What do We Know? Teaching Medical Students to Deal with Uncertainty as a Pandemic Unfolds

INDIANA UNIVERSITY SCHOOL OF MEDICINE

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ABSTRACT

The global COVID-19 pandemic has had a major impact on medical student education. As the pandemic spread nationwide, numerous universities shut down with only days' notice, and medical students were removed from all patient care settings and restricted from campuses. Yet, the need and curiosity of these future physicians to understand this new disease was great, including how to interpret and integrate rapidly evolving information on the underlying viral and immune mechanisms, pathophysiology, and epidemiology. Time students spent away from patient care settings presented an opportunity to rapidly develop and deliver new curriculum covering SARS-CoV-2 and COVID-19. A team of students and faculty at Indiana University developed a Fundamentals of COVID-19 course that included up-to-date information on the virology, immunology, and pathophysiology of COVID-19. The course was delivered online, with both synchronous and asynchronous activities. Virology and immunology of the coronavirus family, including current knowledge to-date of SARS-CoV-2, were delivered using a series of readings and brief videos, followed by a small group exercise that required students to choose and present to their peers a paper from the scientific literature on COVID-19. A similar approach was used to deliver content about the pathophysiology of COVID-19. To place the COVID-19 experience in context of other pandemics, students researched and educated their small group cohort on another historical pandemic. To measure course effectiveness, we administered a pre-course survey gauging students' self-confidence in their knowledge of these topics; the same survey was administered after completion of the course. Surveys from 645 (89% of enrolled) 3rd and 4th year medical students who completed both surveys were analyzed. Results showed that the course elicited a 57% increase ($p< 0.001$) in students' confidence in their knowledge of COVID-19 virology and immunology and a 64% increase ($p< 0.001$) in knowledge of the pathophysiology. Data showed that the asynchronous content and group activities were successful in engaging and educating the students on foundational knowledge of COVID-19 and were an effective approach to rapidly evolving information when faced with a novel disease.

INTRODUCTION

In mid-March, 2020, in response to the COVID-19 pandemic, medical students across the nation were removed from patient care settings and, at many institutions including Indiana University School of Medicine (IUSM), prohibited from in-person, on-campus training. Yet, the students needed to understand this new disease that will impact their medical practice for years to come; the students also needed to learn how to sort through the rapidly developing information on COVID-19 that was exploding in the medical literature.

To fill these needs, a team of 3rd and 4th year medical students interested in medical education were recruited to work with faculty to develop a Fundamentals of COVID-19 course. The course was delivered entirely online, with both synchronous and asynchronous activities, and was organized into discrete modules covering different topics related to COVID-19. Emphasis was placed on the virology and immunology of coronaviruses and specifically of SARS-CoV-2 and the pathophysiology of COVID-19. Additional topics of interest included the history of significant epidemics and pandemics as well as the process of vaccine development. Throughout the course, students delved into the evolving literature on SARS-CoV-2 and COVID-19 to discuss the latest findings with a critical eye.

The Fundamentals of COVID-19 course was administered simultaneously to all 3rd and 4th year medical students at IUSM in late April–early May, 2020. To measure effectiveness of the course, students were asked to complete identical pre-course and post-course surveys on their understanding of material covered in the course.

METHODS

Course structure and delivery

The Fundamentals of COVID-19 course was delivered online to all 3rd and 4th year medical students at IUSM using the Canvas Learning Management System (instructure.com) and Zoom (zoom.us). To maximize flexibility at a time when non-academic concerns such as family obligations impacted many students' schedules, most of the course was delivered asynchronously. These asynchronous activities included both individual and small group assignments. For group activities, students were randomly assigned to groups of 6-7 learners; each group was asked to choose a "Zoom Leader" who would schedule Zoom meetings at times when all learners for their group could be available. Students who worked to develop the course served as teaching assistants in tracking completion of and grading course assignments.

Assessment of course effectiveness

Enrollment in the Fundamentals of COVID-19 course included 724 3rd and 4th year medical students. Effectiveness of the course was assessed by surveying students' self-perception of their knowledge of course material in identical pre- and post-course surveys. Surveys asked students to rate their agreement with statements (see Tables 1, 2) using a 5-pt Likert scale (1= strongly disagree; 2= disagree; 3= neutral; 4= agree; 5= strongly agree). 645 students (89%) completed both the pre-course and post-course surveys. Surveys were analyzed by a Mann Whitney U test for differences in the percentage of students who agreed or strongly agreed with the statements (Table 1). Matched surveys were also analyzed by paired-samples t tests (Table 2). The paired-samples t-tests met the required statistical assumptions; for each test, there were no significant outliers and the assumption of normality was not violated, as assessed by visual inspection of Normal Q-Q plots.

