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Systematic evaluation of cardiac life support skills training

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Psychomotor skills development through experiential learning has been shown to be an effective means of retaining skills and knowledge, both by action and practice, through the formative years of medical education through to internship. While skills performance may not be optimal during the training years, significant improvement occurs when opportunities are presented during the postgraduate years.[1] Basic life support including cardiac life support (CLS) is one of the many skills trainings in the medical curriculum.

WHO data published in 2020 shows 21.86 % i.e., 36,729 of all deaths in Malaysia were due to Coronary Heart Disease. Malaysia ranks 61 in the world with an age-adjusted mortality rate of 136.21 per 100,000 of the population. Apart from issues of health literacy and immediate access to health facilities, delay in initiation of CLS at the point of care, and transportation factors have been identified as areas of weakness in health delivery, in reducing preventable deaths due to coronary heart disease. Worldwide, there appears to be problems in effective delivery of CLS due to competency gaps and lack of formal training. Preparing health workers and the community in rendering effective and timely CLS are essential strategies. One center in a low-income country in Africa reported that only 18.4% of patients who had heart attacks received cardio-pulmonary resuscitation (CPR).[2]

Goal-oriented skills training in CLS and advanced basic life support need to be strengthened through programmed strategies at all levels in the health delivery system, including training of by-standers in communities and first responders. The aim of such CLS training is to develop sustained competencies in health care workers and the public.

In this issue of the IeJSME (Aug 2022) Thiruchelvi S. & Shahid Hassan, studied the impact of a cardiac life support course among 37 final year medical students at the International Medical University. The authors lament that though the skills training was effective when pre- and post-test evaluation were done, there was a need to re-strategize the learning methods, as 'decay' in knowledge was noted at the end of 6 months. The mandatory course in CLS, based on the American Heart Association Manual, adopts several strategies in its delivery, which include access to learning materials in the Learning Management System of the university, and formal conduct of the course prior to evaluation. The subjects were tasked to complete four stations i.e., airway devices, chest decompression, drugs and their delivery and mega-code hands-on training on human-patient simulators. Additionally, practice sessions on ECG interpretation for cardiac emergencies were included in the contents. Repeated measures of competencies showed a decline in knowledge, when evaluated at the end of six months. The authors of this paper have therefore suggested various strategies to improve the current training focusing on reinforcing memory and re-training. Similar findings among both undergraduate medicals students and postgraduates have been reported by others.[3-5]

Identifying gaps in training

Incorporating CLS training into the medical curriculum has been one of the strategies adopted by medical schools, worldwide. Clearly, the development of learning materials and its delivery

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to undergraduates contents are not issues to contend with. However, educators would like to see the impact of such training in authentic clinical situations; the 'return on investment' must be realized. The decline in knowledge and skills over time is of concern, as any form of skills training focuses on mastery and eventual readiness of the trainee for clinical practice. The problems of decline in knowledge and skills will need to be addressed employing effective strategies based on identification of the problems, to sustain the skills over long periods of time. Most certified courses in CLS require re-training every two years; the basis of the time period is difficult to justify if the root cause of the decline in knowledge and competencies are not critically evaluated.

Timing of the course within the medical curriculum is a point in contention. Junior students would need to be initiated in CLS as early as possible, as current strategies in basic life support extend to first aid basic life support (BLS) for by-standers and the community at large. Senior students could be incrementally exposed to hybrid learning to sustain clinical performance, as they mature and gain experience in clinical instructions. "Low-dose-spaced high frequency cardiac resuscitation' and high-fidelity simulation training has been suggested as a means to check the decline in knowledge over time. Additionally, other measures like short- duration-distributed CLS training have been suggested. While these options in conduct and delivery of learning are laudable, one needs to re-look at the reasons for decline of desired knowledge (and skills), rather than suggest alternative content delivery teaching methods.

Experiential and reflective learning cycles, shown in the Kolb's' learning theory,[6] clearly shows the importance of contextual learning, ensuring learners are seen to reflect on their learning to ensure sustenance of competencies in CLS and related skills training. While learning the fundamentals of cardio-pulmonary resuscitation and basic life-support in clinical skills lab and on e-learning platforms (learning management systems) are essential, contextual learning is required in current adult learning methods.

