledge; physicians; adrenaline; training

Introduction

In recent years, the global incidence of all-cause anaphylaxis has been on the rise, primarily driven by reactions to medications and food [1]. Current data indicate a worldwide incidence of anaphylaxis ranging from 50 to 112 episodes per 100,000 person-years, with an estimated lifetime prevalence between 0.3% and 5.1%. These figures vary depending on the definitions used, study methodologies, and geographical locations [2]. The lack of accurate anaphylaxis diagnoses and suboptimal management practices contribute to significant public health challenges [3].

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Despite the rising occurrence of anaphylaxis, numerous instances have gone unnoticed or unreported. The study by M. Cuevas *et al.* [4] established a significant correlation between the administration of adrenaline and the improvement in outcomes in the ground-based emergency cohort. M.S. Shaker *et al.* [5] mentioned that anaphylaxis, presenting various clinical manifestations, takes place in doctor practice of any speciality. It is crucial to recognise this condition and know how to act due to a patient's life depends on the correctness and immediacy of the actions of doctors. Practical experiences not only solidified their understanding of medical concepts but also enhanced their ability to apply that knowledge in real-life scenarios, leading to more accurate diagnoses and treatment plans [6].

Earlier research uncovered the challenges faced by healthcare professionals in precisely recognising anaphylaxis and providing appropriate treatment. The study by S. Cimen Sipahi & S.B. Sayili [7] noted that just 66.7% of participant of cross-sectional survey indicate the correct dose of epinephrine. The administered questionnaire was conducted in Al-Qassim, Saudi Arabia by H.N. Alsaleem *et al.* [8]. According to it, the average knowledge score of primary healthcare physicians was 4.74 out of a total of 10 points. Almost half (48.8%) had poor knowledge levels, 43% had moderate knowledge levels, and only 8.3% had good knowledge levels. According to the data of M. Cuevas *et al.* [4] study, guideline-compliant first-line therapy with adrenaline was not administered in the majority of cases analysed in this study. The significant impact of adrenaline on outcomes highlighted in this study underscores the need to enhance the emergency treatment of anaphylactic reactions. Epinephrine stands as the primary drug in addressing anaphylaxis, and various earlier studies indicate a deficiency in understanding its prescribed dosage and administration route. Ambiguity persists in choosing the initial treatment line. The purpose of this study was to assess the level of Ukrainian doctors' knowledge regarding anaphylaxis, ability to recognise variable presentations of anaphylaxis, and knowledge of adrenaline administration depending on their form of training.

Materials and Methods

This cross-sectional study was conducted between May 2023 and June 2023 in the simulation centre TESIMED of the I. Horbachevsky Ternopil National Medical University, Ukraine. A total of 175 medical practitioners from different part of Ukraine took part in the survey. To further explore the impact of simulation-based training, the knowledge of diagnosis and treatment of anaphylaxis was evaluated and compared between two groups. Group 1 consisted of 89 medical practitioners who completed ERC courses in simulation centres, while Group 2 comprised 86 respondents who did not practice in such centres.

An anonymous questionnaire based on the European Academy of Allergy and Clinical Immunology (EAACI) guidelines [9] for anaphylaxis (2021 update) was employed to evaluate their knowledge of clinical criteria for diagnosing and treating anaphylaxis. The questionnaire consisted of 18 multiple-choice questions designed to assess respondents' ability to identify the true manifestations of anaphylaxis, including possible combinations of affected systems and their relationship with allergen exposure. Participants were required to recognise key clinical features such as the rapid onset of symptoms (ranging from minutes to several hours), involvement of the skin, mucosal tissues, or both, and signs of respiratory distress or reduced blood pressure (BP) along with associated symptoms of end-organ dysfunction. They also needed to identify reduced BP following exposure to a known allergen and recognise respiratory compromise or persistent gastrointestinal symptoms after exposure to a likely allergen for that individual. In addition, they must know about the route and the knowledge regarding the timing of the second dose of adrenaline administration. It was decided to compare the knowledge of medical practitioners from 12 cities in Ukraine who completed European Resuscitation Council (ERC) courses such as Advanced Life Support (ALS), European Paediatric Advanced Life Support (EPALS), with those who had not had such experience. Permission for the processing and publication of the collected information was obtained from every respondent via Google Form. The information from individuals was collected without revealing their identity. A graphic guide on the criteria for the diagnosis of anaphylaxis, based on the EAACI guidelines [9] developed by the author of this manuscript in the Ukrainian language, was distributed to those who responded to the given anonymous questionnaire automatically after submission of Google form. According to excerpt from Protocol No. 75 (01.11.2023) of the meeting of the Bioethics Commission of I. Horbachevsky Ternopil National Medical University of the Ministry of Health of Ukraine, the study meets the requirements of norms and principles of bioethics. The study also adheres to the principles of the Declaration of Helsinki, ensuring ethical conduct and the protection of participants' rights and well-being throughout the research process [10]. Descriptive statistics (group-wise percentages) was performed using MSExcel 2000 software suite to compare the level of knowledge between the different groups. Chi-square test was used to assess the differences and statistical significance was defined as a p value <0.05.

