

Impact of an Online Curriculum on Trainee Learning during a Pediatric Pulmonary Elective

Nooralam Rai¹, Audrey Chang¹, Alexandra Kass¹, Sophie Berger², Aubrie Swan Sein², and Aliva De¹

¹Division of Pediatric Pulmonology, Columbia University Irving Medical Center, Vagelos College of Physicians and Surgeons, New York, New York; and ²Department of Pediatrics, Columbia University Irving Medical Center, New York, New York

ORCID ID: 0000-0002-4796-9009 (N.R.)

Considering that respiratory illnesses are a leading cause of hospitalization among young children (1), it is critical that pediatric trainees develop skills to manage pulmonary disease. Our group created an online curriculum to encourage asynchronous distance learning for medical students and residents rotating in our pediatric pulmonology elective. Our objectives were to: 1) test the effectiveness of this novel curriculum on learning outcomes, 2) kindle the trainees' interests in pediatric pulmonology and assess satisfaction, and 3) improve the popularity of the elective course.

METHODS

An online curriculum was developed by the pediatric pulmonary fellowship program director and fellows in interactive

video or case-based module (CBM) format using Articulate Storyline, Panopto, and Camtasia software. Interactive videos have recorded audio and slides with interspersed multiple-choice questions. CBMs are self-paced multiple-choice questions and discussions centered around a specific clinical scenario. The curriculum included commonly encountered concepts such as asthma, pneumonia, sleep apnea, and mechanical ventilation. Educational material was published on CourseWorks, a university-specific learning management system. The entirely digital design of the curriculum allows for sharing between organizations. Pre- and posttests of 20 questions for voluntary completion were offered at the beginning and end of the 2-week rotation, respectively, to assess the effectiveness of the curriculum. Two sets of counterbalanced questions aligned with the learning

(Received in original form October 4, 2023; accepted in final form January 26, 2024)

This article is open access and distributed under the terms of the Creative Commons Attribution Non-Commercial No Derivatives License 4.0. For commercial usage and reprints, please e-mail Diane Gern.

Supported by the Children's Health Innovation Nucleation Fund, Education Program Award, Columbia University, 2021.

Correspondence and requests for reprints should be addressed to Nooralam Rai, M.D., Pediatric Pulmonary Division, Columbia University Irving Medical Center, 3959 Broadway, CHC-701, New York, NY 10032. E-mail: nr2640@cumc.columbia.edu.

ATS Scholar Vol 5, Iss 2, pp 254–258, 2024
Copyright © 2024 by the American Thoracic Society
DOI: 10.34197/ats-scholar.2023-0119BR

objectives were alternated. The number of learners who selected the pulmonary elective per year was recorded as a measure of course popularity.

Medical students (years 3 [MS3] and 4 [MS4]) and pediatric residents (postgraduate years [PGYs] 1, 2, and 3) rotating between August 2020 and March 2023 were included in the study.

Feedback was elicited via anonymous Qualtrics surveys for each video or CBM module and for the overall curriculum to assess the effectiveness and popularity of the new material. Pre- and posttests were distributed using Qualtrics and collected, deidentified, and scored by the principal investigator. Participation in the tests and surveys was voluntary. Paired data were compared using a two-tailed paired *t* test. Multiple comparison analysis was performed with one-way analysis of variance. Ordinal survey data were compared with the Mann-Whitney *U* test. Statistical analyses were performed with GraphPad Prism software. The study was approved by the institutional review board (protocol AAAU7726).

RESULTS

There were 82 rotators who completed the 2–4-week elective, 47 (57%) of whom completed the pre- and posttests. Of these, 5 were in MS3 (11%), 11 in MS4 (23%), 17 in PGY1 (36%), 5 in PGY2 (11%), and 9 in PGY3 (19%). All 16 rotating medical students completed the pre- and posttests, whereas 31 of 66 residents did not. The mean pretest result was 14 of 20 correct (70%), and the mean posttest result was 16 of 20 correct (80%). Analysis of all pre- and posttest results demonstrated significant improvement ($P < 0.0001$) after completion of our online curriculum and elective rotation (Figure 1). Subgroup analysis by year of training demonstrated

that MS3, MS4, and PGY1 scores improved significantly ($P = 0.03$, $P = 0.01$, and $P = 0.001$, respectively). However, PGY2 and PGY3 scores remained unchanged. Of note, there was no significant difference in pretest performance among all groups ($P = 0.12$).

We analyzed responses to surveys on a scale of 1–5 (1, not useful; 5, very useful). Twenty-eight of 30 responders (93%) rated the CBM as a 4 or 5 (useful or very useful), and 76% of the 30 responders rated the prerecorded videos similarly. Analysis of responses in regard to learning format preference demonstrated a significant preference for the CBM over videos (*U*-value, 292.5; $P < 0.05$). Responses to the statement “the online curriculum helped improve my knowledge of commonly encountered pediatric pulmonary disorders” were graded on a scale of 1–5 (1, disagree; 5, strongly agree), and 75% of responses were 4 or 5 (agree or strongly agree). Written feedback was positive, with comments that the CBMs and videos supplemented learning, and covered the highest-yield topics in the rotation. Three of 10 learners who left written feedback specifically wrote that the elective experience increased their interest in a career in pediatric pulmonology.

