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Post-COVID innovation in postgraduate medical education: Insights from five countries

Dujeepa D Samarasekera¹, Chung-Hsien Chaou², Ardi Findyartini³, Jamuna Vadivelu⁴, Malcolm Mahadevan⁵, Yang Faridah Abdul Aziz⁶, Faith Chia⁷, Yeo Su Ping¹ & Lee Shuh Shing¹

¹Centre for Medical Education (CenMED), Yong Loo Lin School of Medicine, National University of Singapore, Singapore; ²Department of Emergency Medicine & Medical Education Research Center, Chang Gung Memorial Hospital, Linkou Branch, Taiwan; ³Department of Medical Education, Faculty of Medicine, University of Indonesia, Indonesia; ⁴Medical Education and Research Development Unit (MERDU), Faculty of Medicine, University of Malaya, Malaysia; ⁵Department of Emergency Medicine, National University Hospital, National University Health System (NUHS), Singapore; ⁶Department of Biomedical Imaging & Medical Education and Research Unit, Faculty of Medicine, University of Malaya, Malaysia; ⁷Department of Rheumatology, Allergy and Immunology, Tan Tock Seng Hospital, Singapore

Abstract

Introduction: The COVID-19 pandemic significantly impacted postgraduate medical education (PGME). This led to rapid adaptations to ensure training continuity and to develop competent healthcare professionals.

Methods: This descriptive study focusses on the sustainable innovations made in Indonesia, Malaysia, Singapore, Taiwan and the USA PGME residency training. Draft country sections were written by co-authors with direct, current knowledge of postgraduate training in those settings.

Results: Key lessons emerged from curricular adjustments, digital transformation, operational agility, assessments, and faculty development. Curriculum changes included integrating pandemic-specific content, such as COVID-19 management and public health priorities, into training programs. Singapore's rapid revision efforts and Indonesia's compulsory topic introduction are typical examples. Despite movement restrictions and constraints on clinical training, innovative solutions like simulations and telemedicine preserved skill development. Digital transformation played a crucial role, with countries adopting virtual platforms and hybrid simulation models. Technology-driven innovations like augmented reality and teleconsultation expanded training scopes. However, challenges like engagement, transitioning faculty to remote learning systems and unstable internet connectivity remained challenges. Operational agility was demonstrated through cross-institutional collaborations. Assessment formats evolved, with hybrid models and virtual logbooks introduced to maintain educational standards. Accreditation processes were adapted, with flexibility granted in assessment delivery while ensuring quality. Faculty development was accelerated with Singapore leveraging international trends to ensure resilience in local training programs.

Conclusion: The pandemic instigated a paradigm shift from reactive adaptation to proactive transformation in PGME, positioning systems as global exemplars of how medical education can evolve amidst complexity and incorporate necessary changes envisioning long-term strengthening of the systems.

Practice Highlights

PGME adaptation during COVID-19 pandemic and transformation post pandemic is supported by:

- Implementation of operational agility by placing residents in diverse environments and fostering national collaborations to sustain training.
- Integration of simulations and telemedicine to maintain skill development amid constraints during crisis situations.
- Development of teleconsultation and hybrid learning models to enhance inclusivity, accessibility, and resilience in medical education.
- Adoption of flexible models to accredit and sustain quality of training and accreditation of programmes.
- Evolvment of assessment and accreditation with hybrid models and virtual tools to preserve educational standards and flexibility.

I. INTRODUCTION

The COVID-19 pandemic has profoundly impacted postgraduate medical education (PGME) worldwide. The challenges and opportunities have led to significant transformations in how medical training is delivered (Sklar, 2020). This manuscript examines the experiences and adaptations to PGME in Singapore, Indonesia, Malaysia, Taiwan, and the USA. Draft country sections were written by co-authors with direct, contemporary knowledge of postgraduate training in each setting (authors are listed under Notes on Contributors). We used a shared template (curriculum changes; clinical exposure; digital transformation; assessments; faculty development; operational agility) to ensure comparability. Country drafts were iteratively edited centrally to harmonise scope and remove duplication. This manuscript is a descriptive synthesis of these country reports and the peer-reviewed literature cited.

A. Curricular Adjustments and Clinical Exposure

The onset of COVID-19 served as a catalyst for revising PGME curricula across the globe. In Singapore, the curriculum was quickly adjusted to include COVID-19 management and public health priorities. The curriculum in internal medicine and infectious diseases was updated to cover outbreak containment, infection prevention, and control. Emergency medicine and surgical specialties underwent targeted curricular revisions to embed pandemic-specific protocols and essential skills (Oon et al, 2023).

In Indonesia, while the curriculum remained largely unchanged, COVID-19 management became a compulsory knowledge area, with online courses and skills training introduced to equip residents for frontline duties. Residents gained competencies in global health problem management, highlighting the need for an integrated curriculum approach.

