

# The Simulated Virology Clinic: A Standardized Patient Exercise for Preclinical Medical Students Supporting Basic and Clinical Science Integration

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## Abstract

**Introduction:** Virology is inherently challenging due to the sheer volume of information medical students are responsible for learning. Cognitive integration of this content is critical for early medical students to practice applying this knowledge to diagnostic problem-solving. Simulation offers learners engaging opportunities to practice cognitive integration. We developed a simulated clinic activity for first-year medical students consisting of standardized patient (SP) encounters representing viral infections. **Methods:** Student small groups rotated through eight SP encounters during which they collected patient histories, reviewed physical exam findings, and developed a differential diagnosis and diagnostic plan for each case. The instructor debriefed students on the cases afterward. We assessed students' evaluation of the activity through online surveys. **Results:** Two hundred seventy-eight students participated in the simulated clinic in 2018 and 2019. Students rated the activity as very effective for learning about the infections represented and for providing opportunities to integrate clinical skills. Students agreed that the event's instructional design was appropriate for its objectives and that the problem-solving aspect was intellectually stimulating. They indicated that the most effective aspects were solidifying illness scripts for the infections represented, integrating knowledge and skills to diagnose patients in a realistic clinical context, and working collaboratively to problem-solve. **Discussion:** The simulated virology clinic is an effective method for providing students opportunities to integrate microbiology and clinical skills and has been positively received by students. This instructional method offers learners an opportunity to solidify illness scripts for viral infections using an interactive, collaborative approach.

## Keywords

Diagnostic Reasoning, Clinical Skills, HIV, Herpes Zoster, Norovirus, Hepatitis B Virus, West Nile Encephalitis, Viral Myocarditis, Croup, Parvovirus B19, Cardiovascular Medicine, Infectious Disease, Pediatrics, Simulation, Standardized Patient

## Educational Objectives

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

1. Identify the distinguishing features of a patient's presenting symptoms through focused history taking for patients with viral infections.
2. Interpret physical exam findings in patients presenting with viral infections to further develop a patient's problem representation.
3. Compare and contrast a patient's problem representation with the illness scripts of infectious diseases to formulate

a concise, prioritized differential diagnosis based on recall and/or self-directed learning.

4. Select diagnostic studies to narrow their differential diagnosis for patients presenting with symptoms of viral infections.

## Introduction

Learning the clinical features of infectious diseases (and viral infections in particular) can be especially challenging for preclinical medical students, given the wide range of infections students are responsible for learning, along with their limited clinical experience at this point in their training. As a result, students are often required to memorize large amounts of information on this content, which can be challenging to recall without having experiences (e.g., actual patient encounters) to which this learning content can be cognitively connected. A recent national survey of preclinical microbiology course

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directors found that when asked about challenges in medical student microbiology education, respondents “overwhelmingly reported that their students found that there is not enough time to effectively learn the material” and noted “an excess of basic science and requests for more clinically relevant teaching.”<sup>1</sup>

In 2010, the Infectious Diseases Society of America published a set of guidelines for improving instruction in microbiology and infectious diseases for medical students, the overall goals of which were to train students to integrate their infectious diseases knowledge and apply it to specific patients (including differential diagnosis generation), teach them which pathogens infect certain organ systems, and familiarize them with diagnostic approaches to these diseases. The teaching methods recommended in these guidelines emphasized the importance of limiting factual information delivery and instead using active, collaborative problem-solving, including case-based learning activities with differential diagnosis practice, to “allow students to apply their knowledge to real clinical problems, and organize facts into more clinically relevant contexts.”<sup>2</sup>

Cognitive integration of basic science and clinical skills is important for physicians at all stages of training, as diagnostic problem-solving and clinical decision-making require the ability to apply one’s biomedical knowledge in the appropriate clinical context. A learner’s understanding of basic science is thought to provide a scaffolding upon which the learner can then anchor his/her clinical knowledge.<sup>3,4</sup> Experts posit that learners’ cognitive integration of basic and clinical science concepts is supported most effectively at the level of individual instructional sessions, during which learners directly interact with the learning content.<sup>5,6</sup>

