

Impact of COVID-19 Pandemic on Medical Education: Insights and Recommendations

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Abstract

Disruptions in medical education are inevitable as healthcare systems across the world are set to be further stretched with the increasing burden of COVID-19 pandemic. Given the risks of nosocomial infection and other unique, similar challenges, there is difficulty in adapting required changes in medical education, particularly for the medical students and training junior doctors.

This paper discusses the different elements affecting and the widespread impact of COVID-19 pandemic on medical education. It concludes with strategies to minimize the impact of these factors and a call to action for the medical education system to adapt so it can meet the needs of healthcare learners during this pandemic and beyond. These include online learning, telemedicine and simulations that may help in both teaching/learning and assessment in basic and clinical education. The adaptation of these approaches, however, should be based on the intended learning outcomes and availability of resources. Teaching/learning strategies to develop reasoning skill and increasing the focus on formative assessments appears to be a fundamental requirement in the current context. The programme should adopt flexibility and collaboration as the guiding principles to mitigate the ill-effects of the pandemic on medical education.

Keywords: COVID-19, Pandemic, Medical education, Undergraduate, Postgraduate, Continuing, Impact

Introduction

Disruptions in medical education are inevitable as healthcare systems across the world are set to be further stretched with the increasing burden of COVID-19 pandemic. The impacts on doctors, nurses, physician assistants, and other healthcare workers continue to be extensively covered by journals and the media in general. Given the risks to healthcare workers of nosocomial infection, one area of particular difficulty has been the adaptations required in medical education, particularly for the students and training junior doctors.

However, medical education overall has rarely been mentioned despite being significantly impacted (Newman *et al.*, 2020; Ahmed *et al.*, 2020). There is added pressure and increased urgency to ensure that medical students are appropriately trained to strengthen the medical workforce reserve each year.

This paper discusses the different issues affecting and the widespread impact of COVID-19 pandemic on medical education mainly from educators' perspective with some reference to the student/trainee perspective where appropriate. The topics discussed would be relevant to all models of undergraduate and postgraduate programs and continuing medical education (CME). It concludes with strategies to minimize the impact of these factors and a call to adapt medical education systems to meet the needs of healthcare learners during this COVID-19 pandemic and beyond.

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Practice Points

1. The outcomes of both COVID-19 pandemic itself and the control strategies have severely impacted all stages of medical education. The impact is not confined to the educational aspect of students, trainees and trainers, but also the social aspect.
2. The need for maintaining the quality but with less flexibility in training time is a unique challenge faced by medical educators.
3. Although classroom-based teaching can be supplemented with online distance learning approaches, maybe in a more educationally sound manner, the disruption to clinical education is largely not compensable. The ill-effects of limitations to clinical training increases from undergraduate to postgraduate education.
4. Online learning, telemedicine and simulations may help in both teaching/learning and assessment in basic and clinical education, and the adaptation of these approaches, however, should be based on the intended learning outcomes and availability of resources.
5. Reorienting teaching/learning strategies to develop reasoning skill and increasing the focus on formative assessments appeared to be fundamental requirements in the current context.
6. The programme should adopt flexibility and collaboration as the guiding principles to mitigate the ill-effects of the pandemic on medical education.
7. The quality assurance and accreditation criteria should be revised to include the preparedness of institutions and programmes for online distance education and outcome-based progressive testing preparatory measures of facing similar challenges in the future.

Challenges

It is a fact that almost all sectors were affected by the consequences of COVID-19 pandemic at varying levels. Medical education is one sector which cannot afford long-term disruptions, as it holds the formal responsibility of preparing human resources which are required to maintain the smooth running of the health system in a country. Therefore, in medical education, the quality of the product cannot be compromised, yet there is very limited flexibility in training time. This basic element has been severely challenged by the outcomes of the COVID-19 pandemic itself and the controlling

measures used. The restrictions on physical gathering, limitations on clinical exposure, lessening the educational focus in clinical environments, issues related to the wellbeing of learners are some of the key challenges faced by medical educators during the pandemic in ensuring the quality of the product. These factors, however, have affected the different stages of medical education to variable extents.

