

Is There an Optimal Training Interval to Improve the Correct Use of Adrenaline Auto-Injectors?

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Keywords

Anaphylaxis · Adrenaline auto-injectors · Education · Training interval

Abstract

Background: Accurate use of adrenaline auto-injectors (AAIs) for anaphylaxis is critical to decrease mortality and morbidity. **Objective:** In this study, we aimed to assess user knowledge of AAIs and evaluate the factors that affect their correct use. **Methods:** The study involved caregivers of pediatric patients diagnosed with anaphylaxis who were trained with trainer injectors up to 24 months ago. The demographics of the caregivers, anaphylaxis history of the patients, usage of AAIs in the case of anaphylaxis, and the reasons for not using AAIs in anaphylaxis were evaluated. Users were asked to demonstrate the use of Penepin® with a trainer injector. **Results:** Fifty-nine caregivers were enrolled in the study. Forty-seven (79.7%) users stated that they always carry AAIs with them. Forty-one (69.5%) of the users demonstrated all steps of the use of AAIs. The time from the last AAI training was the most significant parameter affecting the ability to use AAIs correctly (OR 0.678, 95% CI 0.546–0.841, $p < 0.0001$). AAI training every 6 months results in the proper usage of AAIs, with 96% probability. Thirty (50.8%) care-

givers stated that anaphylactic reactions occurred in their children after the last AAI training. Of these, 16 (53.3%) users stated that they did not use an AAI for the anaphylactic reaction. The most common reason (50%) was not carrying an AAI on their person. **Conclusion:** Training users at least every 6 months is associated with the proper application of AAIs. Although regular training increases the frequency of AAI use in anaphylaxis, awareness of carrying AAIs is the most important factor for usage of AAI in anaphylaxis.

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Introduction

Anaphylaxis is a systemic allergic reaction that is potentially life-threatening. Use of an adrenaline auto-injector (AAI) is the first-line of treatment for anaphylaxis [1]. Early and accurate administration of AAIs improves the clinical outcome. On the other hand, failure to use AAIs contributes to fatality [2]. Therefore, it is important to accurately demonstrate how to use AAIs and to remember to carry AAIs at all times [3, 4].

Edited by: H.-U. Simon, Bern.

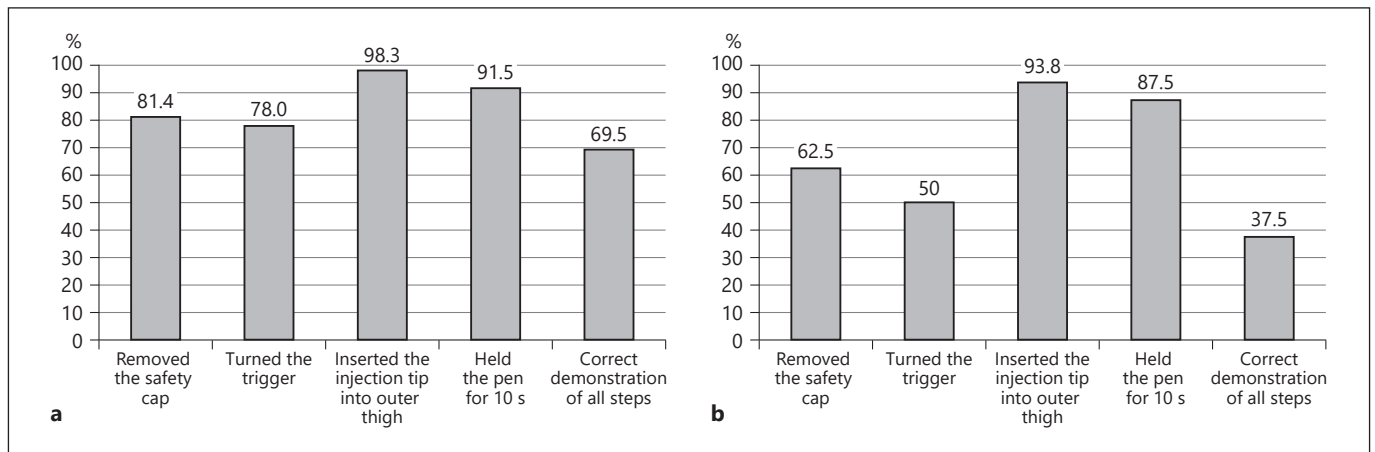


Fig. 1. a The percentage of caregivers describing AAI administration steps accurately ($n = 59$). **b** The rates of describing AAI administration steps accurately in caregivers who did not use AAI in anaphylaxis ($n = 16$).