Vertical and horizontal integrated curriculum

In relation to timing of delivery of the CLS and other skills training in the medical curriculum, one needs to review the spiral MBBS curriculum and incorporate the value of vertical and horizontal integration of curriculum contents.[7] Extending this concept to CLS, low dose-spaced learning through the spiral curriculum will support meaningful learning. Horizontal integration in linking the fundamental principles of situational learning, as students rotate through the critical clinical areas, provides opportunities for application of principles of CLS and re-visits in real clinical environment (e.g., Emergency Department, Coronary Care Units) to appreciate the value of CLS and related skills. We are reminded of the vertical integration of clinical and basic science components throughout the five-year MBBS program. If the design of the course followed adult learning principles, vertical integration will ensure that the skills training course will relate to motivation and engagement by learners, at various stages of the program. A continuum of education will be seen with proper design of the course, as the student's transit through pre-clinical to clinical years to internship and beyond. Impact of skills training and medical education should extend to professional identity formation and application of learnt principles in real situations, as students mature, engage, and participate in clinical situations (situated learning) when opportunities for learning arise outside the skills labs. Wijnen-Meijer, M., et al[7] summarise the concept of vertical integration in evaluating the 'outcome-based' curriculum as integral to professional education as 'knowledge-based engagement in practice with graduated responsibilities in patient care' will meet intended objectives of the training.

Evaluating the design and development of skills training courses

In evaluating the design and development of skills courses like CLS, three components need to be addressed:

i. The audience and conditions for learning

ii. Applying 'Instructional Design' principles

iii. Evaluating the final product after implementation

Incorporation of skills training, which includes cognition and affective domains, need to be evaluated in a systematic way employing time-tested approaches like the ADDIE model.[8] The ADDIE framework, a popular model among others, is used in 'Instructional Design' of instructional courses. It adopts a sequential approach, though not necessarily linear. Thiruchelvi S and Shahid Hassan and other researchers,[3-5] who lament on the predictable decline in knowledge and skills over time, make little reference to 'analysing the situation (CLS course) and reviewing the conditions of learning, before customizing a course that will be engaging and motivate learners to meet the intended goals i.e., to be competent in applying the skills in the clinical context of cardiac resuscitation.

Adopting available course materials, designed, and developed elsewhere, without considering the current learners' capacity and learning needs (audience) may be reasons for not meeting the objectives of the course completely. The focus of the 'analysis' phase in the ADDIE model, is to explore what the student already knows (prior knowledge) and what is to be learned (learning objectives) at the end of the course. The training course constructors are better placed if they determined the audience and conditions of learning before implementing the training program.

The design of the course needs to be thoroughly thought-through, with feedback from learners and peers, to pitch the course objectives to the level of maturity and experience of the learner. The aim of training is aligned to the scope and depth of the curriculum, as the BLS is for undergraduates, who will re-visit the skills at a later stage of their training. The design stage in ADDIE focuses on learning objectives, and learning materials, which should be analysed prior to incorporation into the course. A lesson plan should be developed with sufficient formative assessment tools at all stages of the course. The design and development of the course are two distinct steps in good models (of ADDIE) which require good planning. Andragogic principles of adult learning will need to be incorporated in the development of the course, as adult learners come with a background of prior knowledge, own experience and have differing learning styles.

The constructors of the CLS course will review the format and plan of the course, as it needs to reflect on the concepts that are to be learned in meeting the learning objectives. The 'audience' or learner is the focus of the design and development of this phase of

ADDIE - it must be aligned to the curriculum and be acceptable to the audience to produce meaningful learning. Engaging Instructional Designers is helpful, as media and presentation of learning materials need to be appealing to meet the functional criteria of a good course, especially when delivered as a blended or entirely on-line asynchronous mode. Most educators are encouraged to develop a prototype of the course, which then undergoes quality check based on feedback from all stakeholders. Testing and re-testing the course material based on timely feedback, will lend to quality assurance. If the analysis and design phases were developed well, the development phase will be well streamlined with the storyboard. The planning would also include the method of delivery of the course that best fits learner's learning style and needs. This could be traditional face to face for practical sessions, supplemented by blended learning employing on-line learning taken at the learners' own time and pace, in line with adult learning preferences.

The delivery of the completed skills training course will consider these aspects of learning before a decision is made about delivery methods. This could be face to face for practical skills with portions of the course being better delivered in a blended asynchronous method.