Simulation-based activities provide learners with opportunities to engage in cognitive integration through immersion in explicit clinical contexts.<sup>7</sup> Most medical schools employing simulation in the preclinical years have used it to teach clinical skills, with few publications thus far describing its use for basic science instruction.<sup>8-10</sup> Examples of simulation-based instruction include standardized patient (SP) encounters, in which learners interact with patient actors in order to practice or be assessed on performance of one or more patient-encounter tasks.<sup>11</sup> SP encounters are one example of whole-task instruction, in which learners’ tasks represent the complexity of real-life clinical tasks rather than only one part or subset.<sup>12</sup> The use of simulation for cognitive integration of basic science knowledge and clinical skills is supported by Kolb’s experiential learning theory, in which learning is grounded in experiences where the learner is actively involved with his/her environment.<sup>13</sup>

To improve our first-year students’ engagement with virology learning content and to provide them with opportunities to practice basic and clinical science integration, we developed a simulated virology clinic consisting of a series of eight SP encounters, each representing one of the following conditions:

- Acute human immunodeficiency virus infection,
- Varicella zoster virus (VZV) infection manifesting as shingles,
- Acute gastroenteritis due to norovirus,
- Acute hepatitis due to hepatitis B virus (HBV),
- Acute encephalitis due to West Nile virus (WNV),
- Acute myocarditis due to enterovirus,
- Acute laryngotracheitis (croup) due to parainfluenza, and
- Acute aplastic crisis due to parvovirus B19 in a patient with sickle cell disease.

A thorough search of *MedEdPORTAL* revealed that few resources have been published previously for the above list of viral infections.<sup>14-59</sup> No resources of any type were found representing VZV, HBV, or WNV. Of the resources published for the other five infections, nearly all were designed for use with non-SP-based instructional methods (e.g., team-based learning,<sup>30</sup> simulations with high-fidelity mannequins,<sup>54-57</sup> multiple-choice questions,<sup>58</sup> didactics<sup>59</sup>). Of the few resources designed as SP cases for the above list of infections, learner tasks involved disclosure of diagnoses<sup>14</sup> or patient counseling<sup>15</sup> rather than diagnostic problem-solving. Other resources have been developed for cases with presenting symptoms similar to those represented in our learning activity, but these resources represented other disease conditions rather than the above viral infections.<sup>16-29,31-37,41-53</sup> Other studies have described case-based interventions for developing students’ diagnostic reasoning for infectious diseases; however, these interventions involved non-SP-based methods, such as student review of written cases followed by oral presentations<sup>60</sup> and virtual patient cases.<sup>61</sup>

## Methods

### Educational Context

We designed this activity for first-year medical students in the virology course at our institution, with the goals of increasing learner engagement and improving knowledge retention through a series of SP encounters. This method was selected in order to provide our learners with opportunities to reinforce illness scripts for diseases encountered in the virology course and to support students’ integration of virology learning content and clinical concepts rather than relying on rote memorization to learn about these viral infections. The simulated virology clinic

activity occurred near the end of the virology block, prior to the final exam in the microbiology course.

At our school, the virology block was part of the microbiology course and occurred approximately 6 months into the 18-month preclinical curriculum. Prior to virology, students had completed the anatomy and physiology, biochemistry, and genetics courses, and they had received instruction on bacterial, fungal, and immunological diseases. Students had encountered some dermatology content in each of these courses, including in microbiology. In the week leading up to the simulated virology clinic, students had encountered learning content on viral structure and pathogenesis; viral infections affecting a variety of organ systems, including the skin, head and neck, respiratory system, cardiovascular system, GI system, and nervous system; prions; and viruses causing cancer (more detailed instruction on organ systems–based pathophysiology occurred after microbiology in our preclinical curriculum).

