Clinical Learning in Medical and Health Professions Education amid COVID-19 Pandemic: A Literature Review of Various Methods and Innovations

Totok Harjanto1*, Sri Setiyarini1, Titi S. Prihatiningsih2

1Department of Basic and Emergency Nursing, Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia; 2Department of Medical Education and Bioethics, Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia

Abstract

BACKGROUND: COVID-19 has caused disruption to medical education and health care systems around the world. The highly contagious nature of the virus makes it difficult for educational institutions to continue their studies as usual, thus affecting the medical and health professions education which is based on face-to-face lectures, practicum, skills laboratories, and clinical practice in health facilities.

AIM: This paper discovers clinical learning initiatives across the globe and highlights the contribution toward educational processes.

METHODOLOGY: This study utilized an integrated literature review method. A systematic search for articles published was performed in Springer, ScienceDirect, PubMed, and EBSCOHost. Primary search monetary terms were e-learning (all synonyms) and health sciences education (all synonyms), including COVID-19. Articles published within the period of COVID-19 pandemic included in this study. For the synthesis, the 20 included studies selected were coded. In this study, data were synthesized through narrative synthesis using thematic analysis (TA). To identify the recurrent themes author followed six steps when synthesizing data using TA, for example, familiarizing with the data, developing initial (sub) codes, searching for (sub) themes, reviewing (sub) themes, compiling ideas or issues, and producing final data in line with the study aims and objectives.

RESULTS: Out of records identified, a total of citations was screened, of which 20 were found to be of relevance to this study most were quantitative (14.70%) in design. Studies were published in 2020 since the beginning of COVID-19 pandemic. The geographical range of papers covered mostly the moderate-income regions. On conducting TA of the included studies, it was possible to obtain two broad descriptive themes/categories: enablers or drivers of, and barriers or challenges to, under which important themes have emerged.

CONCLUSION: Study suggests that developing e-learning in effective clinical learning is needed, not only limited to moving the learning process but also needing to follow the instructional design, so that learning outcomes can be achieved by students. In addition, a learning process that promotes self-directed-learning is needed so that students have flexibility, use relevant learning styles and are able to integrate knowledge, skills and attitudes as a meaningful learning process.
should be noted that too intense interaction using digital devices causes symptoms of both physical and mental fatigue [7], [8].

Medical education and health professions institutions have also suspended student placements and clinical observation activities in hospitals as well as primary and community health services [2], [9]. There are many effects of this action. On the one hand, students’ competence in clinical skills may decrease because they no longer have access to patient or laboratory skills. Therefore, students need a rich training and considerable time after returning to the clinical setting to achieve the desired level of competence. In addition, students in medical education and clinical health are unable to complete certain research, attend conferences, make presentations or conduct other scientific activities because of the risk of virus transmission that may occur [3]. The above activities are very important for students in developing knowledge, skills and attitudes as well as specialization in the future. Missing learning opportunities at this time results in students’ anxiety about career development and competence [10].

Evaluation of students’ knowledge and skills is greatly affected by the pandemic in all medical and health professions institutions. A written exam is changed to an open book exam and the evaluation of clinical skills is adjusted to the availability of learning tools [11], [12]. Medical and health professions institutions were able to identify risks of decreasing exam quality. Extensive learning materials from online sources promote theoretical knowledge acquisition among the students. Various policy measures have been implemented, including online supervision of all forms of written exams. The presence of an online proctor can simulate a more traditional exam environment where students do not have access to external resources for answering questions [13], [14]. It encourages students to do thorough preparation in studying relevant theoretical contents during the exam.

Meanwhile, in order not to eliminate clinical skills evaluation, educational institutions have scheduled a postponement of skills exams until a safe circumstance. This can result in a greater academic burden among students as they are required to master and perform many clinical skills in a short period of time [15], [16]. Overcoming the constraints on practical assessments is more complex and these assessments will likely continue to be postponed until a face-to-face evaluation is permitted. Medical and health professions institutions should seriously provide adequate time and a safe environment for students to prepare for clinical evaluation.

