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Using a Computer Module to Teach Use of the EpiPen®

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Abstract

Background: The medical literature suggests that patients and physicians are deficient in their ability to use a self-injectable epinephrine device (EpiPen®) for management of anaphylaxis. This study aims to determine whether a computer module is an effective tool for the instruction of a technical skill to medical trainees.

Methods: We conducted a two group comparison study of 35 Post-Graduate Year 1 and 2 Family Medicine residents. Participants were instructed on use of the EpiPen® using either a written module or a computer module. Participants were evaluated on use of the EpiPen® using standardized objective outcome measures by a blinded assessor. Assessments took place prior to and following instruction, using the assigned learning modality.

Results: There were 34 participants who completed the study. Both groups demonstrated significant improvement in demonstrating use of the EpiPen® following training ($p < 0.001$ for both). A significant post-training difference favouring the computer module learners over the written module learners was observed ($p < 0.05$). However, only 53% and 18% of candidates (computer module and written module, respectively) were able to correctly perform all of the checklist steps.

Conclusion: While our findings suggest computer modules represent an effective modality for teaching use of the EpiPen® to medical trainees, the low number of candidates who were able to perform all the checklist items regardless of modality needs to be addressed.

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Introduction

Anaphylaxis is an acute onset, and potentially fatal, systemic reaction requiring immediate medical intervention. Since the majority of anaphylactic reactions occur in the absence of medical professionals, self-injectable epinephrine devices (e.g. EpiPen®) are the first-line treatment in these situations.[1,2] Accordingly, an EpiPen® is often prescribed for patients at risk for future anaphylactic episodes.

It has been demonstrated that patients, their families, and health care professionals are deficient in their knowledge and comfort in using the EpiPen®.[3,4,5] In one study of 68 patients prescribed an EpiPen®, only 29% employed it in a recurrent anaphylactic episode.[6] A cross-sectional study demonstrated that parents' comfort with the use of the EpiPen® correlated with previous administration of the device, previous EpiPen® training, and the feeling of a sense of empowerment in its use.[7] In another study of 101 families of children prescribed an EpiPen®, 86% of families reported that they carry it "at all times"; however, it was found that only 55% had unexpired devices with them at that time. Furthermore, only 32% of were able to demonstrate correct use of the device.[5]

The lack of comfort and familiarity may be due in part to poor patient instruction. A recent cross-sectional study found that of 45 physicians who had previously prescribed an EpiPen®, 49% reported that they had not given education in any form to their patients and only 7% reported that they demonstrated use of the device.[8]

The lack of patient instruction may be the result of physicians lack of expertise in regards to the EpiPen®. In a study of 100 residents and consultants, only 2 were able to demonstrate all six steps without first reading the instructions. Of the 95 physicians who read the instructions, only 39 correctly demonstrated the remaining 5 steps. The most concerning finding was that only 63% of the demonstrations would have resulted in adequate administration of epinephrine to the patient.[8]

Due to improved technology and the widespread use of the internet, computer assisted learning is capable of providing medical professionals an opportunity to learn technical skills at their own pace.[9] Learning is not restricted geographically, and can be extended to remote areas and developing countries.[10,11] Computer modules are capable of conveying visual and spatial components of technical skills.[12,13]

The objective of the present study was to evaluate the use of computer modules in teaching a technical skill using resources that are currently available to physicians. Specifically, this study compared a computer-based learning module to traditional reading materials in teaching medical residents the use of the EpiPen® for management of an anaphylactic episode.

Methods and Materials

Two instructional modalities were employed to compare a computer module in teaching the use of the EpiPen® to traditional reading materials. Both the computer module and the written module were obtained from the manufacturer of the EpiPen® and are currently available to all physicians (King Pharmaceuticals, Bristol, Tennessee). A trainer EpiPen® (issued by the same manufacturer) that contains neither a needle nor epinephrine was used for demonstrations. Ethics approval was obtained via the University of Western Ontario Research Ethics Board (UWO REB# 15904E).

Participants

All post-graduate year 1 (PGY-1) and post-graduate year 2 (PGY-2) Family Medicine residents at the Schulich School of Medicine & Dentistry, University of Western Ontario, were invited to participate in this study on a voluntary basis. Thirty-five residents agreed to participate.

Intervention

Participants were randomly assigned to receive instruction regarding use of the EpiPen® via either a computer module or a written module. Prior to assignments, all participants were asked to complete questionnaires which covered both demographic information and previous training, use, and level of comfort with the EpiPen® (Table 1).