Learning and assessment

In undergraduate education, the traditional in-person and face-to-face classroom-based approach to the basic and applied sciences education and hospital and community-based clinical education has become almost impossible. Although a certain degree of shift of the learning system towards digital learning was observed in classroom-based teaching it was virtually absent in clinical education (Guze, 2015). The classroom-based education has been disrupted due to measures of infection control, as in-person gatherings for large and small group teaching/learning activities and sharing of resources, e.g. mannequins, pose a significant threat. The halting of clinical training for medical students has been mainly due to the risk of spread of the infection from frequent rotations between different clinical disciplines and hospitals make medical students and trainees' potential vectors for COVID-19. With soaring healthcare costs, in most instances, the provision of PPE for medical students has been unaffordable. Therefore, to remove all forms of patient contact and to further mitigate the risk to patients and students alike, clinical placements and ward-based teaching had been suspended for a considerable duration. Medical undergraduates have also had their planned elective appointments cancelled due to regional and international travel restrictions. This has affected schools which had electives as a part of their core curriculum. Medical schools had no options but to abandon the elective programs as a prerequisite for qualifying. The resulting impact on the ability to experience disciplines that are not available in the student's institution will have to be addressed. The basic and applied sciences stages of undergraduate medical education already have the infrastructure to adapt—most schools continue basic science education online, and there is a plethora of online resources available to students. In contrast, similar infrastructure has been less developed and unavailable for the clinical years. This has left medical schools unprepared at short notice to improvise a distance-based curriculum for clinical teaching. The development of distant-learning strategies

encompassing all the fundamental principles of clinical education can be virtually impossible. In most instances, exit examinations for medical students typically consist of theory-based examinations and clinical assessments, which require physical contact and examination of simulated or real patients. The credibility of existing online assessments platforms has been more than adequate to conduct formative assessments, either theory-based or simulated. The sophisticated online assessment systems with summative assessments capabilities were not affordable to average medical schools. The most challenging situation for clinical examinations was the limited number of patients in hospitals for the examination of students and trainees. Many institutions had no alternative but to postpone summative exams, at least the clinical components.

Postgraduate medical education is almost entirely practical and hospital or community-based (Chew *et al.*, 2005) with very prominent components of face-to-face patient-trainee interactions in wards, clinics procedure rooms, theatres and in the community-based settings (Sandhu, 2018). There are supplementary 'teaching' components such as Grand Rounds, morbidity and mortality meetings, journal clubs, resident presentations, etc. which requires the physical gathering of a group. Both these aspects were severely affected and possible alternatives such as simulation have been able to replace this clinical exposure only to a limited degree (Guze, 2015; Sandhu, 2018). Postgraduate trainees comprise a large portion of the workforce in many academic centres. As hospitals experience surges in admissions, residents in many disciplines have been redeployed to function outside their speciality training to join COVID-19 treatment units to address the shortage of medical staff. Postgraduate training has also been severely disrupted due to conversion of Teaching Hospitals to COVID-19 treatment centres (Kwon *et al.*, 2020; Kogan *et al.*, 2020; Mousa *et al.*, 2020; Alvin *et al.*, 2020). For some trainees, the normal changeover of specialties in training did not occur. Therefore, residents have faced the challenges regarding personal safety and wellbeing and disruptions in their speciality training. Simulated patients, who are a supplementary source of clinical practice, have shown reluctance to visit hospitals in the prevailing situation, limiting their contribution to clinical training. Postgraduate medical education due to its very nature is severely hampered by lack of clinical material due to reduced regular admission, tremendous drop inpatient census, cancellation of clinics and

routine procedures resulting in loss of significant clinical training opportunities. The necessity to abide by the social distancing measures further affected ward-based teaching. Rounding while maintaining social distancing is a challenge. Standardized patients are most often unwilling to participate. Therefore, hands-on training (either simulated or real) is limited. The reduced exposure in specific specialties, can cause a detrimental effect on exam performance and overall clinical competence of the trainees. In postgraduate training, the lack of opportunities to provide feedback due to the reduced number of patient encounters and the limited ability to conduct periodical and exit examinations of summative nature have severely affected the progression of residents. This may result in a vacuum at the level of consultant at least in the immediate future.

