

COVID-19: Ensuring safe clinical teaching at university optometry schools

Sven Jonuscheit,¹ Andrew KC Lam,² Katrina L Schmid,³ John Flanagan,⁴ Raul Martin,⁵ David Troilo⁶

¹Department of Vision Sciences, Glasgow Caledonian University, Cowcaddens Road, Glasgow, G4 0BA, UK

²School of Optometry, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China

³School of Optometry and Vision Science, Queensland University of Technology, 60 Musk Ave, Kelvin Grove, Qld 4059, Australia

⁴School of Optometry, University of California Berkeley, CA 94720-2020, USA

⁵Department of Optometry, University of Valladolid, Spain

⁶SUNY College of Optometry, 33 West 42nd Street New York, NY 10036, USA

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Abstract

The COVID-19 pandemic has been spreading across the globe for several months. The nature of the virus (SARS-CoV-2) with easy person-to-person transmissions and the severe clinical course observed in some people necessitated unprecedented modifications of everyday social interactions. These included the temporary suspension of considerable elements of clinical teaching at optometry schools worldwide. This article describes the challenges optometry schools were facing in early to mid 2020. The paper highlights the experiences of six universities in five countries on four continents. Strategies to minimise the risk of virus transmission, to ensure safe clinical optometric teaching and how to overcome the challenges presented by COVID-19 are described. An outlook on opportunities to further improve optometric education is provided.

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1. Background and purpose

The global spread of coronavirus and government responses

In December 2019, the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) emerged and subsequently spread globally.¹ The newly identified virus is characterised by easy human transmission, a varying incubation period and a potentially severe clinical course.²⁻⁴ While worse outcomes and fatalities tend to occur more commonly in older people and in those with comorbidities, younger people can also transmit the virus in schools and thus communities.² University curriculum adaptations were necessary to reduce the risk of viral transmission between students, and from students to families as well as the wider community. From January 2020 onwards, many countries have initiated a large-scale lockdown of their societies, albeit at different times, speeds and of varying stringency (Table 1).^{5,6}

Correspondingly, educational institutions such as schools and universities across the globe have taken actions that were largely unprecedented in modern times, and ceased face-to-face in-person teaching, closed their physical campuses for students and staff^{7,8} and moved activities online. Optometry schools worldwide were and still are modifying their teaching and services in response to SARS-CoV-2. For clinical courses like optometry, the hands-on nature of the curriculum has proved challenging; similar issues were reported for medical education.⁹ With little warning and preparation time, all teaching shifted to online and blended learning delivery. These changes were accompanied by a steep learning curve for academicians and students. While lectures can be adapted to online virtual learning platforms, laboratory-based and clinical teaching are not easily modified, and some skills and experiences are impossible to convert to online delivery. This creates a risk for

optometry schools in that it potentially delays or even jeopardises the chances of students completing their programme of study in a timely manner, and it may deter prospective students, who are in the process of applying for university courses, from enrolling in an optometry programme.

Purpose of this paper

A recent editorial and review described the effect of COVID-19 on the eye.¹⁰ The purpose of this paper is to describe the challenges that occurred and continue to affect teaching at optometry schools around the world due to the COVID-19 pandemic. The views presented are those of the authors, and describe measures taken to facilitate safe and effective clinical teaching at university optometry departments. Four key suggestions on how these challenges can be overcome are made, using examples of six universities in five countries and across four continents. An overview is provided as to how optometry schools in Australia, China (Hong Kong), Spain, the United Kingdom and the United States have responded and how, at the same time, optometric university education is being revolutionised. Wider aspects such as the student experience and student mental health are considered. Finally, the residual risks associated with resuming clinical teaching practice are discussed. Prevalence statistics are as of September 2020 where possible.

2. Responses of higher education institutions in five countries across four continents

Following the World Health Organisation (WHO) declaration of COVID-19 being considered a pandemic in March 2020, many countries have taken measures to reduce the spread.

Government advice has led to universities across the world taking precautions to protect their students, staff and, in the case of medical and health profession departments,

patients. The measures taken at the institutions of the authors included ceasing in-person teaching, a rapid switch to remote access teaching, campus and university optometry clinic closures and cessation of patient services (Table 2).

Optometry schools coordinated their communication with regulatory bodies to ensure broad consensus on any measures adopted. There was also close communication between optometry schools through national professional and regulatory organisations including the UK Optometry Schools Council, the Spanish National Board of Optometry Deans, the Optometry Council of Australia and New Zealand and the (American) Association of Schools and Colleges of Optometry. Examples of country- and institution-specific responses are provided below.

Modifications to teaching modalities and impact on students

Following the ceasing of in-person teaching and the closure of physical university campuses, academic staff were asked to transfer all teaching to online delivery. This shift to online teaching using a variety of web-based platforms occurred at high speed and often within a few days, putting considerable strain on academic and professional services staff.