On the other hand, at the final stage of academic studies, medical and health education students face problems due to delays in the Objective Structured Clinical Examination (OSCE). OSCE is still a reliable standard for skills assessment, meanwhile the committee continues to work on establishing virtual practice exam standards [13]. It is possible that virtual clinical evaluations will continue until the COVID-19 pandemic subsides. This topic is still being discussed at the level of educational institutions and students related to the validity of the results of clinical skills testing in very different situations.

It is important to consider how clinical practice will be returned to the way it was. As the number of the COVID-19 cases decreases over time, the social distancing rules will gradually be eased. As students practice in various clinical facilities and move from region to region, policy differences may occur as local cases remain active [17]. Another consideration that becomes the focus of clinical learning is the limited availability of personal protective equipment (PPE) for medical personnel and students. It is important to ensure that both the clinical facilities ensure the availability of PPE for instructors and educational institutions facilitate the provision of PPE for students’ protection [18].

Institutions and educators were facing challenges to preserve effective yet meaningful clinical rotation amid COVID-19 pandemic. Diverse approaches have been introduced, following learners' characteristics and resources availability. However, research focusing on the field of clinical learning remains limited. This paper discovered clinical learning initiatives across the globe and highlighted the contribution to educational processes.

**Methods**

This study utilized an integrated literature review method. Author performs identification, appraisal, and synthesis toward evidence-based study findings to achieve the research purposes. Literature review is intended to cater information from evidence-based studies [19]. In this study, we collect original research articles to present novel innovations that being implemented for the learning in medical education and health professions amid COVID-19 pandemic. Databases in this study covers wide-range option that popular and also present extensive topic in medical and health education. Searching strategy and processes are being recorded during the literature search. In addition, validation of the identified article was performed to ensure publication relevancy and period.

Systematic search for articles was performed in Springer, ScienceDirect, PubMed, and EBSCOHost in 2020. The primary keywords were e-learning and health sciences education using. The searching included words as follow “e-learning” OR “online learn*” OR “distance learning” OR “virtual learning” OR “flipped learning”; “medical student” OR “nursing student” OR “health student AND; “clinical education” OR “clinical rotation”
The inclusion criteria of this study were:

- Articles published in 2020; written in English language;
- Involving research participants/study population from health professions education;
- Organizing clinical learning education and implementing a qualitative or quantitative research methods Paper with no full-text availability, review, case studies, commentaries, discussion papers, posters, conference abstracts, thesis and dissertations, as well as articles published in secondary, non-empirical studies or grey literature excluded from this study (Figure 1).

For the synthesis, the 20 articles were coded for the following information: (1) educational level, (2) health professions major/program, (3) research design, (4) learning methods/e-learning variation), (5) learning outcome/variable, and (6) Study phase/learning process.

**Data analysis**

Final search results were the basis of data analysis and synthesis. 20 articles, mostly quantitative were met the review criteria. Data synthesis performed through a narrative synthesis using a thematic analysis (TA). TA recognized as methods in identification, analysis and themes reporting among scientific literatures. Author of this study entitled to follow six steps TA data synthesis. The steps including data familiarization, initial codes development, sub themes definition, sub-themes review, topic/idea compilation and extraction of final results.

**Results**

Out of 1557 identified records, by following the Prisma Flow Diagram 20 articles were included in this study. 14.70% of the articles were quantitative study and all of the identified records published in 2020 from the beginning of pandemic. TA performed on the identified records suggested two major themes: driving force of the learning and challenges experienced by the educators and students.

The results of the analysis of the 20 articles indicated that e-learning in the clinical education amid the pandemic situation is potential to support the learning process. E-learning offers flexible and accessible educational activities. Several articles reported that e-learning provides high quality learning opportunities even in complex situations, utilized at various levels of study programs in the health majors and facilitates the achievement of specific clinical learning objectives [14], [20], [21]. Detailed summary of the reviewed articles provided in Table 2.