Concurrently throughout the first year of their curriculum, these students were also participating in several longitudinal courses, including clinical skills, population health and epidemiology, and bioethics. Prior to the simulated virology clinic, students had learned the essentials of patient-centered communication skills, how to perform a full history, and fundamental physical exam (PE) skills including vital signs, cardiovascular exam, lung exam, abdominal exam, head and neck exam, thyroid exam, and musculoskeletal exam maneuvers. Students were also participating in a longitudinal, problem-based learning course throughout the year during which they practiced differential diagnosis formulation and self-directed learning for a series of written case scenarios.

#### Learner Prerequisites

Prerequisite knowledge for students to participate in this activity included some exposure to the learning content on these viral diseases through readings, didactics, or other instruction. Mastery of this content was not required.

#### Event Overview and Logistics

We conducted this learning event in our medical school's simulation center, which had a group of simulated outpatient exam rooms. The event consisted of eight unique SP encounters. Each individual learner ultimately encountered each of these eight cases over the course of the event. Each case was allocated a total of 15 minutes: 10 minutes for students to collect data from the SP and 5 minutes for small-group discussion of the differential diagnosis for each case (see below for a detailed description of event implementation). A given student

participated in the event for a total of 2 hours, although we repeated the activity for two large groups of students (for 4 hours total).

SP cases were arranged so that student small groups rotated between adjacent rooms over the course of the activity, simulating a real clinic environment. We assigned two SPs to each of the eight cases and used 16 of our center's simulated exam rooms, so that a large group of students could be divided among and rotated between these 16 rooms simultaneously. Based on an educator's available facilities, this exercise could be implemented for smaller learner group sizes using fewer rooms.

#### Event Preparation and Space Setup

*Staff needs:* The following staff were recruited to assist with this event: one SP program manager, to recruit SPs for the event and distribute event-related materials to them, and two additional staff, to assist with event preparation and implementation.

*SP training:* Our SP program manager recruited SPs according to the demographics of each case, and each SP received a copy of his/her assigned case script prior to the event. The virology course directors met with the SPs for a training session to review the logistical plan for this event and the details of each case and to field SP questions (our training session for this event took approximately 60-75 minutes); detailed SP instructions were included in the SP script file for each case (Appendices A-H). For cases involving visual PE findings, we instructed the SPs to direct students to the computer in the room, which displayed high-resolution images along with a brief description of other abnormal pertinent PE findings (Appendix I). Alternatively, a printed copy of these findings could be provided to students, or, if the instructor desires, time can be allocated for students to perform a PE on the SP during the encounter; in the latter case, SPs would need to be trained on the applicable PE maneuvers, including when to provide PE findings cards to students during the exam (see Appendices A-H for the PE instructions for SPs and the PE findings cards).

One of the eight cases involved a pediatric patient with croup (Appendix G); for this case, we provided an adult SP (playing the role of the patient's parent or grandparent) with a video file of a pediatric patient demonstrating the cough and inspiratory stridor characteristic of croup. This file was downloaded onto the SP's smartphone, and we instructed him/her to show this video to students during the encounter when asked by them to characterize the patient's cough and/or noisy breathing (Appendix J).<sup>62</sup>

One of the eight cases involved a patient who was exposed to a child with parvovirus B19 (Appendix H). For this case, we provided a photo file of a child's face demonstrating the classic "slapped cheeks" rash (Appendix K). We instructed the SP to put this image file on his/her smartphone and to show it to students when the SP provided the history of this sick contact during the encounter. Inclusion of this element (and of the video-sharing, mentioned above) was intentional, to simulate the common occurrence of smartphone photo- and video-sharing by patients.

*Exam room preparation:*

- Door charts: A simulated patient chart document corresponding to each patient case, with information applicable to that case (patient name, age, chief complaint, and vital signs), was placed outside of each exam room for student review prior to each encounter (Appendix L).
- Visual PE findings: Each of the exam rooms had a computer, on which a high-resolution copy of the PE image files for each case was loaded.
- Written PE findings: A document with the written description of all other (nonvisual) abnormal PE findings for each case was placed in the exam rooms.

