

Management of anaphylaxis in a Swiss university hospital emergency department: a retrospective observational study assessing adherence to epinephrine administration

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Summary

INTRODUCTION: Anaphylaxis is a severe and potentially life-threatening allergic reaction, most frequently triggered by food, medication and insect venom. Its diagnosis is challenging due to the absence of pathognomonic signs and instead relies on the sudden onset of multisystem symptoms. Although international guidelines recommend intramuscular (i.m.) epinephrine as the first-line treatment, several studies suggest that it remains underused, with antihistamines and corticosteroids still frequently administered. This highlights a persistent gap between guideline recommendations and real-world clinical practice.

OBJECTIVE: To assess use of i.m. epinephrine in patients with anaphylaxis and to identify factors associated with its administration.

METHODS: We conducted a single-site, retrospective observational study of all consecutive patients presenting to the emergency department (ED) of a Swiss university hospital who were triaged under the "allergy" category between 1 January 2022 and 31 December 2023. Among these patients (n = 915), 277 met the World Allergy Organization (WAO) criteria for anaphylaxis, 553 were identified as non-anaphylactic immediate allergic reactions and 85 were excluded due to missing data or missed triage. For the 915 patients, data on the medical history, vital signs, clinical examination, management and the discharge summary were extracted from the hospital information system for analysis. Cases were classified as anaphylactic or non-anaphylactic immediate allergic reactions, based on the WAO systemic allergic reaction grading system. Treatments received in the ED were then analysed. The primary outcome was the proportion of patients with anaphylaxis who received i.m. epinephrine as first-line treatment. The secondary outcome was the identification of clinical and demographic factors associated with its administration.

RESULTS: Among patients meeting the WAO criteria for anaphylaxis, only 30.1% received i.m. epinephrine. Antihistamines and/or corticosteroids, despite being regarded as second-line treatments, were administered without epinephrine in 39.4% of cases. The administration of epinephrine was positively associated with older age, respiratory or cardiovascular symptoms, elevated heart rate and reduced systolic blood pressure. In contrast, it was less likely in females and in those presenting anaphylaxis with mucocutaneous symptoms. Gastrointestinal symptoms were not significantly associated with the likelihood of receiving i.m. epinephrine.

CONCLUSION: Despite clear guideline recommendations, the use of i.m. epinephrine in anaphylaxis remains suboptimal, with frequent reliance on second-line therapies. Female sex was independently associated with underuse, highlighting a potential sex bias. In contrast, haemodynamic instability and respiratory or ear-nose-throat involvement increased the likelihood of appropriate treatment.

Introduction

Allergy is an exaggerated immune response to an otherwise inert and harmless substance, known as an allergen [1]. The most frequent allergens include drugs, food and insect venom [2, 3]. In some cases, this hypersensitivity reaction can become systemic, leading to anaphylaxis [2].

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The World Allergy Organization (WAO) defines anaphylaxis as a severe and potentially life-threatening allergic reaction [4]. Typical symptoms include onset of skin, respiratory or gastrointestinal manifestations, along with reduced blood pressure or bronchospasm [2, 5, 6]. In Switzerland, anaphylaxis affects 10 people per 100,000 inhabitants [7] and causes an estimated 1 to 3 deaths per million [8]. Although some anaphylactic reactions may sometimes resolve spontaneously without appropriate treatment, their severity and unpredictability make prompt diagnosis and i.m. epinephrine administration essential in all cases [9].

The diagnosis of anaphylaxis is primarily based on clinical presentation, along with consideration of a known or highly probable allergen and the patient's awareness of it [10]. Recognition relies on characteristic symptoms affecting the skin, mucous membranes, and the cardiovascular, respiratory or gastrointestinal systems. The absence of a definitive test and the wide variability in clinical manifestations make prompt and accurate diagnosis particularly challenging [2, 6, 10].

The cornerstone of treatment is i.m. administration of epinephrine and stabilisation of vital signs, alongside discontinuation of exposure to the suspected allergen [2, 9].

Current international guidelines recommend prompt administration of i.m. epinephrine as first-line treatment for anaphylaxis, with repeated doses every 5 minutes if necessary [2, 6, 9, 10]. Adjunctive therapies such as oxygen, intravenous fluids, inhaled β_2 -agonists and nebulised epinephrine for airway oedema may be used, but should never delay i.m. epinephrine [2, 6, 9, 10]. Antihistamines and corticosteroids are not considered first-line treatments due to limited efficacy for acute symptoms [2, 6, 9, 10]. Patients should be observed for at least two hours post-treatment [5]. Longer observation is advised for severe presentations due to the risk of biphasic reactions, which can occur without re-exposure [6, 9]. Patients should receive education, an epinephrine auto-injector prescription and a referral to an allergist [2, 6, 10]. Current international guideline recommendations for the emergency management of anaphylaxis are described in table S1 in the appendix.

In Switzerland, a recent study by Ehrhard et al. conducted in a university emergency department (ED) demonstrated substantial gaps between guideline recommendations and clinical practice, with frequent underuse of i.m. epinephrine in anaphylaxis [11].