The closure of on-campus optometry clinics prevented students from attaining their required number of clinical case episodes. The universities have taken different approaches to mitigate the shortfall of clinical experience (Table 3). Similarly, students were unable to complete external clinical placements, for example at hospital eye clinics (Table 4). At the end of the academic term, many optometry schools were faced with new difficulties relating to the assessment of students' knowledge in order to establish module (course) marks (grades). Lastly, another common observation at all universities, and likely affecting the

majority of academic staff and students, was that the transition to online teaching and learning resulted in a rather steep learning curve, as academics and students had to familiarise themselves with the intricacies of new software applications to deliver and participate effectively in online teaching sessions (Tables 4 and 5). Clinical teaching will only be possible under social distancing rules and with the use of personal protective equipment. The following sections highlight some of the approaches taken by individual schools and illustrate the immense challenges associated with returning to in-person clinical teaching on a university campus.

Glasgow Caledonian University (GCU), UK

The UK has been severely affected by COVID-19 with more than 400,000 confirmed cases and more than 41,000 deaths.^{5 11} As of September, 2020, Scotland has emerged from a lockdown that lasted more than three months. GCU had responded quickly and effectively and ceased face-to-face teaching in March, which preceded the country-wide lockdown by about one week. GCU operates a trimester structure, which separates the academic year into three distinct elements. The move to online-only teaching occurred at week 9 (of 12) of the second trimester of the academic year, meaning up to 75% of the teaching material had already been delivered. Regulatory approval for the proposed changes was gained from the General Optical Council in the UK. The team ensured that the learning outcomes of each module were still met. Written exams were replaced by timed online assessments, including open book, short answer questions which were made available for a 48-hour period. Clinical assessments were replaced with one-to-one case discussions with an emphasis on student communication and patient management.

Some international students who had returned to their home countries experienced difficulties due to having to go into quarantine upon arrival (e.g. in Singapore), which impacted their ability to participate in online sessions. Some were adversely affected by psychological strains of the lockdown and campus closure. GCU provided a wide range of measures to support student wellbeing, including telephone and chat hotlines for students. Academic advisors provided intensive pastoral care including weekly virtual coffee meetings. With all casual work opportunities stopped, some students faced financial difficulties and had to apply for financial support from GCU hardship funds. Following completion of their university studies, UK graduates enrol in the 'Scheme for Registration' of the College of Optometrists (pre-registration trainees). Successful completion of this scheme is required in order to become eligible to apply for professional registration to practise as an optometrist. Final year students at GCU who were expecting to start their pre-registration training in summer 2020 now feared that commencement of their training may be delayed by up to one year. A phased re-opening of the clinical facilities at GCU commenced in the summer, and the provision of essential optometric patient care resumed in August 2020, following newly developed standard operating procedures. The clinical teaching resumed in autumn 2020, with priority consideration given to final-year students to ensure timely completion of their studies and clinical experience. Staff have prepared for extended online delivery of large group lectures, which may be synchronous (in real time) or asynchronous (without real-time interaction), including the development of webinars and narrated lectures of 20-30 minutes duration, leaving face-to-face / in-person capacity to the hands-on training that is an integral part of an optometry degree programme.

The Hong Kong Polytechnic University (HKPU), China

Hong Kong was comparatively mildly affected by COVID-19, with less than 1,778 confirmed cases and 12 recorded fatalities, indicating limited transmission in the community.¹² The government's response to the outbreak following the first confirmed COVID-19 case on 23 January 2020 resulted in border closures in late January, and widespread use of face masks in the population. HKPU commenced its second academic term online-only on 10 February 2020. After five weeks, a one-week recess period allowed academic staff to review their teaching and provide assistance to any students experiencing difficulties with online learning. To aid final-year students who had logged a lower than anticipated number of face-to-face patient encounters, staff implemented a clinical distance learning scheme, which was modelled on the Student Online Clinical Case Education Program of the American Academy of Optometry with the Association of Schools and Colleges of Optometry (18 hours per student; for details please contact co-author Dr AKC Lam). In addition, junior-year students were encouraged to utilise clinical skills videos that were provided to complement written material. With the campus re-opening in May, written examinations were held in person following social distancing guidelines, with students using face masks and desks being disinfected. Access to the optometry clinic resumed and final-year students were able to continue their clinical placements. In-person practical sessions for junior students resumed on 1 June 2020. These changes occurred notably earlier than at the other institutions listed here. However, placements at hospital ophthalmology departments have not resumed.