Results

Regarding the sources of their knowledge, a majority of the respondents pointed to their university education (101 respondents, 57.7%) and Ukrainian guidelines (87 respondents, 49.7%) as the main contributors to their understanding of anaphylaxis diagnosis and treatment. However, only a minority of respondents (36 or 20.5%) relied on international guidelines, possibly suggesting the need for greater dissemination and incorporation of international best practices into Ukrainian medical education. Of note, 89 respondents (50.8%) had completed ERC courses in simulation centre.

In general, respondents demonstrated a relatively high level of correct diagnosis for anaphylaxis scenarios involving mucosal tissue in combination with hypotension (119

of all respondents – 68%) or respiratory failure (132 of all respondents – 75.4%). The comparison between the two groups revealed only minor differences in their responses to these scenarios (Fig. 1).

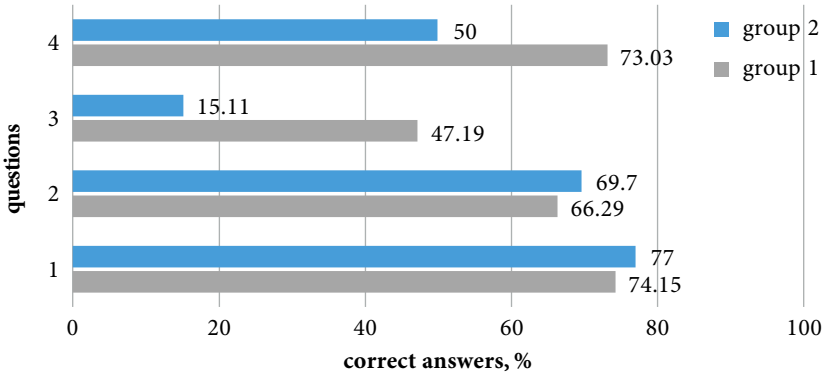

Figure 1. Correct answers about clinical criteria for diagnosing anaphylaxis, %
Notes: 1. acute onset of an illness with involvement of the skin/ mucosal tissue and respiratory compromise; 2. acute onset of an illness with involvement of the skin/ mucosal tissue and reduced BP; 3. respiratory compromise + persistent gastrointestinal symptoms after exposure to a likely allergen for that patient; 4. reduced BP after exposure to known allergen for that patient
Source: compiled by the authors

Group 1 (ERC course completion) exhibited a higher rate of correct diagnosis in case of reduced blood pressure after exposure to a known allergen for that patient (65 respondents, 73.0%) ($p < 0.05$) compared to Group 2 (43 respondents, 50.0%). However, both groups showed a similar rate of incorrect diagnoses, with 118 of all respondents (67.4%) mistaking angioedema for anaphylaxis (59 persons, 66.0% in Group 1 vs. 59 persons, 68.6% in Group 2).

There was a substantial difference in recognising anaphylaxis with respiratory compromise and persistent gastrointestinal symptoms without involvement of skin-mucosal tissue after exposure to a likely allergen for that patient. Group 1 respondents demonstrated a higher rate of correct recognition (42 persons, 47.19%) ($p < 0.05$), whereas only 13 (15.11%) ($p < 0.05$) of Group 2 respondents answered correctly.

Nonetheless, there was also a tendency for overdiagnosis by respondents in Group 1, as 45 (50.56%) of them recognised anaphylaxis in scenarios involving skin and gastrointestinal tract symptoms without information about exposure to a likely allergen for that patient (Fig. 2).