Table 1: Baseline Characteristics of Study Participants

Characteristics	Computer Module (n=17)	Written Module (n=18)
Demographics		
Age (years) [a]	31.06 (6.74)	30.44 (5.19)
Male : Female	7:10	4:14
PGY-1 : PGY-2	14:3	13:5
Average Computer Usage (hours/week)	>10	>10
Pre-Intervention Questionnaire [b]		
Previously trained to manage anaphylaxis	7 (41%)	10 (56%)
Previously trained to use an EpiPen®	3 (18%)	5 (28%)
Previously taught someone to use an EpiPen®	1 (6%)	0 (0%)
Previously experienced anaphylaxis themselves	0 (0%)	1 (6%)
Previously encountered someone experiencing anaphylaxis	2 (12%)	5 (28%)
Previously used an EpiPen®	0 (0%)	0 (0%)
Comfortable using an EpiPen® [c]	2.25 (1.99)	2.69 (2.23)
Comfortable teaching use of an EpiPen® [c]	2.5 (2.56)	1.94 (2.42)
Pre-Test Results [d]		
Recognized pen	8 (47%)	10 (56%)
Removed grey cap	10 (59%)	9 (50%)
Selected outer mid-thigh as injection site	14 (82%)	11 (61%)
Black end injected	7 (41%)	9 (50%)
Adequate pressure to activate device	2 (12%)	1 (6%)
Hold in place for >5 seconds	0 (0%)	0 (0%)
Overall score (/6)	2.41	2.22
Total time elapsed (seconds) [a]	19.84 (11.09)	18.19 (9.30)

[a] Data reported as No. (Standard Deviation)

[b] Indicates participants who selected a 'yes' answer

[c] Scored on a Visual Analogue Scale of 0 (low) – 10 (high) (Standard Deviation)

[d] Indicates participants who performed the step correctly, except for the "Overall Score", which is the sum of all parameters in the pre-test (maximum score is 6).

Before receiving any instruction, all participants completed a pre-test evaluation to establish their baseline skill. Participants were asked to demonstrate use of the EpiPen® on themselves as they felt was necessary for management of anaphylaxis. Participants were not permitted to ask questions.

Participants were then provided their learning modules in a quiet study area without any time constraints. The written module was a concise one-page document demonstrating appropriate use of the EpiPen® using text, graphics, and photographs. It specifically demonstrates removing the cap, selecting the mid-outer thigh as the injection site, using the black end to inject, applying adequate pressure and holding it in place. These represent five of the six points that participants were evaluated on during their demonstrations (see Outcomes). All of these points are included in text, and some are supplemented with images.

The computer module group was provided a computer preloaded with the web-based module. The computer module demonstrated the appropriate use of the EpiPen® via a real-time video demonstration, along with verbal instructions from the presenter. Participants could forward and rewind the computer module as necessary. Like the written module, the computer module specifically demonstrated the five competencies mentioned above. Neither module referenced the 6-step scale that was used as the primary outcome measure (see Outcomes); this scale is largely a research tool.

The written module and computer module were the same as what is currently available to physicians from the manufacturer without any modifications. We were unable to obtain permission from the manufacturer to reproduce the modules; both are freely available to physicians and the public directly from the manufacturer: King Pharmaceuticals, Bristol, Tennessee.

After the intervention, all participants were asked to once again demonstrate use of the EpiPen® as a post-test. Finally, participants were asked to complete a post-intervention questionnaire that inquired about their respective module, and their post-test performance.

Procedures

Participants were randomly assigned to either the written module group or computer module group. Allocation concealment was ensured by use of sealed opaque envelopes. All participants' demonstrations were assessed at pre- and post-test by one assessor. The assessor (ASR) was blind to participants' group allocation.

Outcome Measures

For both pre-test and post-test, the time taken to demonstrate use of the EpiPen® was measured in a standardized manner: time started when the participant first picked up the EpiPen® and stopped when the participant put it down or announced their completion.

Objective outcome measures: All demonstrations were assessed by one author (ASR) on a 6-point scale previously published in the EpiPen® literature[8] (Table 2).

Table 2: 6-point EpiPen® Demonstration Checklist

1 point	Recognized pen
1 point	Removed grey cap
1 point	Selected outer mid-thigh as injection site
1 point	Black end injected
1 point	Adequate pressure to activate device
1 point	Hold in place for >5 seconds

Recognition of the EpiPen® was deemed complete if the participants were able to orient themselves to the EpiPen® within 5 seconds; pressure to activate the device was deemed adequate once the device made a 'clicking' sound, as it is designed to do; the time that the participant held the device in place was measured with a stopwatch. The items on the 6-pt scale were evaluated as either complete or incomplete.

The primary outcome measure was the total score on the 6-pt scale for demonstration of the EpiPen®. The secondary outcome measures included the pre-intervention and post-intervention questionnaires as well as the total time elapsed for the demonstration during both the pre- and post-learning tests.