The role of the clinical teacher, usually the supervising consultant, is paramount in both undergraduate and postgraduate medical education. In-person training had been a significant part of program delivery. Patient and learner interaction is undoubtedly the richest mode of learning. Variety and diversity of exposure is a crucial determinant of developing reasoning and diagnostic skills (Charlin *et al.*, 2007). These unique features of medical education were severely affected by the homogeneity of patient influx, the inundation of healthcare workforce, especially clinical teachers, with COVID-19 patients, the essentiality of social distancing and the reluctance among the public to visit healthcare facilities. During the pandemic, the educational focus was subdued by the need for treating patients with COVID-19 and the prevention of spreading the disease, posing a severe challenge to medical education at all levels (Liang *et al.*, 2020).

Continuing medical education (CME) is meant to improve the performance of clinical teachers and postgraduate trainees and to enhance the health outcomes of patients (Cervero *et al.*, 2015). It has been practiced mainly through sharing of expertise and experiences in local, regional and international meetings. CME was severely hampered by restrictions for travelling and gathering. Providing evidence for continuing medical education or professional development may be mostly optional and interest-based. However, in contexts where it is formal and mandatory, the activities have mainly been disrupted, and the 'evidence' had to be redefined. Fortunately, many clinicians have adopted the use of web-based programs for some time, and up-to-date evidence for

practice may not have been an issue. However, the in-person hands-on training or sharing of experience has become scarce due to lack of time and restriction of people's movement.

Self- and social wellbeing

Medical students and residents face uncertainty about the recommencement of their universities and the completion of the examinations. They are highly vulnerable to stress, anxiety, fear and depression (Shaw, 2020). Health care systems should consider regular house staff screenings for mental health issues such as anxiety, depression, insomnia, and distress; mental health services, including emergency hotlines, should be readily available to those in need.

Many residents have been deployed to unfamiliar clinical environments, faced with challenges that may threaten their physical and mental health. Many trainees separated from their families and living in new premises to reduce the risk of viral transmission. During this time of physical separation, residents tend to make attempts to maintain their social relationships despite physical isolation.

Among the clinicians in practice, the stress levels may have become high due to unprecedented increment of workload, anxieties about the illness and the experience of a large number of deaths (Redinbaugh *et al.*, 2003; Aziz, 2004). Long working hours creates pressures on attendings' ability to teach. These factors may lead to early burn out (INTeReSTS, 2015). On the other hand, in some specialties, patients may not visit their doctors, reducing the number of patients seen by certain specialists, causing anxiety and depression among them. Many faculties have been furloughed because of patient number impacts of the pandemic resulting in additional burden on some medical educators (Hall *et al.*, 2020).

Resumption strategies and associated issues

The resumption of educational activities will not be straight forwards and easy even for resourceful programmes. Multiple-prong approach will be needed and it should be adopted with due consideration of general and contextual factors (Hall *et al.*, 2020).

Guiding principles

Given the uncertain duration of the COVID-19 pandemic, and the possibility of multiple waves

of infection (Xu *et al.*, 2020), long-term action plans can help prepare under-graduate medical and resident training programs during these unprecedented times. However, planning of any sort is the primary challenge in the time of uncertainty. Planning should be based on two interwoven principles; flexibility and collaboration (Zuo *et al.*, 2020). Across all stages of medical education, flexibility is the requirement of the hour. Both teachers/trainers and learners should be flexible in their attitude and approach. Programs should help each other developing collaborations to bridge the gaps in resources (Zuo *et al.*, 2020). Learners must adopt collaborative learning strategies. The cohort-based approach may have to be reviewed for its pros and cons. The debate on the necessity of being in-person for learning theory should take a more pragmatic than a philosophical line. These have already been in practice to a certain extent (Naz *et al.*, 2017).