**Discussion**

The author identified 20 articles published in 2020 relevant to clinical learning amid the pandemic (Table 2). Articles dominated by studies from postgraduate program (resident and fellowship) with 13 articles. A total of 6 articles conducted studies on undergraduate student, either medical or nursing education. Only 1 article reported e-learning for health professionals’ population within the field of neonatal nurse. Residency education dominates the proportion of published articles, followed by undergraduate program. It conveyed that clinical skills competency shall not be deprecated or reduced even in a crisis.

Some studies reported that COVID-19 pandemic causing significant reduction of learning opportunities in clinical environments. This is indicated by the closure of health facilities, the decreased number of patients, the elimination of rotation, to the absence of specific disease cases needed in the study [14], [22]. Despite clinical education persists, the main concern of universities is the safety of students. Previous studies reported that educational institutions were obliged to follow public health strategies in promoting safe environment and community well-being. As several universities lifted limitations and substantially returning to normal learning sessions; COVID testing, other health and safety measures continued in place to protect students and community [20], [23], [24].

Current challenges demand medical educators to find new ways in continuing meaningful education. Postponement of students’ educational progression is not a viable option given for the future health workforce. Students are encouraged to complete their education in a timely manner which is beneficial for themselves and the community. In this case, medical and health professional program that requires patient encounter encouraged to implement innovative learning activities based on the organization culture and resources availability. Tailored learning activities provide extensive benefits for the institution by delivering high quality materials, expanding interest in certain fields and promote competent healthcare personnel in the future.
The purpose of implementing e-learning in clinical education amid the pandemic was to safeguard the academic activities and allowing students to acquire knowledge and skills in accordance with the competency standards [22], [25]. In general e-learning would facilitate the mastery of clinical skills as part of a patient care process [15], [26]. Facilitating clinical education ultimately contribute to the achievement of student competence.

Several initiatives have been introduced by higher institutions such as virtual clerkships and online team-based learning [24]. The learning activities were carried out to engage students with clinical facilities. In this regard, video conferencing was fundamental modality for students to stay connected with the clinical environment. Consumer software such as Zoom, Microsoft Teams, and Cisco WebEx were used by educational institutions. Characteristics and features that being considered in choosing the software including ease of use, bandwidth usage and integration functionality with academic systems [12].

In Wisconsin, medical students were invited to participate in novel learning opportunities that have been adapted for competency evaluation. A “night on call” virtual approach presented opportunities to bridge learning gaps despite being considered lack of

