

Original Publication

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Human Papillomavirus: From Basic Science to Clinical Management for Preclinical Medical Students

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Abstract

Introduction: Human papillomavirus (HPV) is associated with 30,000 cancer diagnoses a year, but the HPV vaccination is administered less frequently than other vaccinations. Future providers are a potential target for improving rates, and this flipped classroom module was developed to educate future vaccinators on HPV virology, vaccination, and clinical management. **Methods:** Designed as a clinical correlation for a basic science curriculum on introductory virology and immunology, this weeklong module consisted of a 1-hour lecture and case presentation, assigned articles, and a 90-minute wrap-up session including individual and group quizzes over the assigned material, a group clinical application exercise, and a 20-minute lecture on the case and real-world applications. A pre-/posttest survey was done on general knowledge of HPV, satisfaction with education, and willingness to recommend vaccination for HPV.

Results: This module was designed for first-year students, 491 of whom have performed well in it. Pre-/posttest surveys of 243 students indicated that they significantly improved their knowledge of HPV (from 66.3% premodule to 86.3% postmodule, $p < .001$) and their satisfaction with medical education on vaccination-related topics, as well as increasing their willingness to recommend vaccination (from 58% premodule to 100% postmodule, $p < .001$). **Discussion:** This module is an effective and satisfactory way to teach first-year medical students about HPV and HPV vaccination and improves reported willingness to recommend vaccination. With limited resources available to effectively teach HPV vaccination to preclinical medical students, this module fills a gap.

Keywords

TBL, Vaccination, Cervical Cancer, Preclinical, HPV, Human Papillomavirus, Oropharyngeal Cancer, Anal Cancer, Team Based

Appendices

- A. Introductory Lecture.pptx
- B. Case Presentation.mp4
- C. Individual and Group Assessment.docx
- D. Individual and Group Assessment - Instructor Copy.docx
- E. Team Exercise.docx
- F. Team Exercise - Instructor Copy.docx
- G. Closing Lecture.pptx
- H. PrePost Quiz.docx
- I. PrePost Quiz Answers.docx

All appendices are peer reviewed as integral parts of the Original Publication.

Educational Objectives

By the end of this activity, learners will be able to:

1. Describe the viral characteristics and life cycle of human papillomavirus (HPV).
2. Recognize the variety of clinical manifestations of HPV.
3. Explain the relationship of HPV to development of dysplasia and cancer.
4. Illustrate how HPV vaccination interacts with the HPV life cycle and carcinogenesis.
5. Respond to common patient and parent questions regarding the HPV vaccination.

Introduction

The human papillomavirus, also known as HPV, is a recognized potential cause of nearly 40,000 newly diagnosed cases of cancer each year across the US.¹ However, despite the link between HPV and development of cancer, the HPV vaccine has not been fully implemented across the US. The Centers for Disease Control and Prevention have recommended universal adolescent vaccination against HPV since 2011; however, the vaccination rate for HPV has significantly lagged behind other adolescent vaccines.² For example, in 2015, of adolescents ages 13-17 years, only 63% of females and 50% of males had received at least one dose of HPV vaccine compared to overall coverage of 86% for the tetanus booster vaccine and 81% for the meningococcal vaccine.³

One of the most significant factors that can predict HPV vaccine uptake is the strength of the health care provider recommendation to patients and parents.^{2,4} However, only 25% of adolescent males and 60% of adolescent females in the US will receive a recommendation for the HPV vaccine from their primary physician.^{2,4} There may be multiple reasons for the lack of a strong provider recommendation, but there is evidence that providers with more knowledge about HPV consistently report higher intentions to recommend the HPV vaccine.⁵⁻⁷ Knowledge deficits may be related to the lack of a widespread recommendation of the vaccine to US adolescents, as well as being a target for possible intervention.