Despite international guidelines clearly recommending prompt i.m. epinephrine as first-line treatment for anaphylaxis, studies – including the Swiss study by Ehrhard et al. [11] – suggest that it remains underused in clinical practice. Understanding the local determinants of this treatment gap is therefore essential. Based on these guidelines, this study aimed to evaluate the clinical management of patients presenting with anaphylaxis in our ED, with a specific focus on factors associated with i.m. epinephrine use, including sex, age, clinical presentation and treatment patterns.

We hypothesised that the management of anaphylaxis in our ED did not consistently follow international guidelines, particularly regarding the use of i.m. epinephrine, which may be underused. The primary objective of this study was to assess adherence to these treatment guidelines. A secondary objective was to identify the factors associated with the administration of i.m. epinephrine.

Materials and methods

Study design, setting and population

This study was a retrospective, cohort study conducted between 1 January 2022 and 31 December 2023 in the ED of the Centre Hospitalier Universitaire Vaudois (CHUV), a Swiss university-affiliated tertiary care hospital. CHUV has 1500 beds and receives over 42,500 ED adult admissions annually. The study synopsis prepared for the Master's thesis served as the study protocol. No protocol deviations occurred during the conduct of the study.

Inclusion criteria considered patients aged 16 years or older who presented with a clinically suspected immediate allergic reaction at the time of ED triage. Triage was systematically performed by specifically trained ED nursing staff using the Swiss Emergency Triage Scale (SETS), a 4-level scale [12]. Eligible patients were identified based on the presence of an allergy label recorded during triage according to the SETS. Medical records related to their ED visit were subsequently anonymised, extracted from the hospital electronic health record system, and compiled

into a dedicated study database for analysis. These data were first analysed to identify cases meeting the WAO criteria for anaphylaxis, after which the management of confirmed anaphylactic cases was specifically examined.

Exclusion criteria were: (1) patients under 16 years of age, (2) records with critical missing data, and (3) cases that, after review, did not correspond to an immediate allergic reaction.

Definitions of anaphylaxis and classification of reactions were based on the WAO systemic allergic reaction grading system [2]. Two investigators (ES, final-year medical student, and CB, clinical fellow) independently reviewed all medical records to determine whether the clinical criteria for anaphylaxis were met. In case of disagreement, consensus was reached through discussion.

Patients were classified as either anaphylactic or non-anaphylactic immediate-type allergic reactions, based on clinical data including vital signs, medical history, physical examination, ED management and discharge summary. This classification was done regardless of pre-hospital treatment or self-administered medication. Cases with symptoms that had spontaneously resolved or regressed before triage, thus not meeting WAO criteria at presentation, were classified as non-anaphylactic immediate allergic reactions. Only patients who met the clinical criteria for anaphylaxis after a full analysis of the medical file were classified as having anaphylaxis, even if they were initially labelled as allergic reactions at ED triage.

The treatment received in the ED was analysed, with a specific focus on the administration of i.m. epinephrine.

Data collection

The following variables were extracted from patient medical records: age, sex, date and time of ED admission, allergy history (including known or suspected allergens and previous anaphylactic episodes), other relevant medical history, medications and mode of arrival to the ED. Information about any pre-hospital or self-administered treatment, including epinephrine, antihistamines, corticosteroids, β_2 -agonists, intravenous fluids and oxygen, was also collected (table S2 in the appendix).

Regarding ED management, details on medication use were recorded, including epinephrine dose and route (i.m., subcutaneous, intravenous, inhaled). Additional treatments and supportive care measures such as airway management, oxygen administration, intravenous fluid resuscitation (volume) and initiation of continuous monitoring were also documented.

Outcomes

The primary outcome was descriptive, focusing on the proportion of anaphylaxis cases receiving i.m. epinephrine during the ED visit.

The secondary outcome was analytical, aiming to identify factors associated with i.m. epinephrine administration among patients meeting WAO criteria for anaphylaxis. Covariates considered included patient age, sex, cardiovascular and respiratory comorbidities, clinical features (gastrointestinal, oral, respiratory, mucocutaneous, cardiovascular and neurological symptoms), vital signs (systolic blood pressure, heart rate) and co-administered treatments.

A directed acyclic graph (DAG) was drawn to graphically represent hypothesised relationships between variables and potential confounders (figure 1).