Sample size

A priori sample size calculations were performed to determine the number of participants needed to detect effect sizes. We expected a difference of at least 1 point on the 6-pt scale, which we considered to represent an educationally and clinically significant improvement. A sample size of 16 participants per group was identified as necessary to achieve 80% power with a two-sided significance level of .05, assuming an equivalent standard deviation of 1 in both groups.

Statistical analysis

Paired *t*-tests were used to compare the pre-intervention and post-intervention demonstration scores of participants from both the computer and written module groups. Paired *t*-tests were also used to compare the pre-intervention and post-intervention total time elapsed for demonstration for both intervention groups. Two-sample *t*-tests were used to compare the total change in score and total change in time elapsed for demonstration. Two-sample *t*-tests were used to compare the number of participants correctly performing each step on the 6-pt demonstration scale.

Results

Of the 163 post-graduate year 1 and post-graduate year 2 Family Medicine residents at the University of Western Ontario, 35 agreed to participate. Of those included in the study, 17 were randomly assigned to the computer module group, and 18 to the written module group. One participant from the written module group subsequently withdrew from the study.

Participants in both groups were similar for age, sex, level of academic training, and previous training and comfort in regard to both anaphylaxis and the EpiPen®. The pre-intervention questionnaire revealed that only about half of all participants had previously learned how to manage anaphylaxis; of note, only a quarter of respondents had previously received training in use of the EpiPen®. Pre-test results demonstrated equal performance across both groups. No participant was able to demonstrate all 6 steps correctly (Table 1). Similar equivalence was observed between groups when evaluating specific items in the 6-point checklist. Overall scores and total time elapsed were also comparable between the two groups.

Both educational groups demonstrated significant improvement from pre-test to post-test as evidenced by EpiPen® demonstrations ($p < 0.001$ for both) (Table 3). Of note, when comparing the change in score from pre-test to post-test, the computer module group demonstrated a statistically significant improvement in score compared to the written module group ($p < 0.05$). Both groups also demonstrated improvements in total time elapsed for their demonstrations; the computer module group demonstrated a statistically significant faster time during the post-test demonstration than the written module group ($p < 0.01$) (Table 4). The computer module group scored significantly higher in post-test scores in steps 5 and 6, which are the final steps in the delivery of epinephrine intramuscularly into the patient or demonstrator. Both groups performed particularly poorly, however, in the final step, i.e. to hold the EpiPen® in place for 5 seconds (53% for computer module, 18% for written module).

The post-test questionnaire demonstrated that participants using both modules thought that they were well designed (Table 5). Without having seen the other intervention, all of the participants in the computer module group would choose the computer module if they had the choice; 71% of the written module group would choose the written module if given the choice. This too reflects well on the design of both modules.

Discussion

The implications of this study are two-fold. First, it appears that many PGY-1 and PGY-2 Family Medicine residents have not been taught use of the EpiPen® in their medical school or residency curricula. Second, computer modules provide a viable vehicle for continuing medical education, especially as it relates to a technical skill.

Self-injectable epinephrine devices such as the EpiPen® have become a mainstay of treatment for patients at risk of an anaphylactic episode. Unfortunately, many patients are uncomfortable in

Table 3: Comparing Pre-Test to Post-Test Performance (Scores and Elapsed Time)

Modules	Pre-Test Mean Total Score (/6)	Post-Test Mean Total Score (/6)	p-value
Computer Module	2.41	5.41	< 0.001
Written Module	2.22	4.35	< 0.001
	Pre-Test Mean Elapsed Time (s)	**Post-Test Mean Elapsed Time (s)**	**p-value**
Computer Module	19.84	10.83	< 0.01
Written Module	18.19	15.45	ns

Table 4: Post-test Results of Study Participants

Post-test Results[a]	Computer Module (n=17)	Written Module (n=17)	p-value
Recognized pen	17	17	
Removed grey cap	17	16	0.324
Selected outer mid-thigh as injection site	17	15	0.153
Black end injected	17	16	0.324
Adequate pressure to activate device	15	8	0.009*
Hold in place for >5s	9	3	0.031*
Overall Score (/6)	5.41	4.35	<0.001*
Change in Overall Score	+3	+2.13	0.035*
Total Time Elapsed (seconds) [b]	10.83 (2.67)	15.45 (4.87)	0.0017*

[a] Indicates participants who performed the step correctly, except for the "Overall Score", which is the sum of all parameters in the pre-test (maximum score is 6).