Malaysia adopted remote learning platforms for curricular delivery, introducing virtual ward rounds and telemedicine consultations. Training e-portfolios were developed to record and review trainee progress systematically. This shift presented new training opportunities, allowing engagement in telehealth and familiarisation with hospital delivery systems.

Taiwan leveraged its experience from previous outbreaks to make pandemic-related curricular adjustments, including telemedicine. Their curriculum stability stemmed from existing frameworks that allowed swift incorporation of new competencies such as video-assisted intubations.

In the USA, tele-supervision and tele-health were integrated into curricula, accommodating training disruptions with an emphasis on tele-consultation skills. The ACGME's flexibility enabled programs to maintain educational continuity despite the challenges.

Clinical exposure faced challenges due to movement restrictions and infection control measures. In Singapore, inter-hospital rotations were halted. This limited the breadth of exposure but ensured procedural training through simulations and telemedicine. Indonesia encountered similar constraints. In addition to this, residents were developed as frontline healthcare workers combating the pandemic in the healthcare system. These circumstances led to urgent and creative adaptations in teaching and supervision formats to support skill acquisition. Cognitive components were taught online, while skill development was conducted in person in various possible and safe forms. These online learning methods have been further developed and integrated into current residency training programmes (Balakrishnan et al., 2020).

B. Digital Transformation in Teaching

The pandemic catalysed a rapid digital transformation in PGME, redefining teaching methodologies across countries. Singapore quickly transitioned to virtual platforms for didactic sessions, ensuring continuity and increasing accessibility. Simulation-based learning adapted to hybrid models, preserving educational value while meeting safety requirements. Emerging technologies like augmented reality have redefined surgical training, providing scalable educational models (Balakrishnan et al., 2020) (Renaud et al., 2021).

Indonesia embraced online learning, integrating video learning and flipped classrooms for cognitive acquisitions. However, engagement challenges persisted due to unstable internet connections and multitasking of both the consultants and residents during online sessions. Practical skill development continued in clinical settings with enhanced simulations and adapted supervision system.

Malaysia's teaching innovations partially replaced face-to-face interactions with a hybrid approach, enhancing attendance monitoring and assessment efficiency. However, the "hidden curriculum" often delivered through personal interactions was less effectively communicated online (Yusoff et al., 2020).

Taiwan's use of virtual simulations and online OSCEs (Objective Structured Clinical Examinations) allowed for skill development in an online environment. Challenges included financial limitations and resistance

to change. Although most faculty members and students have become accustomed to online courses and virtual meetings in the post-pandemic era, face-to-face interaction still offers irreplaceable benefits, particularly in communication, engagement, and collaborative learning.

During the COVID-19 pandemic, postgraduate programmes across the USA reported a rapid expansion of both remote didactic sessions and tele-health patient encounters, though adoption varied widely across specialties. Psychiatry, internal medicine and paediatrics shifted substantial portions of clinical care and teaching online, whereas procedure-intensive fields such as surgery and obstetrics transitioned more selectively. Programme evaluations highlight that learning outcomes were most positive when virtual teaching incorporated interactive case discussions, small-group sessions, and real-time feedback rather than passive online lectures. Concurrently, the ACGME issued time-limited flexibilities on supervision and clinical learning environments, endorsing tele-supervision in appropriate contexts while safeguarding procedural competency standards. These experiences have accelerated national discussions on how tele-education and tele-supervision can be safely integrated into residency training. The ACGME's ongoing review of its Common Program Requirements aims to include evidence-informed guidance on remote education, supervision, and competency assessment. Going forward, US training programmes are encouraged to document the impact of these modalities on trainee performance, patient outcomes, and wellbeing to inform sustainable, equitable models of postgraduate medical education.

C. Operational Agility and Workforce Planning

The pandemic presented unprecedented challenges for PGME operational management, requiring adaptive strategies to sustain training and healthcare delivery. Singapore implemented a "fostering" approach, integrating residents into alternative hospital environments to maintain clinical exposure. This model enriched training and spurred national coordination of residency programs, fostering cross-institutional collaborations. This is now ongoing and residents from different sponsoring Institutions (SI) have the opportunity to train and use learning resources from another SI (Renaud et al., 2021).

Indonesia and Malaysia adapted their operational frameworks for remote learning, employing proctoring systems and modifying assessment methods. While these adaptations ensured quality, challenges remained in

creating learning resources and encouraging faculty transition to online formats.

Taiwan maintained operational stability by leveraging past outbreak management experiences, while the USA's ACGME allowed temporary emergency statuses for flexibility in training requirements.

D. Assessment and Accreditation

Assessment and accreditation processes were restructured to accommodate pandemic constraints while maintaining educational integrity. In Singapore, summative assessments shifted to hybrid formats, preserving fairness and rigour. Virtual logbooks and electronic portfolios were introduced, enriching formative assessment ecosystems.

Indonesia's accreditation processes were simplified, conducting online exams with real-time monitoring. Malaysia faced accreditation delays due to SOP adjustments for virtual formats but integrated online assessments into credentialing processes.