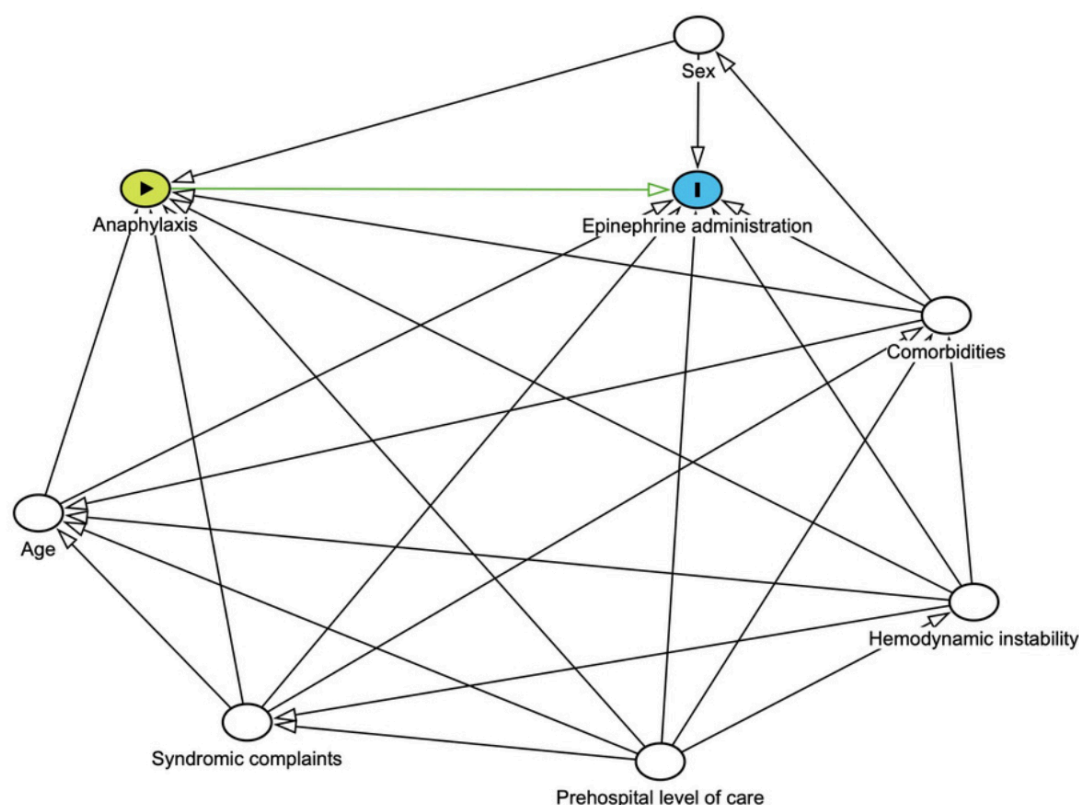


Figure 1: Directed acyclic graph representing hypothesised relationships between variables and potential confounders.

Data analysis

Quantitative variables are reported as mean (standard deviation) when approximately normally distributed. Categorical variables are reported as absolute counts and percentages.

The administration of i.m. epinephrine was analysed in terms of sensitivity, specificity, positive predictive value and negative predictive value to address the primary outcome.

To explore the factors associated with the administration of epinephrine, we performed a backward stepwise logistic regression model. We selected variables in a parsimonious way based on clinical reasoning, from demographic characteristics (age and sex), comorbidities, main system affected by symptoms (neurological, gastrointestinal, respiratory, ear-nose-throat [ENT]), vital sign and haemodynamic instability, and prehospital level of care. We assessed linear relationship for continuous variables by plotting the risk of epinephrine administration against the continuous variable. We included restricted cubic splines for all continuous variables that showed a non-linear relationship. We include all variables and plausible interactions in the model and removed, one at a time, variables for which there was no evidence of association based on the Wald test ($p > 0.05$). We considered plausible interactions for comorbidities and age, sex and systolic blood pressure. Results are presented as odds ratios (OR) with 95% confidence intervals (CI). A two-sided p -value < 0.05 was considered statistically significant. Collinearity was assessed by estimating the variance inflation factor (VIF). A collinearity was suspected if the VIF was higher than 5.

Data were analysed using Stata™ version 19.0 (StataCorp LLC, College Station, TX, USA).

Missing data

Cases with incomplete essential data, such as symptoms, clinical signs or treatment information, were excluded if the missingness prevented reliable classification of outcome analysis. We performed multiple imputation with chained equation to fill in the missing value of systolic blood pres-

sure and heart rate. Systolic blood pressure was missing for 16% of observations and heart rate for 6% of observations. We generated 20 imputed datasets and imputed 177 missing values before fitting the logistic regression model.

Ethical approval

The study was deemed exempt from formal ethical approval by the Institutional Ethics Committee of Lausanne University Hospital (Req-2023-01475), as it was considered a quality-control study.

Results

During the study period, 85,137 cases were recorded in the ED. Of these, 915 patients (1.1%) were triaged for a suspected immediate allergic reaction; 40 cases were excluded due to a non-allergic diagnosis and 45 were excluded due to missing data, leaving a final cohort of 830 patients. Among them, 277 (33.4%) were diagnosed with anaphylaxis following chart review (figure 2).

