



Team-Based Learning Module for Undergraduate Medical Education: a Module Focused on the Human Papilloma Virus to Increase Willingness to Vaccinate

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Abstract

Human papilloma virus (HPV) vaccination rates lag behind other vaccines, primarily because of weak provider recommendations, and are associated with nearly 30,000 new cancer diagnoses a year. Educating medical students about HPV using active, team-centered learning may increase assimilation of information and may increase vaccination rates. A team-based learning (TBL) module focused on HPV for first-year medical students about HPV will better increase knowledge and likeliness to vaccinate than traditional education methods. Baseline HPV knowledge in medical students across Texas was assessed by surveying all 4-year undergraduate medical schools. Students at one medical school then participated in a week-long TBL focused on basic and clinical concepts relating to HPV, and then were re-surveyed upon completion of the course module. At baseline assessment, first-year student at the intervention site performed at the same level as first-year medical students across the state of Texas on knowledge and satisfaction with their HPV-related medical school education. After the TBL implementation, students performed significantly better than similar-year students and equal to graduating seniors, on knowledge of HPV- and HPV-related cancers, and report significantly higher satisfaction with education measures. Students at the intervention site were significantly more likely to recommend the HPV vaccination in future practice. Short-term knowledge and willingness to recommend vaccination are improved with a targeted HPV TBL early in medical education, which may provide a basis of knowledge that could translate into improved vaccination rates.

Keywords Team-based learning · HPV · Vaccine education

Introduction

Human papilloma virus, or HPV, is a recognized potential cause of 38,793 newly diagnosed cases of cervical, oropharyngeal, vaginal, anal, and penile cancer across the USA each year [1]. However, despite the CDC recommendation for universal adolescent vaccination against HPV, the vaccination rate for HPV has significantly lagged behind that of other adolescent vaccines [3]. Healthcare provider recommendation

to patients and parents is one of the single best predictors of adolescent uptake in HPV, and yet, only two thirds of adolescent females and one quarter of adolescent males will receive the recommendation for the HPV vaccine in the USA [2, 3]. Lack of strong provider recommendation may be linked to deficits in physician knowledge about HPV, as providers with more knowledge have been found to consistently report higher intentions to recommend the vaccine [4–6].

In light of the importance of HPV knowledge in protecting future generations against HPV-related morbidity and mortality, educational initiatives aimed at current medical students may be an avenue to enhance provider knowledge and thereby improve vaccination rates. In recent years, undergraduate medical education has undergone a shift from teacher-centered passive learning to student-centered, active learning using clinical scenarios [7]. As a part of improving pre-clinical education, McGovern Medical School transitioned to a student-centered curriculum in 2016, designed to reflect the

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cultural shift in medical education towards increased active group learning. The goal of multimodality teaching techniques is to emphasize concepts and application, as well as communication skills in small groups. Each module was focused on a specific clinical topic, and related basic science concepts are taught to accompany that focus. To test whether these implemented multimodal teaching techniques could improve future provider knowledge on HPV, one such module was designed around HPV-related cancers and vaccine-related education.

Prior research on medical students' familiarity with HPV and HPV-related disease has indicated that students are not attaining an adequate level of knowledge of HPV [3] or of vaccination education in general to feel comfortable in future clinical practice [6]. Team-based learning, or TBL, is being increasingly used as a tool in medical education to enhance student's comprehension, since previous work with TBL has indicated that students have enhanced mastery of concepts after use of team-based techniques, especially students in the lower quartiles of their class [4].

There have already been efforts to educate medical students using team-based or case-based modules on immunization. A curricula called TIME was developed to help promote preventative medicine skills and showed that students significantly improved knowledge and approved of team- or problem-based learning as a method of teaching about immunizations [5]. Additionally in studies of medical students in France, students who were exposed to vaccine-related education using team- or problem-based experiential learning retained more knowledge and were more satisfied with their education than traditional, lecture-based courses [4]. However, team- or problem-based learning has not been used to teach about HPV and HPV vaccination.