Alternatively, educators could create (1) printed hard copies of these PE findings to place in the rooms for the applicable cases or (2) PE findings cards for SPs to provide to students, if educators choose to have students perform a PE during each encounter (see individual case scripts in Appendices A-H for the PE findings cards). Because our students had not yet learned some of the requisite PE skills by this point in our curriculum and because we wanted students to rotate through eight cases over the allotted time period, we chose to provide them with the description of the exam findings on written documents rather than tasking them with performing PE maneuvers, thereby making their task list for the short encounter times more achievable.

*Learner orientation:* A few days prior to the event, students were sent an informational email with instructions on expected dress (professional attire, including white coats), logistics of this attendance-mandatory event, and instructions for participation in the activity. They were instructed to report to the simulation center lobby 10-15 minutes prior to their assigned activity time, sign in, and receive their assigned exam room rotation schedule. Throughout the virology course, students were encouraged to review the course materials that corresponded to didactic class sessions, but they were not required to complete any additional assignments prior to attending the simulated clinic activity.

*Event Implementation*

Based on the number of exam rooms available, we split up the students (140-142 total) into two large subgroups (approximately 70 each); a given student participated in the activity during his/her assigned 2-hour time frame. Ten minutes were allocated for data gathering (history taking and PE findings review) for each case, and an additional 5 minutes were allocated for small-group discussion and worksheet completion immediately following each encounter. We chose to limit the encounter time to 10 minutes so that students could rotate through all eight cases within the allotted 2-hour time period we had available for this event. The event duration could be adjusted accordingly for other learner group sizes and space needs, available space, desired number of cases, and time for PE practice on SPs during each encounter.

Students were assigned to small groups of four to five for this activity. Upon check-in with our staff prior to the start of the activity, students were given a slip of paper with their small-group assignment as well as their group's rotation schedule and room assignments (Appendix M). Each small group was given a set of worksheets upon which students were instructed to write their group's differential diagnosis for each case, their suggested diagnostic studies, and their justification for their suggested plan (Appendix N). Immediately prior to the activity, one of the virology course directors briefly reviewed with students the instructions for the activity. Student small groups then began their simulated clinic rotation. Overhead announcements told students when the time for each encounter expired and when to move to their next assigned room.

*Learner Assessment*

Following completion of the activity, staff collected the worksheets from all student small groups. The virology course directors reviewed these worksheets prior to the debriefing session, to assess students' success in generating a differential diagnosis for these cases (learning objective 3) and the appropriateness of their diagnostic testing recommendations (learning objective 4). During the worksheet review, we looked for any patterns of incorrect or incomplete differential diagnoses generated or incorrect or irrelevant diagnostic labs suggested. We then used this information to adjust our approach to the debrief session, so that more time was allocated to clarifying those learning points and less time was spent discussing items on which students had performed well.

Students' performance of identifying distinguishing features from the history (learning objective 1) and of interpreting simulated PE findings (learning objective 2) was self-assessed by individual

students during the debriefing, by reflecting on their ability to identify these items as the course directors reviewed this information for each case.

Students' performance on these worksheets did not impact their course grades in any way. The debriefing session provided formative feedback to students on their performance of the above diagnostic reasoning tasks.

#### Event Debrief

On the day following the simulated clinic activity, one of the virology course directors met with students for a 1-hour, attendance-optional debriefing session to review the cases from the activity. A summary of each case was presented along with case-associated images, and students were invited to share their diagnoses and diagnostic testing recommendations. The instructor then presented the diagnosis for each case along with other conditions in the differential diagnosis, applicable diagnostic testing, and management; during this discussion, the instructor explicitly identified key distinguishing features of each infection to emphasize knowledge that was especially important for successful diagnostic reasoning and management of each case (Appendix O).

#### Program Evaluation

We collected evaluation data from participating students through an anonymous, online, voluntary survey following the event (Appendix P). The survey assessed learners' evaluation of the activity's instructional design (small-group format, pace, duration, and use of SP encounters) and the multimedia materials used (photos, audio file, and video file used for PE findings) through 5-point, Likert-scale questions. The survey also presented open-

ended questions for students' narrative comments about the instructional design, most effective aspects of the activity, and aspects needing improvement. Students' narrative comments for these items were qualitatively analyzed for themes. In addition, students were asked to rate their overall learning experience on a numeric scale (1-10).

