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INNOVATION, IMPLEMENTATION, IMPROVEMENT

THE CLINICAL TEACHER

# Virtual medical research mentoring

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## Abstract

**Background:** Medical research is important for professional advancement, and mentoring is a key means by which students and early-career doctors can engage in research. Contrasting international research collaborations, research mentoring programmes are often geographically limited. As the COVID-19 pandemic has led to increased use of online technology for classes and conferences, a virtual, international approach to medical research mentoring may be valuable.

**Approach:** We hereby describe our experience at the Cardiovascular Analytics Group, a virtual international medical research mentoring group established in 2015. We make use of virtual platforms in multi-level mentoring with peer mentoring and emphasise active participation, early leadership, an open culture, accessible research support and a distributed research workflow.

Jeffrey Shi Kai Chan and Dawnie Ho Hei Lau are co-first authors.

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**Evaluation:** With 63 active members from 14 different countries, the Group has been successful in training medical students and early-career medical graduates in academic medicine. Our members have led over 100 peer-reviewed publications of original research and reviews since 2015, winning 13 research prizes during this time.

**Implications:** Our accessible-distributed model of virtual international medical research collaboration and multi-level mentoring is viable and efficient and caters to the needs of contemporary healthcare. Others should consider building similar models to improve medical research mentoring globally.

## 1 | BACKGROUND

International medical research collaboration has become prevalent, with an increasing interest in cultivating medical students' participation in medical research.[1] An important means for that is mentoring, defined as 'a special partnership between two people based on commitment to the mentoring process, common goals and expectations, focus, mutual trust and respect'.[2] Many medical schools have launched research mentorship programmes, with some having found positive impacts on students' career and personal development.[1,3–5] However, unlike collaborative research, most mentoring programmes are limited to organisations/countries for resources and logistical reasons,[5,6] potentially representing a missed opportunity as international research exposure is beneficial for mentees.[4]

Recent years have seen an increasing interest in virtual research mentorship, where mentoring occurs over the internet.[7–10] Although these efforts have demonstrated the feasibility of virtual research mentoring, most remained institution specific. Meanwhile, we believe that virtual research mentoring may help break the bounds of nationality and facilitate participation in international research, an idea already shown to be plausible in a small, highly structured cancer research programme.[11] The relevance of virtual research mentoring was further reinforced by the COVID-19 pandemic, which forced many in-person learning activities, including research mentoring, to switch to virtual settings.

Therefore, we hereby present our experience with an accessible-distributed model of virtual international medical research collaboration and multi-level mentoring. Although we started in 2015 as a smaller group of researchers in Hong Kong, years of development have transformed the group into a semi-structured international mentoring programme aimed at enhancing mentees' research skills and, hence, output. Whilst COVID-19 did not motivate the founding of our programme, we believe that COVID-19 has fundamentally changed medical education practices, with greater recognition of the potential and importance of virtual medical education.[11,12] Overall, we believe that our experience is ever more relevant to medical educators today, a belief that constituted the motivation for this article.

*We hereby present our experience with an accessible-distributed model of virtual international medical research collaboration and multi-level mentoring.*

## 2 | APPROACH

### 2.1 | The Cardiovascular Analytics Group

Established by GT, the Cardiovascular Analytics Group is an international medical research group primarily focusing on risk stratification, predictive modelling and pharmacoepidemiology in cardiovascular medicine, with heavy emphasis on the participation of medical students and early-career graduates.[13] Mentees were recruited from the mentors' institutions both by invitation and informal inquiries to our members, minimising barriers to access. Mentees ranged from preclinical medical students to early-career clinicians, with 60% of the active members having joined as undergraduates. Considering the increasing emphasis on multidisciplinary healthcare and translational research, we also included allied healthcare professionals/students and graduates from natural sciences (Figure 1a).

To maximise international participation, all mentoring and research activities were conducted on virtual platforms including real-time messaging platforms, emails and video conferences. As of September 2021, the Group had 63 active members from mainland China, Hong Kong, the United Kingdom, the United States, Greece, Cyprus, Brazil, Malaysia, Philippines, Romania, Canada, Iran, Turkey and Pakistan (Figure 1b), with past members from the Netherlands, Czechia, Italy, South Korea and Nepal. With diverse ethnic and professional backgrounds, we firmly adhere to the principle of equal opportunities and treatment regardless of age, gender, race, nationality, sexual orientation, family background, institution of study/practice,