Alternative approaches

In the wake of restricted physical gathering, online distance learning, simulation and telemedicine may be the most effective options available for education. These options should be used singularly or in appropriate combinations depending on the stage of medical education and respective intended learning outcomes which are expected to be achieved.

Medical students have continued their learning programmes but without patient contacts in authentic settings, e.g. wards and clinics. Faculties have transitioned from face-to-face formats to digital platforms. These include online teaching/learning activities and simulations using various digital platforms (Moszkowicz *et al.*, 2020; Evans *et al.*, 2020; Gaber *et al.*, 2020; Almarzooq *et al.*, 2020). In digital platforms, participants have the opportunity to engage with learning material on their own pace and to be interactive with peers and teachers. Such features of online teaching have helped uphold some of the important educational principles. However, there seem to be certain issues associated with online digital formats. The scope of online teaching may be limited to cover a minor portion of a total curriculum. Increasing the capabilities of online teaching can be costly. The lack of expertise is another the inherent limitation of online learning. Furthermore, faculty have been adjusting to their own professional and personal needs in this rapidly changing climate, limiting the ability of faculty to create more educational content (Eltayar *et al.*, 2020).

A grass-roots effort to provide online undergraduate clinical education and continuing postgraduate medical education need solutions to satisfy the educational needs of learners during this time (Almarzooq *et al.*, 2020). First, faculties that draw resource persons from across the country (or the world) provides the ability to create a full curriculum; no individual institution was able to create and implement previously and rapidly. Second, an online platform to distribute clinical content would both abide by the safety guidelines defined by governing and advisory bodies, e.g. the Association of American Medical Colleges, and be flexible to rapidly adapt to constantly changing timelines and guidelines (AAMC, 2020).

One way to supplement clinical training is to get students and trainees actively involved in telemedicine clinics (AAMC, 2020). Many hospitals have encouraged clinicians to transfer their clinics to telemedicine platforms for patients, who do not require physical examination or procedures (Mann *et al.*, 2020). We encourage students and residents to partake in telehealth initiatives, as permitted by their institutions. By participating in these virtual visits, residents can review a patient's medical problems and charts and engage in patient counselling under the supervision of attending specialists. Several studies have demonstrated the feasibility and success of telemedicine clinics for both paediatrics and adults (Waseh *et al.*, 2019). Virtual examinations, which minimizes student-patient engagement, has its obvious drawbacks, as William Osler once proclaimed, 'He who studies medicine without books sails an uncharted sea, but he who studies medicine without patients does not go to sea at all' (Mian *et al.*, 2020). On resumption of clinical training, rotating between specialties will likely involve several logistical challenges such as familiarizing one's self with new teams, protocols and computerized systems (Goghari *et al.*, 2020).

Webinar and virtual meeting have been gaining popularity as an approach to CME during this pandemic. The recently concluded annual scientific meeting of Sri Lankan Medical Association, which is a national conference, was showcasing the potential and capability of online facilities in conducting a successful virtual conference with limited resources. Similarly, across all disciplines, the avenues for conducting conferences and scientific meetings virtually should be strengthened and diversified. Investing in virtual conferencing by

professional bodies will give dividends even in post-COVID 19 periods, in terms of dissemination of knowledge and social justice; the cost of CME for individual health professionals around the world would become bearable. However, the resource persons of CME may need support both on technical aspects and online facilitation for the successful implementation of online CME programmes (Lockyer *et al.*, 2006).