Queensland University of Technology (QUT), Australia

The Australian government responded quickly to COVID-19, and closed its international borders, restricting entry for non-residents on 20 March 2020. Australian citizens returning

from overseas were required to self-isolate for two weeks. A national working from home directive was issued on 30 March 2020. Similar to New Zealand, Australia, with over 27,000 confirmed cases and >800 COVID-related deaths as of September 2020, has relatively few cases, especially in contrast to the picture emerging from Spain and the UK. Relatively few new cases have been detected in Australia since mid-May and the country is gradually reopening in a staged manner, although a partial local lockdown was instated in Melbourne, Victoria, in early July 2020 to mitigate an emerging increase in COVID-19 case numbers. At the start of lockdown, only four weeks of semester 1 had been completed and the mid-semester break was extended to two weeks. Following the break, all teaching activities were provided online within the digital campus framework. The QUT optometry clinic closed in mid-March, at about the same time as the GCU clinic, not because of a government directive, but at the initiative of the university. As patients cancelled their appointments, largely due to anxiety over acquiring COVID, the QUT optometry clinic became unviable as a teaching centre. Clinical skills teaching resumed in July 2020.

One facet that may not be immediately obvious to educators but may have caused distress to students and staff is the intensive media coverage, including images of large numbers of people requiring intensive medical care and those dying from/with COVID-19 in other countries. Similarly, concern for one's own health and that of family and friends, the anticipated economic downturn because of lockdown and the immediate financial stress caused by redundancies have had great impact. Thus, despite low case numbers and fatalities, the mental health of Australians has been affected by this situation and QUT is concerned for its students. To reduce the severity of this impact, QUT has developed mental health and well-being fact sheets including how to cope with isolation and anxiety and how

to help others. The university also increased its financial support programmes for students in need.

University of Valladolid (UVa), Spain

Spain has been severely affected by COVID-19 with more than 430,000 confirmed cases and more than 29,000 deaths to date. On 16 March 2020, the Spanish Government announced a state of emergency, introducing severe lockdown regulations. These were relaxed in early May using a phased approach and ceased on 20 June 2020. The changes occurred after the first third of the second academic term at UVA had been completed, leaving two thirds of teaching activities (about 10 weeks) and 4 weeks of assessments to be delivered. The programme team followed the recommendations of the Spanish regulatory agencies and the National Board of Optometry Deans to modify the teaching programme. These changes included assessment modifications to allow for continuous assessment of all modules utilising online tests and interactive discussion forums. UVa, aware of the difficulties of this teaching transformation, offered staff and students skills development opportunities to increase digital literacy. The students' ability to participate in online classes from home may have been restricted; most students (98%) had the technological resources (computers) but about 33% had no access to a reliable high-speed internet connection. To support student wellbeing, UVa's medical department launched an 'Emotional and Personal Support Unit' to attend to student and staff psychological needs, including learning assistance and psychological strain management.

University of California Berkeley, School of Optometry, USA

In California, COVID-19 case numbers have been increasing throughout June and July 2020 with 391,460 confirmed cases and 7,710 fatalities (as of 20 July 2020).¹³ The distribution across the state is asymmetrical, with southern California being proportionally more affected than the northern part of the state (where the optometry school of UCB is located). Similar to authorities in other countries, the Californian state, county and city governments have responded with a range of measures that initially included the closure of public services and educational institutions including schools and colleges. The majority of the Bay area, including Berkeley, have been in Shelter-in-Place (lockdown) from 16 March 2020. Face masks are mandatory. The California Department of Public Health has recently issued guidance for the safe re-opening of schools using strict case monitoring criteria and health requirements including masks and symptoms checks. Teaching at Berkeley Optometry was considerably affected by the COVID-19 pandemic. The campus closed on 16 March 2020 and access was only available to essential personnel. The clinic continued to be open for urgent and emergency care, along with 24-hour, 7 days per week on-call services. The changes made to learning and teaching were similar to those at the other optometry schools listed in this paper; a summary is provided in Tables 2-4. During Shelter-in-Place all teaching switched to synchronous, remote, on-line instruction, including daily case-based teaching for the third- and fourth-year classes. In contrast to some schools, the university optometry clinic re-opened for patient services in June 2020 under strict safety measures, allowing the continuation of clinical training of students. External placements also resumed at the same time. Social distancing within the clinic, along with additional safety protocols, has resulted in approximately 50% of pre-pandemic capacity. With case numbers still evolving in California, all measures are being reviewed on a regular basis to prevent the emergence of any COVID-19 clusters. First- and second-year students returned to campus in late summer.

State University of New York (SUNY), College of Optometry, USA

As of June 2020, the United States of America has had approximately 25% of the cases (> 2.5 million) and deaths (> 125,000) from COVID-19 world-wide. New York State had the largest number of cases (> 397,000) and deaths (31,000), with New York City accounting for more than 219,000 of the cases and nearly 22,000 deaths.^{13*} Following the declaration of a state of emergency by the Governor of New York State, all non-essential businesses closed on March 20 2020.

The State University of New York (SUNY), comprising 64 independent colleges including the College of Optometry, suspended all teaching and limited research, while attempting to minimise the loss of data in ongoing studies and COVID-related research. The lockdown amounted to a loss of seven instructional weeks.