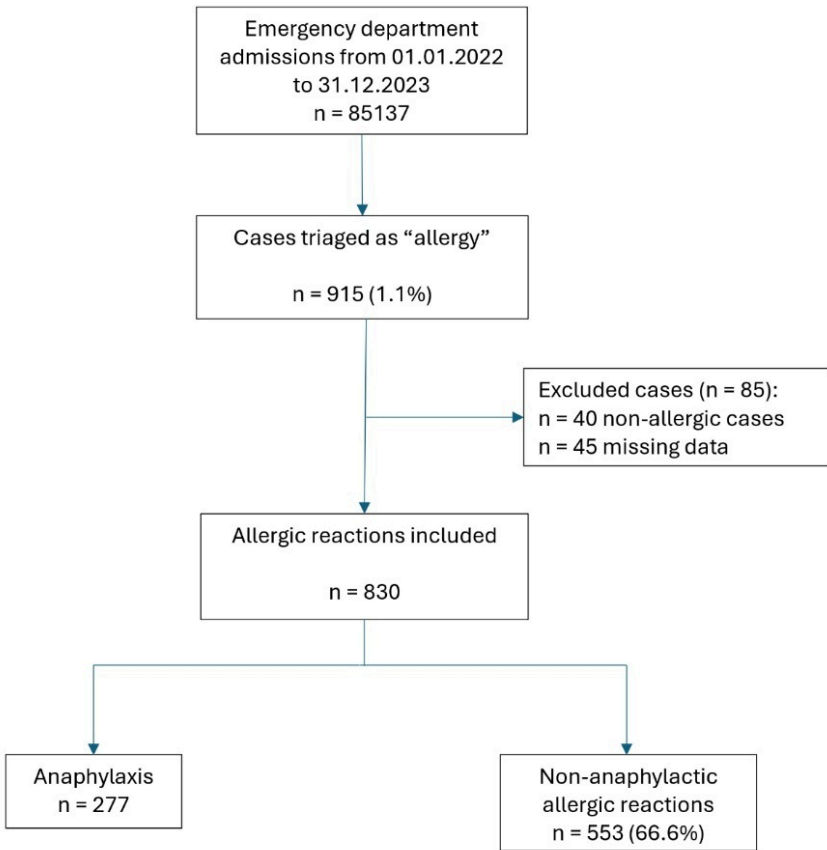


Figure 2: Flowchart.

Table 1 summarises the characteristics of the 830 patients. The suspected allergen in anaphylactic patients was food in 133 cases (48.0%), medications in 57 (20.6%) and insect venom in 30 (10.8%). In 49 cases (17.7%), no specific allergen could be identified. Most patients with anaphylaxis (n = 155, 56.0%) reported a history of prior allergic reactions, among whom 42 (27.1%) (15.2% of the total anaphylactic cohort) had a documented previous episode of anaphylaxis.

Table 1: Patient characteristics.

		Anaphylaxis (n = 277)		Non-anaphylaxis (n = 553)	
Female sex, n (%)		164	(59.2%)	343	(62.0%)
Age, n (%)	16–64	252	(90.1%)	505	(91.3%)
	≥65	25	(9.9%)	48	(8.7%)
	Age, mean (standard deviation)	41	(8.8)	39	(9.2)
Cause of allergic reaction, n (%)	Food	133	(48.0%)	142	(25.7%)
	Medications	57	(20.6%)	122	(22.1%)
	Hymenoptera venom	30	(10.8%)	80	(14.7%)
	Other	8	(2.9%)	46	(8.3%)
	Unknown	49	(17.7%)	163	(29.2%)
Allergy grade (according to WAO), n (%)	1			435	(78.7%)
	2			118	(21.3%)
	3	245	(88.4%)		
	4	5	(1.9%)		
	5	27	(9.7%)		
History of allergic reaction, n (%)		155	(56.0%)	250	(45.2%)
History of anaphylaxis, n (%)		42	(15.2%)	48	(8.7%)
Clinical presentation*, n (%)	Mucocutaneous symptoms	228	(82.3%)	429	(77.6%)
	ENT symptoms	155	(56.0%)	80	(14.5%)
	Gastrointestinal symptoms	134	(48.4%)	72	(13.0%)
	Respiratory symptoms	116	(41.9%)	7	(1.3%)
	Cardiovascular symptoms	82	(29.6%)	90	(16.3%)
	Neurological symptoms	45	(16.2%)	44	(8.0%)
Specific medications, n (%)	Antihistamine	212	(76.5%)	336	(60.8%)
	Corticosteroid	198	(71.5%)	246	(44.5%)
Mode of arrival at CHUV, n (%)	Self-referred	183	(66.1%)	359	(64.9%)
	Ambulance	70	(25.3%)	126	(22.8%)
	Ambulance with an emergency physician	5	(1.8%)	15	(2.7%)
	Ambulatory patients from other medical service within CHUV	10	(3.6%)	21	(3.8%)
	Unknown	9	(3.2%)	32	(5.8%)

CHUV: Centre Hospitalier Universitaire Vaudois (Vaud University Hospital); ENT: ear-nose-throat; WAO: World Allergy Organization.

Among all 830 allergic reactions, severity was graded according to the WAO. Grades 1 and 2 accounted for 435 (52.4%) and 118 (14.2%) cases, respectively, and were considered non-anaphylactic immediate allergic reactions. Grades 3, 4 and 5 represented 245 (29.5%), 5 (0.6%) and 27 (3.3%) cases, respectively, and were classified as anaphylactic reactions.

Regarding the clinical presentations of the 277 patients with anaphylaxis, 222 (82.3%) exhibited mucocutaneous symptoms, 165 (56.0%) had ENT symptoms, 134 (48.4%) presented gastrointestinal symptoms, 116 (41.9%) had respiratory symptoms, 82 (29.6%) had cardiovascular symptoms and 45 (16.2%) exhibited neurological symptoms. All symptoms falling into these categories are listed in table S2 in the appendix.

Patients with anaphylaxis arrived by their own means in 183 (66.1%) cases and by emergency medical services in 75 (27.1%).