We designed the survey instrument by adapting a standard set of postevent learner evaluation questions used for simulation-based learning activities developed for our school's preclinical curriculum. The items were adapted based on the learning objectives for this event.

We also reviewed students' narrative comments related to the virology simulated clinic activity from the virology end-of-course learner evaluation survey administered annually by our institution's educational leadership and analyzed those comments qualitatively for themes.

### Results

During its first implementation (January 2018), 140 students participated in the simulated virology clinic. In its second iteration (January 2019), 142 students participated in the event.

The postevent evaluation survey in 2018 indicated that students valued the simulated virology clinic as a helpful exercise. The results for the first implementation of this event are presented in the [Table](#). The weighted average of students' ratings of the overall effectiveness of this activity was 9.0 out of 10 (1 = *poor*, 10 = *excellent*), and 98% of respondents reported that they would like to participate in additional case-based SP activities structured like this one.

**Table.** Learner Evaluation Survey Results (N = 66, 47% Response Rate)

Question	Yes	No	Extremely	Quite	Moderately	Slightly	Not at All
Was the small-group format of this learning activity appropriate for the learning content presented?	100%	0%					
Were the pace and duration of this learning activity appropriate for the learning content presented?	92%	8%					
Was the problem-solving aspect of this activity intellectually stimulating?	100%	0%					
Do you prefer classes that include this type of small-group problem-solving activity rather than classes that do not include this type of activity?	92%	8%					
<b>Relevance</b>							
How relevant was the content of this learning activity to your role as a future physician?			66%	22%	12%	0%	0%
<b>Effectiveness</b>							
Effectiveness of SP encounters for learning about the diseases presented in this learning activity			67%	30%	3%	0%	0%
Effectiveness of the SP interviews for reinforcing skills you have learned in the Clinical Skills 1 course			47%	42%	8%	3%	0%
Effectiveness of the audio and visual materials for learning about the diseases presented in this learning activity			53%	34%	13%	0%	0%

Abbreviation: SP, standardized patient.



When asked “Which aspects of this event were most effective?” three major themes emerged from analysis of the students’ narrative comments and are presented below (January 2018:  $N = 66$ , 47% response rate).

1. Encountering these viral infections with SPs facilitated students’ ability to learn the illness scripts for these conditions:
  - “Putting a face to the virus.”
  - “I could pinpoint which symptoms I needed to pay attention to based on the hooks. I couldn’t remember every single virus for each case, but afterwards I could relate the viruses back to the SPs!”
  - “Interviewing the 8 SPs was very useful because the information/cases/illnesses I remember best are the ones I have seen first-hand (even if it was just simulation).”
  - “This was amazing. Every time I thought of one of these viruses after this, I pictured the patient, and I was able to incorporate all the information together so much better.”
  - “Having the opportunity to hear patients describing symptoms and circumstances. In lecture we get the bullet points, but it was cool to hear patients describing these diseases as real patients.”
  - “Getting to practice what information is key to distinguishing the viruses (e.g., determining which ones cause rash).”
  - “I liked that you could gather as much or little information from the SPs as you wanted depending on the nature of the questions. Thinking about what questions to ask was an important activity in determining the importance of the differentiating factors of each disease.”
2. Students appreciated how the simulated clinic construct provided them with opportunities to integrate knowledge and clinical skills in a realistic clinical context:
  - “This was a really great way to help put the classroom information into a clinical context, practice some targeted history taking and elementary clinical reasoning skills all at the same time. Highly relevant and enjoyable.”
  - “Having real people to mine for details.”
  - “I found it most effective and a great learning experience to have to think about the relevant questions to ask to obtain the necessary information, rather than in a question stem where all the relevant information is already provided.”

