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Title: Using an Interactive Self-Directed Module to Teach Nicotine Use Disorder Management

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ABSTRACT

Background

Tobacco use is the largest and most preventable cause of morbidity and mortality. Though cessation counseling is an effective treatment, its priority is lowered in overcrowded medical curricula, reducing students' confidence in clinical counseling. Self-directed e-modules help with didactic lectures and could be used to teach nicotine cessation practices. This study evaluated an interactive self-directed module on students' knowledge acquisition and confidence in nicotine use disorder management.

Methods

This pre-post interventional study had 155 medical students complete the module between January and December 2022. Students were given knowledge-based pre- and post-module tests, and later a post-module survey to evaluate their learning experience and comfort with nicotine use disorder management. Paired differences between pre- and post-module tests were assessed for the overall- and question-specific scores. The survey data was qualitatively analyzed.

Results

The module significantly improved students' overall test scores with a mean difference of 13.4 (95% CI: 10.5-16.3) between the pre- and post-module tests. There was a significant increase in understanding of electronic nicotine devices' role in smoking cessation (difference: 29.7; CI: 21.2-38.2), evidence-based pharmacology therapy (difference:15.5; CI: 9.2-21.8), and combination treatment plans (difference: 16.1; CI: 8.8-16.1). Topics related to nicotine use disorder diagnosis and the harms of electronic nicotine devices showed no significant change. Additionally, students self-reported a significant improvement in comfort with nicotine use disorder management (difference: 0.75; CI: 0.58-0.93).

Conclusion

Medical students developed knowledge of and confidence in nicotine use disorder management with this interactive self-directed e-module.

Keywords: self-directed learning; nicotine use disorder; smoking cessation; electronic nicotine delivery systems; medical education

Introduction

Tobacco use is a leading preventable cause of mortality, with more than 8 million deaths worldwide annually.[1] Smoking cessation is an effective intervention to reduce nicotine use disorder (NUD) and its complications, like myocardial infarction.[2] However, surveys show that the pathophysiology and treatment for NUD are not adequately covered in the medical curricula, with a national survey in Germany showing that less than 10% of graduating students feel comfortable counseling patients willing to quit smoking.[2] Students are even less confident with electronic nicotine delivery systems (ENDS) counseling given its rising prevalence since the turn of the century.[3] Some reported barriers to implementing smoking cessation teaching include curriculum crowding, insufficient funding, and the low priority placed on smoking cessation counseling.[2,4] Given the burden of disease and the clinical effectiveness of smoking cessation interventions, medical curricula need to teach practical skills in managing NUD.[5]

In response to the 2019 pandemic, most learning transitioned online. Studies showed that electronic learning (e-learning) was comparable to in-person didactic lectures regarding knowledge acquisition.[6-9] Therefore, a self-directed interactive PowerPoint® module may be a solution to teaching the knowledge needed for NUD diagnosis and management in a crowded curriculum due to its immediate feedback and self-paced tempo. The objective of this study was to evaluate the impact of a self-directed interactive teaching module on medical students' knowledge and comfort with managing NUD.

Methods

Participants

This pre-post interventional study had one-hundred fifty-five medical students at a large, academic, tertiary care center complete the self-directed interactive e-module on NUD management as a rotation requirement during their Internal Medicine clerkship between January - December 2022. Students were in their clinical year of medical training (year 2 or year 3 of medical school) and had no prior formal teaching on NUD management. The project was determined to be a non-human subjects research by the local Human Subjects Office/Institutional Review Board in October 2021 (IRB ID: 202110118).