In terms of management (table 2), 85 patients (30.7%) diagnosed with anaphylaxis following chart review received i.m. epinephrine. Among patients with non-anaphylactic immediate allergic reactions, 541 (97.8%) cases were managed without i.m. epinephrine, although 12 (2.2%) cases did receive i.m. epinephrine injection.

Table 2: Intramuscular (i.m.) epinephrine treatment in the emergency department.

	Anaphylaxis (n = 277)	Non-anaphylaxis (n = 553)	Total
i.m. epinephrine	85	12	97
No i.m. epinephrine	192	541	733
Total	277	553	830

The performance of appropriate anaphylaxis treatment was assessed using sensitivity and specificity, which are independent of prevalence. The sensitivity was 30.7%, indicating that only 30.7% of patients with anaphylaxis received i.m. epinephrine. The specificity was 97.9%, indicating that 97.9% of patients without anaphylaxis did not receive i.m. epinephrine. Given that predictive values are directly influenced by disease prevalence, positive and negative predictive values were not emphasised in the interpretation of these results.

In this cohort of anaphylactic patients, 2.9% (n = 8) were treated exclusively with i.m. epinephrine, while 22.4% (n = 62) received i.m. epinephrine plus antihistamines and/or corticosteroids. The largest group (39.4%, n = 109) consisted of patients managed with antihistamines and/or corticosteroids, without epinephrine.

In the multivariable analysis of anaphylactic patients (figure 3), several factors were associated with the administration of i.m. epinephrine. Female sex was significantly associated with a 29% decrease in the odds of receiving i.m. epinephrine. Comorbidities showed no significant association with i.m. epinephrine administration. In contrast, increasing age was statistically associated with higher odds of receiving i.m. epinephrine.

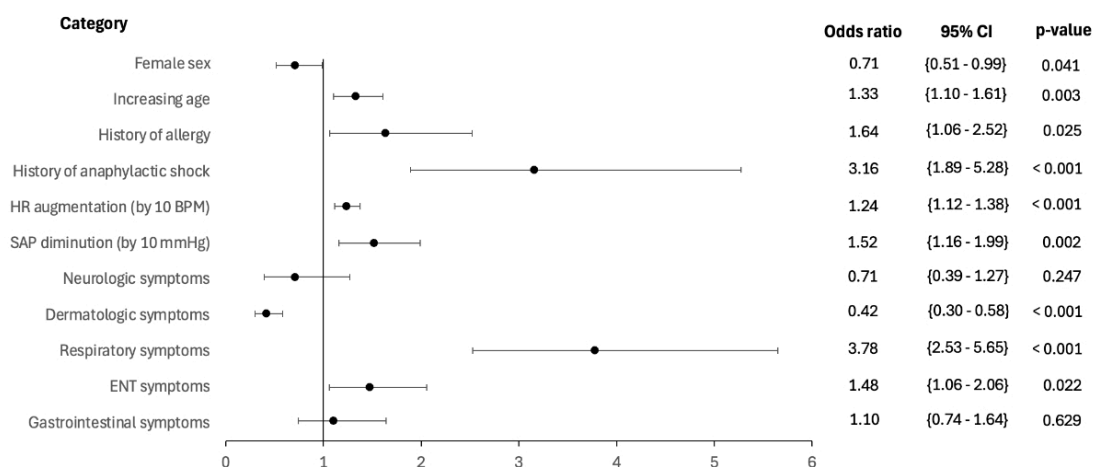


Figure 3: Multivariable logistic regression regarding intramuscular (i.m.) epinephrine administration in anaphylactic patients. Abbreviations: ENT: ear-nose-throat; HR: heart rate; SAP: systolic arterial pressure.

Regarding clinical symptoms, the presence of ENT or respiratory manifestations, as well as signs of shock (decreased systolic blood pressure and elevated heart rate), were linked to higher odds of i.m. epinephrine administration. Conversely, the presence of mucocutaneous symptoms was significantly associated with lower odds of receiving i.m. epinephrine. Gastrointestinal symptoms were not significantly associated with i.m. epinephrine administration.

Discussion

Appropriate treatment of anaphylaxis with i.m. epinephrine was provided in only 30.1% of cases. This finding aligns with previous studies reporting similar underuse of i.m. epinephrine in ED management of anaphylaxis, with rates ranging from 25% to 70% [11, 13]. This study demonstrated that anaphylaxis management did not reliably adhere to international guidelines recommending i.m. epinephrine as first-line therapy.

Despite the evolution of clinical guidelines and the fact that antihistamines and corticosteroids are no longer considered first-line treatments, their use remains more common than that of i.m. epinephrine. In our cohort, corticosteroids and antihistamines were administered without i.m. epinephrine in 39.4% of cases, showing a continued tendency towards the overuse of antihistamines and corticosteroids [14–16]. This variability in treatment suggests persistent gaps in the recognition or acute management of anaphylaxis, despite current recommendations emphasising i.m. epinephrine as first-line therapy [17]. This practice is concerning: reliance on antihistamines has been cited by healthcare providers as a common reason for not administering i.m. epinephrine, highlighting the knowledge gap about therapies used in anaphylaxis treatment.