In this study, we adapt team-based learning initiatives in line with McGovern Medical School's curriculum in order to effectively teach medical students about HPV-related cancers and communication. First-year medical students at McGovern Medical School were exposed to a dedicated HPV-related team-based learning activity, and attitudes about HPV, future vaccination, and education quality were compared to other medical schools across the state.

Methods

This research project was reviewed and approved by the UT Health Science Center at Houston and MD Anderson Institutional Review Board.

Team-Based Learning Exercise

The HPV team-based learning exercise was a week-long learning experience, organized as shown in Fig. 1. On day 1,

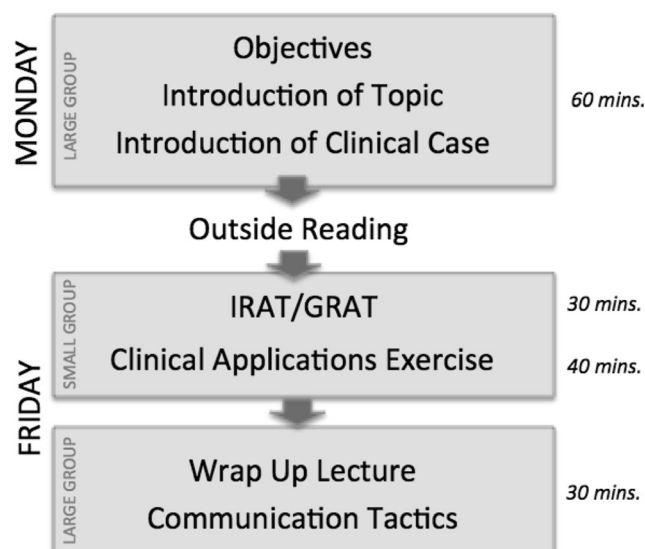


Fig. 1 Step by step organization of TBL session. The session took place in two organized sessions over the course of 1 week, with assigned readings for students on their own

students were introduced to the topic, objectives, and basics of HPV virology and immunology in an hour-long lecture. They subsequently watched a short video of a clinical scenario involving HPV vaccination between a patient and a physician, and were introduced to a thematic patient case on HPV-related cancers, and given primary literature references [8–10] to read on HPV over the course of the week. During the week, more traditional lecture style courses on the basics of immunology and microbiology were given to the students. On day 5, students were given a multiple-choice quiz in two short 15-min sessions, first as individuals as an IRAT (individual readiness assurance test), and then in a small-group setting as a GRAT (group readiness assurance test). They were then given 40 min as a small group to work through an application of 15-question multiple-choice and short-answer questions based on the patient case, during which they were allowed access to the Internet, videos, and textbooks. The class reconvened after the application exercise for a clarification session on HPV immunization, communication tools, and clinical relevance of the topic. The total amount of class time for the dedicated HPV experience was approximately 3 h.

Survey Distribution

All first-year medical students ($n = 234$) at McGovern Medical School were invited to participate in this study. An e-mail invitation to a Qualtrics survey link was sent out from UT Student affairs on each week for 3 weeks, 1 month before the team-based learning session, and concluding 1 week before the TBL. Students who participated in the pre-test were invited via e-mail 1 month after conclusion of the exercise to

participate in the post-TBL survey, with up to three reminder e-mails.

Additionally, students across the state of Texas of all levels of medical education were invited by their student affairs departments to participate in a baseline knowledge survey. E-mail invites to approximately 6000 total students for the Qualtrics survey were sent out from each school three times during the fall semester. The other medical schools utilized variety of education methods, some depending heavily on traditional teaching methods and others utilizing flipped classroom- or team-based methods; however, none contained a dedicated HPV-related module.