Table 2: Integrated review summary

| Author | Participants | Research design | Variable/outcome | Learning phase | Learning methods | Mediums |
|--------|--------------|----------------|------------------|---------------|-----------------|---------|
| Adesoye et al. | resident, general surgery | narrative/sharing | Patient Care, Professionalism, Interpersonal and Communication Skills, Practice-Based Learning and Improvement, Systems-Based | During | Didactic, clinical, non-clinical | Cisco WebEx |
| Calhoun, Kristine et al. | residents | Thoughts | Practice learning quality over quantity | During | Virtual learning not necessary | Virtual modules |
| Chertoff et al. | residents | Explore | Faculty development, resident education and virtual teaching | During | Virtual session with remote desktop software | Zoom, TeamViewer |
| Chick, Robert Connor et al. | residents | maintain education and safety of residents, educators, and patients. | Medical knowledge, practice-based learning and improvement | During | Propose innovative solutions to maintain rigorous education. | Zoom, WebEx, Skype |
| Conroy et al. | psychiatry education | Curriculum development | Raise the profile of AAGP; with the goal of inspiring interest within geriatric psychiatry. | Post | A web-based geriatric psychiatry curriculum for psychiatry residents and other learners | |
| Cunningham, Collette et al. | neonatal nurse education | critical discussion | form the basis for the critical discussion of the term eHealth, and the association with neonatal nurse education | Pre | Easily accessible and user-friendly resources | |
| De Ponti, Roberto et al. | 6th year medicine and surgery students postgraduate rheumatology | Action research | perception on fully online training including simulated clinical scenarios impacts on formal education programs, development and deployment of online teaching, reflect on the challenges and opportunities for technology-enabled learning | During | Introduction, virtual patient-based training, and debriefing | VRIL Collaborative, technology-based learning platform |
| Durfee et al. | Radiology clerkship Undergraduate and Postgraduate Medical | Action research | Student's performance and feedback teaching pedagogies and assessment strategies of medical curricula | During | 4-week virtual radiology clerkship | Zoom, Microsoft Teams, Blackboard, and ClickMeeting |
| Jumat, Muhammad Rahian et al. | Medical school | Cohort reporting | Team-based learning | During | Team LEAD Team-based Learning | Zoom |
| Konad et al. | Nursing students | Commentary | Clinical competence | Pre | Online formats for nursing clinical course | Zoom |
| Pedregosa et al. | Academic partnership | Systematic review | Model for health education | During | Clinical practice ability and teaching effectiveness in better in partnership model. Students from the group in partnership had greater clinical practice ability after clinical experience compared with students in the traditional group. | Zoom, Poll Everywhere |
| Polnom et al. | Clerkship | Action research | Radiation oncology | During | Virtual radiation oncology | Zoom, WebEx, Epic Systems |
| Ramos et al. | residency and fellowship in orthopedic and neurosurgery radiology residents | Objective measurement | Pandemic effect on education and measures taken | During | online virtual meeting spaces | |
| Royzman and Shareena | Narrative | Communication, preparation, leadership, education, wellness | During | virtual video conferences, simulated education, portable home workstation | Zoom, VPN |
| Sneyd et al. | Postgraduate students in anaesthesia fellow residency in orthopedic | Sharing/ opinion narrative | Service delivery, rotations effects, flexibility, innovations, digitalization time for rotation | During | socially distanced tutorials, virtual platforms, video laryngoscope online surgical video databases, orthopedic video theatre plus, digital educational experience, cadaver, bone substitute simulation, virtual face-to-face discussion | Video Web-based platforms |
| Stambough et al. | orthopedic training cross sectional survey | (i) Impact on PG teaching (ii) Impact on surgical training | During | Virtual classes and online video platform | Zoom, Cisco WebEx, Microsoft Teams |

The purpose of implementing e-learning in clinical education amid the pandemic was to safeguard the academic activities and allowing students to acquire knowledge and skills in accordance with the competency standards [22], [25]. In general e-learning would facilitate the mastery of clinical skills as part of a patient care process [15], [26]. Facilitating clinical education ultimately contribute to the achievement of student competence.

Several initiatives have been introduced by higher institutions such as virtual clerkships and online team-based learning [24]. The learning activities were carried out to engage students with clinical facilities. In this regard, video conferencing was fundamental modality for students to stay connected with the clinical environment. Consumer software such as Zoom, Microsoft Teams, and Cisco WebEx were used by educational institutions. Characteristics and features that being considered in choosing the software including ease of use, bandwidth usage and integration functionality with academic systems [12].

In Wisconsin, medical students were invited to participate in novel learning opportunities that have been adapted for competency evaluation. A “night on call” virtual approach presented opportunities to bridge learning gaps despite being considered lack of
sufficiency to meet clinical courses objectives [24]. At the orthopedic education, rising concerns in the learning process including fair amount of appropriate orthopedic education and sufficient exposure toward surgical opportunities. The American Board of Orthopedic Surgery increased away residency training from 4 to 6 weeks in fostering students’ medical knowledge, interpersonal skills and communication skills, patient care, professionalism, systems-based practice and practice-based learning [27].

Author classified the articles based on clinical learning phases. The included phases were pre, during and post clinical learning. This review dominated by articles that focusing in the course of learning by 20 articles (86%). There were 2 articles in the pre phase and one article in the post clinical learning phase.

The articles in the pre phase focused on preparing educators, learners and learning resources. The activities at this phase including briefings, content development [28] and others [24]. Preparations established by creating relevant case vignettes and provision of learning media (videos, images and sounds) [15], [29].

The implementation phase of clinical learning associated with student’s rotation in health facilities through e-learning. Activities organized in this phase were virtual case conferences, online focused group discussions, remote skills laboratory simulation and (virtual) bedside teaching and telehealth exercises [22], [23], [30], [31]. Educational institution takes advantage of learning management system (LMS) to distribute various learning resources. Many educational institutions implemented popular LMS, but there were also institutions that developed their own LMS.