CURRICULUM: PATHOPHYSIOLOGY OF COVID-19

A Laboratory Science module included a series of brief videos from IU faculty experts in public health and pathology on a variety of topics related to detection, prevention, and pathology of COVID-19. Specific assignments included:

- Background materials:
  - Select from a list of online videos and articles to learn about adaptation of vaccine development to SARS-CoV-2
- Up-to-date videos from IU faculty covering the following topics:
  - Public health surveillance and vaccine development
  - Histopathology of SARS-CoV-2 Associated Disease in the lung, heart, kidney, liver, spleen, and small bowel
- Written assignment
  - Students were asked to write about barriers to developing a COVID-19 vaccine.

CURRICULUM: VIROLOGY & IMMUNOLOGY OF COVID-19

The course module covering virology and immunology included online content used as background materials, supplemented with up-to-date videos recorded by IU faculty who applied their expertise in virology, immunology, and infectious disease to SARS-CoV-2 and COVID-19. Module included the following assignments:

- Background materials:
  - First paper in the literature describing COVID-19 (1)
  - Basic virology and immunology module of the Harvard COVID-19 course (2)
- Up-to-date videos from IU faculty covering the following topics:
  - Differences between human and zoonotic coronavirus infections
  - SARS-CoV-2 life cycle and mechanism of antiviral drug Remdesivir
  - Immune responses, including antibody dependent enhancement, to SARS-CoV-2
- Literature discussion
  - Each student was assigned to select, read, and critically appraise an article on COVID-19 from the current literature and present it to their small group.

To put the COVID-19 pandemic in perspective, students also completed exercises on the history of epidemics and pandemics. The module included the following assignments:

- Background materials:
  - Visualizing the history of pandemics (3)
- Discussion
  - Each student selected a pandemic from history to investigate and reported to their small group about how the pandemic began, spread, and was contained, as well as social, economic, and other repercussions of the pandemic.

VALUE-ADDED EFFECT OF THE COURSE

Table 1. Comparison of student's self-confidence in their knowledge of COVID-19 virology, immunology, and pathophysiology before and after participating in the course: analysis by Mann Whitney U test.

	Pre-course Survey		Post-course Survey			
Statement	N	% Agree or Strongly Agree[a]	N	% Agree or Strongly Agree	Difference	*P* value
I am knowledgeable about virology and immunology as they relate to COVID-19.	645	31.0%	645	87.6%	56.6%	<0.001
I am knowledgeable about the pathophysiology of COVID-19.	645	21.9%	645	85.6%	63.7%	<0.001

[a] Percent of students who agree or strongly agreed with the statement on a 5-point Likert scale (1= strongly disagree; 2= disagree; 3= neutral; 4= agree; 5= strongly agree).

VALUE-ADDED EFFECT OF THE COURSE

Table 2. Comparison of student's self-confidence in their knowledge of COVID-19 virology, immunology, and pathophysiology before and after participating in the course: analysis of mean ± SD by paired-samples t-test.

	Pre-course Survey		Post-course Survey		
Statement	N	Mean ± SD[a]	N	Mean± SD	*P* value
I am knowledgeable about virology and immunology as they relate to COVID-19.	645	3.08 ±0.81	645	4.02 ± 0.61	<0.001
I am knowledgeable about the pathophysiology of COVID-19.	645	2.88 ± 0.82	645	3.98 ±0.63	<0.001

[a] Mean ± standard deviation using a 5-point Likert scale (1= strongly disagree; 2= disagree; 3= neutral; 4= agree; 5= strongly agree).

Results: Analysis of matched pre-course and post-course surveys demonstrated a significant increase in students' self-perceived understanding of the virology, immunology, and pathophysiology of COVID-19.

CONCLUSIONS

- The online Fundamentals of COVID-19 course developed by IUSM faculty, working closely with medical students, was an effective vehicle for enhancing student knowledge about the virology, immunology, and pathophysiology of SARS-CoV-2 and COVID-19.
- Online, asynchronous course modules provide an effective approach to deliver rapidly evolving information about a novel disease, while adding flexibility to student schedules during a time of uncertainty in the Spring of 2020.
- The rapid development of new curricular content was greatly enhanced by the inclusion of medical students in the curricular design process and selection of an optimal delivery strategy to enhance student engagement.
- Students gained confidence in their knowledge of the COVID-19 pandemic and the SARS-CoV-2 virus during the "pause" of their standard curriculum which aided their return to the clinical environment in June 2020.
- Students experienced the rapidly changing nature of information and guidelines related to diagnosis, treatment, and prevention of this disease in real-time and with a paucity of high-quality study data.

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