Significant and unprecedented changes to assessment methods will have to be made, given the risk of students undertaking examinations close to other students and patients (Goh *et al.*, 2020). To prevent exposure and spread of COVID-19 to patient volunteers, examinations on real patients may be replaced with on-screen assessments; videos of elicited physical signs may be played to candidates for them to identify and interpret. Medical schools may have to remove traditional written assessments and replace them with remote online, open-book assessments for both clinical and pre-clinical medical students. In addition, the effects of the pandemic may be an opportunity for a culture shift in assessments; adopting formative assessments and provision of feedback as the main stay of assessment while using summative assessments judiciously and sparingly for certification will be more educationally sound. Some institutions offered degrees using projected gradings based on previous performances of students. This was possible for medical schools which have adopted assessment strategies of outcome-based progressive testing. However, schools, which used stage-based assessment systems, e.g. pre-clinical, para-clinical and clinical, left with no options but the postponement of high-stake examinations. Adoption of outcome-based progress testing assessment approach may help withstand similar challenges in the future.

Safety aspects

These are uncertain times and all healthcare professionals, including medical students and junior trainees, have a role to play in tackling this pandemic (Ashokka *et al.*, 2020). However, with added responsibility placed on students and junior doctors, necessary measures need to be in place to ensure, patient safety and adequate training at all levels, from volunteer medical student to qualified doctors (Rose, 2020).

The students and postgraduate trainees should adhere to strict health care guidelines and should take respiratory precautions by wearing

masks and wash their hands or use hand sanitizers frequently and thoroughly (CDC, 2020). They should avoid over crowding and practice physical distancing as much as possible. Initially, partial resumption of clinical rotations with reduced numbers and in smaller batches would be helpful. Administrators should adhere to health care guidelines to prevent the spread of COVID-19 within their higher education institutions (CDC, 2020). The large number of HCW infections and deaths from COVID-19 has underscored the importance of access to personal protective equipment (PPE) (Wang *et al.*, 2020; Koh, 2020; CDC, 2020). If and when clinical teaching is resumed, appropriate PPEs should be provided to the students and resident trainees (CDC, 2020). Providing PPEs for trainees will be challenging. The ethical issue of such provisions, when workers are facing a PPE shortage and are reusing disposable PPE, needs addressing. As a result of PPE shortages, many institutions have encouraged employees to reuse single-use PPE items for several days or longer, in accordance with appropriate guidance [e.g. Centers for Disease Control and Prevention (CDC)] (CDC, 2020). Trainee doctors are to participate in clinical environments if they have appropriate PPE. Proper fit-testing and training, especially when multiple types/brands of PPE are being utilized, are also critical safety factors (Kwon *et al.*, 2020). Simultaneously, we should ensure the rights and the safety of the patients involved in clinical teaching by reducing their infection risk and limiting contact with student and resident to a minimum. Many healthcare workers, including students and trainees, are asymptomatic carriers of COVID-19 and can spread the virus to others (Black *et al.*, 2020). Access to COVID-19 testing for both healthcare worker and patients has been variable, and testing policies differ by country, region and institution. However, it is critical that junior doctors and residents who experience symptoms suggestive of a COVID-19 infection self-quarantine, return to work only after cessation of symptoms and testing. In addition, testing for COVID-19 of the returning students and trainees from the community by serology will be helpful to limit the spread of the infection to medical educational facilities (Studdert *et al.*, 2020).

Making up lost time

The essential components of clinical training in undergraduate and postgraduate medical education, which have been postponed due to the effects of the pandemic, may have to be re-arranged. This is a crucial component of

resumption as both confidence and competence of learners in clinical skills, especially among medical students, appeared to be affected by COVID-19 pandemic (Choi *et al.*, 2020). Recruiting additional institutions and community settings for clinical training may be necessary to accommodate multiple cohorts awaiting the completion of clinical training components and to maintain the national and institutional policies on social distancing. Postgraduate institutions and colleges should consider the disruption of normal clinical training and aim to provide fair alternatives for postgraduate trainees who require extended time away from work and develop long-term alternatives to traditional resident educational activities.