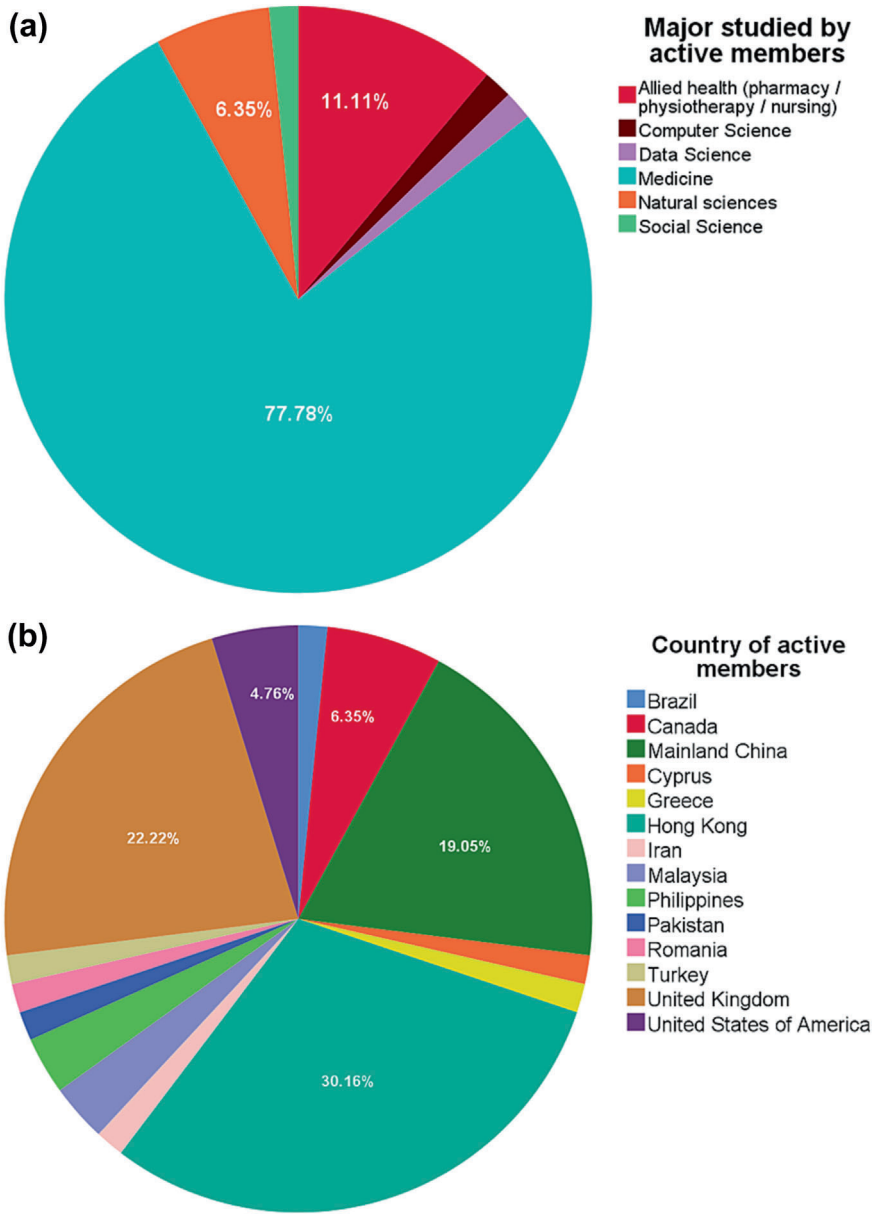



**FIGURE 1** Pie charts showing (a) the majors studied by the Cardiovascular Analytics Group's members and (b) the countries in which the Cardiovascular Analytics Group's members are based

disability, religion and gender identity. Using English as our primary language, we have not experienced any significant problems with communication nor have we experienced conflicts due to differences in nationality or ethnicity.

*To maximise international participation, all mentoring and research activities were conducted on virtual platforms.*

## 2.2 | Mentoring system

Our Group aims to provide mentees with first-hand experience of all aspects of academic medicine, from formulating research questions and designing studies to data analysis and communicating findings (Table 1). Whilst there is no fixed curriculum, we provide all Group members with self-help learning resources atop lectures and interactive discussions (Table 2). These constitute the main means of learning alongside direct participation in research projects. We encourage all Group members, however junior, to lead their own projects and be involved in all phases of research including the publication process. Members often lead multiple projects simultaneously. These allow mentees to have a solid, hands-on experience with real-life academic medicine.

