

# Anaphylaxis and epinephrine auto-injector training: Who will teach the teachers?

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**Background:** Anaphylaxis is the most urgent clinical immunologic event. Effective treatment is best achieved by administration of epinephrine. Accidental exposure to the responsible allergen is the most common cause of anaphylaxis, and because it could be fatal within minutes, epinephrine in pre-loaded syringes and auto-injectors has been introduced. In our experience patients and medical personnel are not familiar with the use of this device.

**Objective:** We sought to assess community-based professionals' knowledge of epinephrine auto-injector use and their ability to educate patients.

**Methods:** Study participants consisted of a medical convention's delegates and emergency department personnel in metropolitan Toronto, as well as pharmacists of the target hospitals and retail pharmacists. Research assistants approached eligible professionals to fill out a questionnaire and demonstrate their ability to use a standard placebo auto-injector trainer.

**Results:** A total of 122 professionals (composed of emergency physicians, family practitioners, and pediatricians) consented to participate in this study. The majority of participants (81%) did not have a placebo trainer to educate their patients; 76% did not know the 2 available dose strengths. To provide instructions and reinforcement, physicians clearly must have the necessary skills and knowledge, yet only 25% of the study participants were able to demonstrate the 3 steps of injection correctly.

**Conclusion:** Our study highlights a specific and important deficiency in medical professionals' care of patients at risk for anaphylaxis. The results challenge the current methods of educating professionals, as well as patients, when prescribing or using epinephrine auto-injectors. Clearly a new approach to educating and maintaining such skills is required. (*J Allergy Clin Immunol* 1999;103:190-3.)

**Key words:** Anaphylaxis, epinephrine, auto-injector, training, medical professionals, therapy

Anaphylaxis is the most urgent of clinical immunologic events. Often explosive, it results from the generation and release of potent biologically active mediators

## Abbreviation used

CI: Confidence interval

and their concentrated effects on various target organs,<sup>1</sup> and therefore it should be always considered a medical emergency. Anaphylaxis has been estimated to occur in 1 of every 3000 patients, and the rate of fatal anaphylaxis from any cause has been estimated to be 0.4 patients per million individuals per year in Ontario.<sup>2</sup>

Treatment should be directed toward the maintenance of an effective airway and circulatory system, which is best achieved through the use of epinephrine, the most important single agent in treating anaphylaxis.<sup>1,3</sup> Accidental exposure to the responsible allergen is the most common cause of anaphylaxis, and because this can be fatal within minutes, a preloaded syringe and auto-injector has been introduced (Ana-kit; Hollister-Stier Laboratories, Etobicoke, Ontario, Canada or Epi-Pen; Allerex Laboratories, Kanata, Ontario, Canada).<sup>4</sup> These devices must be carried by patients or caregivers of children who are known to be at risk for anaphylaxis. More importantly, these individuals should know the proper method of administration if any emergency arises.<sup>4</sup> A major limitation of the auto-injector is the inability of many patients to use it correctly (pilot study by M. Grouhi, unpublished). Digital injection is a major complication, especially when anaphylaxis is accompanied by panic.<sup>5</sup> It is therefore critical that patients receive appropriate education in the correct self-administration of epinephrine.

Because administration of epinephrine by means of the auto-injector is potentially a life-saving procedure, it is critical to assess the educators of this procedure, including physicians, nurses, and pharmacists. We therefore chose to study community-based professionals' knowledge and ability to use epinephrine auto-injector device systems.

## METHODS

A general pediatric medical convention in Toronto was selected as the source for our study subjects. The Hospital for Sick Children Annual Pediatric Update attracts a broad spectrum of medical personnel from medical students, family doctors, and emergency physicians to members of pediatric subspecialties and fellows in training. All the delegates were considered eligible for participation in the study. To decrease the sample bias, a predefined geographic area was selected in metropolitan Toronto, and all the emergency