Evaluation of skills training course

Although statistical methods have been often used to determine criterion for passing, mastery learning is encouraged in skills development. Formative assessment with progressive learning requires thoughtful input from course constructors based on feedback from learners. Evaluating the course continuously has advantages for both trainers and learners for improvement in the design and development of the course. The Kirkpatrick model is a common framework for evaluation of training.[9]

The four levels of evaluation in the Kirkpatrick framework i.e., reaction, learning, behavior, and results, can be comprehensively employed to evaluate all aspects of training. Leaners can reflect on the learning materials and teaching styles in an objective way (reaction). Learning reflects on the degree the subjects acquire knowledge, skills and attitude based on learning outcomes. It should also reflect on engagement and commitment in extending their learning to contextual learning. Assessing the third level of behavior requires long term observation using tools like case encounters and portfolio of real cases seen in the clinical context. All courses have objectives in determining if learners have achieved the learning objectives. This should be the basis of the first three levels in assessment.

The fourth level is an overall assessment of the impact of the skills training which reflects on 'return on investment'. A more comprehensive assessment tool is required to assess all aspects of the course apart from staff requirement and learning materials. The Kirkpatrick's model of assessment is time consuming, especially the fourth level.[9] However, it is worthwhile, as skills training are dynamic and investments are high. Evaluating the 'results' of training has huge implications. Business models of training include a fifth level, rightfully so i.e., ROI-return on investment!

Conclusion

Long term retention of learning appears to be reduced after CLS and skills development courses in medical education curricula. Using criterion references in evaluating competence in skills development would not be sufficient a measure in determining impact of such courses. The return on investment and being 'industry-ready' are two elements not factored in evaluating such courses. It is necessary for educationists to adopt instructional design steps in construct of skills training courses based on andragogy and design and development of such courses. Mastery training requires appropriate formative assessment tools. Feedback from learners, as the course is being designed and developed, will ensure quality products that lend to meaningful learning. Educational courses need to be evaluated based on well-developed frameworks like the Kirkpatrick's model.

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Comparison of altmetrics with conventional bibliometrics in the surgical literature

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Keywords: *Altmetrics; Bibliometrics; Surgical Research; Citations; Social Media; Citations*

Abstract

Background: The impact of a research publication has traditionally been quantified by its citation count. Newer bibliometric indices such as Altmetric Attention Score (AAS) and article page views are emerging as supplementary measures to quantify the academic influence of research.

Objective: The aim of the current study was to interrogate the relationship between novel and traditional bibliometric indices for research published in a leading surgical journal and evaluate the role of these newer indices in measuring the impact of surgical research.

Methods: All articles published in JAMA Surgery between 1 January 2019 and 1 September 2021 were examined. The literature database PubMed was used to identify all articles published within the specified time period. Cumulative citation count (Web of Science), AAS and article page views were retrieved from the journal website. Statistical analysis using the Spearman rank correlation coefficient (r) was performed on Minitab 19.

Results: A total of 1,071 articles were retrieved for further analysis. The correlation (95% CI) between ranks for all articles was 0.635 (0.594-0.673) for AAS and citation scores, 0.680 (0.642-0.714) for citations and article page views, and 0.813 (0.788-0.835) for AAS and article page views.

Conclusions: We demonstrated a strong correlation between citations and AAS for articles published in a leading surgical journal. The inter-year correlation between 2019 and 2021 was similar, suggesting that AAS could be predictive of future citations. AAS may be useful in evaluating the wider societal impact of the surgical literature and could serve to promote greater public engagement in surgical research.

Introduction

Social media platforms have assumed an increasingly prominent role in the dissemination of research output to the public. The impact of a research publication has traditionally been quantified by its citation count. Altmetric Attention Score (AAS) and article page views have emerged as surrogate indices of the popularity of published articles. Previous studies have demonstrated varying degrees of positive correlation between AAS and citation scores in the most cited surgical literature[1,2,3] and in other disciplines, including travel medicine[4] and pediatrics.[5] The aim of the current study was to determine the correlation between novel and traditional bibliometric indices for research published in a leading surgical journal.