Prior studies have examined medical students' familiarity with HPV and HPV-related disease and found that students are not reaching a satisfactory level of knowledge about HPV or vaccination to feel comfortable making strong recommendations in future practice.^{2,7} However, this comfort varies based on the exposure students have in medical school, and students who are exposed to experiential or case-based learning feel more prepared to answer questions from future patients.⁵

In light of the importance of HPV knowledge in protecting future generations against HPV-related morbidity and mortality, our intention was to create an interactive module that could incorporate preclinical concepts with clinical scenarios to educate preclinical medical students about HPV. This module was built as a part of McGovern Medical School's curriculum recreation to shift towards a more learner-centered curriculum with early exposure to clinical concepts. Our HPV module was built on the team-based learning approach because of growing evidence of its effectiveness and to capitalize on the improved learning shown when HPV-related concepts are taught in a case-based format; however, significant modifications were made in order to fit into McGovern's curriculum.^{5,8,9} We used multiple methods to reach students, including a video recording of a case study, traditional lecture, outside readings, and small- and large-group interactive application exercises. This work and its impact compared to traditional teaching methods in Texas have been previously published by Wiley, Shelal, Bernard, Urbauer, Toy, and Ramondetta.¹⁰ However, there are no similar modules in *MedEdPORTAL* aimed at preclinical education on HPV, and we wanted to offer a prebuilt clinical case aimed at first-year medical students during initial exposure to microbiology and immunology concepts.

Methods

This resource was developed as a group-based instruction module that used a flipped classroom format to fit into the curriculum of McGovern Medical School. We developed an introductory lecture on the basic microbiology and clinical presentation of HPV disease, offered on a Monday before any preparation materials were distributed to students. This lecture also introduced the mechanism of the HPV vaccination, indications for vaccination, and the public health impact of vaccination. Reading materials were assigned for self-study over the next week. During that week, students were given lectures on other modules as part of McGovern Medical School's larger curriculum, generally timed so the HPV module overlapped with lectures on basic immunological and microbiological topics. These lectures change based on the schedule of the other modules each year and are not essential to the administration of the HPV module. While our implementation chose to space out the administration of the module's elements over a week, the module could instead be administered on 2 consecutive days with no intervening lectures or could fit into an existing curriculum. The class reconvened on Friday for individual and group assessments. First, students participated in an individual assessment, which was performed in a test-taking format with no access to outside materials; next, the exercise was given to preassigned small groups, and they were allowed to discuss but not have access to outside materials. The class then split into teams for a team exercise, during which discussion and access to textbooks, readings, and the internet were allowed. Finally, the module concluded with a short wrap-up lecture given by a leader in the field to underline clinical significance.

As part of a larger study on HPV across the state of Texas, students were invited by an email from the Student Affairs Office to take a survey on baseline HPV and HPV vaccine knowledge and their satisfaction

with HPV-related education in medical school. This survey is not necessary for implementation of this module in other curricula; however, it did provide valuable information about the effectiveness and acceptableness of the module and has been included as Appendix H.

Facilitation Schema

- Monday:
 - 60-minute lecture and case presentation (Appendices A & B).
- Tuesday-Thursday:
 - Traditional style lectures on immunology or microbiology as part of McGovern Medical School's curriculum. These are not necessary for implementation of the module and vary based on where the module falls in the curriculum each year.
 - Primary literature on HPV.
- Friday:
 - 10-minute individual assessment (Appendices C & D).
 - 10-minute group assessment (Appendices C & D).
 - 40-minute team exercise (Appendices E & F).
 - 30-minute wrap-up lecture (Appendix G).
- Additional:
 - Pre-/posttest evaluation (Appendix H).

This format was used every week throughout the first year of medical school under the new McGovern Medical School curriculum, and so, it was familiar to students. This module was placed in November in both 2016 and 2017. For students not as familiar with this format, instructions on expectations may be appropriate during the initial introductory lecture.

The following materials were included:

- Introductory lecture (Appendix A)—a PowerPoint with a lecture including HPV virology, immunology and carcinogenesis, explanation of the immunological mechanism of the HPV vaccine, epidemiological data, and talking points for discussing concerns regarding the HPV vaccine with patients and families.
- A recorded video of a case presentation (Appendix B)—a patient presenting to an OB-GYN with questions on HPV concerning a family member's diagnosis of HPV-related oropharyngeal cancer.
- Assigned reading materials (not included in the present publication for copyright reasons) by the Committee on Adolescent Health Care Immunization Expert Work Group¹¹; Blitzer, Smith, Harris, and Kimple¹²; and Juckett and Hartman-Adams.¹³
- Individual and group assessments (Appendix C)—learner version of the readiness assessment test.
- Individual and group assessments, instructor copy (Appendix D)—key for instructor consultation featuring highlighted answers and references.
- Team exercise (Appendix E)—learner version of the group application exercise. This was designed as multiple choice to fit with McGovern Medical School's curriculum.
- Team exercise, instructor copy (Appendix F)—key for instructor consultation featuring highlighted answers and references.
- Wrap-up lecture (Appendix G)—a PowerPoint including the conclusion to the case, as well as a guide to discussing the HPV vaccine with patients.
- Pre-/posttest assessment (Appendix H)—five-section quiz, 37 questions total, used to assess HPV knowledge and satisfaction with HPV-related education in medical school.
- Pre-/posttest answers (Appendix I)—answers to the survey on HPV knowledge and satisfaction.