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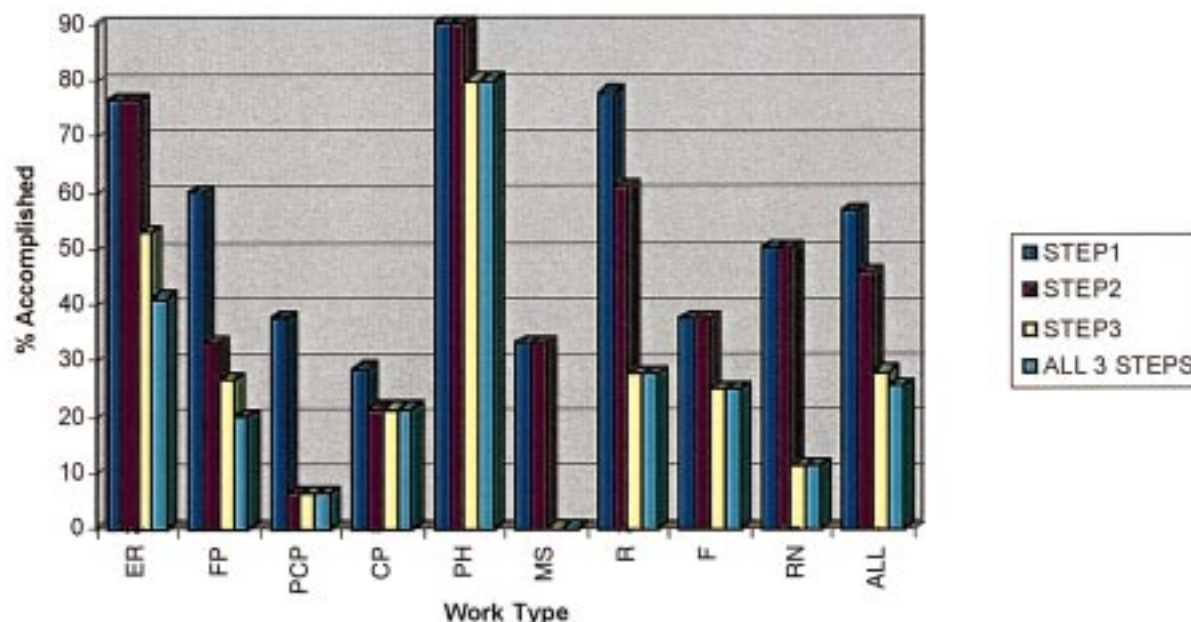


**FIG 1.** Proportion of medical personnel correctly performing the 3 steps for use of the epinephrine auto-injector together and individually. *ER*, Emergency room physician; *FP*, family physician; *PCP*, primary care pediatrician; *CP*, consultant pediatrician; *PH*, pharmacist; *MS*, medical student; *R*, resident; *F*, fellow in training; *RN*, registered nurse; *ALL*, all participants.

**TABLE I.** Steps for use of the epinephrine auto-injector trainer device\*

1. Pull out the gray safety cap.
2. Hold the device in the palm with the thumb covering the index finger and the black tip toward the small finger.
3. Place the black tip on the outer thigh. Push hard until you hear the trainer function. Hold in place for 10 seconds.

\*Modified from Epipen manufacturer instructions for the US.

department personnel, including physicians, medical students, residents, nurses, pharmacists, and regional retail pharmacists, were targeted. Professionals who were approached by a research assistant and those who declined participation at this initial contact were excluded from the study. Professionals deferring response until a later date for reasons of inconvenience received one additional visit only. The study was composed of 2 sections. The first section involved background and demographic information collected by questionnaire. The second section evaluated ability to use a standard auto-injector trainer, which does not contain any needle or medication. For the first part, study subjects were simply asked whether they have an auto-injector trainer with which to teach their patients and to identify the 2 doses available.

Use of the auto-injector was divided into 3 steps (Table I). Seven research assistants were trained to assess proper injection technique. Grading between the research assistants was compared, and discrepancies were reconciled until there was minimal interobserver variability. Only one of the research assistants conducted all assessments and interviews of the participating professionals in the regional centers, whereas (due to time constraints) 7 assistants conducted the assessment and interview of participants in the medical convention during one social intermission. To assess adequacy of auto-injector technique, all participants were given placebo devices with which to demonstrate correct use.

Data are presented as frequencies and percentages. Differences

between participants' work type were compared by using chi-square analysis, and differences were considered statistically significant at *P* values of less than .05.

## RESULTS

Of a total of 154 professionals approached, 122 (79%) consented to participate in this study. The group was composed of 17 emergency physicians, 15 family practitioners, 16 primary care pediatricians, 14 consultant pediatricians, 8 fellows in training in various subspecialties, 18 residents (pediatric and internal medicine), 6 medical students, 10 pharmacists, and 18 nurses (emergency). The participants' time of graduation varied from 1953 to the present. Most participants graduated after 1980 (68%); 36% graduated between 1980 and 1990, and 39% graduated after 1990.

The majority of participants (81%) did not have an epinephrine auto-injector trainer device with which to educate their patients (confidence interval [CI]: 0.74-0.87). However, the majority of pharmacists had the trainer device (7 of 10 [70%]). None of the medical students and fellows in training had a trainer device, which puts them and their patients at a disadvantage. Only 1 of the 18 nurses (5%) had a trainer device, although some of them were in practice for decades. Interestingly, among 17 emergency physicians approached, only 3 (18%) had the trainer device. Family physicians fared poorly also because only 2 (13%) had a trainer. Meanwhile, primary care pediatricians and consultant pediatricians who had their own trainer devices scored better (25% and 36%, respectively).