Social well-being

Addressing the issues of the social well-being of students and trainees may be overlooked in the process of resumption. They may face issues related to adapting to new normal even they remain in familiar settings. They may develop new issues related to adaptation when the programs are reorganized and reoriented. The pandemic situation itself may be a causative factor of additional stress and anxiety. The availability of mentors and using technology-enhanced communication methods for mentor-mentee communications has become highly important in these testing times (Hodgson *et al.*, 2020).

Quality assurance and accreditation

In the 'new normal', the governing bodies should make allowance for individualized and contextualized decisions making for institutions and programmes while upholding the principles of quality assurance (Tolsgaard *et al.*, 2020). The future assessment of programmes for quality should include a criterion on their preparedness for online distant learning not only in infrastructure development but in staff development and expertise.

Conclusion

Similar to many aspects of modern day-to-day life, education is impacted and has changed dramatically during the COVID-19 pandemic. Even with all of the rapidly developing innovations that current pandemic has sparked, it is difficult to imagine that life will return to the previous 'normal' state immediately if and when the pandemic resolves. While in-person learning will always remain an essential component of medical education, distance

online learning may prove to be a highly effective and flexible supplement or even an alternative (Emanuel, 2020).

The educational approach to new 'normal' looks to be multiprong and its facets may vary from adopting online learning strategies to refocusing on quality assurance criteria. The present crisis could be the catalyst that pushes clinical medical education for medical students, residents, and practicing professionals to innovate and utilize online education. We should use this opportunity to streamline and improve medical education by incorporating novel approaches to medical education (Liang *et al.*, 2020; Emanuel, 2020). Therefore, the medical education system must prepare to adapt to this challenge sooner than later.

Notes on contributions

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Declarations

Competing interests

The authors have no declarations of interest to report

Authors' Contributions

MAN, CM conceptualized and drafted the paper. STDeS and APDeS critically revised the manuscript. All author read and approved the final version.

References

AAMC (Association of American Medical Colleges). From Bedside to Webisode: Future Doctors Learn How to Practice Remotely. <https://www.aamc.org/news-insights/bedside-webisode-future-doctors-learn-how-practice-remotely>. Accessed May 06, 2020

AAMC (Association of American Medical Colleges). Important Guidance for Medical Students on Clinical Rotations During the Coronavirus (COVID-19) Outbreak. <https://www.aamc.org/news-insights/press-releases/important-guidance-medical-students-clinical-rotations-during-coronavirus-covid-19-outbreak>. Accessed May 06, 2020

Ahmed, H., Allaf, M. and Elghazaly, H., 2020. COVID-19 and medical education. *The Lancet Infectious Diseases*.

Almarzooq, Z., Lopes, M. and Kochar, A., 2020. Virtual learning during the COVID-19 pandemic: a disruptive technology in graduate medical education.

Alvin, M.D., George, E., Deng, F., Warhadpande, S. and Lee, S.I., 2020. The impact of COVID-19 on radiology trainees.

Ashokka, B., Ong, S.Y., Tay, K.H., Loh, N.H.W., Gee, C.F. and Samarasekera, D.D., 2020. Coordinated responses of academic medical centres to pandemics: Sustaining medical education during COVID-19. *Medical Teacher*, pp.1-10.

Aziz, A., 2004. Sources of perceived stress among American medical doctors: a cross-cultural perspective. *Cross Cultural Management: An International Journal*.

Black, J.R., Bailey, C., Przewrocka, J., Dijkstra, K.K. and Swanton, C., 2020. COVID-19: the case for health-care worker screening to prevent hospital transmission. *The Lancet*, 395(10234), pp.1418-1420.