Module Design

The module used PowerPoint®, an accessible software, to address: the presentation and diagnosis of nicotine withdrawal, the impact of ENDS and their role in smoking cessation, and evidence-based NUD treatments. The research team made a 30-minute module that follows a patient who presents with nicotine withdrawal symptoms. Students are asked to diagnose the patient, explore if ENDs can be a treatment as a response to the patient's request, and then explore alternative evidence-based NUD treatments. Each slide provided information related to the case and asked for the "next best step" in management. If the best answer was selected, students would progress through the case; otherwise, they would be re-directed to slides clarifying that topic. Each slide included a voice recording summarizing the slide to diversify methods of receiving information. At the end of the module, a summary slide reviewed the key points of the diagnostic tools and treatments for NUD.

Study Protocol

On Day 1, students completed an online 5-question multiple-choice pre-module test, which was untimed and unsupervised, to assess their baseline knowledge of NUD management (Appendix A). Both pre- and post-module tests were graded only on timely completion, rather than percent correct. Given the test's low-stakes nature, students likely went through the module at their own learning pace and were unlikely to use supplementary materials during the tests, though their use was not expressly prohibited. Pre-test responses were recorded, but the correct answers were not provided. On Day 3, students were given access to the module. They had 11 days to complete the module *ad libitum,* immediately after which, students did the same online 5-question test, untimed and unsupervised. Upon completing the post-module test, students were given the answers to the questions with detailed explanations for each distractor answer. They were also given the professor's email for further questions. Students were encouraged to complete an end-of-module survey that had 2 Likert questions comparing their pre- and post-module knowledge, and two free-text questions asking about their experience with the module (Appendix B). The data was collected by the Internal Medicine clerkship, who anonymized the year-worth of data. They only provided the researchers with the overall test scores, the score breakdown for each question, and survey responses.

Outcomes

The primary outcome measure was the difference between the overall and question-specific pre-and post-module test scores. The secondary outcomes were students' opinions on learning from the module, and the change in students' confidence using NUD evidence-based practices.

Statistical Analysis

The test questions' ability to accurately assess the mastery of the content was evaluated using a point-biserial correlation; which checks how well each question distinguishes between students who understand the topic and those who do not. The differences in overall and question-specific pre- and post-module test scores were measured using paired t-tests (alpha = 0.05) and a 95% confidence interval (CI). CI is a range of values in which the true difference would likely occur 95% of the time; and is significant if it does not cross zero as a non-zero value means that some difference exists. Students' confidence in cessation counseling was measured with a weighted average of their responses on the Likert scale. Pre- and post-module averages were compared using a paired t-test. Additionally, common themes (mentioned >5% of the time) on the two free-response items (primary takeaway points and module feedback) were qualitatively analyzed. All statistical analyses were completed using SAS software v9.5 (Cary, NC).[10]

Results

Knowledge acquisition questions were deemed to be effective measures to discriminate between students who mastered the content and those who did not, as the point biserial of correct answers for all questions was > 0.25 [11], indicating that students who performed well overall, did so with consistency.

Students' knowledge acquisition following the module significantly improved as suggested by the overall pre- and post-module scores (difference: 13.4; 95% CI: 10.5-16.3). Additionally, there was a significant

improvement in the understanding of ENDS use in smoking cessation (Q2 - difference: 29.7; CI: 21.2-38.2), evidence-based medications (Q4 - difference: 15.5; IQR: 9.2-21.8), and combined treatment options (Q5 - difference: 16.1; IQR: 8.8-16.1). Q1 (nicotine withdrawal symptoms) and Q3 (risks of ENDS) had high pre- and post-test scores; therefore, there was no significant change in students' understanding before and after the module (Table 1).

The post-module survey was completed by 96 (61.9%) students. Ninety-four (97.9%) students agreed or strongly agreed that medications and counseling are effective in smoking cessation, an increase from 87 (90.6%) prior to the module. Eighty-three students (86.5%) agreed or strongly agreed that they were comfortable using medications for NUD, an increase from only 43 (44.8%) prior to the module. After the module, students noted a statistically significant increase in both knowledge acquisition of (difference: 0.30; CI 0.20-0.40) and confidence in (difference: 0.75; CI 0.58-0.93) NUD management (Table 2).