In this study, a higher proportion of women (59.2%) presented with anaphylactic reactions. However, after multivariable adjustment, they were less likely to receive i.m. epinephrine. This highlights the need to pay particular attention to allergic reactions in female patients. The presence of a sex bias in our cohort is similar to patterns observed in other emergency clinical situations such as myocardial infarction or stroke [18, 19]. To our knowledge, such a potential bias was not previously identified in anaphylaxis. One possible explanation for this could involve unconscious biases among healthcare professionals, leading to a more severe assessment of events experienced by male patients. Alternatively, male patients may present with more pronounced clinical manifestations, thereby justifying the more frequent use of epinephrine. Finally, in situations where patients are conscious, it is important to consider the possibility that female patients may be more likely to refuse or express greater concern about receiving this treatment, and may request alternative options when feasible.

Epinephrine administration was positively correlated with increasing age, which may reflect the tendency for anaphylactic reaction to be more severe for older patients [20–22].

In this cohort, the presence of respiratory, ENT and cardiovascular symptoms (hypotension, tachycardia) was associated with a higher likelihood of receiving appropriate i.m. epinephrine treatment. One hypothesis is that these symptoms, particularly those involving the larynx and pulmonary manifestations, like wheezing, dyspnoea, dysphonia or laryngeal oedema, are more widely recognised by clinicians as indicative of anaphylaxis. They may be perceived as more severe or urgent, thereby prompting timely administration of i.m. epinephrine.

In contrast, gastrointestinal symptoms, despite being included in the WAO diagnostic criteria for anaphylaxis, were not significantly associated with i.m. epinephrine administration. These symptoms are less well-known among healthcare providers as features of anaphylaxis and may have broader differential diagnoses. This aspect of anaphylactic presentation should be emphasised in education and training for healthcare providers.

It is also noteworthy that mucocutaneous symptoms were associated with a decreased likelihood of i.m. epinephrine administration. This may be because isolated mucocutaneous symptoms are highly characteristic of non-anaphylactic immediate allergic reactions, appropriately leading clinicians to withhold epinephrine in these cases and could be confusing for healthcare providers when associated with symptoms suggestive of anaphylaxis.

Our findings suggest that anaphylactic reactions continue to be predominantly managed without the use of i.m. epinephrine. Two hypotheses may explain this observation.

First, the diagnosis of anaphylaxis is primarily clinical, and distinguishing it from less severe allergic reactions can be subtle [15, 23]. This diagnostic ambiguity may hinder accurate recognition and timely treatment. It also explains why 12 cases classified as non-anaphylactic immediate allergic reactions nonetheless received i.m. epinephrine. Furthermore, no rapid diagnostic test exists to definitively confirm anaphylaxis at the bedside. The underuse of i.m. epinephrine, combined with frequent administration of antihistamines and corticosteroids, despite their second-line status, suggests that some cases of anaphylaxis may have been misclassified or knowledge gaps about current clinical guidelines persist.

Second, clinicians may hesitate to administer i.m. epinephrine due to concerns or apprehension about its use [15, 24-26]. However, there are no absolute contraindications to the administration of i.m. epinephrine in the treatment of anaphylaxis, even in patients with pre-existing cardiovascular conditions or haemophilia [27, 28]. While cautious monitoring is appropriate in such populations, the risks of withholding i.m. epinephrine far exceed its potential side effects. Clinicians should be aware of its common but generally transient and mild and reversible side effects – such as tachycardia, palpitations, sweating, tremor and anxiety – and ensure patients receive appropriate clinical monitoring after administration.

To improve the management of anaphylaxis, it is essential to raise awareness among health-care providers about diagnostic criteria, particularly that anaphylaxis is defined by a constellation of symptoms, including gastrointestinal manifestations, occurring in the context of allergen exposure and appropriate timing. Clinicians should also be reminded that there are no absolute contraindications to i.m. epinephrine use and that its potential side effects are generally mild and manageable. Most importantly, education should emphasise that i.m. epinephrine is the first-line treatment for anaphylaxis, to be given promptly and supported by adequate oxygenation and fluid resuscitation if needed. Antihistamines and corticosteroids should be considered only as second-line therapies, not as substitutes for i.m. epinephrine.

Limitations

This study has several limitations. First, its retrospective design limits the scope of interpretation. For example, we could not investigate the specific reason why i.m. epinephrine was not administered despite apparent clinical indication.

Another limitation is that we analysed only anaphylaxis cases that were labelled as “allergy” at triage. Consequently, some anaphylactic patients may have been triaged under different categories, leading to potential underrepresentation of atypical presentations.

Additionally, as some symptoms are subjective and open to interpretation, it is difficult to retrospectively standardise the clinical criteria. Furthermore, the retrospective design and use of routinely collected data limited our ability to assess physician-related and system-level factors that may influence adherence to anaphylaxis management guidelines. Finally, the WAO does not provide a fixed list of symptoms defining anaphylaxis but rather describes a probability-based diagnostic framework. The classification of immediate allergic reaction severity was based on the WAO severity scale and relied solely on clinical symptoms. This approach may have introduced classification bias, particularly for grade 4 severity, as the study design did not allow for monitoring the progression of symptoms. Classification bias could have affected the accuracy of severity grading and the percentage of i.m. epinephrine administration in anaphylactic patients. To minimise interpretation bias, all cases were independently reviewed by two different authors.