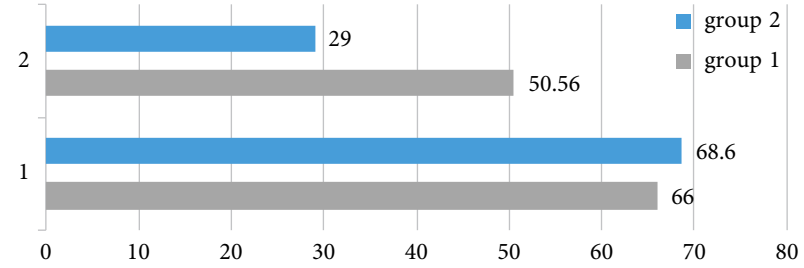

Figure 2. Wrong answers about clinical criteria for diagnosing anaphylaxis, %
Notes: 1. angioedema; 2. vomiting and generalised hived without exposure to a likely allergen for that patient
Source: compiled by the authors

Regarding the treatment of anaphylaxis, the majority of medical practitioners (133.76%) preferred the intramuscular (IM) route for adrenaline administration. Group 1 respondents demonstrated better knowledge of the correct route, with 79 (88.76%) ($p < 0.05$) selecting IM, compared to 53 (61.63%) in Group 2. 129 (73.7%) of the medical practitioners indicated the right site of IM (among respondents of Group 1 – 77 (86.51%) ($p < 0.05$), among respondents of Group 2 – 52 (60.40%). Nevertheless, some misconceptions were observed, as 16 (9.1%) of all respondents mistakenly believed that adrenaline should be administered subcutaneously (SC) (among respondents of Group 1 – 3 (3.37%), among respondents of Group 2 – 13 (15.11%)), and 26 (14.9%) wrongly selected the intravenous route (IV) (among respondents of Group 1 – 7 (7.86%), among respondents of Group 2 – 20 (23.25%)) (Table 1).

Table 1. Adrenaline administration route

Variants of answers	Group 1		Group 2	
IM	79	88.76%	53	61.63%
IV	7	7.86%	20	23.25%
SC	3	3.37%	13	15.11%

Notes: IM – intramuscular; IV – intravenous; SC – subcutaneous
Source: compiled by the authors

The minimal timing of possible repeating adrenaline administration is 5 minutes after the first dose if there was no improvement or worsening of symptoms [11]. The majority of respondents (119, 68%) accurately indicated this timing. Notably, Group 1 respondents displayed better understanding, with 74 (83.15%) ($p < 0.05$) providing the correct response, compared to 45 (52.32%) in Group 2. Some respondents (25, 14.3%) erroneously noted that the second dose should be administered just after 20 minutes: among respondents of Group 1 – 7 (7.86%), among respondents of Group 2 – 19 (22.09%). 15 (8.57%) of all medical practitioners mistakenly believed that it was not possible to repeat the dose at all: among respondents of Group 1 – 1 (1.12%), among respondents of Group 2 – 14 (16.28%) (Table 2).

Table 2. Knowledge about the second dose adrenaline administration

Variants of answers	Group 1		Group 2	
It is possible to repeat adrenaline administration 5 min. after the first dose.	74	83.00%	45	52.33%
It is possible to repeat adrenaline administration just after 20 min.	7	7.86%	19	22.09%
It is not possible to repeat the dose at all.	1	1.12%	14	16.28%
The second dose must be administrated just IV.	7	7.86%	8	9.30%

Source: compiled by the authors

Thus, high proportions of medical practitioners from both groups diagnose anaphylaxis in the two scenarios involving mucosal tissue demonstrating anaphylaxis with respiratory failure and anaphylactic shock. But there is a huge difference in recognising anaphylaxis with persistent gastrointestinal symptoms without involvement of the skin-mucosal tissue after exposure to a likely allergen for that patient. The respondents of Group 1 showed much better results than of Group 2. However, there was overdiagnosis by respondents of Group 1. Medical practitioners who completed ERC courses (Group 1) performance was better than those who did not practice in simulation centres (Group 2) on questions regarding dose, route, and site of adrenaline administration.

Discussion

In the study by S.N. González-Díaz *et al.* [12], 1023 respondents were scored through a questionnaire focused on the management of anaphylaxis. Results indicated that healthcare providers with over 30 years of experience, and medical students, achieved higher percentages of correct answers (50% and 39.4%, respectively). The ability to recognise, diagnose, and treat anaphylaxis, and subsequently refer patients to specialists in Allergy and Clinical Immunology, is critical for healthcare providers. The study revealed significant differences in approval rates among various speciality groups. Notably, in a post-hoc analysis, specialists in allergy and immunology had significantly higher approval rates compared to general medicine practitioners (62.9% vs. 25%; $p < 0.001$). This underscores the importance of specialised knowledge and training in the effective management of anaphylaxis.