Taiwan's credentialing remained stable, with minor shifts toward competency-based medical education. Relevant assessment tools, such as milestones and Entrustable Professional Activities (EPAs), have been widely adopted across various specialty training programs nationwide. The USA maintained accreditation standards, adapting supervision practices and reporting on pandemic impacts in PGME activities.

E. Educational Innovations

The pandemic drove enduring innovations in PGME, including teleconsultation and hybrid learning models. The observed differences map to four system-level features. First, health system structure focusing on centralised systems (e.g., Singapore's national clusters) were able to coordinate cross-institutional resources faster than highly fragmented systems. Second, resource availability determined technological sophistication (high in Singapore/US, constrained in parts of Indonesia/Malaysia). Third, accreditation flexibility and governance (e.g., ACGME guidance vs local regulator timelines) influenced how quickly assessments could be adapted. Finally, learning culture and prior outbreak experience (Taiwan's SARS legacy) shaped faculty and trainee readiness to adopt remote modalities. Recognising these drivers helps tailor recommendations: resource-intensive tech works where funding and digital literacy permit, whereas low-cost simulation and task-sharing strategies are more applicable in lower-resource settings.

F. Faculty Development and Pedagogical Shifts

The global transformation in faculty development was accelerated by the pandemic, compelling educators to rethink teaching, assessment, and mentorship delivery. Singapore harnessed international innovations to enhance local faculty development, adopting flipped classroom models and microlearning inspired by global trends.

Participation in international faculty development programs enriched local practices, building faculty champions who guided reforms and shared Singapore's innovations on global platforms. The USA encouraged programs to document faculty adaptation, recognising resilience as crucial to PGME sustainability.

By observing and adapting international best practices, local institutions weathered the pandemic's educational storm and emerged with a more agile, inclusive, and scholarly approach to faculty development.

G. Postgraduate Medical Education in the Post-Covid Era

The COVID-19 pandemic disrupted traditional models of postgraduate medical education, prompting rapid shifts towards digital learning. Initially driven by necessity, these changes have since evolved into permanent components of contemporary curricula, reflecting the adaptability of residents, faculty, and institutions.

During the pandemic, clinical exposure was significantly curtailed, and the informal curriculum typically acquired through in-person interactions and experiential learning was diluted. In response, digital simulations, telemedicine, and virtual case-based discussions were introduced to bridge the gap. While these tools could not fully replicate the complexity of real patient care, they laid the groundwork for blended learning models that are now being refined and embedded into routine training.

Faculty development became a priority, with short, focused programmes in digital pedagogy helping educators gain confidence and competence in online teaching. Peer support networks and institutional incentives have further encouraged sustained engagement. These efforts have led to more inclusive and flexible teaching approaches, better suited to diverse learner needs.

Assessment practices also underwent transformation. Hybrid models combining online and in-person evaluations were trialled and are now being formalised,

offering greater adaptability while maintaining rigour. Cross-institutional collaborations, initially formed to share resources during the crisis, have matured into structured partnerships that enhance access and quality across programmes.

Today, interactive digital platforms, gamification, and real-time feedback mechanisms are routinely used to foster engagement and recreate aspects of the informal curriculum. Augmented reality and high-fidelity simulations are increasingly integrated into clinical skills training, complementing supervised patient encounters. These innovations are not temporary fixes but strategic enhancements to educational delivery.

Equity remains a central concern. Institutions are investing in infrastructure and inclusive teaching strategies to ensure all trainees regardless of background can participate fully and benefit equally. The pandemic revealed gaps, but it also accelerated progress towards more resilient, responsive, and equitable systems.

Postgraduate medical education has not simply recovered it has reoriented. The adaptations made under pressure have become embedded practices, shaping a future that is more flexible, collaborative, and inclusive.

II. CONCLUSION

The COVID-19 pandemic influenced and accelerated innovations both necessary and lasting transformations in postgraduate medical education. Our cross-country comparison shows that the nature and scale of innovations were shaped by health-system structure, resource/digital readiness, accreditation flexibility and learning culture. Future resilience will depend on tailoring strategies to these systemic features investing in scalable, equity-minded digital solutions where resources permit, and prioritising low-cost, high-impact simulation and regional collaborations in lower-resourced settings.

Notes on Contributors

Yang Faridah Abdul Aziz, Chung-Hsien Chaou, Faith Chia, Ardi Findyartini, Malcolm Mahadevan Jamuna Vadivelu drafted the respective portion for their countries and subsequently, the manuscript was combined and edited by Dujeepe Samarasekera, Lee Shuh Shing and Yeo Su Ping. All the authors read the final version and provided their suggestions and/or approvals.

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Declaration of Interest

The authors declare no conflict of interest.

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*Dujeepa D. Samarasekera
Yong Loo Lin School of Medicine,
National University of Singapore, Singapore
10 Medical Drive, Singapore 117597
Email: dujeepa@nus.edu.sg