Team Formation

The teams used for the group assessment and clinical application exercises were assigned at the beginning of the year. Teams were made up of five to seven members, were randomly assigned, and worked together in the same group every week starting at the beginning of the school year.

Setting

The initial and closing lectures took place in a 250-person lecture hall, with the lectures recorded and made available for students to view at home. The room was equipped with screens for PowerPoint presentations, as well as audio equipment for the recorded case presentation. The individual and group assessments were performed in this same room with assigned seating in groups; then, students moved to smaller classrooms or libraries scattered across the medical school to work as a team before returning for the closing lecture.

Introductory Lecture

Occurring on a Monday, the initial case presentation (Appendix A) was designed to also serve as the introduction to the students' module on introductory microbiology and immunology. It covered basic immunological and microbiological concepts in the context of HPV and then discussed HPV as a broader public health issue. The lecture also covered clinical manifestations of HPV-related disease. Objectives for the week were presented at the opening of the lecture. Finally, the video of the case was played at the end of the lecture to bring clinical relevance to the basic science discussed. The goal of this approach was to teach at an MS1 level and to reference clinical and public health impact in a level-appropriate manner. At the end of the initial lecture, the case video (Appendix B) was shown to bring clinical relevance to the upcoming readings.

Outside Preparation

After the introductory lecture was completed, students had access both to its slides and to three primary literature publications (by the Committee on Adolescent Health Care Immunization Expert Work Group,¹¹ Blitzer and colleagues,¹² and Juckett and Hartman-Adams¹³) to expand on HPV. The goal of choosing primary literature publications was to get students comfortable reading and abstracting information from published journal articles early in their medical career.

Individual and Group Assessment

Students met in a large group for individual and group quizzes, identified as individual and group assessments, on Friday (Appendices C & D). The quiz was intended to confirm understanding of the major concepts presented in the introductory lecture and the assigned readings. The individual and group assessments were both taken without access to outside materials. The individual assessment was a low-stakes quiz in a test-taking environment with proctors monitoring communication. Students selected answers on sheets of paper, which were collected before the group assessment began.

Students were then given the group assessment, which consisted of an immediate feedback scratch-off card (obtained from <http://epsteineducation.com>). Students were allowed to discuss and select answers as a team without access to any outside materials. The correct answer was marked with an asterisk when scratched off, while the incorrect answers were blank. The group assessment was scored as one scratch = 2 points, two scratches = 1 point, and three scratches = 0 points. Students were encouraged to appeal incorrect answers by email to the course director and were asked to include the question and arguments for any answer other than the preselected correct answer along with citations to primary sources.

Team Exercise

Students had 40 minutes to complete the team exercises (Appendices E & F). Students broke off into groups and could go to locations of their choosing across campus as small groups. The small groups were

allowed to leave the large lecture hall due to the difficulty of having simultaneous discussions between multiple groups in one room. Locations were available in smaller classrooms across campus; however, students were also allowed to gather outside or in other locations of their choosing as long as they remained as a group and could simultaneously work on the application exercise. Students were allowed access to any materials, including textbook, articles, slides, and the internet. Future implementations could consider restricting access in order to facilitate communication amongst teams. A team had to discuss and come to consensus on all answers prior to submission. This exercise was administered as an online quiz through the campus learning website Canvas and was graded online. Students did not get immediate feedback on answers but were encouraged to email if they believed two answers might be equally correct in order to encourage discussion amongst team members. Students were given 40 minutes to complete this exercise.

Students within the groups were discussing and simultaneously developing answers to the same problems; however, each group was allowed to work at its own pace. For future applications, if a space can be found that can accommodate the noise level of multiple groups discussing answers, groups can work on the same problem in the same space and simultaneously review answers to each question as a large group.