E.J. Jares *et al.* [13] published the results of a cross-sectional study to evaluate the knowledge of doctors who have worked in allergy units from 12 Latin America countries and Spain about features of anaphylaxis by an online questionnaire designed by professional allergists. The researchers noted that epinephrine was prescribed in fewer than half of the incidents. They underscored the critical necessity to enhance the spread and application of international anaphylaxis guidelines. In the cross-sectional study conducted by D. Almarri *et al.* [14], 173 physicians completed a survey assessing their ability to identify clinical scenarios of anaphylaxis. The results showed that only 5.2% of the physicians correctly identified all three proposed clinical scenarios of anaphylaxis. Additionally, 16.8% of the respondents accurately identified two scenarios, while 51.4% managed to correctly identify only one scenario. Regarding first-line management, 42.8% recognised it correctly. However, only 24.3% knew the correct epinephrine dosage, and 24.9% identified the proper administration route. Z.A. El-Sayed *et al.* [15] indicated that Egyptian doctors' understanding and approach to anaphylaxis remain insufficient. It was shown in this survey that only 91 participants (37.6%) out of 242 respondents correctly identified all four proposed clinical scenarios of anaphylaxis. 75 respondents (31%) correctly identified the appropriate dose of epinephrine, while 119 (49.2%) correctly identified the proper administration route. Authors made a conclusion of obtained data underscored the importance of promoting

and implementing international guidelines for diagnosing and treating anaphylaxis in Egypt.

In accordance with the findings of a study by M. Serbes *et al*. [16], a notable number of participants seemed unfamiliar with the diagnostic criteria for anaphylaxis. Nearly half of the participants incorrectly diagnosed one or more scenarios. Respondents had not used recent recommendations from the EAACI regarding anaphylaxis management, especially concerning the use of epinephrine. The researcher uncovered significant gaps in the knowledge and readiness of family physicians regarding anaphylaxis. They highlighted the necessity for more effective guidance and national training programmes. These programmes should be regularly provided as part of continuous medical education to ensure physicians maintain up-to-date and comprehensive knowledge levels. In the study, it was demonstrated that the knowledge of medical practitioners does not depend on different specialities but rather depends on completed ERC courses.

Administering adrenaline stands as the central pillar of anaphylaxis management. I. Alen Coutinho *et al.* [17] noted that the staff of tertiary Hospital Emergency Department responded that the treatment for anaphylaxis preferred intramuscular route in 57.1%. Y.A. Alghasham *et al.* [18] have indicated primary healthcare providers participated in the cross-sectional study in Qassim region of Saudi Arabia demonstrated poor knowledge regarding the diagnosis and management of anaphylaxis patients: only 38.4.7% of them answered that the correct route of administration is intramuscular. While the study has shown a higher percentage 76.0% of right answers by Ukrainian healthcare staff of correct answers. There is a critical need for physicians to receive education aimed at enhancing their proficiency in promptly diagnosing and treating cases of anaphylaxis.

J.A. Pimentel-Hayashi *et al.* [19] reported that in Mexico city of 196 specialist physicians: pediatrics, internal medicine, cardiology, anesthesiology, general surgery, orthopedics, and gynecology, The study found that 96.44% of participants demonstrated correct diagnosis of an anaphylaxis case with cardiovascular, cutaneous, and respiratory symptoms. Additionally, 52% of all respondents accurately diagnosed anaphylaxis even in the absence of cutaneous symptoms. Regarding the administration route, 63.4% correctly indicated that the first dose of epinephrine should be given intramuscularly, while 50% of the participants accurately selected the appropriate dose of epinephrine. Surprisingly, only 2.6% of the participants managed to answer all 10 questions correctly. While in this study, respondents demonstrated a relatively a bit lower level of correct diagnosis (68%) for anaphylaxis scenarios involving mucosal tissue combined with hypotension. Similarly, 75.4% of all respondents correctly diagnosed anaphylaxis scenarios associated with respiratory failure. The comparison between the two groups (studies) revealed only minor differences in their responses to these particular scenarios. Overall, both studies emphasise the importance of accurate anaphylaxis diagnosis and the role of medical practitioners in understanding and effectively managing anaphylactic cases.

The study showed that Ukrainian health providers have some difficulties in the recognising anaphylaxis with persistent gastrointestinal symptoms without the involvement of skin-mucosal tissue. Similar results were obtained by J.A. Pimentel-Hayashi *et al.* [19]. Research findings of Ibrahim Irwani *et al*. indicated a tendency among doctors to overdiagnose cases of single organ involvement without hypotension as anaphylaxis. Only 42.6% out of 47 doctors of the Emergency Department were able to diagnose anaphylactic hypersensitivity in such scenarios [8]. In this study 66.0% and 68.6% respondents (in Group 1 and Group 2 respectively) overdiagnosed cases of single organ for anaphylaxis.

Studies like that of S.H. Sicherer *et al.* [20] have shown that many healthcare professionals, including doctors, lack confidence in the correct administration of adrenaline, leading to potential errors in delay in administration. It was found that 14.3% of Ukrainian respondents made a mistake answering about the timing of medicine administration.