Methods

All articles published in JAMA Surgery between 1 January 2019 and 1 September 2021 were examined. Data were extracted in September 2021. All categories of article were included in our analysis. The literature database PubMed was used to identify all articles published in JAMA Surgery within the specified time period. The cumulative citation count (http://cel.webofknowledge.com), AAS (https://www.altmetric.com) and article page views were retrieved from the journal website. Web of Science/Web of Knowledge was used in preference to Google Scholar as the latter is subject to inflated citation counts due to the

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inclusion of multiple less scholarly literature sources such as promotional pages, tables of contents, and course readings lists. Data were entered in a Microsoft Excel 2019 database. Statistical analysis using the Spearman rank correlation coefficient (r) for non-parametric ordinal data was performed on Minitab 19. Correlation values were reported as r (95% confidence interval). Correlations between variables were interpreted as small ($r < \pm 0.29$), medium ($r = \pm 0.30 – 0.49$), strong ($r = \pm 0.5 – 0.99$), or perfect (r = near ±1) according to standard statistical practice. This analysis was repeated for the top 100 cited articles. Content analysis was performed to identify articles which were COVID-related.

Results

A total of 1,071 articles were retrieved for further analysis. The Special Communication article category had the highest mean citation score (38.9), AAS (111.1), and article views (35,173). The correlation (95% CI) between ranks for all articles was 0.635 (0.594-0.673) for AAS and citation scores, 0.680 (0.642-0.714) for citations and article page views, and 0.813 (0.788-0.835) for AAS and article page views (Figures 1A-1C). The correlation between ranks (95% CI) for citations and AAS was 0.686 (0.622-0.741) for articles published in 2019, 0.680 (0.618-0.733) for articles published in 2020, and 0.549 (0.454-0.632) for articles published in 2021. Figure I illustrates the correlation between AAS and citations for the top 100 most cited articles. Content analysis revealed that a minority (n=24) of articles were COVID-related. The correlation between AAS and citation count for COVID-related articles was stronger (r=0.765, 95% CI 0.480-0.904). The article with both the highest AAS (1,348) and page views (37,976) was an original investigation relating to the professional behaviour of surgeons. The article which received the highest number of citations (139) reported guidelines for perioperative care in cardiac surgery.

Discussion

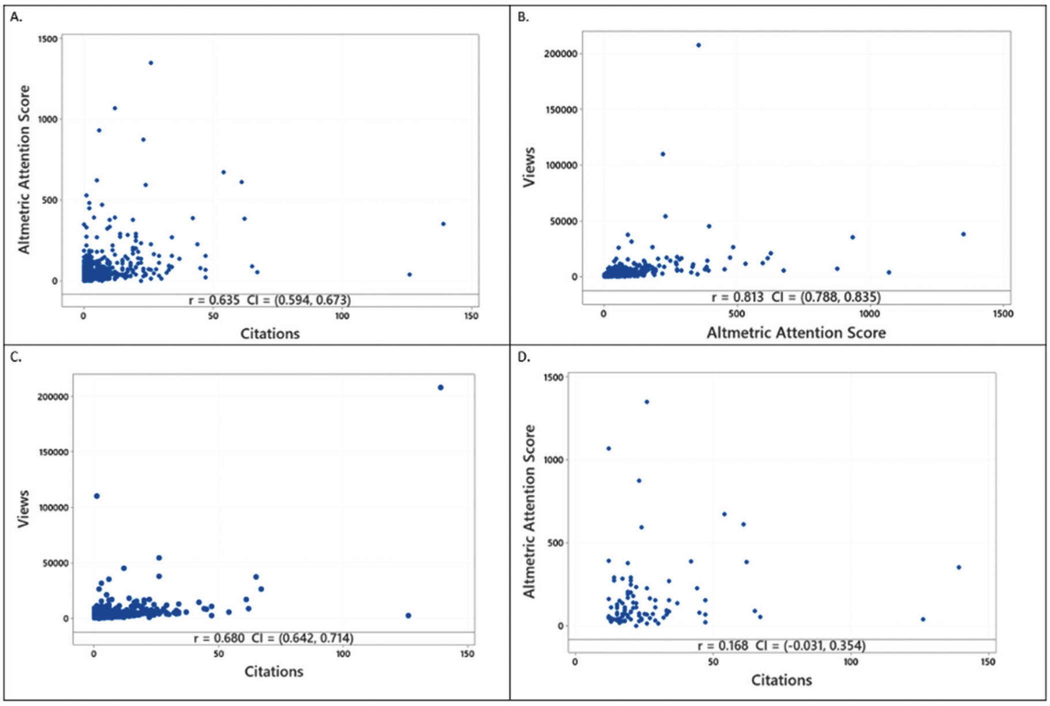

Figure I

Panel A: Altmetric attention scores vs citation counts for all articles (n=1,071). **Panel B**: Altmetric attention scores vs views for all articles (n = 1,071). **Panel C**: Citations vs views for all articles (n = 1,071). **Panel D**: Altmetric attention scores and citations for top 100 cited articles.