Survey Instrument and Development

The online survey consisted of five sections, totaling 37 questions. In the first section, participants answered demographic information, including age, gender, year, ethnicity, and prospective specialty. The next two sections were focused on HPV-related knowledge. They completed questions on HPV knowledge with two different subsections related to HPV general knowledge and vaccination-related knowledge. The second subsection included topics such as mechanism of disease, pathogenesis, and transmission. The third subsection included topics related to HPV vaccination, including efficacy, indications, and risk to HPV vaccination. There were 41 questions in total, spread across true/false questions, and multiple-choice questions with 25 related to general knowledge and 16 related to HPV vaccination. This questionnaire was piloted among 15 upper level medical students and faculty before release to ensure questions were unambiguous and instructions were clear. No major changes were made to the survey.

Data Collection and Analysis

The survey distribution parameters were configured to ensure response anonymity, and each respondent was assigned an ID to link pre- and post-test responses. Data was collected through Qualtrics, and descriptive statistics are presented in this report, as well as hypothesis testing against statewide scores using an unpaired *t* test and pre-/post-test scores using a paired *t* test.

Results

Study Participants

In total, 239 students were invited to participate in the pre-test survey at McGovern Medical School. Ninety-three students responded to the initial survey (rate = 38.9%) and of those, 61 completed the post-test survey, for a follow-up response rate of 25.5%.

Demographics of this cohort of study participants were consistent with the demographics from the general population of medical students across Texas. The total population surveyed was 6058 students, of which 896 responded for a response rate of 14.8%. The population was 58% female, majority 20–25 years old (95% for McGovern and 99% for Texas schools), and majority identifying as White (68% for McGovern and 71% for Texas schools).

Knowledge Scores

For the knowledge section of the survey, there were 41 questions in total, spread across true/false questions and multiple-choice questions with 25 related to general knowledge and 16 related to HPV vaccination. The results of the knowledge subsections can be found in Table 1. There were no significant differences between the pre-test scores among statewide first-year medical student population and the McGovern Medical School TBL cohort in terms of total knowledge (TBL group = 66.3%, statewide = 64.5%), general knowledge (TBL group = 58.4%, statewide = 58.1%), and vaccine-related knowledge (TBL group = 78.8%, statewide = 75.3%). In contrast, the post-TBL, post-test cohort, demonstrated significant improvements from baseline pre-test scores (post-test = 87.6%, $P < 0.001$), general knowledge (post-test = 85.3%, $P < 0.001$), and vaccine-related knowledge (post-test = 91.7%, $P < 0.001$). First-year medical students post-test surveys did not differ significantly from the scores of graduating students across the state of Texas, except in vaccine knowledge, where MS1 students in the test population scored significantly higher than graduating seniors across the state (TBL group = 91.9%, statewide = 81.8%, $P < 0.001$).

Satisfaction with Education

Students were surveyed using 5-point Likert scales on their perception of their education quality in terms of pathophysiology and clinical impact of HPV, counseling and indications for the HPV vaccination, and comfort with talking with patients on HPV and vaccinations in general, as show in Table 2. First-year students at McGovern Medical School's pre-test scores for satisfaction with education were similar to statewide MS1 perception in general education (pre-test = 2.05 vs. state MS1 = 2.35), vaccination education (pre-test = 2.09 vs. state MS1 = 2.45), or comfort in patient care (pre-test = 2.89 vs. state MS1 = 3.17). Post-test satisfaction was significantly improved over pre-test for general knowledge (post-test = 4.3, $P < 0.001$), vaccine education (post-test = 4.44, $P < 0.001$), and comfort in patient care (post-test = 4.25, $P < 0.001$). Most notably, the post-test satisfaction with education was improved over graduating seniors' perception of their 4 years of education across the state of Texas, as summarized in Table 2.