With regards to the clinical pearl question, 29 (30.2%) students learned about the pros and cons of evidence-based pharmacological treatments, 26 (27.1%) students learned about practices related to prescribing and following-up, 16 (16.7%) students took away the importance of combination management with pharmacologic and non-pharmacologic options, 9 (9.4%) learned about the use of ENDS in NUD management, and 8 (8.3%) students noted improved understanding of NUD evaluation.

Finally, with respect to module feedback, 51 students (53.1%) provided no additional comments, 14 students (14.6%) requested more information on counseling treatments, and 13 students (13.5%) commented on the audio. Students had concerns about not being able to speed up the audio, the audio not adding to what was on the slide, or suggested video-recorded lectures as an alternative.

Discussion

This study found that an interactive self-directed module significantly improved students' overall understanding of NUD management. Specifically, it improved their understanding of: the role of ENDS in smoking cessation, the evidence-based medications available for NUD, and the combined pharmacologic and non-pharmacologic NUD management. There was no significant change in identifying nicotine withdrawal or the harms of ENDS, topics taught in preclinical curriculums.[2-4] This finding is also supported by students' reporting a better understanding of NUD management. Based on qualitative analyses, the module improved students' confidence in prescribing evidence-based medications and following up on patients with NUD.

This study highlights the knowledge gap in ENDS use. Unlike prior studies, this study showed that students were aware of the negative consequences of ENDS (Q3 96.1%); however, similar to those studies, students did not know ENDS' role in smoking cessation (Q2 45.8%).[3] ENDS role in NUD management had the lowest average test scores before and after the module, though there was a significant improvement following learning from the module. Since all the questions had appropriate point biserial values, the low score suggests that students are uncertain about the use of ENDS in NUD management.

Limitations of this study include its single-site population and short-term follow-up evaluation. This limits the study's generalizability and assessment of long-term knowledge retention. Although students reported confidence in NUD management, this study did not evaluate for skill acquisition. Incorporating NUD management as an observed clinical skilled assessment could be considered. Finally, though this module improved students' clinical knowledge and comfort with NUD management, how this medium compares to an in-person lecture or an alternate medium like a video lecture is unknown and could be further investigated.

Conclusion

Given the rising prevalence of ENDS and the clinical effectiveness of nicotine cessation interventions, this study demonstrated that an interactive self-directed module can improve students' knowledge of and comfort with managing NUD. Though further studies are needed to evaluate long-term knowledge retention and clinical skill acquisition, an online interactive module may be a solution to developing clinical knowledge related to NUD management in a crowded curriculum that places a lower priority on nicotine cessation counseling.[2,4]

SUMMARY - ACCELERATING TRANSLATION

Using an Interactive Self-Directed Module to Teach Nicotine Use Disorder Management

Tobacco use is the largest and most preventable cause of morbidity and mortality. Though cessation counseling is an effective treatment, its priority is lowered in overcrowded medical curricula, reducing students' confidence in clinical counseling. Self-directed e-modules can help teach nicotine cessation while not burdening the medical syllabus. The objective of this study was to evaluate the impact of a self-directed interactive teaching module on medical students' knowledge and comfort with managing nicotine use disorder (NUD).

The research team developed a self-directed interactive e-module that taught the current diagnostic guidelines and evidence-based treatment options for NUD, including the role of electronic nicotine delivery systems (i.e. e-cigarettes). One hundred fifty-five 2nd and 3rd year medical students, without prior formal training in NUD management, completed the module at their own pace. There were mandatory knowledge-based pre- and post-module tests. They were then encouraged to complete an optional post-module survey to evaluate their learning experience and comfort with nicotine use disorder management.