Previous studies associated the accurate application of AAI with several factors, including the education level of the user, time from the last training, age of the user, history of severe anaphylactic reaction, and the regular clinical follow-up of patients [3–5]. To date, there has been no study that investigates the optimal interval for AAI training. Only in one study were no differences in the demonstration of AAI use found between patients who were trained less than 12 months and more than 24 months ago [5].

In this study, we primarily aimed to analyze the relation between time from the last training and accurate demonstration of AAI use. The secondary aim was to evaluate the factors that affect the correct use of AAI, identify the steps in which users make a mistake, and determine the differences between caregivers who used and did not use AAI in the case of anaphylaxis.

Materials and Methods

A single-center study was performed in the Pediatric Immunology and Allergy Outpatient Clinic. The study involved caregivers of pediatric patients diagnosed with anaphylaxis and prescribed a Penepin® (Vem Pharmaceuticals, Ankara, Turkey) device, who were trained by physicians with trainer injectors up to 24 months ago. The demographics (age, education status) of the participants responsible for the use of AAI were recorded. The anaphylaxis history, habit of carrying the AAI at all times, and history of AAI use in the case of anaphylaxis were also recorded. The reasons for not using AAI in anaphylaxis were interrogated.

The caregivers were asked to demonstrate Penepin use with a trainer injector. The application of an AAI consists of 4 steps: (1) removing the safety cap, (2) turning the trigger, (3) inserting the

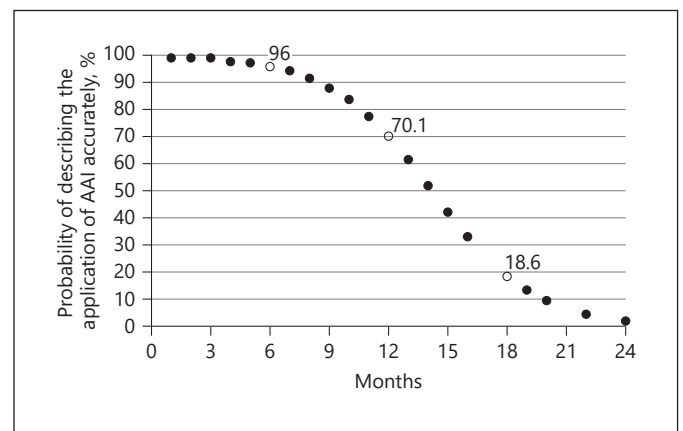


Fig. 2. Logistic relationship between the probability of describing the application of an AAI accurately and the time from the last AAI training.

injection tip into the outer thigh, and (4) holding the pen for 10 s. Users accomplishing all steps correctly were regarded as competent in the use of an AAI.

Statistical Analysis

Categorical variables were assessed by means of the χ^2 test and expressed as numbers and percentages. Shapiro-Wilk tests were performed to evaluate the normality of continuous variables. Non-parametric continuous variables (median with 25th–75th percentile) were analyzed with the Mann-Whitney U test. The relationship between the education level of caregivers and the time from the last AAI training and describing the application of AAI accurately was analyzed by logistic regression. A probability curve was plotted according to the outputs of the logistic regression. Data were analyzed with the Statistical Package for Social Sciences (SPSS) computer software (version 21.0; SPSS, Chicago, IL, USA). A two-tailed p value <0.05 was considered significant.