We demonstrated a strong correlation of 0.635 between citations and AAS for articles published in a leading surgical journal. Previous research showed a medium correlation of 0.462 for the general surgery literature,[1] and small positive correlations of 0.33 for plastic surgery and 0.12-0.21 for specialised burns research journals, respectively.[6,7] We found that AAS peaked earlier than citation count for articles published between 2019 and 2021. The inter-year correlation between 2019 and 2021 was similar, suggesting that AAS could be predictive of future citations. Our analysis showed there was no significant correlation between AAS and citation count for the top 100 cited articles. This is likely attributed to the fact that citation count reflects academic influence of research while AAS reflects online reach and popularity. Social media has facilitated the more rapid dissemination of journal article content.[8-11] AAS may be useful in evaluating the wider societal impact of the surgical literature and could serve to promote public engagement in surgical research. This may yield benefits in terms of securing sustainable funding for patient-centered surgical research.

Our study reveals a high level of correlation between AAS and citation count in surgical research and provides insights into the potential role of AAS as a metric in this field. We restricted our analysis to a single journal with a high impact factor and we did not perform separate analyses for individual article categories since in general the majority of citations stem from original research articles and review articles. We recommend that further research should extend the analysis to multiple surgical journals. In conclusion, we have identified a strong positive correlation between citations and Altmetric scores for articles published in a leading surgery journal. AAS may prove to be predictive of future citations and it may have a role in evaluating the wider societal impact of surgery publications and thus promote greater public engagement in surgical research.

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Data availability: The raw journal data underlying this study are in the public domain from the sources specified in the methods. All data are also available upon request from the corresponding author.

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Challenges in the diagnosis and management of post-covid-19 organizing pneumonia: A clinician's perspective

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Abstract

COVID-19 caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection can result in multiple complications such as long COVID syndrome, pulmonary fibrosis, and organizing pneumonia (OP). Although OP is a well-known complication of COVID-19, several challenges remain; from suspecting and confirming the diagnosis to its management. These challenges are aggravated further in patients who are critically ill and when surgical biopsy is not feasible. Post-COVID-19 OP is a subset of secondary organizing pneumonia that shares similar clinical and radiological characteristics and similar computerized tomography (CT) scan features with OP of various etiologies. In this review, we propose a clinical approach based on current available evidence for the management of COVID-19 patients with suspected OP. Typical CT findings such as consolidations, perilobular opacity, reversed halo sign and ground-glass opacities are highly suggestive of OP, but are not pathognomonic. Confirmation by histopathology should be done but when not possible, a trial of corticosteroid therapy may be considered. However, biopsy should be done if corticosteroid therapy fails or when there is clinical deterioration and worsening of hypoxia while on corticosteroid therapy especially if the onset of the symptoms is longer than two weeks.

Keywords: *COVID-19; SARS-CoV-2; organizing pneumonia; corticosteroid; computerized tomography scan*

Introduction

Coronavirus disease 2019 (COVID-19), caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, is an ongoing pandemic with multiple complications including long COVID syndrome, pulmonary fibrosis, and organizing pneumonia (OP). The latter is of particular interest because of the challenges in its diagnosis and management, especially in the early course of the illness, for the clinicians managing these cases.

Defining organizing pneumonia

Organizing pneumonia is a process of pulmonary tissue repair, defined histopathologically by the presence of intra-alveolar plugs of granulation tissue (Masson bodies) consisting of fibroblasts and myofibroblasts mixed with the connective matrix. These granulation tissues extend from the alveoli into the lumen of distal bronchioles.[1–4] Various etiologies have been identified to cause organizing pneumonia (secondary organizing pneumonia). These secondary causes include viral infection, connective tissue disease, toxic fumes, and drugs.[2,5,6] When no specific etiologies are found, it is called cryptogenic organizing pneumonia (COP). However, several studies have shown no significant clinical or radiological differences between secondary and COP.[7–10] Hence, it is conceivable the two share similar pathological and clinical processes; regardless of whether a specific causative agent is found or not. When OP is linked to SARS-CoV-2 infection, it is known as post-COVID-19 OP. The definitive evidence for post-COVID-19 OP is limited as the majority of reported post-COVID-19 OP were not biopsy-confirmed but rather diagnosed based on clinical presentation and computerized tomography (CT) findings [Table I] and hence, should be interpreted cautiously.[11–23]

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Table I

Case reports & case series on post-COVID-19 OP. Abbreviations: GGO: Ground-glass opacity.