The governor's programme, as well as the actions taken by the wider public, such as the wearing of face coverings, adherence to hygiene and distancing measures, successfully reduced new cases and deaths to pre-shut-down levels by the end of June 2020. As of August 2020, New York is in a phased re-opening plan. College reopening is also phased, with research and clinical activity resumed and planning for the re-opening of the SUNY Colleges for in-person instruction in September under review. With the safety of students and staff being the highest priority and the desire to keep the academic programme on track, a number of curriculum adaptations were made with the permission of its accreditors, i.e., the Accreditation Council on Optometric Education (ACOE), the Middle States

* "Data are based on reports by states and counties at the time of publication. Local governments may revise reported numbers as they get new information. Some deaths may be reported by officials in two different jurisdictions. When possible, deaths have been reported here in the jurisdiction where the death occurred."

Commission on Higher Education (MSCHE) and the New York State Department of Education.

For third-year students, the missed hours were made up using two hours of small group case presentations drawn from actual cases with follow-up reading assignments and weekly student presentations that emphasise clinical decision-making. The students spent approximately eight hours per week on these assignments, and were assessed by their participation, presentations and weekly quizzes. Fourth-year students continued throughout the summer. Competencies were assessed by the supervising doctors at each site. To compensate for lost time, staff developed an interactive, remote access clinical decision-making programme covering all principal areas of clinical optometry (approximately 30 hours per week per student; for details please contact co-author Prof. David Troilo). As of September 2020, the college continues to offer remote access delivery of didactic material to maintain social distancing while providing in-person laboratory and clinical experiences. To protect students, staff and the public, SUNY operates an active surveillance system that includes daily screening questions, temperature checks, case contact management and rapid testing capabilities for students and staff who are coming from designated travel advisory states and countries, or who have been exposed to a positive COVID-19 case.

3. Teaching environment at university optometry schools, placements and resulting challenges

Optometry schools across the globe provide a mix of theoretical and practical clinical teaching. While theoretical large-group teaching such as lectures can be delivered effectively using a variety of online platforms, clinical teaching as well as placements at hospital ophthalmology and optometry departments and private optometry clinics require

person-to-person contact. Clinical teaching typically takes place in special clinical teaching rooms, which are often separated into smaller units (examination cubicles), allowing small groups or individual students to examine patients under close supervision by clinically qualified staff (depending on individual facilities at each school). These clinical teaching facilities allow for in-depth, hands-on learning but necessitate unavoidable close student-to-student and student-to-patient contact, suggesting that students, supervisors and patients are at higher risk.¹⁴ However, COVID-19 has, at least temporarily, disrupted the traditional face-to-face interaction between supervisors, students and patients. It has also been suggested that the presence of the virus in the eye warrants special consideration in eye care practice.¹⁴ Routine precautions include symptom screening and body temperature checks for all clinic personnel and patients, the wearing of surgical masks and frequent hand washing.¹⁵ When examining symptomatic patients or patients unable to wear face masks, higher levels of personal protective equipment (PPE) are generally required, including N95 respirators which may provide a better protection against viral transmission than single-layer masks.¹⁶ These measures apply not only to optometry practices, but also to teaching departments.

4. Ophthalmic instrument use and face-to-face clinical investigation

Many clinical diagnostic techniques require working distances of approximately arm's length or less between the student (practitioner) and the patient, including subjective refraction, direct ophthalmoscopy and slit lamp biomicroscopy. While some skills can be taught using interactive modalities such as video, simulation and analysis of provided data sets, the online teaching mode is not suitable for all teaching of clinical skills. However, some techniques requiring close proximity could be replaced by alternatives that allow for more

remote distancing. As an example, the use of trial frames or manual phoropters during subjective refraction could be replaced with electronic phoropters, where the examiner can maintain a greater distance from the patient.

An issue related to clinical teaching involves the practising of ocular examination routines on volunteers or paying patients from the general public, who attend university optometry clinics. Some patients, particularly volunteers, who are often older than 60 years of age, may be hesitant to attend university campuses due to the perceived increased risk of acquiring SARS-CoV-2 while having their eyes examined by an optometry student, and being in the proximity of other students and staff.

Clearly, optometry schools are facing several challenges in their pursuit to continue to provide high-quality education to their students, while being severely restricted in the scope of teaching activities due to public health and government guidelines, such as: 1) campus closures; 2) social distancing requirements; 3) increased personal protection requirements for patients, students and staff; 4) hesitation and potential anxiety of patients when attending university optometry clinics and 5) hesitation and potential anxiety of students and staff upon returning to campus. Novel ways of preparing students for their working life in optometric practice and to overcome these challenges need to be devised and implemented. Rapid adaptation of academic practice is currently underway at the institutions of the authors, and optometry training is being revolutionised. Approaches on how this adaptation can be achieved safely and effectively are provided in the following section.