CDC (Centers for Disease Control and Prevention). Guidance for the Selection and

- Use of Personal Protective Equipment (PPE) in Healthcare Settings. <https://www.cdc.gov/hai/pdfs/ppe/ppeslides6-29-04.pdf>. Accessed May 06,2020.
- CDC (Centers for Disease Control and Prevention). How to Protect Yourself & Others. <https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/prevention.html>. Accessed May 06, 2020
- CDC (Centers for Disease Control and Prevention). Interim Guidance for Administrators of US Institutions of Higher Education. <https://www.cdc.gov/coronavirus/2019-ncov/community/guidance-ihe-response.html>. Accessed May 06, 2020
- CDC (Centers for Disease Control and Prevention). Recommended Guidance for Extended Use and Limited Reuse of N95 Filtering Facepiece Respirators in Healthcare Settings. <https://www.cdc.gov/niosh/topics/hcwcontrols/recommendedguidanceextuse.html>. Accessed May 06,2020.
- CDC (Centers for Disease Control and Prevention). Using Personal Protective Equipment (PPE). <https://www.cdc.gov/coronavirus/2019-ncov/hcp/using-ppe.html>. Accessed May 06,2020.
- Cervero, R.M. and Gaines, J.K., 2015. The impact of CME on physician performance and patient health outcomes: an updated synthesis of systematic reviews. *Journal of Continuing Education in the Health Professions*, 35(2), pp.131-138.
- Charlin, B., Boshuizen, H.P., Custers, E.J. and Feltovich, P.J., 2007. Scripts and clinical reasoning. *Medical education*, 41(12), pp.1178-1184.
- Chew, C.H. and Chee, Y.C., 2005. Postgraduate medical education and specialist training in Singapore. *Ann Acad Med Singapore*, 34(6), pp.182C-189C.
- Choi, B., Jegatheeswaran, L., Minocha, A., Alhilani, M., Nakhoul, M. and Mutengesa, E., 2020. The impact of the COVID-19 pandemic on final year medical students in the United Kingdom: a national survey. *BMC medical education*, 20(1), pp.1-11.
- Eltayar, A.N., Eldesoky, N.I., Khalifa, H. and Rashed, S., 2020. Online faculty development using Cognitive apprenticeship in response to COVID 19. *Medical Education*.
- Emanuel, E.J., 2020. The inevitable reimaging of medical education. *Jama*, 323(12), pp.1127-1128.
- Evans, D.J., Bay, B.H., Wilson, T.D., Smith, C.F., Lachman, N. and Pawlina, W., 2020. Going Virtual to Support Anatomy Education: A STOPGAP in the Midst of the Covid-19 Pandemic. *Anatomical Sciences Education*.
- Gaber, D.A., Shehata, M.H. and Amin, H.A., 2020. Online Team-Based Learning Sessions as Interactive Methodologies During The Pandemic. *Medical Education*.
- Goghari, V.M., Hagstrom, S., Madon, S. and Messer-Engel, K., 2020. Experiences and learnings from professional psychology training partners during the COVID-19 pandemic: Impacts, challenges, and opportunities. *Canadian Psychology/Psychologie canadienne*, 61(3), p.167.
- Goh, P.S. and Sandars, J., 2020. A vision of the use of technology in medical education after the COVID-19 pandemic. *MedEdPublish*, 9.
- Guze, P.A., 2015. Using technology to meet the challenges of medical education. *Transactions of the American clinical and climatological association*, 126, p.260.
- Hall, A.K., Nousiainen, M.T., Campisi, P., Dagnone, J.D., Frank, J.R., Kroeker, K.I., Brzezina, S., Purdy, E. and Oswald, A., 2020. Training disrupted: Practical tips for supporting competency-based medical education during the COVID-19 pandemic. *Medical Teacher*, pp.1-6.
- Hodgson, J.C. and Hagan, P., 2020. Medical education adaptations during a pandemic: transitioning to virtual student support. *Medical education*, 54(7), pp.662-663.
- INTeReSTS, D.O., 2015. Burnout in physicians. *JR Coll Physicians Edinb*, 45, pp.104-7.
- Kogan, M., Klein, S.E., Hannon, C.P. and Nolte, M.T., 2020. Orthopaedic education during