	DATE OF CT SCAN (Day of illness)	CT SCAN FINDINGS	BIOPSY PERFORMED	TREATMENT	TIMING OF TREATMENT (Day of illness)	RESPONSE TO TREATMENT
Okamori et al., July 2020	Day 13 (estimation)	Consolidation with reversed halo sign, traction bronchiectasis, and volume loss of the lower lobes.	No	1,000mg methylprednisolone daily for 3 days, followed by a daily dose of 80mg/day (1 mg/kg) prednisolone. Tapered and off within 18 days of admission (12 days of steroid).	Day 13 (estimation)	Improved, response rate unclear.
	Day 13 (estimation)	Bilateral Consolidations with band-like opacities and distributed in subpleural or peri-bronchial region. Traction bronchiectasis was also present.	No	50mg/day (0.75 mg/kg). Tapered and off within 18 days of admission (12 days of steroid).	Day 13 (estimation)	Improved, response rate unclear.
de Oliveira Filho et al., Feb 2021	Day 21	Peripheral areas of consolidation in both lower lobes.	No	Prednisone at 1 mg/kg. Tapering dose not reported.	Day 26	Improved, response rate unclear.
	Day 14	Patchy areas of subpleural consolidation, perilobular distribution with reticular opacities.	No	Prednisone at 1 mg/kg. Tapering dose not reported.	Day 23	Tapering off ventilatory support in less than 48 hours.
	Day 14	Consolidation and GGOs with perilobular distribution.	No	Prednisone at 1 mg/kg. Tapering dose not reported.	Day 23	De-escalating to low-flow nasal cannula from CPAP after three doses of steroid.

Kanaoka et al., Feb 2021	Day 26	GGOs and consolidations.	Yes	Prednisolone at 1 mg/kg/day (60mg) for a week and reduced to 0.5mg/kg/day for 6 weeks, followed by 15mg OD.	Day 35	From nasal prong oxygen to room air within 7 days.
	Day 43	GGOs and consolidations.	Yes	Prednisolone at 1 mg/kg/day (60mg) for a week and reduced to 0.5mg/kg/day for 4 weeks, followed by 20mg OD.	Day 51	Improved within 7 days with resolution of hypoxia on exertion.
Horii et al., November 2020	Day 17 (estimation)	Previous ground glass opacities progressed to lung consolidation without new GGOs.	No	Prednisolone ay 1 mg/kg/day (60mg). Then, tapering down gradually (approximately 10mg per week) to 30mg upon discharge (28 days of inpatient steroid). After discharge, prednisolone was tapered down to 20 mg for 20 days, 10 mg for 14 days and 5 mg for 14 days and discontinued thereafter.	Day 17 (estimation)	From 10 L/min oxygen requirement to 1L/min after 3 days.
Kim et al., October 2020	Day 20	Multiple patchy areas of consolidation, mainly in the sub-pleural zones of the right lower lobe with GGOs.	No	Methylprednisolone at 40 mg for 3 days, followed by prednisolone 30mg for 3 days and 20mg for 2 days.	Day 27	From 4L/min nasal cannula to 2L/min within 48 hours.