- “Practicing a patient interview and history. I also liked that the SPs didn’t just tell you the important info—we had to use our history taking skills to ‘bring’ it out.”
  - “Being able to formulate hypothesis-driven questions.”
  - “I liked the process of us being able to think on our feet and ask questions to the SPs to narrow down our differentials.”
  - “It felt like we were real doctors! So nice to put our knowledge to use immediately.”
3. Students appreciated working collaboratively in small groups to problem-solve:
    - “I really liked this activity and I am glad that we got to work in groups. I was a little nervous at first because I did not feel like I had mastered the material yet, but this was a good way to solidify it, and working in groups was helpful because what I did not remember, someone in my group likely did, and vice versa.”
    - “Team work which helped in cross-learning of other people’s effective strategies in interviewing and critical thinking.”
    - “Group discussion of symptoms was helpful in learning typical presentation.”

Aspects needing improvement primarily related to logistical and orientation aspects and included the student small-group size, the timing of student small-group discussions about each case, simulated door charts for each room, guidance to students on how to structure their time with the SPs, instructions regarding the PE information provided in each room, and the debriefing format.

Narrative comments on the end-of-course learner evaluation results also indicated that students found this simulated clinic activity helpful for learning virology content in both years of implementation. Themes from these surveys are presented below (January 2018:  $N = 72$ , 47% response rate; January 2019:  $N = 88$ , 63% response rate).

1. The simulated virology clinic was a fun, engaging, and enjoyable activity for students:
  - “The virology patient encounter was awesome.”
  - “I really enjoyed Virology and all the different ways we were able to learn the material through the case day and collaborative work with peers.”
  - “I loved the interactive learning with Dr. Peters, especially when we got to see standardized patients in groups.”
  - “The virus simulation [day was] excellent... fun and served as a good way to assess knowledge.”

- “Really enjoyed the... standardized patient experience where we interviewed patients with viral disorders and we had to ask directed questions.”
2. The simulated virology clinic provided clinical relevance to didactic content:
    - “I particularly enjoyed the patient cases we had as a way of connecting the clinical presentation to what we learn in class.”
    - “Patient virology clinic... was a great opportunity to apply the information we were learning in lecture.”
  3. Students would like to have similar clinical/application-based activities in other courses:
    - “Absolutely loved the application aspects of virology, would love to see that applied to all units!”
    - “I think [another course] could have been presented in the same way as the virology where it is front loaded initially and then applied clinically or contextually to reinforce concepts.”
    - “Virology patient simulation was fantastic!! One of the most helpful ways to solidify our classroom learning. Really wish that this had been part of [another course].”
    - “Virology’s case-based learning should be adapted to all of [a first-year course block].”
  4. The simulated virology clinic activity enhanced the learning environment (responses to “What features/characteristics enhanced the learning environment?”):
    - “The teamwork that was instilled in the patient simulations.”
    - “The virology simulation [and] patient interaction... activities were AMAZING!!! I wish we had more of this in other courses. I can’t say enough how much that enhanced my learning. Just wonderful.”
  5. The simulated virology clinic effectively helped students retain information about the viruses represented:
    - “Patient simulation during virology was very helpful. I remember the 8 different cases/viruses very well.”
    - “The patient simulation activity was awesome—it helped me solidify viruses in my mind with a story of a patient.”
    - “The way virology was taught was very effective. Front loading the course and having interactive learning the following days was extremely helpful and one of the reasons I retained a lot of the information.”
    - “I also really appreciated the opportunity to do the simulation and clinic to apply the knowledge—it really helped lock things in after a weekend to review it.”

- “The Virology Simulated Clinic... [provided] excellent reinforcements for the material.”

## Discussion

This simulated virology clinic activity provides a unique and engaging opportunity for preclinical medical students to practice basic and clinical science integration through focused history taking and diagnostic reasoning. The activity requires limited faculty time and provides educators with several design options to tailor the event to their learning objectives and resources. This resource fills a current *MedEdPORTAL* gap for SP cases for the viral infections included in this set. Students at our institution found the activity to be a valuable and engaging learning experience and particularly appreciated how SPs brought these diseases to life in a memorable way that their classroom lectures and other learning materials could not. Within this instructional design, learners engage in the active experimentation and concrete experience stages of Kolb’s experiential learning cycle by applying virology knowledge from the classroom to simulated patient encounters through data collection and evaluation of PE findings, and they engage in the reflective observation and concept formation stages of Kolb’s cycle by reflecting on their performance and formulating decision-making and problem-solving strategies while participating in the debriefing session following the simulated clinic event.<sup>13</sup>