Seventy-six percent of the participants did not know the 2 available doses (Table II) for the epinephrine auto-

TABLE II. Summary of results

| No. (%)                | Total        | ER          | FP           | PCP          | CP           | PH          | MS         | R            | F           | RN           | P value |
|------------------------|--------------|-------------|--------------|--------------|--------------|-------------|------------|--------------|-------------|--------------|---------|
| Participants           | 122<br>(100) | 17<br>(3.9) | 15<br>(12.3) | 16<br>(13.1) | 14<br>(11.4) | 10<br>(8.2) | 6<br>(4.9) | 18<br>(14.7) | 8<br>(6.5)  | 18<br>(14.7) |         |
| Have trainer           | 23<br>(18.8) | 3<br>(17.6) | 2<br>(13.3)  | 4<br>(25.0)  | 5<br>(35.7)  | 7<br>(70.0) | 0          | 1<br>(5.5)   | 0           | 1<br>(5.5)   | .001    |
| Knowledge of doses*    | 17<br>(13.9) | 1<br>(5.8)  | 1<br>(6.6)   | 3<br>(18.7)  | 2<br>(14.2)  | 7<br>(70.0) | 0          | 1<br>(5.5)   | 0           | 2<br>(11.1)  | .0001   |
| Correctly demonstrated | 31<br>(25.4) | 7<br>(41.1) | 3<br>(20.0)  | 1<br>(6.2)   | 3<br>(21.4)  | 8<br>(80.0) | 0          | 5<br>(27.7)  | 2<br>(11.1) | 2<br>(11.1)  | .001    |

ER, Emergency room physician; FP, family physician; PCP, primary care pediatrician; CP, consultant pediatrician; PH, pharmacist; MS, medical student; R, resident; F, fellow in training; RN, registered nurse.

\*The epinephrine auto-injector is available in 2 different doses of 0.3 mg (Epipen) and 0.15 mg (Epipen Jr).

injector (CI: 0.70-0.81). Nine percent of the participants were aware of only one available dose, and 22% defined the 2 available doses incorrectly (CI: 0.15-0.29).

Although the majority of participants (75%) did not demonstrate an ability to use the epinephrine device, the majority of pharmacists performed well (8 of 10 [80%]). Fifty-seven percent of the total participants demonstrated step 1 correctly, 46% demonstrated step 2 correctly, and a minority (28%) demonstrated step 3 correctly. Only 25% of the participants demonstrated all 3 steps of the method of injection correctly (CI: 0.21-0.29). Among those who performed the 3 steps correctly, pharmacists were the majority (25%); next were emergency physicians, with a total of 22%. Interestingly, primary care pediatricians and consultant pediatricians who had a better score for having trainer devices (25% and 36%, respectively) scored poorly in correctly demonstrating the 3 steps of injection; only 6% of primary care pediatricians and 21% of consultant pediatricians performed the 3 steps correctly. The most common problem with the use of the auto-injector trainer device was forgetting to hold the auto-injector in site for 10 seconds (step 3); 72% of the total participants failed to do so (CI: 0.64-0.80). Medical students, fellows in training, and nurses performed poorly in correctly demonstrating the 3 steps of injection. Of these participants, none of the 6 medical students, 2 of the 8 fellows in training (11%), and 2 of the 18 nurses (11%) demonstrated the 3 steps of injection correctly. The results are summarized in Table II and Fig 1.

## DISCUSSION

Few studies have assessed medical professionals' knowledge and ability to use medicine delivery systems.<sup>6-8</sup> We made an observation of patients, physicians, house staff, and nurses, who are often unable to use the epinephrine auto-injector adequately despite being involved in its prescription. A number of experts and professional organizations have recommended that instructions detailing how to use an epinephrine auto-injecting kit be provided when the prescription is given.<sup>3,4,9,10</sup>

We suspect that the ability of medical professionals to use the epinephrine auto-injector may have been overes-

timated by our study. Twenty-one percent of medical professionals approached did not participate, and although we cannot be sure of their familiarity with the device, we suspect the nonparticipants were likely to have performed no better and possibly worse than the participants. Furthermore, important issues, such as instructing patients about side effects and immediate care after epinephrine use, were beyond the scope of this study and should be addressed in the future.

Although the majority of participants did not demonstrate an ability to use the epinephrine auto-injector device, the majority of pharmacists performed well. However, the pharmacist group appeared to have an advantage over the other medical professionals because the majority had their own patient-training device. Relative to the pharmacists, the medical students, fellows, and nurses fared poorly when asked to demonstrate the 3 steps of injection. Furthermore, none of the medical students and fellows and only 1 of the nurses had their own patient-training device. Although the most common mistake in administering the device occurred in step 3 (Table I), step 2 is of prime importance because holding the device incorrectly, with the black tip toward the thumb and the thumb placed on the tip, will cause digital injection that may result in thumb amputation.<sup>5</sup>

The epinephrine auto-injector kit is usually prescribed by emergency physicians or other primary care physicians after an episode of severe systemic reaction. Our study demonstrates that only a small number of emergency physicians have a trainer device, and they perform poorly in training patients, if they train at all. Furthermore, the results of this study showed that medical professionals have significant deficiencies not only with respect to the practical skills of epinephrine auto-injector use but also with knowledge of the doses available (Table II). It is well known that proper patient instruction is vital to the correct delivery of medications requiring delivery devices.<sup>11,12</sup> However, to provide the instructions and reinforcement, health care workers clearly must have the necessary skills and knowledge. Implementation of simple educational programs, such as periodic rehearsal of emergency situations on simulated patients or the use of computer-generated teaching programs, might be of benefit.

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