Simões JP et al., Jan 2021	Day 30	Diffuse patchy consolidations and GGOs with band opacities and perilobular distribution.	No	Prednisolone at 1mg/kg/day for 16 days and were tapered over 13 weeks	Day 30 (presumed)	Improvement within 36 hours and complete resolution of respiratory failure within 7 days.
	Day 30	Patchy consolidations and GGOs with peripheral and peribronchic distribution	No	Methylprednisolone 1mg/kg/day for 20 days and were tapered over 13 weeks	Day 30 (presumed)	Resolution of respiratory failure within 6 days.
Pogatchnik et al., August 2020	3 weeks (approximation)	Patchy GGOs distributed peripherally in the lungs and crazy paving patterns	Yes	Remdesivir; other medications not mentioned.	N/A	Clinically recovers and CT imaging 26 days later showed minimal residual opacities.
Giannakis et al., June 2021	Day 22	GGOS with crazy paving; “bullseye” and “reversed halo” sign.	No	Dexamethasone (unknown dose and duration)	N/A	Improved and discharged home.
Seo H et al., February 2021	Day 17	GGOs with consolidations	Yes	No steroid given	N/A	Improved and discharged home.
Funk et al., April 2021	4 weeks (approximation)	Patchy subpleural GGOs and linear consolidation	Yes	No steroid given	N/A	N/A

Tamura et al., December 2020	Day 19	Consolidation with traction bronchiectasis and volume loss.	No	Methylprednisolone 1000mg for 3 days followed by prednisolone 40mg (0.5mg/kg/day). Tapering regime not known.	Day 19	Extubated 3 days after initiation of therapy.
	N/A		No	Methylprednisolone 1000mg for 3 days followed by prednisolone 30mg (0.5mg/kg/day). Tapering regime not known.	Day 15	Extubated 6 days after initiation of therapy.
	N/A		No	Methylprednisolone 1000mg for 3 days	Day 29	Extubated the next day.
	N/A		No	Methylprednisolone 1000mg for 3 days followed by prednisolone 30mg (0.5mg/kg/day). Tapering regime not known.	Day 14	Extubated 15 days after initiation of therapy.
Cortés Colorado et al., June 2021	Day 11 (approximation)	GGOs, peribronchovascular consolidation, and bilateral pleural effusion.	Yes	Prednisolone 1mg/kg/day. Tapering regime not known.	N/A	Radiological improvement after 15 days of steroid. Clinical details are not available.

Ng et al., October 2021	Approximately 2 months	Bilateral GGOs with visible intralobular lines	No	Methylprednisolone 500 mg/day for 3 days, followed by intravenous dexamethasone 6 mg/day for 10 days. Then, oral prednisolone of 0.5 mg/kg/day for 4 weeks, followed by 20 mg/day for 4 weeks tapered to 10 mg/day for 2 weeks and 5 mg/day for 2 weeks	N/A	Improved over 2 weeks
	Approximately 2 months	Right middle lobe consolidative mass	Yes	Prednisolone at 0.5 mg/kg/day for 4 weeks, then 20 mg/ day for 4 weeks, followed by 10 mg/ day for another 2 weeks and tapered over 3 months.	N/A	Improved at outpatient review at 12 weeks. Inpatient details not reported.

Are post-COVID-19 OP and DAD the same?

Katzenstein et al. introduced the term "diffuse alveolar damage" (DAD) to describe the histopathological changes that occur in the lung after insults from different aetiologies.[24] Since then, this histopathological description was considered the hallmark finding for acute respiratory distress syndrome (ARDS), although several later studies showed not all ARDSs have histological findings of DAD.[25–32] Although DAD is not pathognomonic of COVID-19 pneumonia, the main pulmonary pathology in COVID-19 is DAD characterized by histopathologic evidence of oedema, endothelial and alveolar lining cell injury with the presence of hyaline membrane.[33–35]

DAD is divided into 3 phases, namely: early exudative phase, proliferative/organizing phase, and the fibrotic phase. The early (acute) exudative phase is characterized by edema, hyaline membranes, and interstitial acute inflammation. This is followed by the subacute (proliferative/organizing) phase with loose organizing fibrosis predominantly within alveolar septa and the presence of type II pneumocyte hyperplasia.[25,36–39] The proliferative phase typically occurs a week after the exudative phase and is replaced by the fibrotic phase 2-3 weeks later; although these phases tend to overlap.[40,41]

Thus, one important differential for OP is DAD in the proliferative or organizing phase, but such distinction is not always clear.[39,42,43] As they share similar histopathological descriptions, it is of interest to know if the organizing phase of DAD is a separate entity from OP or they are inter-related entities within the spectrum of the same pathology. Histologically, the proliferative phase of DAD is evident by the presence of myofibroblasts in both the intra-alveolar and interstitial space. Although the fibroblast-myofibroblast mixed matrix is also present in OP, the interstitial space is usually spared or only mildly inflamed, with relative preservation of the general architecture of lung parenchyma.[44,45] Interestingly, foci of OP may also be found in the DAD process, which makes differentiating OP from DAD difficult.[42,46]