The study discovered wide range of learning media and methodologies. The most common applied synchronous modality was live lecture with scheduled online video conferencing. Asynchronous learning was dominated by video contents to visually convey information among students to enable them to learn comprehensively. However, video playback did not allow real-time discussion. In more advanced level, institutions facilitated clinical simulation through the internet to enable direct interaction with instructors [13], [22]. A virtual clinical encounter was executed to response the suspension of clinical practice. This learning activity allows students to perform assessment, diagnosis, planning, implementation, and treatment evaluation remotely.

Virtual delivery of healthcare is another option that should be taken into consideration in facilitating clinical education. Telemedicine was neglected due to lack of regulation and scarce financial resources, but since amid pandemic, telehealth services were being delivered to outpatient clinics. The role of clinical instructors becomes ultimately important in this context. Instructors required to present information related to patient care [22], [26]. In the meantime, students expected to actively engage themselves in creating meaningful encounter with clinical instructors and patients [14], [25].

Disruption of the pandemic affected the assessment and exams in medical and health professions education. Standardized methods that remain in place to assess students’ knowledge and competencies were multiple-choice questions, OSCE, logbooks and portfolio [28]. Maintain a high quality of assessment process is fundamental. Notwithstanding physical movement limitation, organize virtual assessment without physical attendance of students and examiners is feasible [3].

Corresponding to the recovery of medical education in post pandemic era, curriculum reform is required [28]. As students losing their practice opportunities due to limitation of attendance in a sense of COVID-19, the e-learning exist to bridge the gap. In the future, this could be an alternative for permanent curriculum modification especially for students with limited opportunities in their home programs. Nevertheless, it is essential to customize the learning activities based on student’s characteristic and readiness of the resources. Continuous needs assessment in medical and health professional education favorable to produce competent graduates [20].

This integrated review has several limitations. First, the articles discovery related to e-learning in clinical education amid the pandemic carried out limited to five electronic databases. There was no gray literature searched by the author in the study phase, as it is possible that there are articles that not being included in the review. Second, this study did not contact the authors for validation purpose that led to the
absence of additional information/data in avoiding bias. Third, this review had limited diversity of articles quality, study sample size and study population.

Conclusion

This review discovered various forms of e-learning in medical and health professional education during COVID-19 pandemic and points out rarely studied areas. Study finding suggests that development of e-learning potential to enhance effective clinical learning. Transforming conventional learning into digital activities need to comply with instructional design in promoting the outcome achievement. In addition, a learning process that promotes self-directed learning is essential to provide flexibility for students in applying relevant learning styles to integrate knowledge, skills, and attitudes.

Institutional strategy is a key point in the implementation of e-learning in clinical education. Emerging disruption caused by COVID-19 demand institutions to adaptively response by developing flexible, accessible, and low-cost learning activities. Nevertheless, applied initiatives in the clinical education supposed not leave behind the goal to facilitate students in acquiring designated competencies. Integration of e-learning in traditional clinical education needed to ensure future development, despite the main idea of the implementation was to facilitate learning amid the pandemic.