Table 1. The correct usage rate of AAIs in relation to time elapsed since training

	0–6 months	7–12 months	13–18 months	19–24 months
Demonstrating the application of AAI accurately, <i>n</i> (%)	25 (100.0)	9 (69.2)	6 (50.0)	1 (11.1.0)
Demonstrating the application of AAI inaccurately, <i>n</i> (%)	0 (0.0)	4 (30.8)	6 (50.0)	8 (88.9.0)

Table 2. Reasons given by the caregivers for not using an AAI (*n* = 16)

	<i>n</i> (%)
Forgot to use an AAI	2 (12.5)
Failed to recognize anaphylaxis	3 (18.8)
Not carrying an AAI on person	8 (50)
Forgot the AAI application steps	3 (18.8)

Results

Fifty-nine patients were enrolled in the study. Among these, 21 (35.6%) were female and 38 (64.4%) were male. The median age of the patients was 70 months (25th–75th percentile 29–120). In 53 (89.8%) and 4 (6.8%) patients, the diagnosis was food allergy and venom allergy, respectively. Two (3.4%) patients were diagnosed with idiopathic anaphylaxis.

The median age of the caregivers (56 females, 94.9%, and 3 males, 5.1%) was 37 years (32–40). All caregivers were trained for AAI use up to 24 months ago. The median time from the last AAI training was 9 months (2–14). Forty-seven (79.7%) caregivers stated that they always carry an AAI on their person. Also, 79.7% of them claimed that after training at the hospital they practiced the use of AAI by themselves at home.

In the assessment of using the AAI, 41 (69.5%) of the users demonstrated all steps of AAI use. The most frequent error was noted to be the turning the trigger step (Fig. 1a).

In the comparison of users that demonstrated the application of AAI accurately and inaccurately, education level was found to be higher in caregivers who could demonstrate the application of AAI accurately (rates of university graduation 53.5 vs. 16.7%; $p < 0.0001$). The median time from the last AAI training in users able to demonstrate the application of AAI accurately (4 months, 25th–75th percentile 2–10.5) was shorter than that of users who demonstrated the application of AAI inaccurately (17 months, 13.5–24). Logistic regression analysis showed that the time from the last AAI training

was the most significant parameter affecting the ability to use AAIs correctly (OR 0.678, 95% CI 0.546–0.841, $p < 0.0001$). The probability curve of demonstrating the application of AAI accurately was calculated as determined by the time from the last AAI training; 96, 70.1, and 18.6% probabilities of proper usage of AAI were detected for training at 6-, 12-, and 18-month intervals, respectively (Fig. 2). The rate of correct usage of AAIs in relation to the time elapsed since training is presented in Table 1.

There were no differences between the two groups in terms of the age of caregivers and the rate of practicing by themselves at home ($p = 0.722$; $p = 0.226$). Thirty (50.8%) patients declared that an anaphylactic reaction had occurred after their last AAI training. Of these, 14 (46.7%) patients stated that they used an AAI for the anaphylactic reaction. For 16 (53.3%) participants, the reasons for not using AAIs are listed in Table 2. The most common reason (50%) was not carrying the AAI on their person. The rate of accurate demonstration of AAI application was higher (92.9%) in participants who used an AAI than those who did not (37.5%; $p = 0.002$). One caregiver who used an AAI in anaphylaxis failed to hold the pen for 10 s. The rates of accurately describing the AAI administration steps among those who did not use an AAI in anaphylaxis are shown in Figure 1b. The most frequent error (50%) was noted to be in the step of turning the trigger. The level of education was found to be higher (the frequency of university graduates was 64.3%) in participants who used an AAI than those who did not use an AAI in anaphylaxis (the frequency of university graduates was 31.3%), but this difference was not statistically significant ($p = 0.07$). The median time from the last AAI training in participants that used AAI (8 months, 25th–75th percentile 4.8–12.3) was shorter than in those who did not use an AAI, despite carrying one, in anaphylaxis (13.5 months, 12.3–19.5; $p = 0.001$). There were no differences between the two groups in terms of user age and rate of practicing by themselves at home ($p = 0.745$; $p = 0.256$).

Discussion

In this study, the correct use of AAI was assessed in caregivers with anaphylaxis-diagnosed pediatric patients who were trained in AAI use up to 24 months ago. The factors related to the usage of AAIs in the case of anaphylaxis were also investigated. The most important finding of our study is that the time from the last AAI training inversely influences the ability to use an AAI.