- the COVID-19 pandemic. *The Journal of the American Academy of Orthopaedic Surgeons*.
- Koh, D., 2020. Occupational risks for COVID-19 infection. *Occupational medicine (Oxford, England)*, 70(1), p.3.
- Kwon, Y.S., Tabakin, A.L., Patel, H.V., Backstrand, J.R., Jang, T.L., Kim, I.Y. and Singer, E.A., 2020. Adapting urology residency training in the COVID-19 era. *Urology*.
- Kwon, Y.S., Tabakin, A.L., Patel, H.V., Backstrand, J.R., Jang, T.L., Kim, I.Y. and Singer, E.A., 2020. Adapting urology residency training in the COVID-19 era. *Urology*.
- Liang, Z.C., Ooi, S.B.S. and Wang, W., 2020. Pandemics and their impact on medical training: lessons from Singapore. *Academic Medicine*.
- Lockyer, J., Sargeant, J., Curran, V. and Fleet, L., 2006. The transition from face-to-face to online CME facilitation. *Medical Teacher*, 28(7), pp.625-630.
- Mann, D.M., Chen, J., Chunara, R., Testa, P.A. and Nov, O., 2020. COVID-19 transforms health care through telemedicine: evidence from the field. *Journal of the American Medical Informatics Association*.
- Mian, A. and Khan, S., 2020. Medical education during pandemics: a UK perspective. *BMC medicine*, 18(1), pp.1-2.
- Moszkowicz, D., Duboc, H., Dubertret, C., Roux, D. and Bretagnol, F., 2020. Daily medical education for confined students during COVID-19 pandemic: A simple videoconference solution. *Clinical Anatomy*.
- Mousa, A.Y. and Broce, M., 2020. The impact of COVID-19 on vascular training. *Journal of Vascular Surgery*.
- Naz, A.S., Rehman, R., Jamil, Z., Ahmed, K. and Surti, A., 2017. Students' perceptions of usefulness of Anatomy demonstrations in traditional and hybrid undergraduate medical education curricula. *JPMA. The Journal of the Pakistan Medical Association*, 67(3), p.461.
- Newman, N.A. and Lattouf, O.M., 2020. Coalition for medical education—A call to action: A proposition to adapt clinical medical education to meet the needs of students and other healthcare learners during COVID-19. *Journal of Cardiac Surgery*.
- Redinbaugh, E.M., Sullivan, A.M., Block, S.D., Gadmer, N.M., Lakoma, M., Mitchell, A.M., Seltzer, D., Wolford, J. and Arnold, R.M., 2003. Doctors' emotional reactions to recent death of a patient: cross sectional study of hospital doctors. *Bmj*, 327(7408), p.185.
- Rose, S., 2020. Medical student education in the time of COVID-19. *Jama*.
- Sandhu, D., 2018. Postgraduate medical education—Challenges and innovative solutions.
- Shaw, S.C., 2020. Hopelessness, helplessness and resilience: The importance of safeguarding our trainees' mental wellbeing during the COVID-19 pandemic. *Nurse Education in Practice*, 44, p.102780.
- Studdert, D.M. and Hall, M.A., 2020. Disease control, civil liberties, and mass testing—calibrating restrictions during the COVID-19 pandemic. *New England Journal of Medicine*.
- Tolsgaard, M.G., Cleland, J., Wilkinson, T. and Ellaway, R.H., 2020. How we make choices and sacrifices in medical education during the COVID-19 pandemic. *Medical Teacher*, pp.1-3.
- Wang, J., Zhou, M. and Liu, F., 2020. Reasons for healthcare workers becoming infected with novel coronavirus disease 2019 (COVID-19) in China. *J Hosp infect*, 105(1).
- Waseh, S. and Dicker, A.P., 2019. Telemedicine training in undergraduate medical education: mixed-methods review. *JMIR medical education*, 5(1), p.e12515.
- Xu, S. and Li, Y., 2020. Beware of the second wave of COVID-19. *The Lancet*, 395(10233), pp.1321-1322.
- Zuo, L., Dillman, D. and Miller Juve, A., 2020. Learning At-Home During COVID-19: A Multi-institutional Virtual Learning Collaboration. *Medical edu*