References

1. Silva ON, Hernandez S, Kim EH, Kim AS, Gosnell J, Roman SA, et al. Surgery clerkship curriculum changes at an academic institution during the COVID-19 pandemic. J Surg Educ. 2021;78(1):327-31. http://doi.org/10.1016/j.jsurg.2020.07.009 PMid:32888850
2. Guadix SW, Winston GM, Chae JK, Haghdal A, Chen J, Younus I, et al. Medical student concerns relating to neurosurgery education during COVID-19. World Neurosurg. 2020;139:e836-47. http://doi.org/10.1016/j.wneu.2020.05.090 PMid:32426066
3. Poliom EL, Sandhu N, Frank J, Miller JA, Obeid JP, Kastelowitz N, et al. Continuing medical student education during the coronavirus disease 2019 (COVID-19) pandemic: Development of a virtual radiation oncology clerkship. Adv Radiat Oncol. 2020;5(4):732-6. http://doi.org/10.1016/j.adro.2020.05.006 PMid:32775783
4. McNeely CL, Schintler LA, Stabile B. Social determinants and COVID-19 disparities: Differential pandemic effects and dynamics. World Med Health Policy. 2020;12(3):206-17. http://doi.org/10.1002/wmh3.370
5. Chretien KC, Raj JM, Abraham RA, Aronowitz P, Astiz DJ, Chhedha SG, et al. AAIM recommendations for the 2020-2021 internal medicine residency application cycle in response to the COVID-19 pandemic. Am J Med. 2020;133(10):1223-6.e6. http://doi.org/10.1016/j.amjmed.2020.06.002 PMid:32659220
6. Chioldini J. Online learning in the time of COVID-19. Travel Med Infect Dis. 2020;34:101669. http://doi.org/10.1016/j.tmaid.2020.10.1669 PMid:32289547
7. Dewart G, Corcoran L, Thirk L, Petrovic K. Nursing education in a pandemic: Academic challenges in response to COVID-19. Nurse Educ Today. 2020;92:104471. http://doi.org/10.1016/j.nedt.2020.10.4471 PMid:32502723
8. Doherty I, McKimm J. e-learning in clinical teaching. Br J Hosp Med. 2010;71(1):111-4. http://doi.org/10.12968/hmed.2010.71.1.45973 PMid:20081642
9. Malhotra R, Gautam D, George J. Orthopaedic resident management during the COVID-19 pandemic AIMS model. J Clin Orthop Trauma. 2020;11:S307-8. http://doi.org/10.1016/j.jcot.2020.05.001 PMid:32405190
10. Matalon SA, Souza DA, Gaviola GC, Silverman SG, Mayo-Smith WW, Lee LK. Trainee and attending perspectives on remote radiology readouts in the era of the COVID-19 pandemic. Acad Radiol. 2020;27(8):1147-53. http://doi.org/10.1016/j.acra.2020.05.019 PMid:32507612
11. Huang HL, Chou CP, Leu S, You HL, Tiao MM, Chen CH. Effects of a quasi-experimental study of using flipped classroom approach to teach evidence-based medicine to medical technology students. BMC Med Educ. 2020;20(1):31. http://doi.org/10.1186/s12909-020-1946-7
12. Haworth A, Fielding AL, Marsh S, Rowshanfarzad P, Santos A, Metcalfe P, et al. Will COVID-19 change the way we teach medical physics post pandemic? Phys Eng Sci Med. 2020;43(3):735-8. http://doi.org/10.1007/s13246-020-00898-9 PMid:32720293
13. Chertoff JD, Zarzour JG, Morgan DE, Lewis PJ, Canon CL, Harvey JA. The early influence and effects of the coronavirus disease 2019 (COVID-19) pandemic on resident education and adaptations. J Am Coll Radiol. 2020;17(10):1322-8. http://doi.org/10.1016/j.jacr.2020.07.022 PMid:32818485
14. Sneyd JR, Mathoulin SE, O’Sullivan EP, So VC, Roberts FR, Paul AA, et al. The impact of the COVID-19 pandemic on anaesthesia trainees and their training. Br J Anaesth. 2020;125(4):450-5. http://doi.org/10.1016/j.bja.2020.07.011 PMid:32773215
15. Kan JY, Zhu L, Fong NJ, Ruan X, Ong AM, Lee G, et al. Conducting of web-based workshops for final year medical students preparing to enter the workforce during the COVID-19 pandemic. Med Sci Educ. 2020;31(1):1-5. http://doi.org/10.1007/s40670-020-01125-6 PMid:33133758
16. Khursheid Z, De Brún A, Moore G, McAuliffe E. Virtual adaptation of traditional healthcare quality improvement training in response to COVID-19: A rapid narrative review. Hum Resour Health. 2020;18(1):81. http://doi.org/10.1186/s12905-020-00548-x
17. Boyd CJ, Inglesby DC, Corey B, Greene BJ, Harrington MA, Johnson MD, et al. Impact of COVID-19 on away rotations in surgical fields. J Surg Res. 2020;255(205):96-8. http://doi.org/10.1016/j.jss.2020.05.049
18. Balhareth A, AlDuhileb MA, Aldualajian FA, Aldossary MY. Impact of COVID-19 pandemic on residency and fellowship training programs in Saudi Arabia: A nationwide cross-sectional study. Ann Med Surg. 2020;57:127-32. http://doi.org/10.1016/j.amsu.2020.07.025