[b] Data reported as No. (Standard Deviation)

Table 5: Secondary Endpoints: Post-intervention Questionnaire[a]

Questionnaire Items	Computer Module (n=17)	Written Module (n=17)	p-value
1. How did the module improve your understanding of administering an EpiPen®?	8.91 (1.66)	7.93 (2.23)	0.154
2. How useful is the module format for teaching skills to physicians?	8.19 (1.87)	7.76 (1.89)	0.516
3. How comfortable are you with administering an EpiPen® for management of anaphylaxis?	8.71 (1.95)	8.15 (2.17)	0.435
4. How comfortable are you with teaching the use of EpiPen® for management of anaphylaxis?	7.87 (2.31)	8.10 (2.26)	0.772
5. How likely are you to use the module to teach your patients about the use of an EpiPen®?	8.76 (1.65)	8.60 (1.53)	0.773
6. If given option of how to learn, would you choose the module to which you were randomized?	17 (100.0%)	12 (71%)	

[a] Scored on a Visual Analogue Scale of 0 (low) – 10 (high) (Standard Deviation)

regard to their ability to use the EpiPen®, and most do not use it when the need arises.[5] When patients do use the EpiPen®, they may employ the device incorrectly and we cannot be assured that they received a therapeutic dose of epinephrine. A surprisingly common complication of EpiPen® use is digital ischemia: there is a series of case reports in which the patient held the EpiPen® in an inverted manner and injected the epinephrine into a finger, creating a second emergency.[15,16,17,18]

Physicians frequently fail to instruct their patients on use of the EpiPen®. It is likely that physicians' lack of familiarity with the device is contributing to the lack of patient instruction.[8] Computer modules provide a potential vector for teaching technical skills to physicians.

Current medical literature is ambiguous in regard to the effectiveness of computer modules as a teaching tool: knowledge and skill retention rates have demonstrated no difference in some studies comparing didactic teaching to computer modules, and others have favoured one modality over the other.[9] However, much of the literature is focused on acquisition of conceptual knowledge while the current study focuses on acquisition of a psychomotor skill. A previous study involving medical students found computer modules to be superior to written modules in the teaching of nose packing for epistaxis management.[9]

Previous studies have demonstrated that patients, their families, residents, and attending physicians lack familiarity with use of the EpiPen®.[5,8] As expected, the low pre-test performance of participants from both groups in our study confirmed the lack of training (Table 1). This demonstrates that use of the EpiPen® is not entirely intuitive and requires at least some level of training for effective and safe use.

In this study, participants from both groups demonstrated statistically significant improvements in performance on the post-test with training. Additionally, there was a statistically significant post-test difference favouring the computer module group over the written module group (Table 2). This leads to the suggestion that the computer module group was able to learn the skill more effectively than their written module counterparts. Since both modules were designed to cover the same content, it is unlikely that these differences can be attributed to content discrepancies. Participants in the computer module group were able to benefit from continuous audio-visual input as opposed to written text and static images.

Additionally, unlike with written materials, real-time demonstrations are possible using computer modules. The computer module group had significantly better performance in the final two steps of the procedure compared to the written module group. The fifth step involved applying adequate pressure to activate the device; this was confirmed when a 'clicking' sound was made, and the sound was audible in the computer module. This step is limited by the fact that the study involves a trainer EpiPen®. Many participants seemed wary of the training device although they were informed at the start of the study that it did not contain a needle nor any medication. However, they were not permitted to ask questions during the demonstrations and this may have resulted in some participants in both groups applying less pressure and failing this step. It seems reasonable that many participants would apply more pressure in an emergency setting in order to provide an intramuscular injection but this would be difficult to evaluate.

The final step in the checklist evaluation required the participant to hold the EpiPen in place for at least five seconds. The computer module group did perform better in this final step and it is possible that this group had a better appreciation of the time required to administer the epinephrine because they were able to see the demonstration in real-time. Performance across both groups was poor for this final step in the post-test demonstration (53% for computer module, 18% for written module). This suggests that future modules that involve a timed step should place greater emphasis upon this during the training. Medical trainees work in a busy environment and may have underestimated how long 5 seconds is or undervalued the significance of holding the device in place for 5 seconds. The latter point does have some merit: we chose an objective measure of 5 seconds that has been previously used

as a research tool; the clinical significance of holding the device in place for 5 seconds has not been established and an adequate dose may be possible with a shorter duration of injection.[5,8]

The present study does have limitations, including the absence of a cross-over design. Furthermore, it compares only two possible learning modalities. Future studies should aim to explore didactic learning, small group seminars, and direct instruction from an expert. While this study demonstrates short-term skill acquisition, long-term skill retention is unknown.

Conclusion

Professional organizations have begun to adopt computer modules for medical education at all levels of training.[9] This is beneficial for the trainees because they can access peer-reviewed modules produced by experts. Given the global reach of the internet, computer modules have the potential to provide medical professionals with improved access to medical training tools. Prior to implementation, modules must be studied empirically to ensure efficacy in skill acquisition.

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