The main problem in the administration of AAIs in anaphylaxis is not having the device to hand at all times. Ridolo et al. [4] reported that 82% of adult patients using self-injectable adrenaline have the device with them at all times. In another study, this rate for parents who have pediatric patients with anaphylaxis was 75% [6]. The study which included parents with anaphylaxis-diagnosed children and teenage patients with anaphylaxis reported the rate of carrying AAIs as 71% [7]. Similarly, in our study 79.7% of the caregivers stated that they always carry an AAI on their person. On the other hand, our study revealed that “not carrying the AAI on person” was the main reason (50%) for half of the patients not using AAIs in anaphylaxis. This contradiction leads us to consider the reliability of the answers given in the survey. A study performed in the UK showed that in non-iatrogenic fatal anaphylaxis, 2 out of 9 (22.2%) patients did not use an adrenaline self-treatment kit because of not carrying the kit on their person [2]. These findings suggested that not only the correct use of AAIs, but also the awareness of carrying an AAI on one's person at all times is important for appropriate AAI usage.

In several studies, proper use of different AAI kits was evaluated [3, 4, 8, 9]. In a study conducted in Turkey that evaluated the EpiPen competency, nearly 40% of users (50 caregivers and 14 children older than 12 years) demonstrated all of the AAI steps [3]. In another study that included parents with anaphylaxis-diagnosed children and teenage patients, this rate was found to be 38% [7]. While Topal et al. [3] reported that the most common mistake is in holding the device in the thigh for 10 s, another study detected the most common mistake as selecting an inappropriate injection site [4]. The major difference of our study from these studies is that our patients used a different AAI kit (Penepin). Only one study has compared the application steps of EpiPen and Penepin [9]. Although volunteers in the study were not actual patients experiencing anaphylaxis, the most common error for both auto-injectors was the step of selecting the correct injection site. In this study, 42.9% of volunteers correctly demonstrated all steps in the use of the Penepin [9]. We found a higher

rate of correct demonstration of all steps (69.5%) than was the case in that study. The inclusion of different study groups (volunteers, not actual patients experiencing anaphylaxis) may explain this difference.

Previously, studies evaluated the factors that affect the accurate application of AAIs. The education level of users, age of patients, time from the last clinic visit, video training, and continued training by physicians were associated with the correct usage of AAIs [3–5, 10–12]. We found that the education status of users and the time from the last training affect the correct demonstration of AAI use. Kapoor et al. [6] claimed that parental auto-injector education improves the ability of parents to use an AAI. We found an inverse relation between the time from the last training and accurate administration of AAIs. Moreover, the time from the last training has a negative effect on using AAIs in the case of anaphylaxis. This finding suggests that the less time that has elapsed since the last training, the more comfortable users feel in operating the AAI in the case of anaphylaxis. There is limited information about the ideal interval for AAI training. No difference was observed concerning the effective use of AAIs in parents who received training less than 12 months ago compared with 24 months ago [5]. This is the first study that investigates the optimal training interval for the proper application of AAIs and we determined that AAI training at 6-month intervals results in proper usage of AAIs, with 96% probability. We believe that this is the most important finding of this investigation compared to other studies. However, the results of this study should not be generalized to the adult population based on evaluation of the ability of caregivers to correctly apply AAIs to their children.

In light of the findings of our study we may conclude that accurate use of AAIs by caregivers has a strong relation with training every 6 months. Although regular training increases the frequency of AAI use in anaphylaxis, awareness of carrying an AAI on one's person is the most influential factor for the appropriate usage of AAIs in anaphylaxis.

Statement of Ethics

This study was granted approval by the Dokuz Eylul University Research Ethics Board. Written informed consent was obtained from the parents upon enrollment in the study.

Disclosure Statement

The authors have no conflicts of interest to declare.

Funding Sources

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Author Contributions

S.S.K. and D.T. collected the data. S.As., S.Al., O.A., O.Kan., N.U., and O.Kar. analyzed the data. S.S.K. analyzed the data and drafted the manuscript. All authors approved the final manuscript.

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