The team exercise was 14 multiple-choice questions based on the case presented. Topics covered included presentation of HPV-related disease and carcinogenesis, basic immunological concepts and how they relate to HPV, and questions at a basic science level of histology and pathology. The final section was more clinically relevant, asking about cervical cancer screening, HPV vaccination guidelines, and common vaccine questions. At our institution, we plan to incorporate additional free-answer components; however, the initial implementations were with the questions shown in order to fit within McGovern's grading schema.

Wrap-up Lecture

Finally, students regrouped for a 20-minute lecture (Appendix G) to conclude the clinical case that the week had been based around and another lecture by a gynecologic oncologist on the impact of HPV and how to effectively communicate with patients or patients' parents regarding concerns about the HPV vaccine. This lecture could be led by a gynecologic oncologist, general OB-GYN, pediatrician, or family medicine provider with clinical experience in discussing the HPV vaccine with vaccine-hesitant patients.

Additional Pre-/Posttest Assessment

The initial year that this module was developed, we asked students to participate in a pre-/posttest on HPV and their satisfaction with medical education related to HPV (Appendices H & I). The survey was developed and piloted among upper-year medical students and faculty. All first-year medical students ($n = 234$) at McGovern Medical School were invited to participate in this study. An email invitation to a Qualtrics survey link was sent out from the Student Affairs Office each week for 3 weeks, beginning 1 month before the team-based learning session and concluding 1 week before the module started. Students who participated in the pretest were invited via email 1 month after conclusion of the exercise to participate in the postmodule survey, with up to three reminder emails. This pre-/posttest assessment was not repeated during the second year of the module administration and is not planned for future classes, as the intent was to initially assess the efficacy of the module.

For comparison data across the state of Texas, all medical students and faculty at eight participating institutions' 4-year medical schools were invited to complete the pre-/posttest survey online via their Student Affairs Offices. An introductory email with an embedded reusable survey hyperlink inviting participation was sent, and a reminder link was emailed once to all participants 2 weeks after the initial invitation. The survey was open for a total of 4 weeks. Data collection was completed using Qualtrics at

the MD Anderson Cancer Center, and data were encrypted and deidentified. This segment of the study did not provide any benefit for the implementation of the learning module and was performed for comparison data.

Results

This learning activity has now been implemented twice in the McGovern Medical School curriculum over two terms (Fall 2016 and Fall 2017) and is planned to continue. In 2016, 243 students participated in the module, and in 2017, 248 students participated in the module.

In 2016, a survey on students' knowledge of HPV and satisfaction with education on HPV and vaccine-related education was performed before and after the case. Of the 243 students participating in the module, 93 responded to the initial survey (rate = 38.9%), and of those, 61 completed the postmodule survey, for a follow-up response rate of 25.5%. Students significantly improved their total HPV-related knowledge from 66.3% to 86.3% ($p < .001$), comparable with the level of HPV knowledge of graduating MS4 students across the state of Texas. Students also improved their general HPV-related knowledge from 58.4% to 83.2% ($p < .001$), comparable with the level of HPV knowledge of graduating MS4 students across the state of Texas, and their vaccine-related knowledge improved from 78.8% to 91.9% ($p < .001$). These results are illustrated in the [Table](#).

Table. Comparison to Statewide Data

Item	Module Intervention		Traditional HPV Education	
	Premodule	Postmodule	Statewide MS1	Statewide MS4
Knowledge score ^a				
Total HPV knowledge	66.3%	86.3%	64.8%	82.6%
General HPV knowledge	58.4%	83.2%	58.1%	83.2%
Vaccine-related knowledge	78.8%	91.9%	75.3%	81.8%
Satisfaction with: ^b				
General HPV education	2.05	4.30	2.35	3.80
Vaccine-related education	2.09	4.44	2.45	3.81
Comfort in patient care	2.89	4.25	3.17	3.95
Willingness to recommend vaccine ^c	58%	100%	61%	92%

Abbreviation: HPV, human papillomavirus.

^aKnowledge scores calculated as percentage correct.

^bSatisfaction rated on a 5-point scale (1 = *strongly disagree*, 5 = *strongly agree*).

^cPercentage of students who responded *agree* or *strongly agree* to the question "Would you be willing to recommend the HPV vaccine?"