Table 1 Knowledge scores. Percent correct was calculated from a possible 41 points for overall score, 25 questions for general knowledge, and 16 questions for vaccine-related knowledge. The questions were a mix of true/false and multiple choice

	TBL intervention		Traditional HPV education	
	Pre-TBL (%)	Post-TBL (%)	Statewide MS1 (%)	Statewide MS4 (%)
Total knowledge scores	66.3	86.3	64.8	82.6
General knowledge	58.4	83.2	58.1	83.2
Vaccine-related knowledge	78.8	91.9	75.3	81.8

Recommendation of Vaccination

Students were asked how likely they were to recommend the vaccination on a 5-point Likert scale when they were providers, with 5 being extremely likely and 1 being will not recommend at all. The average score for recommending vaccination in the pre-test group was 3.82 and the state at large was 4.02, which was not significantly different. Post-test, the likelihood of recommending the vaccine was 4.8, with 100% of participants reporting that they would recommend the vaccine compared to 58% in the pre-test. Additionally, 82% of those reported that they were extremely likely to recommend the vaccine vs. 41% in the pre-test.

We further compared differences in knowledge scores between respondents who reported being hesitant or ambivalent about vaccination compared with those who reported being likely or strongly recommend the vaccination, as summarized in Table 3. In the statewide population, respondents who reported being hesitant or ambivalent about vaccination scored significantly lower on general and total knowledge tests for HPV than all other respondents (total knowledge recommend vaccination 79.6%, not willing 70.4%, $p < 0.001$; general knowledge recommend vaccination 77.8%, not willing 64.4%, $p < 0.001$; and vaccine knowledge recommend vaccination 82.4%, not willing $p = 0.016$). In the pre-test cohort, a similar pattern was found for general and total knowledge, but not vaccination knowledge (total knowledge recommend vaccination 70.5%, not willing 63.8%, $p = 0.026$; general knowledge recommend vaccination 63.3%, not willing 55.2%, $p = 0.03$; and vaccine knowledge recommend vaccination 81.3%, not willing 76.9% $p = 0.183$). In the post-test cohort, no

students indicated that they would be hesitant to recommend vaccination in the post-intervention group. In this study, gender or vaccination status did not have any significant relationship to willingness to recommend vaccination.

Discussion

HPV-related disease is a significant burden in Texas, and universal vaccination could make a significant impact in mortality and cost [1]. Provider recommendation remains one of the most important aspects of patients' willingness for vaccination [3], and so how future providers are educated about HPV is an important potential area to increase future vaccination rates. The results of this study demonstrate that TBL learning is an effective method to teach general and vaccine-related HPV knowledge and patient communication skills, ultimately resulting in enhanced willingness to recommend vaccination in future practice.

Students showed a significant improvement in general and vaccine-related HPV knowledge, equal to the knowledge among graduating medical seniors across the state and superior specifically in the case of vaccine-related knowledge. Students made the greatest gains in knowledge regarding which cancers and precancerous diseases are associated with HPV, and general knowledge of high-risk HPV.

This improvement in HPV-related knowledge has implications for future practitioners. Across the state of Texas, students who were unwilling or hesitant to recommend vaccination to future patients had lower scores on all measures of this study, as well as students unwilling to vaccinate in the pre-test

Table 2 Education satisfaction scores. Students were asked on a 5-point Likert scale, with 5 being strongly agree, how well they thought their school educated them in various HPV-related topics. There were a total of 10 questions, with 3 questions on general knowledge, 3 on vaccine indications, and 4 on comfort in patient care

	TBL intervention		Traditional HPV education	
	Pre-TBL	Post-TBL	Statewide MS1	Statewide MS4
Satisfaction with education in:				
General education	2.05	4.3	2.35	3.8
Vaccination-related education	2.09	4.44	2.45	3.81
Comfort in patient care	2.89	4.25	3.17	3.95

Table 3 Knowledge scores with intent to vaccinate. This compares Texas students as a whole and pre-intervention TBL student's total knowledge score, general knowledge score, and vaccination knowledge score by their intent to recommend the HPV vaccine to future patients. Knowledge significantly correlated with intent to vaccinate in all but vaccination knowledge for the pre-intervention students

		Will not recommend (%)	Strongly recommend (%)	Significance
Texas	Total	70.4	79.6	< 0.001
	General	64.4	77.8	< 0.001
	Vaccination	79.8	82.4	0.016
Pre-intervention	Total	63.8	70.5	0.026
	General	55.2	63.6	0.03
	Vaccination	76.9	81.3	0.183

portion of our intervention. However, the results of this study suggest that TBL education facilitates changes in knowledge and opinion even in an “unwilling or ambivalent” cohort. In the post-test, all students were willing to vaccinate, and a significant rise in general and vaccination-related knowledge was seen.