In a longitudinal study by T. George *et al.* [21] the majority of students and staff agreed that case-based learning was a superior method of learning compared to didactic teaching. They found that case-based learning facilitated deeper understanding and promoted critical thinking more effectively than didactic teaching. Emphasising practical experiences in medical education fosters a mindset of continuous learning and adaptability to emerging medical trends. Questionnaire results from studies [7, 22] demonstrated that participants who had received anaphylaxis training and had experience managing anaphylactic cases possessed greater knowledge about the correct dosing of epinephrine.

The knowledge of Ukrainian healthcare providers regarding anaphylaxis management was found to be inadequate based on a questionnaire. Therefore, improved education and training of healthcare providers in simulation centres are essential for better anaphylaxis management. This highlights the significance of practical reinforcement of theoretical knowledge.

Conclusions

The purpose of this study was to analyse the level of knowledge of Ukrainian doctors regarding variable manifestations and first-line treatment of anaphylaxis depending on the form of training. The study reveals mixed levels of knowledge among medical practitioners regarding anaphylaxis diagnosis and treatment. While a majority of respondents relied on their university education and Ukrainian guidelines for their knowledge, there was a notable lack of familiarity with international guidelines, suggesting potential gaps in global best practices integration and mostly the half of them had have the simulation training. While respondents generally demonstrate good understanding in diagnosing anaphylactic shock with involving mucosal tissue or skin and respiratory compromise. Medical

practitioners who underwent training in simulation centres (Group 1) showed better expertise in identifying and managing anaphylaxis compared to those who did not receive such training (Group 2). Specifically, there was a notable disparity in their ability to recognise anaphylaxis with respiratory compromise and persistent gastrointestinal symptoms in the absence of skin-mucosal involvement following exposure to a likely allergen for the patient. Group 1 participants exhibited a significantly higher accuracy rate in recognising these symptoms (47.19%, 42 individuals, $p < 0.05$), whereas only 15.11% (13 individuals, $p < 0.05$) of Group 2 participants correctly identified them.

The findings highlight the significance of simulation-based training in enhancing awareness and management of anaphylaxis among Ukrainian medical practitioners. This approach aims to improve healthcare professionals' knowledge and ultimately reduce mortality from anaphylaxis. Future research should evaluate the effectiveness of simulation-based training programmes in medical education institutions across Ukraine and their potential impact on lowering anaphylaxis-related deaths.

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Conflict of Interest

The authors declare no conflict of interest.

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Порівняння ефективності методів навчання медичних працівників в Україні щодо анафілаксії

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Анотація. Кількість випадків анафілаксії зростає у всьому світі. Тому важливо, щоб медичні працівники були обізнаними щодо симптомів анафілаксії та вміли реагувати ефективно. Метою цього дослідження була оцінка рівня знань українських медичних працівників щодо анафілаксії, їхньої здатності розпізнавати різноманітні прояви анафілаксії та знань про введення адреналіну в залежності від їх форми навчання. Було проведено перехресне дослідження протягом травня 2023-червня 2023 року з участю лікарів різних спеціальностей, парамедиків, студентів медичних університетів та інтернів в Україні. Для оцінки знань клінічних критеріїв діагностики та управління анафілаксією використовувався анонімний опитувальник на основі рекомендацій European Academy of Allergy and Clinical Immunology щодо анафілаксії (оновлення 2021 року). Порівнювали дві групи: група, яка завершила курси Європейської ради реанімації у центрах симуляційного навчання (Група 1) та інша без такого досвіду (Група 2). Респонденти в основному здобували знання про анафілаксію під час університетської освіти та з українських рекомендацій, з обмеженим використанням міжнародних гайдлайнів. Приблизно половина учасників завершила курси Європейської ради реанімації, що вказує на потенційну користь практичного підсилення теоретичних знань. Група 1 (ті що завершили симуляційне навчання) демонструвала вищий відсоток розпізнавання анафілаксії у сценаріях, що комбінували симптоми зі сторони дихальної системи та шлунковокишкової ситеми без проявів зі сторони шкіри та слизових після впливу потенційного алернену та більш коректно відповідали щодо шляху введення адерналіну. Тим не менш, також спостерігалася тенденція до гіпердіагностики респондентами групи 1. Дослідження показало відмінності у діагностиці та керуванні анафілаксією серед медичних працівників, з перевагою у тих, хто завершив курси Європейської ради реанімації. Постійна освіта та тренування на основі симуляцій є важливими для зменшення смертності від анафілаксії та покращення результатів лікування

Ключові слова: анафілактична реакція; знання; лікарі; адреналін; збір даних