**TABLE 1** Learning objectives for members of the Cardiovascular Analytics Group

| Learning objectives | Details |
|---|---|
| Formulating research question | To utilise theoretical knowledge and clinical observations (if any) to formulate appropriate and relevant research questions |
| Literature review and appraisal | To systematically search the medical literature for published materials relevant to the formulated research question, and to critically appraise the identified literature and use the acquired information to refine the research question |
| Establishing collaborations | Where the opportunity exists, mentees may contact other mentors or external collaborators to explore the possibility of collecting data from their respective institutions/study groups for the study |
| Study design | To design appropriate studies for answering the formulated research question; this might include writing a full study protocol with application for ethics approval where necessary |
| Data collection | To oversee the data collection process, or, where possible, participate in the data collection process |
| Progress updates | To present a study's progress and interim findings during regular Group meetings to allow for monitoring and fine-tuning of progress, as well as discussing the direction of further studies for future planning |
| Epidemiology and biostatistics | To learn key epidemiological concepts and biostatistical techniques/tests relevant to a study, and to acquire a working level of biostatistics to allow for simple statistical analysis of datasets (all final statistical output is to be checked by a principal investigator/data scientist) |
| Communication of research findings | Abstract/poster: mentees are strongly encouraged to submit abstracts to international academic conferences for presentation; the mentee would be responsible for abstract writing, poster production and presentation<br>Publication: to write a formal academic manuscript that presents all relevant research work done to answer the formulated research question as appropriate, and to submit the resultant manuscript to peer-reviewed academic journals for publication; the mentee is responsible for manuscript writing and formatting, manuscript submission, handling of revisions and producing point-to-point responses to peer reviewers |

**TABLE 2** Learning resources provided to members of the Cardiovascular Analytics Group

| Type of resources | Areas covered |
|---|---|
| Recorded lecture | Systematic review and meta-analysis |
| Self-help manual | Study planning and basic study designs<br>• Randomised controlled trial<br>• Cohort study<br>• Case–control study<br>• Self-controlled case series<br>Confounders and basic means of mitigation (with code templates)<br>• Multivariable regressions<br>• Propensity score-based methods (matching, inverse probability of treatment weighting, stratification, and adjustment)<br>Basic data manipulation on Stata (with code templates)<br>Basic principles and execution of data analysis on Stata (most with code templates)<br>• Descriptive statistics<br>• Histograms<br>• Non-regression tests of hypotheses (t-test, Chi-squared test, Mann–Whitney test, analysis of variance, Kruskal–Willis test, Wilcoxon signed rank test, McNemar test, Stuart–Maxwell test)<br>• Logistic regression<br>• Survival analysis<br>◦ Kaplan–Meier curve<br>◦ Log-rank test<br>◦ Cox regression<br>◦ Fine and grey competing risk regression<br>• Poisson and negative binomial regression<br>• Cost analysis using log-gamma generalised linear models<br>• Propensity score matching<br>• Inverse probability of treatment weighting<br>• Analysis of repeated measures (pairwise comparisons, analysis of variance of repeated measures and multilevel mixed effects models)<br>Study writeup |
| Live virtual lectures | Given irregularly by mentors/peer mentors at monthly meetings<br>• Clinical topics<br>• Research designs/approaches |
| Group support | As-needed open discussions/support requests using real-time messaging software<br>• Recruiting co-authors<br>• Research design and other general research-related issues<br>• Statistical queries<br>• Conference/publication-related queries and updates<br>• Access to full texts of journal articles<br>• General career advice |
| Private support | As-needed discussions with mentors/peer mentors |

*Our Group aims to provide mentees with first-hand experience of all aspects of academic medicine.*

To best support our mentees, we utilise a multi-level mentoring system, in which peer mentoring occurs atop mentoring of junior members by principal investigators and established academics. Senior mentees, mostly early-career graduates or senior medical students, guide junior mentees in their research projects. As junior mentees mature and gain more experience, they gradually become peer mentors, through which they also learn to mentor. This creates a sustainable system that allows closer support and reduces hierarchy. Crucially, we do not limit mentees to specific mentors: Mentees are encouraged to engage multiple mentors freely for support and advice, ensuring flexibility in mentees' learning and reducing the risk of abusive treatment and misconduct by minimising hierarchy. Such risks are also minimised by our principle of equality. Thus far, we have not received any report of abuse, misconduct or breach of our equal opportunities policy.

*Peer mentoring occurs atop mentoring of junior members by principal investigators and established academics.*

### 2.3 | Group strategy

Our Group adopts an 'accessible-distributed' strategy. Accessibility is enabled through open communication and calls for collaboration using real-time messaging platforms and emails, allowing mentees to freely seek research advice and ideas virtually from other members and principal investigators. A monthly video conference further consolidates and coordinates research efforts. Members are strongly encouraged to propose research ideas openly, after which all members are encouraged to discuss the feasibility, design and execution of proposed ideas. Such decentralisation allows easy access to research guidance and inspiration, facilitating exchange of knowledge and ideas. Such early development of holistic independent research skills equips students to become principal investigators and leaders, an area of medical education that is severely insufficient.[14]

*Members are strongly encouraged to propose research ideas openly.*

The distributive element comes from our decentralised research approach, which makes use of individual talents for different aspects of a project, with the project lead ultimately overseeing all stages. Authorship is allocated based on intellectual contribution rather than funding acquisition or seniority. These facilitate productivity, allow flexibility of individual involvement and encourage engagement of talents from diverse backgrounds.

