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Implementation and Assessment of an Anaphylaxis Simulation Curriculum for Boston-area Allergy and Immunology Trainees

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Anaphylaxis is often under-recognized and undertreated, potentially due to knowledge gaps or provider discomfort surrounding its management.¹ Allergy/Immunology (AI) physicians must be specifically skilled in the diagnosis and management of anaphylaxis, especially given the risks associated with common in-office AI procedures (e.g., food and drug challenges, allergen immunotherapy). Although anaphylaxis recognition and management is an Accreditation Council for Graduate Medical Education (ACGME) AI fellowship training program core competency,² there is no standardized AI fellowship anaphylaxis curricula.

High-fidelity simulation is effective in medical education, especially for scenarios uncommonly encountered, such as difficult airway management³ and perioperative anaphylaxis.⁴ Case-based simulation previously increased awareness and identification of anaphylaxis in chemotherapy infusion centers among Hematology-Oncology healthcare providers.⁵ Simulation was also found to improve knowledge on the diagnosis and treatment of antibiotic-induced anaphylaxis and ACE-inhibitor-induced angioedema for medical students and residents⁶. However, anaphylaxis simulation has not been studied in AI trainees who require specific skills related to anaphylaxis recognition and management.

We developed five anaphylaxis simulation cases covering core knowledge for AI trainees: 1) anaphylaxis in an adult after allergen immunotherapy injection, 2) isolated hypotension as a presentation of anaphylaxis in an adult, 3) anaphylaxis management in an adult patient on a beta-blocker, 4) anaphylaxis during a pediatric food challenge, and 5) anaphylaxis in an infant (see Figure E1 for simulation case example).

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We developed two participant questionnaires to assess the simulation program: (1) Knowledge/confidence questionnaire (administered pre- and post-simulation sessions), and (2) Effectiveness questionnaire (administered post-simulation only). The questionnaires were developed by Massachusetts General Hospital (MGH) faculty, and subsequently refined based on feedback from the MGH Survey Research Unit and Allergy/Immunology faculty members to achieve face validity. The knowledge questionnaire included eight questions assessing knowledge and confidence; the effectiveness questionnaire assessed clinical applicability, realistic quality, impact on quality and safety, and if the simulation experience met course objectives (see Figure E2).

We held simulation sessions for Boston-area AI trainees beginning in 2016; sessions were held in the MGH AI clinic or Learning Laboratory using high fidelity mannequins (Figure 1). All AI trainee participants were invited to participate in the simulation sessions and complete questionnaires. RedCap was used to distribute electronic questionnaires and enable anonymous data collection with matching of pre- and post-questionnaires. The electronic questionnaires were distributed one to two weeks before each session and approximately one week following each session. The same knowledge questionnaire was used both pre- and post- simulation, although participants were not informed of their score nor were told the correct answers. We used descriptive statistics to analyze questionnaire responses considering each AI fellow anaphylaxis simulation participation as a discrete event; Likert scales were condensed into binary responses for ease of interpretation (e.g., agree or strongly agree, moderately confident or very confident). Correct answers required all portions of the answer to be correct (i.e. no partial credit was awarded). McNemar's test was used for paired pre-/post-anaphylaxis simulation data. Analyses were performed using SAS, version 9.4 (Cary, NC).

There were 37 anaphylaxis simulation participation events from 19 unique individuals (2016–2019). All trainees completed the pre-simulation knowledge/confidence questionnaire; 23 (62%) completed the post-simulation knowledge/confidence questionnaire and 14 (38%) completed the post-simulation effectiveness questionnaire.

We observed improvement in anaphylaxis knowledge questions: situations that make anaphylaxis likely (89% correct pre vs 96% correct post, $p<0.001$), risk factors for poor outcomes (57% correct pre vs 70% correct post, $p=0.008$), epinephrine concentration (84% correct pre vs 96% correct post, $p<0.001$), epinephrine dosing in adults/pediatrics (97% correct pre vs 100% correct post, $p<0.001$), and first- line treatment for patients on beta-blockers (87% correct pre vs 91% correct post, $p<0.001$, Table 1). AI trainees reported improved confidence regarding anaphylaxis recognition/management (76% pre-simulation confident or very confident vs 100% post-simulation, $p=0.04$).