Data analysis showed that the module significantly improved students' overall test scores with a significant increase in: (1) understanding of electronic nicotine devices' role in smoking, (2) evidence-based pharmacology therapy, and (3) combination treatment plans. Topics related to nicotine use disorder diagnosis and the harms of electronic nicotine devices showed no significant change. Additionally, students self-reported a significant improvement in comfort with nicotine use disorder management following learning from

the module. Though further studies are needed to evaluate long-term knowledge retention and clinical skill acquisition, an online interactive module may be a solution to developing clinical knowledge and confidence related to NUD management in a crowded curriculum that places a lower priority on nicotine cessation counseling.

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Table 1. Mean Paired Difference in Test Scores Before and After the Nicotine Use Disorder Management Module (n = 155)

	Pre-Test Score (%)	Post-Test Score (%)	Mean Paired Difference	Standard Deviation	95% CI for Mean Paired Difference
Overall	78.6	92.0	13.4[a]	18.4	10.5 – 16.3
Q1	94.2	95.1	3.9	27.6	[-8.3] – 0.5
Q2	45.8	75.5	29.7[a]	53.7	21.2-38.2
Q3	96.1	98.1	1.9	21.2	[-5.3]-1.4
Q4	81.9	97.4	15.5[a]	39.7	9.2-21.8
Q5	74.8	91.0	16.1[a]	46.3	8.8-16.1

[a] statistically significant mean difference with an α = 0.05
Q1: NUD Diagnosis | Q2: ENDS role in smoking cessation | Q3: Harms of ENDS | Q4: Pharmacologic Therapy | Q5: Combination treatment plans

Table 2. Weighted Average of Likert Scale Scores Before and After Nicotine Educational Module[a] (n = 96)

	Before	After	Mean Paired Difference	Standard Deviation	95% CI
Q1: *Knowledge Acquisition*	4.26	4.56	0.30	0.48	0.20-0.40
Q2*: Comfort with NUD management*	3.26	4.01	0.75	0.89	0.58-0.93

[a] Mean Likert scale scores: Strongly Disagree (1) – Strongly Agree (5)

Appendix A

Pre- and Post-Test Questions

1) Leif is a 50-year-old male who comes to you after quitting smoking three weeks ago. He reports he has not been sleeping well and has noticed problems focusing at work. His spouse notes he has seemed more irritable, too. He also has been feeling down and notes weight loss.
Which of the following is NOT a symptom of nicotine withdrawal?

A) Difficulty concentrating
B) Sleep problems
C) Depression
D) Weight loss

2) Toby is a 24 yo who presents for his annual physical. He tells you that he would like to stop smoking due to financial reasons. However, cigarettes help him relax during his work-related stress and long days where he is barely able to get enough sleep. In the past, he has tried patches, gums, and some medication that he does not remember, but none of them worked. Therefore, he decided to step down and use a vape pen. He has been using it for 6 months, without touching a cigarette. He currently swears by it. What is your next step?

A) Suggest trying a nicotine nasal spray
B) Refer him to a smoking cessation group
C) Discuss setting a stop date for the vape pen
D) Provide reassurance that vaping is shown to help with smoking cessation

3) Nico is a 16yo who vapes with his friends. When discussing the risk of vaping, he says that it is safer than cigarettes and will not lead to cancer, so he is not interested in stopping it. Which of the following counseling points is the most accurate?

A) Vaping has the same amount carcinogens as cigarettes.
B) Vaping has more nicotine exposure than cigarettes.
C) Vapes were developed to help with smoking cessation
D) Vapes produce free radicals that can lead to lung damage, like cigarettes.

4) Alex is a 36-year-old who has expressed interest in smoking cessation. He decides that he would like to try a medication for smoking cessation. Which of the following is TRUE about pharmacotherapy for smoking cessation?