5. Solutions to overcome the challenges

To facilitate the safe and effective delivery of clinical teaching, optometry schools need to consider carefully a number of factors: 1) the number of students, staff and patients accessing clinics at any one time; 2) aerosol and droplet generation and protection and 3) the risks and benefits of all ophthalmic techniques taught.

Limiting student, staff and patient numbers in the clinic to facilitate social distancing is a key measure to reduce the risk of spreading the virus. However, when seeing patients or training students, breathing and speaking at close range cannot be avoided so the use of appropriate PPE should be considered. A reduction in droplet and aerosol spread can be achieved by using plastic barriers for slit lamps¹⁷ and other equipment. Techniques must be re-assessed for their risks and benefits. Some techniques may carry high risk and comparatively low value, like direct ophthalmoscopy. These should be replaced by suitable alternatives, such as slit lamp funduscopy, headband binocular indirect ophthalmoscopy, central fundus retinal photography and ocular coherence tomography. It has been suggested that non-contact tonometry creates an aerosol of the tears and thus may increase transmission risk of COVID-19,¹⁸ prompting the National Health Service (NHS) and The College of Optometrists in the UK to advise its use.^{10,19} A suitable alternative may be iCare tonometry,¹⁷ albeit close contact is still required.

Further potential for forward-looking changes to optometric education lies in expanding the sharing of teaching resources between optometry departments, such as pooled databases of clinical case scenarios. There are also opportunities for alternative remote teaching modalities of some clinical skills, for example through guided remote demonstration and student observation or simulation-based training, and/or virtual and augmented reality to simulate eye assessments.²⁰ However, such developments will require time to mature and should be assessed for their efficacy and safety before being rolled out widely. The

preparation of these videos will be undertaken by academics who, ideally with the support of digital learning technologists, will demonstrate a particular clinical skill on a colleague. Voice-over description will indicate the individual steps, as well as any mistakes to avoid, to the student. Examples where video demonstration and observation may be useful include a range of skills such as focimetry (lensometry), slit lamp biomicroscopy and Goldmann applanation tonometry.

The use of clinical case discussion to provide intensive diagnostic and patient management training has already been described. Using the adaptations made, such as the Clinical Distance Learning Scheme at HKPU outlined above as an example, digital clinical teaching can facilitate continued learning away from campus. The close collaboration between clinical and academic staff resulted in a portfolio of clinical case scenarios, which allowed final-year students to complete their programme of study. The use of cases that were originally recorded in clinic staff logs gave students a real sense of the breadth of ocular conditions they may be faced with in clinical practice. The in-depth online discussions proved a suitable alternative to in-person teaching, although a mix of in-person and remote teaching might be preferable. Cases were presented to students using one staff member to one student, which was beneficial in allowing all (including the quieter) students an opportunity to express their thoughts without fear of being exposed to group criticism. Focus on optometric management reflected the advanced level of learning of final-year students, while more junior students were provided with narrated clinical demonstrations that were recorded on video and made available in the institution's virtual learning environment. While the long-term success of digital remote clinical teaching still has to be evaluated in the subject area of optometry, the authors are confident that digital clinical teaching can be an effective tool to assist students with achieving their academic aims.

Increased use of blended and digital formats offer staff and students increased flexibility for accessing lectures and transcripts electronically, the option of repeated access to online learning material and enhances the digital capabilities of graduates.

In addition to the clinical teaching adaptations and the development of remotely presented case discussions and videos, the COVID-19 pandemic has also provided educators with an opportunity to provide further education on general infection control, public health and telemedicine, thereby providing an additional learning opportunity for optometry students.²¹

Overall, the changes optometry schools are experiencing and driving present a drastic modification of the way higher education is organised and how optometry training is being delivered. The return to campus is being implemented in ways that ensures consistency with government guidelines, including limits on the numbers of people in labs and other teaching spaces to allow social distancing. For the future, this could mean that current changes will have to be maintained or that further changes may become necessary, especially if another outbreak were to occur (or intensify).

Social distancing requirements

Social distancing will continue to remain a key requirement at all institutions. Detailed protocols have been developed and implemented to facilitate distancing between students, staff and patients. Varying guidelines exist with a separation of 1-2 m commonly being recommended. The introduction of small group teaching under strict conditions has been implemented to facilitate the running of clinical skills sessions. This involved the redesign of teaching schedules to account for reduced practical class size (e.g., by 50%) and with repeats of the same activities. To facilitate social distancing, scheduling changes included

reductions in the number of days that first- and second-year students are required to attend in-person in a given week. Due to ongoing uncertainty as to whether asymptomatic individuals are likely to transmit COVID-19, and emerging evidence that educational institutions such as high schools facilitate transmission,² the UK Optometry Schools Council has suggested a maximum patient examination time of 20 minutes, rather than 90-120 minutes traditionally required in a teaching clinic. The face-to-face patient visit could be complemented by remote real consultations, while remote simulated consultations can also be used to provide the necessary clinical experience.²²