## 3 | EVALUATION

Our multi-level mentoring system and accessible-distributed model have been successful.[13] As of September 2021, our members have led 109 peer-reviewed publications, including 41 original studies, 31 meta-analyses, 28 non-meta-analytical reviews and 9 publications of other types, with numerous abstract/poster presentations at major international conferences.

Since joining the programme, our members have won a total of 13 research prizes. One member of the team, who was new to academic medicine when she joined the Group 4 years ago, has achieved beyond what would be expected of her career stage as a final-year medical student with >45 peer-reviewed publications (>24 first/co-first authorships on original research and systematic review articles), an H-index of 10 and >350 citations. No further outcome evaluation was performed in addition to research output.

## 4 | IMPLICATIONS

We believe our model of virtual international medical research mentoring is viable and effective. With virtual conferences and classes becoming commonplace due to COVID-19, it is time to reconsider and improve the traditional, locally limited model of medical research mentoring. Our virtual international model of mentoring gives mentees the opportunity to have broad, international exposure and idea exchanges. Our model is especially valuable for those in less developed countries, who may have fewer opportunities to engage in research and international networking. With new ideas proposed, discussed, consolidated and distributed to different team members continuously, individuals can gain exposure to a wide range of research topics and work with people from different backgrounds. This not only improves teamwork and leadership ability but is also key to contributing expertise to international medical research.

*Our model is especially valuable for those in less developed countries.*

It is worth noting that we did face obstacles during our Group's development. Our current operational strategy has evolved over time by overcoming issues with active communication and open-mindedness. Additionally, our model is not without limitations. First, since mentees are usually not from the mentor's institution, it is often difficult for mentees to personally collect data for original studies. To overcome this, data retrieval is performed by authorised on-site personnel, and analysis is performed only on anonymized datasets. Second, our model's virtual nature means that many mentees rarely, if ever meet their mentors in person, which might affect the overall learning experience.[9] The international nature also means that time zone and language differences might hamper collaboration and mentoring. Nevertheless, virtual meetings by video conferences were the best practical option during COVID-19, with efforts to closely reproduce the experience of in-person meetings. We also minimised the effects of time zone and language differences by scheduling meeting with consideration given to all members' region of residence and providing detailed meeting minutes in English for all members afterwards. Since our Group's inception in 2015, we have not observed any significant problem posed by these challenges.

*Our current operational strategy has evolved over time by overcoming issues with active communication and open-mindedness.*

We hope that our experience with an accessible-distributed model of virtual international medical research collaboration and multi-level mentoring will inspire others to build similar, if not better research mentoring groups. The future is now, and there is no better time to bring medical research mentoring to a new level. We firmly believe that these efforts will not only produce abstracts and publications, but also plant the seeds for a new generation of global medical researchers.

## AUTHOR CONTRIBUTIONS

**Jeffrey Shi Kai Chan:** Conceptualization; formal analysis; visualization; writing—original draft; writing—review and editing. **Dawnie Ho Hei Lau:** Writing—original draft; writing—review and editing. **Emma King:** Writing—original draft; writing—review and editing. **Leonardo Roever:** Supervision; writing—review and editing. **Tong Liu:** Supervision; writing—review and editing. **Yuki Ka Ling Shum:** Writing—review and editing. **Kenrick Ng:** Writing—review and editing. **Edward Christopher Dee:** Writing—review and editing. **Ana Ciobanu:** Supervision; writing—review and editing. **George Bazoukis:** Writing—review and editing. **Elham Mahmoudi:** Writing—review and editing. **Danish Iltaf Satti:** Writing—review and editing. **Kamalan Jeevaratnam:** Supervision; writing—review and editing. **Adrian Baranchuk:** Conceptualization; supervision; writing—review and editing. **Gary Tse:** Conceptualization; data curation; investigation; methodology; project administration; resources; supervision; writing—review and editing.

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## CONFLICT OF INTEREST

All authors report no conflict of interest.

## DATA AVAILABILITY STATEMENT

All data is available on reasonable request to the corresponding authors.

## ETHICAL APPROVAL

All study participants gave informed consent for participation and publication. The study was conducted in accordance with the Declaration of Helsinki.

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