A. Buprenorphine is a first-line agent for smoking cessation
B. Bupropion, varenicline, and nicotine replacement are each more effective for smoking cessation than placebo
C. Varenicline is contraindicated in patients with bulimia
D. All forms of nicotine replacement therapy are rapid acting and require frequent redosing
E. Due to seizure risk, bupropion should not be used in conjunction with varenicline

5) Trixie is a 30-year-old with a history of epilepsy, who currently smokes 1 pack of cigarettes per day. She is interested in smoking cessation. She tried to quit cold turkey 3 years ago, and it worked for 5 months, however, she returned to smoking due to poor sleep and irritability. She again stopped smoking using nicotine gum but returned use having morning nicotine cravings while experiencing an increase in interpersonal stress. She presents today, interested in trying a nicotine replacement. Which of the following treatment plans includes the most evidence-based interventions?

A) Have her use a patch while smoking ½ a pack and slowly have her wean off smoking
B) Prescribe the nicotine patch only as it may have better success than the gum
C) Provide the nicotine patch and refer her to a local therapist.
D) Prescribe the nicotine patch with bupropion.

Answers

1) D: Weight loss. Weight gain, not weight loss, can be a symptom of nicotine withdrawal. People may gain 10-15 pounds on average. This may be due to loss of the appetite-suppressing effects of nicotine. People who quit smoking may also eat more to keep their hands and mouth busy to replace the behavior of smoking.

Difficulty concentrating, sleep problems, and depression can all be symptoms of nicotine withdrawal. Other symptoms of nicotine withdrawal include irritability, anxiety, restlessness, and cravings.

2) C: Given that Toby found a method that works for him, we should try to use that to work towards smoking cessation. He has tried many different NRTs, so trying another one may not be helpful (Choice A). He barely has enough time in a day for himself, so he probably won't follow through with a group (Choice B). Though vaping may help with smoking reduction and move individuals away from cigarettes, it is not found to help with cessation (Choice D). Therefore, we need to discuss a plan to slowly wean of vaping.

3) D: Vaping does have fewer carcinogens than cigarettes (Choice A), and can have reduced nicotine exposure depending on use (Choice B), however, they still produce radicals via combustion (Choice D). There is no conclusive evidence that vaping helps with smoking cessation.(Choice C)

4) B: While varenicline has the highest quality evidence to support its use, either nicotine replacement therapy, varenicline, or bupropion may be considered based on individual patient factors. Generally, varenicline or NRT are recommended as first line treatment. However, bupropion may be suited to patients who previously had success with bupropion, have comorbid untreated depression, or have financial concerns.

A) is Incorrect – buprenorphine is a medication for opioid use disorder and does not currently have a role in smoking cessation
C) is incorrect – bupropion is contraindicated in patients at risk for seizure, such as those with potential electrolyte derangements due to purging behaviors
D) is incorrect – many forms of nicotine replacement are long acting, such as a patch. Optimal therapy often includes a combination of long acting and short acting forms.
E) is incorrect – bupropion carries an increased risk of seizure, but varenicline does not amplify this risk. Combination bupropion + varenicline may in fact be more effective than varenicline alone.

5) C: Trixie has epilepsy so she should avoid bupropion (Choice D). Her journey to smoking cessation is interrupted by stressors. Therefore some form of counseling may help her in addition to the patch. (Choice C not Choice B) There is a risk of nicotine toxicity with using a patch and smoking simultaneously and titrating become difficult (Choice A not the best answer).

Appendix B

Post-Module Survey

Q1. Medications and counseling are effective in helping people stop smoking.

Prior to Module:
(Strongly Disagree) 1 2 3 4 5 (Strongly Agree)
After the Module:
(Strongly Disagree) 1 2 3 4 5 (Strongly Agree)

Q2. I am comfortable using medications for nicotine use disorder.

Prior to Module:
(Strongly Disagree) 1 2 3 4 5 (Strongly Agree)
After the Module:
(Strongly Disagree) 1 2 3 4 5 (Strongly Agree)

Q3. List at least 1 clinical pearl you plan to implement into the care of people with NUD.

Q4. List at least 1 way this module could be improved and any other feedback you wish to share.