Students also reported a significant increase in their general satisfaction with education on HPV and vaccine-related topics, as well as in their comfort with discussing vaccination and providing resources to patients in a clinical setting. Students' satisfaction was evaluated on a 5-point scale (1 = *strongly disagree*, 5 = *strongly agree*). The average for satisfaction with general HPV-related education moved from 2.05 to 4.30 ($p < .001$), significantly higher than graduating seniors across the state of Texas. The average for satisfaction with vaccine-related education moved from 2.09 to 4.44 ($p < .001$), significantly higher than graduating seniors across the state of Texas. Finally, the average for satisfaction with general HPV education moved from 2.89 to 4.25 ($p < .001$), comparable to graduating seniors across Texas. These results have been published in more detail by Wiley and colleagues¹⁰ and are illustrated here in the Table.

As a part of the initial survey, students were also asked to rate on a 5-point Likert scale how likely they would be to recommend the vaccination when they were providers. The average pretest score for willingness to recommend the vaccine was 3.82, while the posttest average was 4.80, and the percentage of students who would recommend the vaccine increased from 58% to 100%. These results are illustrated in the Table.

Students generally performed well on the individual and group assessments. The average scores for the first year the module was introduced were 74% for the individual assessment and 84% for the group assessment. The score for the clinical application exercise was approximately 90%. Students reported that even in multiple-choice format, the clinical application exercise was able to stimulate discussion and that

they needed 30-35 minutes on average to finish the exercise. Based on student feedback, adaptations to the module will continue to be made, including possibly adding some short-answer questions to the clinical application exercise.

Discussion

Our learning activity has been implemented successfully for 2 years at McGovern Medical School, and students have found it both effective and satisfactory. Students have gained significant knowledge regarding HPV in general and vaccination specifically and have reported that they are much more comfortable with their education on HPV. The module fits easily into the McGovern Medical School's curriculum and requires little more out-of-class time than any other well-maintained lecture on the topic of HPV.

This activity was initially built to fill a gap in medical education regarding knowledge about the HPV vaccine and how to discuss it with vaccination-hesitant patients. Recommendation of the HPV vaccine by providers has been shown to be a key factor in the decision by parents to vaccinate, and so, training providers who are willing to recommend the HPV vaccine and recommend it strongly should be a goal of medical education. At the end of this training activity, 100% of students were willing to recommend the vaccine to patients and friends, and 80% of those, the amount required to meet the Healthy People 2020 goal, were willing to recommend strongly. However, the pre-/postmodule response rates were low, with approximately 25% of the first class participating. It is difficult to make predictions about what will actually happen in future clinical practice, but, keeping in mind the limited number of students responding, our data encourage the idea that this module may have a definite public health impact.

When implementing this module, we found it successfully stimulated discussion about the HPV vaccine and indications for the vaccine; however, students frequently completed the clinical application exercise early. The exercise was initially developed in a multiple-choice format; however, future iterations of this module will likely include a short essay or fill-in-the-blank to encourage more student discussion. Additionally, one of the challenges we found when implementing this module was that students frequently had many questions on how to talk to patients about the HPV vaccine and we ran out of time before answering all their questions at the Friday wrap-up lecture. We plan to adjust this lecture in the future to spend more time on techniques discussing vaccine-related communication. Additional limitations include that there has been no formal assessment of the duration of the improvement in knowledge and that we have not followed the students to determine if the module impacts future practice behavior. Despite the limitations above, we believe that the module could easily be incorporated into either medical school or graduate medical practitioner training.

This module is designed as two 1-hour blocks; however, it can be adapted to fit into other schedules by adjusting the timing of lectures and when assessment tests are given. Additionally, future implementation of this module in an interdisciplinary format, with nursing, nurse practitioner, physician assistant, and pharmacy students, may create more opportunities to educate future providers on HPV and the HPV vaccination. As the module is designed to reach students on a basic science level, it can be easily adapted into first- or second-year schedules. We believe that one of the strengths of the module is that it can be aimed at several different levels of education, including medical education, nurse practitioners, or physician assistant students. McGovern Medical School will continue to offer the module as part of its curriculum, and we hope to expand to other programs, especially in areas with poor HPV vaccine coverage.

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Ethical Approval

The University of Texas MD Anderson Cancer Center Institutional Review Board approved this study.

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