Personal protection requirements for patients, students and staff

In the early stages of the pandemic, there was uncertainty as to how the virus spread, but it is now assumed that it is person-to-person through coughing and sneezing of droplets and aerosols, even breathing, or through touching an infected person and/or potentially contaminated surfaces. While voluntary use of face masks is commonplace among the population in Hong Kong, it has not been accepted universally in Western populations, though increasingly required. Countries like Australia with very few newly identified cases have not made the wearing of face masks universally compulsory. In the UK, face coverings are increasingly required, for example when using public transport as well as in shops.²³ In California, New York, Scotland and Spain, face coverings are now mandatory on public transport as well as in shops, but local restrictions and advice on face coverings are often introduced and lifted at short notice, depending on local virus transmission data.

In June 2020, the WHO updated their public guidance and now recommend the wearing of face masks covering the nose and mouth as part of a comprehensive strategy to reduce the spread of COVID-19, including for all people working in clinical areas of a health facility.²⁴

The advice includes guidance for specific groups of people, e.g., those aged 60 years and older, to wear a face mask in all situations where physical distancing is not possible. These recommendations were preceded by a systematic review on preventative measures giving similar recommendations.¹⁶ Masks have already been introduced as part of the protocols at optometry schools, with visors an optional additional protective measure in some clinical situations.

Public health messages about hand hygiene have increased; in practice, this means repeatedly washing hands throughout the day, e.g., before and after every patient encounter, for at least 20 seconds using soap or special hand cleaning agents. In addition, alcohol gels may be used upon entering the clinic, in between procedures when with the patient, and when leaving the clinic. Disinfecting ophthalmic instruments continues to be critical. Hygiene principles have been the focus of the public health campaign with the promotion of hand washing, use of hand sanitiser and to avoid touching your face.

Surfaces including handrails and doorknobs are cleaned frequently throughout the day.

Clinic staff can be further protected by installing transparent shields at reception desks

(Figure 1).

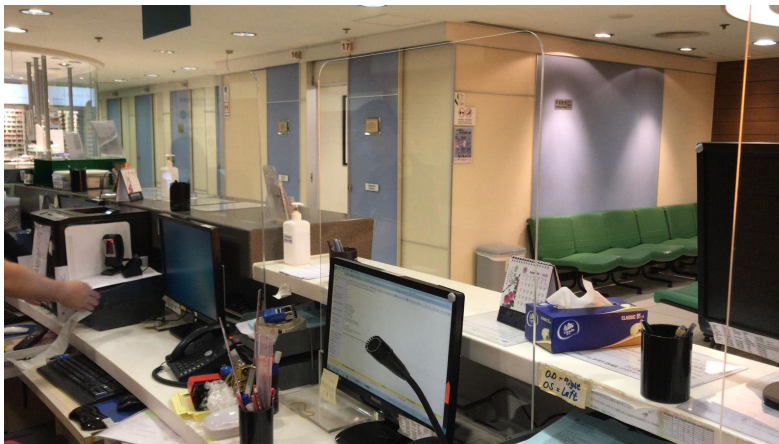


Figure 1. Transparent shields installed to protect reception staff and patients at HKPU.

At SUNY and UCB, extensive use is being made of telehealth technology to minimise unnecessary contact while providing clinical services to the wider population. Remote consultations have been used to assist in diagnosing ocular abnormalities that may require further investigation and treatment, along with follow-up appointments after the initiation of therapeutic treatment, binocular vision therapy, contact lens fittings and neuro-rehabilitation, including traumatic brain injury. A similar scheme is being considered for use at GCU, where optometric triage will help to identify patients who need to be referred to local ophthalmology services. To summarise the four main elements of a transmission reduction strategy at university optometry clinics, a graphical illustration is provided in Figure 2.

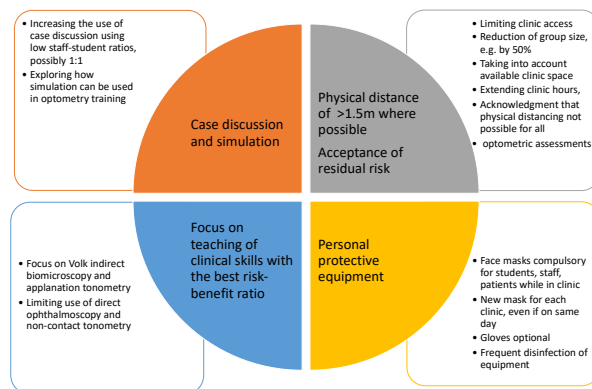


Figure 2. The four key elements of a transmission reduction strategy at university optometry clinics.