19. Creswell JW. Research Design: Qualitative, Quantitative, and Mixed Method Approaches. 4th ed. Los Angeles, Calif: Los Angeles, Calif; 2013.

20. Adesoye T, Davis CH, Del Calvo H, Shaikh AF, Chegreddy V, Chan EY, et al. Optimization of surgical resident safety and education during the COVID-19 pandemic lessons learned. J Surg Educ. 2021;78(1):315-20. http://doi.org/10.1016/j.jsurg.2020.06.040

21. Rosman IS, Schadt CR, Samimi SS, Rosenbach M. Approaching the dermatology residency application process during a pandemic. J Am Acad Dermatol. 2020;83(5):e351-2. http://doi.org/10.1016/j.jaad.2020.07.066

22. Durfee SM, Goldenson RP, Gill RR, Rincon SP, Flower E, Avery LL. Medical student education roadblock due to COVID-19: Virtual radiology core clerkship to the rescue. Acad Radiol. 2020;27(10):1461-6. http://doi.org/10.1016/j.acra.2020.07.020

23. Roytman M, Shah S. Lessons learned during the COVID-19 pandemic: A single institution radiology chief resident experience. Clin Imaging. 2020;68:90-93. http://doi.org/10.1016/j.clinimag.2020.06.030

24. Conlon TA, McCarthy P, McGovern R, Slattery S, Yates J, Murphy S. The impact of COVID-19 on medical student education navigating uncharted territory. Ir Med J. 2020;113(6):109. PMid:32818364

25. Konrad S, Fitzgerald A, Deckers C. Nursing fundamentals supporting clinical competency online during the COVID-19 pandemic. Teach Learn Nurs. 2021;16(1):53-6. http://doi.org/10.1016/j.teln.2020.07.005

PMid:32837448

26. Guraya S. Combating the COVID-19 outbreak with a technology-driven e-flipped classroom model of educational transformation. J Taibah Univ Med Sci. 2020;15(4):283-4. http://doi.org/10.1016/j.jtumed.2020.07.006

PMid:32837509

27. Ramos O, Mierke A, Eastin M, Morrison MJ, Wongworawat DM, Danisa O. COVID-19 pandemic and the implications for orthopaedic and neurosurgery residents and fellows on spine rotations. North Am Spine J. 2020;1:100006. http://doi.org/10.1016/j.namusj.2020.100006

28. Conroy ML, Garcia-Pittman EC, Ali H, Lehmann SW, Yarns BC. The COVID-19 AAGP online trainee curriculum: Development and method of initial evaluation. Am J Geriatr Psychiatry. 2020;28(9):1004-8. http://doi.org/10.1016/j.jagp.2020.06.003

PMid:32624338

29. Dua AB, Kilian A, Grainger R, Fantus SA, Wallace ZS, Buttgereit F, et al. Challenges, collaboration, and innovation in rheumatology education during the COVID-19 pandemic: Leveraging new ways to teach. Clin Rheumatol. 2020;39(12):3535-41. http://doi.org/10.1007/s10067-020-05449-x

PMid:33067772

30. Stambough JB, Curtin BM, Gilliland JM, Guild GN 3rd, Kain MS, Karas V, et al. The past, present, and future of orthopedic education: Lessons learned from the COVID-19 pandemic. J Arthroplast. 2020;35(7):S60-4. http://doi.org/10.1016/j.arth.2020.04.032

PMid:32345564

31. Parke DW. COVID-19 era impacts on the American academy of ophthalmology. Ophthalmology. 2020;127(11):1447-50. http://doi.org/10.1016/j.ophtha.2020.07.056

PMid:32828553