In the 3 academic years before this program was instituted, there was an average of 8 rotators per year; in the 3 academic years afterward, there was an average of 29 rotators per year ($P = 0.07$) (Figure 2).

DISCUSSION

The educational intervention described here improved trainee knowledge, was well received, and seemed to correlate with improved popularity of the elective. This is consistent with recent publications contending that the application of

Pre and Posttest Results

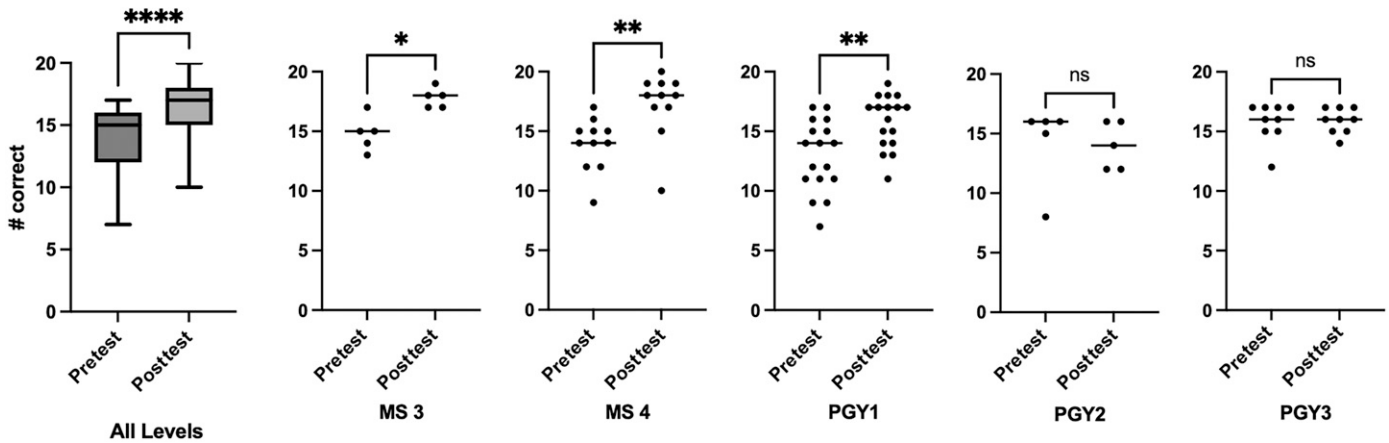


Figure 1. Performance on pre and posttests. MS3 = medical student, year 3; PGY = postgraduate year.

web-based instructional methods can lead to an enriched learning experience and offer the opportunity for asynchronous learning centered around individual learner needs (2, 3). Studies from diverse centers indicate mixed results in terms of effectiveness of asynchronous online lectures, whereas studies on interactive CBM indicate that this is more effective and well received (4–12). Consistent with this, survey feedback from our participants indicated a preference of CBM over recorded lectures, although both were well received.

Based on the increase in the number of learners who selected our rotation, we speculate that this educational format may increase the popularity of the elective,

which is particularly important in a field in which there is concern for a workforce shortage (13–15). We attribute the increase in popularity of our elective largely to this online curriculum, based on direct written feedback from trainees. In accordance with the proposal from Nelson and colleagues (16) that an early introduction of trainees to facets of pediatric pulmonology may influence their future career choices, our curriculum could have broad implications if disseminated. Its long-term impact on trainee career choices needs to be prospectively studied in national organizations.

There was an overall response rate of 57%, with lower response rates among

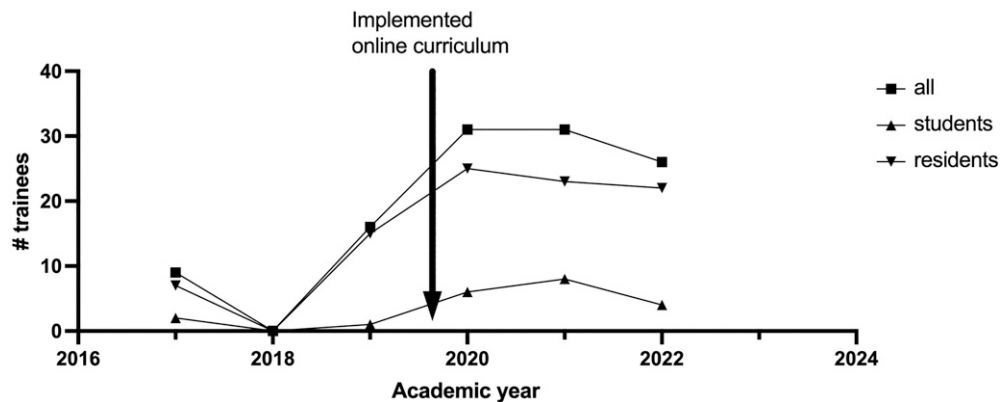


Figure 2. Numbers of students and residents who selected the pediatric pulmonary elective per academic year before and after implementation of the online curriculum.