Conclusions

This study provides insight into the management of anaphylaxis in a Swiss university hospital emergency department. It reveals that i.m. epinephrine, the recommended first-line treatment, remains underused. Factors such as sex, age, low systolic blood pressure, elevated heart rate and the presence of respiratory, ENT or dermatological symptoms influenced the likelihood of receiving appropriate treatment. These findings highlight specific weaknesses in current management practices that could be targeted to improve adherence to clinical guidelines.

Data sharing statement

The dataset contains pseudonymised data that cannot be fully anonymised; therefore, it cannot be shared.

Author contributions

Study concept and design: ES, FD, CB. Data acquisition: ES, CB. Data analysis: ES, CB. Analysis and interpretation of results: ES, FXA, FD, CB. Drafting of the manuscript: ES, FD, CB. Critical revision of the manuscript: FD, DC. Statistical expertise: FXA.

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Potential competing interests

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflict of interest related to the content of this manuscript was disclosed.

References

- Dougherty JM, Alsayouri K, Sadowski A. Allergy. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2025. Available from: <http://www.ncbi.nlm.nih.gov/books/NBK545237/>
- Cardona V, Ansotegui IJ, Ebisawa M, El-Gamal Y, Rivas MF, Fineman S. World Allergy Organization Anaphylaxis Guidance 2020. *World Allergy Organ J*. 2020 Oct 1;13(10). Available from: [https://www.worldallergyorganizationjournal.org/article/S1939-4551\(20\)30375-6/fulltext](https://www.worldallergyorganizationjournal.org/article/S1939-4551(20)30375-6/fulltext)
- Yu JE, Lin RY. The Epidemiology of Anaphylaxis. *Clin Rev Allergy Immunol*. 2018 Jun 1;54(3):366–74.
- Brief Overview of Anaphylaxis As an Adverse Event Following Immunization (AEFI) and Practical Guidance on Its Identification, Case Management and Response in a Primary Care Setting. Geneva: World Health Organization; 2021. p. 1 p..
- Whyte AF, Soar J, Dodd A, Hughes A, Sargent N, Turner PJ. Emergency treatment of anaphylaxis: concise clinical guidance. *Clin Med*. 2022 Jul;22(4):332–9.
- Emergency Treatment of Anaphylaxis May 2021_0.pdf [Internet]. Available from: https://www.resus.org.uk/sites/default/files/2021-05/Emergency%20Treatment%20of%20Anaphylaxis%20May%202021_0.pdf
- aha! Centre d'Allergie Suisse. Allergy, asthma and skin diseases – prevalence [Internet]. aha! Centre d'Allergie Suisse; 2023. Available from: <https://www.pollenundallergie.ch/userfiles/files/praevaenz/aha-chiffres-prevalance.pdf>
- aha! Centre d'Allergie Suisse. aha! Swiss Allergy Centre – Anaphylaxis (allergic shock) [Internet]. aha! Centre d'Allergie Suisse. Available from: <https://www.aha.ch/centre-allergie-suisse/allergies-intolerances/anaphylaxie-choc-allergique>
- Dodd A, Hughes A, Sargent N, Whyte A, Soar J, Turner P. Evidence update for the treatment of anaphylaxis. *Resuscitation*. 2021 Apr 22;163.
- Muraro A, Worm M, Alviani C, Cardona V, DunnGalvin A, Garvey LH. EAACI guidelines: Anaphylaxis (2021 update). *Allergy*. 2022 Feb;77(2):357–77.
- Ehrhard S, Gautschi D, Eyb V, Schaubert SK, Ricklin ME, Klukowska-Rötzler J. Use of epinephrine in anaphylaxis: a 6-year retrospective cohort study at a Swiss university emergency department [Internet]. 2022. Available from: <https://www.researchsquare.com/article/rs-1862866/v1>
- Rutschmann OT, Hugli OW, Marti C, Groscurin O, Geissbühler A, Kossovsky M. Reliability of the revised Swiss Emergency Triage Scale: a computer simulation study. *Eur J Emerg Med*. 2018 Aug;25(4):264–9.
- Wang C, Li Z, Yu Y, Feng M, Liu A. Active surveillance and clinical analysis of anaphylaxis based on the China Hospital Pharmacovigilance System. *Front Pharmacol*. 2023 Jul 11;14:1180685.
- Dami F, Enggist R, Comte D, Pasquier M. Underuse of Epinephrine for the Treatment of Anaphylaxis in the Prehospital Setting. *Emerg Med Int*. 2022 Apr 15;2022:5752970.
- Prince BT, Mikhail I, Stukus DR. Underuse of epinephrine for the treatment of anaphylaxis: missed opportunities. *J Asthma Allergy*. 2018 Jun 20;11:143–51.
- Ruiz Oropeza A, Lassen A, Halken S, Bindeslev-Jensen C, Mortz CG. Anaphylaxis in an emergency care setting: a one year prospective study in children and adults. *Scand J Trauma Resusc Emerg Med*. 2017 Nov 22;25(1):111.
- Shaker MS, Wallace DV, Golden DBK, Oppenheimer J, Bernstein JA, Campbell RL. Anaphylaxis – a 2020 practice parameter update, systematic review, and Grading of Recommendations, Assessment, Development and Evaluation (GRADE) analysis. *J Allergy Clin Immunol*. 2020 Apr;145(4):1082–123.
- Chen EH, Shofer FS, Dean AJ, Hollander JE, Baxt WG, Robey JL. Gender disparity in analgesic treatment of emergency department patients with acute abdominal pain. *Acad Emerg Med Off J Soc Acad Emerg Med*. 2008 May;15(5):414–8.
- Zou Y, Zhu W, Zeng J, Lin J, Dai S. Sex-differences in the management and clinical outcome among patients with acute coronary syndrome. *BMC Cardiovasc Disord*. 2021 Dec 20;21:609.
- Ventura MT, Boni E, Taborda-Barata L, Blain H, Bousquet J. Anaphylaxis in elderly people. *Curr Opin Allergy Clin Immunol*. 2022 Dec;22(6):435–40.
- Francuzik W, Kraft M, Scherer Hofmeier K, Rüff F, Pföhler C, Treudler R. Anaphylaxis in middle-aged patients. *Allergol Sel*. 2021 Mar 23;5:133–9.
- Brown SGA. Clinical features and severity grading of anaphylaxis. *J Allergy Clin Immunol*. 2004 Aug 1;114(2):371–6.
- McLendon K, Sternard BT. Anaphylaxis. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2025. Available from: <http://www.ncbi.nlm.nih.gov/books/NBK482124/>
- Cardona V, Ferré-Ybarz L, Guilarte M, Moreno-Pérez N, Gómez-Galán C, Alcoceba-Borrás E. Safety of Adrenaline Use in Anaphylaxis: A Multicentre Register. *Int Arch Allergy Immunol*. 2017 Aug 29;173(3):171–7.
- Sheikh A, Shehata YA, Brown SGA, Simons FER. Adrenaline for the treatment of anaphylaxis: cochrane systematic review. *Allergy*. 2009;64(2):204–12.
- Droste J, Narayan N. Anaphylaxis: lack of hospital doctors' knowledge of adrenaline (epinephrine) administration in adults could endanger patients' safety. *Eur Ann Allergy Clin Immunol*. 2012 Jun;44(3):122–7.
- Bernstein DI, Blaiss M, Dellon ES, Rance K. Benefits of Epinephrine for Anaphylaxis Outweigh Potential Harm – A Safety Review. *J Allergy Clin Immunol Pract*. 2025 Apr;S2213219825003757.
- Davidov M, Loebstein R, Yonath H, Gueta I. Bleeding complications following intramuscular injections among hospitalized anticoagulated patients: a retrospective observational comparative study. *Thromb J*. 2024 Oct 28;22(1):92.