Intent to vaccinate correlated with the knowledge scores students both in the intervention and statewide study groups had for total, general, and vaccination knowledge (only in the statewide group). Our results are consistent with a study of medical students in China, which demonstrated that greater knowledge of HPV and HPV vaccination in general increases willingness of future providers to vaccinate [6]. This pattern provides evidence that interventions aimed at creating robust knowledge increases at the medical school level at least improve intent to vaccinate.

As one of the most significant barriers to improving the uptake of the HPV vaccine and meeting the Healthy People 2020 goal of 80% coverage is the lack of a strong provider recommendation, intent to vaccinate may be an important area to improve upon. As a result of this TBL, recommendations of HPV vaccination among the first-year medical student class increased from 58 to 100%, with 82% extremely likely to recommend. This is a stronger recommendation than that seen from graduating medical students across the state of Texas, with a rate of 87.4% likely to recommend and 60.3% extremely likely to recommend. If this rate of recommendation persists, it would have significant impact on the vaccine coverage of Texas, and the eventual reduction of HPV-related morbidity and mortality.

Additionally, students reported feeling more prepared discussing vaccines with vaccine-hesitant patients and were more satisfied with their education on who and how to approach for HPV vaccination. Kerneis et al. found that in France, just 11% of students felt comfortable with vaccine-related conversations after traditional lecture style [4]. Case-based learning resulted in 84% satisfaction with education on how to discuss vaccination with hesitant patients. According to the President's Cancer Panel on HPV, one of the most important ways to increase HPV vaccination rates is to catch

patients during “catch up visits,” or visits where vaccination and general health maintenance are not the primary concern [2]. Increased comfort and awareness of the need for HPV vaccination among future providers may decrease the number of missed opportunities to catch patients up on vaccinations and decrease the rate of HPV-related illness.

Although this study demonstrates the benefit of TBL-related medical education to teach about HPV-related knowledge, there are, nonetheless, limitations to this study. McGovern medical students' post-test scores may be inflated due to recall bias from the recent instruction of HPV teaching compared with students surveyed across the state. Similarly, they may perceive their education as superior because of recency of instruction. Despite these limitations, dedicated HPV module early in training may give students a better base to build upon in later years of undergraduate medical education. Additionally, the response rate both in the TBL-exposed population and across the state is low at 25.5 and 14.7%, so there is likely bias that students responding to the survey may have some additional interest in HPV.

Finally, a major limitation to this study is the unknown of how knowledge obtained in medical school will translate into future practice. Studies performed with both students and as continuing medical education credits with physicians show greater and more sustained gains in knowledge with problem-based, interactive learning; however, few follow providers over time to assess changes in practice patterns [5]. Graduating seniors from Texas medical schools still held several false beliefs about indications and side effects of the HPV vaccine, so while the impact on practice patterns may not be possible to predict, the hope is that a solid background will overall improve vaccination rates.

Based on the results of this study, it appears that a dedicated active learning module on human papillomavirus significantly improves future medical practitioners comfort with HPV-related cancers and willingness to advocate for vaccinations. As Texas medical schools are training the physicians that will be on the front lines, working to prevent HPV-related disease, a dedicated module on HPV, may be one tool to help increase uptake of vaccinations across Texas. While it is unknown how

early undergraduate medical education will ultimately affect practice, the results are promising in that 100% of students exposed to the module will recommend vaccination in the future, the first step to protecting Texans against HPV-related cancers.

Compliance with Ethical Standards This research project was reviewed and approved by the UT Health Science Center at Houston and MD Anderson Institutional Review Board.

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