Of the 14 post-simulation effectiveness questionnaires completed, AI trainees considered the simulation realistic (93%), clinically applicable (100%), and likely to improve the quality and safety of patient care (93%). The overall quality of the session was rated as good or excellent (93%) and the debriefing was facilitated effectively to encourage open and honest dialogue (93%). The simulation was reported to enhance teamwork or communication skills (93%); technical or procedural skills (79%); judgement, critical thinking or decision making

skins (93%); and better understand and/or apply institutional protocols, expert recommendations or best-practice guidelines (93%).

We implemented and assessed a novel anaphylaxis simulation program for Boston-area AI trainees using anaphylaxis cases and survey instruments specifically designed for AI trainees. We aimed to improve the recognition and management of anaphylaxis by AI trainees in a realistic, interactive, and effective way, thereby facilitating learning, cooperation, and improved patient care. In this study, we found that the simulation sessions were associated with improved knowledge and confidence. Although the effectiveness questionnaire had a lower response rate, respondents considered the sessions important and effective.

Given these data, and emerging similar data for AI and other fields^{6–8}, we advocate for clinical simulation to be incorporated into AI trainee curriculum whenever feasible to do so. While we used a high-fidelity mannequin for our sessions, similar anaphylaxis simulation training could be implemented with low fidelity simulation, such as using a doll or actor. Data from our AI trainee experience confirm that anaphylaxis simulation provides learners with an opportunity to recognize and manage anaphylaxis in a safe environment. Indeed, facilitators uniformly recognize additional unmeasured benefits such as teamwork and communication skills.

We demonstrated an immediate gain in trainee knowledge and confidence with one anaphylaxis simulation session, but we did not specifically assess improvements over time (or year to year) in the smaller group of individuals who participated in the curriculum throughout their training. Although we demonstrated improved anaphylaxis knowledge and perceived benefits associated with simulation, we have not evaluated whether this translates into improvements in clinical care. While we assessed paired data to elucidate improvements associated with the simulation session, we cannot determine that gains were due to the simulation session and not external factors. Future studies will include an analysis of AI trainees that participated in more than one session and post-training surveys that evaluate whether these anaphylaxis simulation sessions were helpful in their practice.

The use of high fidelity mannequin simulation sessions can be used to teach anaphylaxis recognition and management to AI trainees and sessions improve trainee knowledge and confidence. AI educators should consider implementation of a standardized simulation curriculum.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Clinical Implications:

Early recognition and appropriate management of anaphylaxis is critical for optimal patient care and a core competency for Allergy/Immunology trainees. Simulation training can improve trainee knowledge and confidence regarding recognition and management of anaphylaxis.

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Table 1.

Anaphylaxis knowledge and confidence results pre- and post-simulation.

Knowledge Question	% Correct Pre-Simulation (n=37[*])	% Correct Post-Simulation (n=23)	p-value[†]
Identification of situations that make anaphylaxis likely	89	96	p<0.001
Risk factors for poor outcomes	57	70	p=0.008
Epinephrine concentration	84	96	p<0.001
Epinephrine dosing in adults/pediatrics	97	100	p<0.001
First line treatment for patients on beta-blockers	87	91	p<0.001
Initial anaphylaxis management steps	35	48	p=0.84
Why early administration of epinephrine essential	100	100	N/A
	%Moderately Confident/Very Confident Pre-Simulation (n=37[*])	%Moderately Confident/Very Confident Post-Simulation (n=23)	
Confidence regarding anaphylaxis recognition/ management	76	100	p=0.04

* There were 37 AI trainee participation events from 19 individuals

[†] McNemar's test