Appendix A

Table S1: Current international guideline recommendations for the emergency management of anaphylaxis.

Intervention/management	Recommendation	Notes / comments	References
IM epinephrine	Initial dose: 0.5 mg, administered as early as possible; may repeat every 5 min if necessary	Key first-line treatment; must not be delayed by other therapies	[2], [6], [9], [10]
Refractory anaphylaxis	No improvement after two IM doses → escalate to advanced interventions, e.g., IV epinephrine	Classify as refractory; requires rapid escalation	[6]
Antihistamines	Not first-line; may relieve cutaneous symptoms	Limited efficacy for respiratory, cardiovascular, or airway symptoms	[2], [6], [9], [10]
Corticosteroids	Not effective for acute symptom resolution	May still be used adjunctively, but not primary therapy	[2], [6], [9], [10]
Severe bronchospasm	Use inhaled β ₂ -agonists	Adjunctive therapy; does not replace IM epinephrine	[2], [6], [9], [10]
Laryngeal/pharyngeal oedema	Nebulized epinephrine	Adjunctive therapy; must not delay IM epinephrine	[2], [6], [9], [10]
Observation	Minimum 2 hours posttreatment; longer for severe presentations	Monitor for biphasic reactions; especially if treatment was delayed	[5], [6], [9]
Discharge / follow-up	Education on anaphylaxis, prescription for epinephrine auto-injector, referral to allergist		[2], [6], [9], [10]

Table S2: Vital signs and clinical symptoms searched in electronic medical records.

Vital signs upon arrival	Heart rate
	Systolic blood pressure
	Diastolic blood pressure
	Respiratory rate
	Oxygen saturation
Cardiovascular	Capillary refill time
	Circulatory shock
	Abnormal heart rhythms
	Chest pain
	Syncope
Respiratory	Presyncope or general malaise
	Cyanosis
	Dyspnea
	Abnormal lung auscultation findings
	Stridor
Ear, nose, and throat	Wheezing
	Nasal congestion
	Dysphonia
	Throat swelling
	Laryngeal edema
Cutaneous and mucosal signs	Itching in the laryngeal region
	Urticaria
	Exanthema
	Rash
	Mucosal swelling
Gastrointestinal	Pruritus
	Irritation
	Ocular symptoms
	Dysphagia
	Nausea
Neurological	Vomiting
	Diarrhea
	Abdominal pain
	Headache
	Anxiety
	Confusion
	Altered consciousness
	Dizziness
	Visual disturbances
	Fatigue
	Metallic taste