Acknowledging residual risks

As clinical teaching resumes under the strict combined safety measures described above, it can be assumed that the risk of transmission of SARS-CoV-2 has been greatly reduced. However, not all optometric investigative techniques can be carried out, or indeed be demonstrated, while maintaining a safe distance. An example is subjective refraction using a trial frame or manual phoropter and the use of the iCare tonometer (www.icare-world.com). Students, teaching staff and patients need to be aware of any residual risks, ensuring best ethical practice. This could be achieved through awareness campaigns, disseminated via social media, email and website announcements and through personal communication at the start of the clinic. Equally, the importance of seeking eye care when needed should be emphasised to patients; for example the importance of retinal screening appointments in diabetic patients, particularly in countries with low numbers of active COVID-19 cases and low transmission risk.

Hesitation and potential anxiety of students, staff and patients

Related to the remaining residual risks, it is conceivable that some students, staff and patients may be hesitant to attend an optometry eye clinic for teaching purposes (i.e., non-urgent clinical needs). There are reports that the number of patients in the community seeking medical care through their main point of contact, which in many cases is a general medical practitioner, has dropped during the pandemic, potentially delaying the diagnosis of life- (or sight-) threatening conditions. Similar behaviour could reasonably be expected from students, staff and patients, and an empathic and pragmatic approach needs to be taken to ensure everyone's needs are met while striving towards delivering safe and effective clinical teaching at optometry schools around the world. At SUNY and UCB, students who are

uncomfortable returning to campus have the opportunity to request a leave of absence from their studies.

6. Future outlook

Across the globe, scientists are working on a vaccine to limit the spread of SARS-CoV-2.²⁵ The vaccine needs to be proven safe and effective, and its production must be able to be scaled up to allow for the preparation of many millions of doses. Once such a vaccine is widely available then populations around the world may feel confident and be allowed to resume more widespread international travel and exchange. The post-COVID-19 world will likely be very different, since few people have considered the implications of a pandemic, let alone its health and financial impact. This is likely to change the global perspective, including how optometry is taught at universities and practised across the world. Even though the pandemic represents a significant and serious challenge, optometric education will benefit through enhanced digital capabilities of students and graduates, a wider appreciation and hopefully acceptance of remote consultations and telehealth, the potential improvements in access to eye care for people in remote communities and a more economical use of health care resources (which need to be evaluated). The move to online teaching in optometry, and in fact many other disciplines, is unlikely to be reversed by universities and is here to stay. Classes of hundreds of students may never occur again, at least not until the first wave of the COVID-19 pandemic is forgotten.

Imagining future educational developments, optometry students could be trained in the basic subjects of their profession from educational clusters (traditional university campus) while living in remote towns and even other countries, without having to travel. Subject experts from around the world could be brought together to teach international classes of

students, akin to the virtual scientific conferences that have been taking place, often for the first time in digital format, in 2020, such as the annual meetings of the Association for Research in Vision and Ophthalmology (ARVO), the British Congress of Optometry and Vision Science and the American Academy of Optometry. Putting aside the financial, regulatory and commercial pressures under which universities operate, there are opportunities for optometry departments to share teaching resources, such as case databases or online expert lectures as in academic ophthalmology,²⁶ thus benefiting from cost savings related to database maintenance and the sharing of speaker fees. Therefore, the pandemic also offers opportunities to improve optometric education, establish safer and better examinations, and position optometry to be full partners with medicine and other health care professions. We will learn from COVID-19, and we must emerge stronger in the new normal.

Conclusions

At the time of writing, optometry teaching approaches around the world are being adapted at high speed from primarily in-person teaching to include a wider range of online delivery and simulation. Clinical education and patient care have also been transformed to include more virtual elements through distance learning and telehealth. These transformations have been accelerated by the response to the COVID-19 pandemic and will continue to evolve. However, some clinical optometric skills that are central to optometric patient care simply cannot be taught online and these rely on in-person, hands-on, teaching approaches. For these techniques, it seems likely that new risk-benefit considerations of social-distancing versus in-person activities need to be undertaken. In areas where more than one clinical method is available, e.g., when viewing the posterior segment, it will become

increasingly important to focus on those techniques that provide the greatest clinical benefit and the lowest risk of SARS-CoV-2 transmission. Less teaching emphasis should be placed on techniques that provide limited clinical information and / or a greater risk of viral transmission. The pandemic will help to eliminate procedures that continue to be taught because they are “traditional” and have otherwise resisted attempts to drop them, providing a beneficial outcome of the COVID-19 pandemic on optometric education.