residents compared with medical students. Because of workload and scheduling demands, residents were sometimes unable to attend 2 weeks of the elective, and we speculate that this was a barrier to completing the curriculum. Of interest, although the overall performance improved after the rotation, subgroup analysis indicated no significant improvement for PGY2 and PGY3 residents. This suggests that the educational format is less effective for more advanced trainees. This observation may strengthen the argument that exposure to subspecialty fields earlier in training is more beneficial, before trainees have finalized their career directions. Our study is limited by several factors. Because of the voluntary, rather than randomized, nature of electing the course and participating in the tests, a selection bias may have been introduced, limiting

the generalization of these results. Also, our study lacks a control group, so we cannot definitively conclude that the improvement in test scores was solely secondary to improved learning through the online curriculum.

Conclusions

In conclusion, our study demonstrates that the implementation of an interactive digital platform for pediatric pulmonology education may be an effective tool to improve learning and learner satisfaction while promoting interest in the subspecialty.

Acknowledgment

The authors thank Rachel J. Gordon, M.D., M.P.H. (Columbia University, New York, New York) for her guidance in creation of the online content.

Author disclosures are available with the text of this article at www.atsjournals.org.

REFERENCES

1. Weiss IJ, Liang L, Martin K. Overview of hospital stays among children and adolescents, 2019. Healthcare Cost and Utilization Project (HCUP) statistical briefs. Rockville, MD: Agency for Healthcare Research and Quality; 2022 [published 2022 Nov 29; accessed 2023 Dec 15]. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK588376/#>.
2. Masters K, Ellaway RH, Topps D, Archibald D, Hogue RJ. Mobile technologies in medical education: AMEE guide no. 105. *Med Teach* 2016;38:537–549.
3. Mayer RE. Applying the science of learning: evidence-based principles for the design of multimedia instruction. *Am Psychol* 2008;63:760–769.
4. Ali M, Han SC, Bilal HSM, Lee S, Kang MJY, Kang BH, *et al*. iCBLS: an interactive case-based learning system for medical education. *Int J Med Inform* 2018;109:55–69.
5. Holzmann-Littig C, Zerban NL, Storm C, Ulhaas L, Pfeiffer M, Kotz A, *et al*. One academic year under COVID-19 conditions: two multicenter cross-sectional evaluation studies among medical students in Bavarian medical schools, Germany students' needs, difficulties, and concerns about digital teaching and learning. *BMC Med Educ* 2022;22:450.
6. Khuong YL, Ulano A, Kulikov S, Bazylewicz M. Patient-centered, case-based education in radiology: an interactive module following a patient through their disease course from an imaging perspective. *Med Sci Educ* 2022;32:291–294.
7. Kositanurit W, Vivatvakin S, Kaikaew K, Varachotisate P, Burana C, Chayanupatkul M, *et al*. Asynchronous online lecture may not be an effective method in teaching cardiovascular physiology during the COVID-19 pandemic. *BMC Med Educ* 2022;22:162.

8. Mao S, Guo L, Li P, Shen K, Jiang M, Liu Y. New era of medical education: asynchronous and synchronous online teaching during and after COVID-19. *Adv Physiol Educ* 2023;47:272–281.
9. Rodrigues MAM, Zornoff D, Kobayasi R. Remote pathology teaching under the COVID-19 pandemic: medical students' perceptions. *Ann Diagn Pathol* 2022;56:151875.
10. Tift FW, Nable JV. Online medical control for EMS: a lecture and case-based teaching module. *MedEdPORTAL* 2020;16:10902.
11. van der Keylen P, Lippert N, Kunisch R, Kühlein T, Roos M. Asynchronous, digital teaching in times of COVID-19: a teaching example from general practice. *GMS J Med Educ* 2020;37:Doc98.
12. Villatoro T, Lackritz K, Chan JSY. Case-based asynchronous interactive modules in undergraduate medical education. *Acad Pathol* 2019;6:2374289519884715.
13. Nelson BA, Boyer D, Lahiri T, Oermann CM, Rama JA. A statement on the current status and future needs of the pediatric pulmonology workforce: pipeline workgroup. *Pediatr Pulmonol* 2023;58:690–696.
14. Oermann CM, Lahiri T, Peterson-Carmichael SL, Weiss P. The history of workforce concerns in pediatric pulmonary Medicine. *Pediatr Pulmonol* 2023;58:683–689.
15. Harris C, Katkin J, Cataletto M, Dorkin H, Laskosz L, Ruch-Ross H. US pediatric pulmonology workforce. *Pediatr Pulmonol* 2019;54:444–450.
16. Nelson BA, Rama JA, Weiss P, Hinkle LJ. *How* and *why* trainees choose a career in pediatric pulmonology. A qualitative study. *ATS Scholar* 2020;1:372–383.