## Lessons Learned

In the first iteration of this event in 2018, we used small groups with six to seven students per group. We learned the size of students’ small groups affected the quality of their experience in these encounters, both because the simulated clinic rooms had limited space and because having groups of this size detracted from the fidelity of the simulated encounters. For the second iteration of the event in 2019, we decreased the small-group size to four to five students per group. This improved the learner experience as the smaller group size allowed most students in each group to have two turns leading an SP encounter over the course of the event.

We also learned from our first iteration that students preferred having time between SP encounters to discuss a case with their small group immediately following the encounter. The original design designated time for student small groups to discuss all eight cases only at the end of the 2-hour activity, which proved challenging for students as they had difficulty remembering the details of each case. In the second iteration, insertion of 5 minutes immediately following each SP encounter for students to discuss their differential diagnoses and diagnostic

plans made it easier for students to focus on one case at a time.

In our first iteration, we noted variability in how students approached the data-gathering tasks in each room, with some student groups approaching each encounter as intended (with one student leading the history taking for each encounter), while others interviewed each SP as a group, with a less organized, popcorn-style interrogation of the patient. Students in the latter groups noted that this approach decreased their efficiency in each room. So, in the second iteration of the event, we provided more detailed, explicit instructions to students on the intended structure of each encounter.

We recognized students needed more systematic prompting regarding the simulated PE findings in each room. Although we had instructed the SPs to bring these findings to students' attention, the SPs did not always remember to do so; as a result, some student groups finished those encounters without realizing there was additional information available. In our second iteration, we specifically instructed students that PE information was provided for them in every room, although the encounters were not designed for PE skills practice.

Finally, we learned that our initial approach to the event debriefing—which consisted of an asynchronous debrief via email—was suboptimal. Students wanted the opportunity to interact with the virology instructors to clarify the key features of each case. For the second iteration, we held an in-person, large-group debrief session, led by one of the virology course directors, to allow for interactive discussion and student questions.

#### Limitations

Our results are limited to findings from a single institution, and response rates to our surveys were limited. We acknowledge that the design of this event as outlined requires access to multiple simulated exam rooms and resources for hiring SPs, which may not be readily available to other educators. The logistics of maneuvering large numbers of students through multiple rooms simultaneously can be difficult without access to several event staff or a facility with the ability to make overhead announcements to direct student traffic. Conducting the debriefing session requires knowledge of all viral diseases represented in this activity, although infectious disease subspecialty training is not specifically required to perform this task adequately for preclinical medical students.

#### Future Directions

Future directions for this work include creation of SP cases for other categories of infectious diseases, such as bacterial,

parasitic, and fungal infections. This event format could be used for diagnostic reasoning practice for other learner types, including physician assistant students, more advanced medical students, or resident trainees. Additional work is needed to assess whether this instructional approach affects learning outcomes and conceptual retention beyond the preclinical years.

## Appendices

- A. SP Case 1 Acute HIV.docx
- B. SP Case 2 Herpes Zoster.docx
- C. SP Case 3 Norovirus Gastroenteritis.docx
- D. SP Case 4 Acute HBV.docx
- E. SP Case 5 West Nile Encephalitis.docx
- F. SP Case 6 Enteroviral Myocarditis.docx
- G. SP Case 7 Croup.docx
- H. SP Case 8 Parvovirus Aplastic Crisis.docx
- I. PE Findings.pptx
- J. Croup Case Video.mp4
- K. Parvovirus Case Rash Photo.png
- L. Door Charts.docx
- M. Logistics.docx
- N. Worksheets.docx
- O. Debrief Session.pptx
- P. Learner Evaluation.docx

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

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## Disclosures

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### Ethical Approval

The Wake Forest School of Medicine Institutional Review Board approved this study.

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