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Disclosures

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References

1. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med.* 2020;382(8):727–33.
2. Fontanet A, Tondeur L, Madec Y, Grant R, Besombes C, Jolly N, et al. Cluster of COVID-19 in Northern France: A Retrospective Closed Cohort Study. *SSRN Electron J.* 2020;1–22.
3. Cummings MJ, Baldwin MR, Abrams D, Jacobson SD, Meyer BJ, Balough EM, et al. Epidemiology, clinical course, and outcomes of critically ill adults with COVID-19 in New York City: a prospective cohort study. *Lancet.* 2020;2020.04.15.20067157.
4. Böhmer MM, Buchholz U, Corman VM, Hoch M, Katz K, Marosevic D V, et al. Investigation of a COVID-19 outbreak in Germany resulting from a single travel-associated primary case: a case series. *Lancet Infect Dis.* 2020;3099(20).
5. Johns Hopkins University Coronavirus Resource Centre. COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU) [Internet]. 2020 [cited 2020 Jun 9]. Available from: <https://coronavirus.jhu.edu/map.html>
6. Hale T, Angrist N, Cameron-Blake E, Hallas L, Kira B, Majumdar S, et al. Variation in government responses to COVID-19 | Blavatnik School of Government [Internet]. Working Paper. 2020. Available from: www.bsg.ox.ac.uk/covidtracker%0Ahttps://www.bsg.ox.ac.uk/research/publications/variation-government-responses-covid-19
7. UNESCO. Education: From disruption to recovery [Internet]. [cited 2020 Jun 16]. Available from: <https://en.unesco.org/covid19/educationresponse>
8. Sahu P. Closure of Universities Due to Coronavirus Disease 2019 (COVID-19): Impact

- on Education and Mental Health of Students and Academic Staff. *Cureus*. 2020;2019(4):4–9.
9. Gill D, Whitehead C, Wondimagegn D. Comment Challenges to medical education at a time of physical distancing. *Lancet*. 2020;6736(20):31368–4.
 10. Lawrenson JG, Buckley R. COVID-19 and the eye (editorial, in press). *Ophthal Physiol Opt*. 2020;1–5.
 11. World Health Organization (WHO). Coronavirus Disease (COVID-19) Situation Reports Updates 27 September 2020. *World Health Organ Tech Rep Ser*. 2020;(September):1–23.
 12. Department of Health, Centre for Health Protection (CHP), Kong H. Latest situation of Coronavirus Disease (COVID-19) in Hong Kong [Internet]. [cited 2020 Jul 18]. Available from: <https://chp-dashboard.geodata.gov.hk/covid-19/en.html>
 13. The New York Times. New York Times COVID-19 daily tracking reports. 2020.
 14. Sadhu S, Agrawal R, Pyare R, Pavesio C, Zierhut M, Khatri A, et al. COVID-19: Limiting the Risks for Eye Care Professionals. *Ocul Immunol Inflamm*. 2020;00(00):1–7.
 15. Cho P, Boost M. COVID 19—An eye on the virus. *Contact Lens Anterior Eye*. 2020;(xxxx):0–1.
 16. Chu DK, Akl EA, Duda S, Solo K, Yaacoub S, Schünemann HJ, et al. Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis. *Lancet (London, England)*. 2020;6736(20):1–15.
 17. Lai THT, Tang EWH, Chau SKY, Fung KSC, Li KKW. Stepping up infection control measures in ophthalmology during the novel coronavirus outbreak: an experience from Hong Kong. *Graefe’s Arch Clin Exp Ophthalmol*. 2020;258(5):1049–55.

18. Li C, Tang Y, Chen Z, Wang A, Huang X, Chen Y, et al. Aerosol formation during non-contact “air-puff” tonometry and its significance for prevention of COVID-19. *Zhonghua Shiyan Yanke Zazhi/Chinese J Exp Ophthalmol*. 2020;38(3):212–6.
19. NHS England, NHS Improvement. Guidance and standard operating procedures: General practice in the context of coronavirus (COVID-19). 2020;(June).
20. Wei L, Nahavandi S, Weisinger H. Optometry training simulation with augmented reality and haptics. In: *IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining (ASONAM 2013)*. 2013.
21. Hollander J, Carr B. Virtually Perfect ? Telemedicine for Covid-19. *NEJM*. 2020;382(18):1679–81.
22. Lim ECH, Oh VMS, Koh DR, Seet RCS. The challenges of “continuing medical education” in a pandemic era. *Ann Acad Med Singapore*. 2009;38(8):724–6.
23. BBC. Coronavirus: Who should wear a face mask or face covering? [Internet]. 2020 [cited 2020 Jun 19]. Available from: <https://www.bbc.co.uk/news/health-51205344>
24. World Health Organization. WHO Director-General’s opening remarks at the media briefing on COVID-19 - 5 June 2020. WHO Dir Gen speeches [Internet]. 2020;5 June. Available from: <https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020>
25. Lurie N, Saville M, Hatchett R, Halton J. Developing COVID-19 vaccines at pandemic speed. *N Engl J Med*. 2020;382(21):1969–73.
26. Wong T, Bandello F. Academic ophthalmology during and after the COVID-19 pandemic. *Ophthalmology*. 2020;127(8):e51–2.