A separate histopathological entity, known as acute fibrinous and organizing pneumonia (AFOP), is worth mentioning here. AFOP is diagnosed by histopathological evidence of intra-alveolar fibrin deposition, often described as "fibrin ball" in addition to the intraluminal loose connective tissue with the absence of hyaline membrane as seen in OP.[47] It is uncertain whether AFOP is an entity alongside DAD and OP or whether it results from tissue sampling issues.[3] A full discussion of AFOP is beyond the scope of this review. However, it is crucial to realize that it shares significant similarities with OP and DAD on CT scan; and responds somewhat well to corticosteroid therapy.[48–51] AFOP, once thought rare, has been reported fairly frequent in COVID-19 patients with ARDS.[33,41,52,53] Hence, a patient with COVID-19 may have pneumonia with or without ARDS from DAD, secondary OP, or AFOP; and all 3 are not easily differentiated from each other by CT as described later in this review.

Earlier studies had reported the proliferative phase of DAD to be steroid responsive.[54,55] However these studies included cases with somewhat preserved lung architecture histologically which might very well be OP after all. It is uncertain if DAD, in its entirety is steroid-responsive or whether the proliferative phase of DAD, which is histologically similar to OP, determines its responsiveness to corticosteroid therapy. The heterogeneity of histopathological findings in ARDS could explain the mixed responsiveness to corticosteroid therapy.[56–59]

OP has a wide range of clinical features and severity. They often mimic other lung diseases and requires high clinical suspicion followed by histopathological confirmation for diagnosis.[8,38] Although OP usually has a subacute presentation with symptoms such as cough, dyspnea, fever, malaise and flu-like symptoms, a more severe and acute form has been reported.[60,61] Similarly, DAD which is often linked to ARDS, would also have various presentations depending on the underlying causes. Although, DAD are generally more severe and of acute onset.[44,62,63]

The understanding of the natural course and histopathological process of both OP and DAD is crucial to help us in diagnosing post-COVID-19 OP. Hence, a patient who had a subacute presentation of dyspnea and cough after recovering from COVID-19 weeks later should raise the suspicion of OP rather than DAD. However, difficulty remains in patients with COVID-19 who have progressively worsening respiratory illness within the first two weeks of infection; differentiating between worsening DAD from OP is challenging.

Can CT differentiate between DAD and OP?

Typical CT findings of ARDS include areas of ground-glass opacities (GGO), reticular opacities with or without tractional bronchiectasis, and areas of consolidation.[64–66] Similarly, CT findings of COVID-19 pneumonia demonstrates an initial phase of GGO followed by a later phase of crazy-paving pattern, consolidation, interstitial thickening and/or interlobular septal thickening although these patterns often overlap.[67–71]

Comparisons between CT findings of ARDS/DAD and histopathology findings are very limited before the COVID-19 pandemic, and these comparisons were done at a time when histopathology definition and understanding were different.[64,72] A study conducted by Ichikado et al. comparing CT and histopathology findings in hyperoxia-induced DAD in pigs, showed that the normal attenuation area, GGO and interlobular septal thickening correlated with the exudative phase while heterogeneous attenuation and traction bronchiolectasis correlated with the early proliferative phase of DAD respectively.[73]

Although the COVID-19 pandemic has sparked a surge in studies about DAD, these studies were entirely post-mortem; and CT-histopathology comparison studies are scarce.[53,74–77] Kianzad et al. compared the autopsy findings of COVID-19 patients who had chest CT 72-hours prior to death, showed that patchy GGO corresponded to the exudative phase of DAD while the presence of thickened interlobular septa corresponded to both exudative and proliferative phases of DAD.[78] CT findings of areas of consolidation generally correlated with the proliferative phase of DAD. In addition, well-demarcated consolidation areas correlated with AFOP. On the other hand, a CT-histology comparative study by Henkel et al. showed heterogeneous findings instead.[74] However, the patients in this study had wide-ranging intervals between CT imaging day and death.

Typical CT features of OP include the presence of consolidations, perilobular opacity, reversed halo sign (atoll sign) and ground-glass opacities (Figure I). However, these features are not pathognomonic, and they often overlapped with DAD of COVID-19 and other viral pneumonia.[79–81]

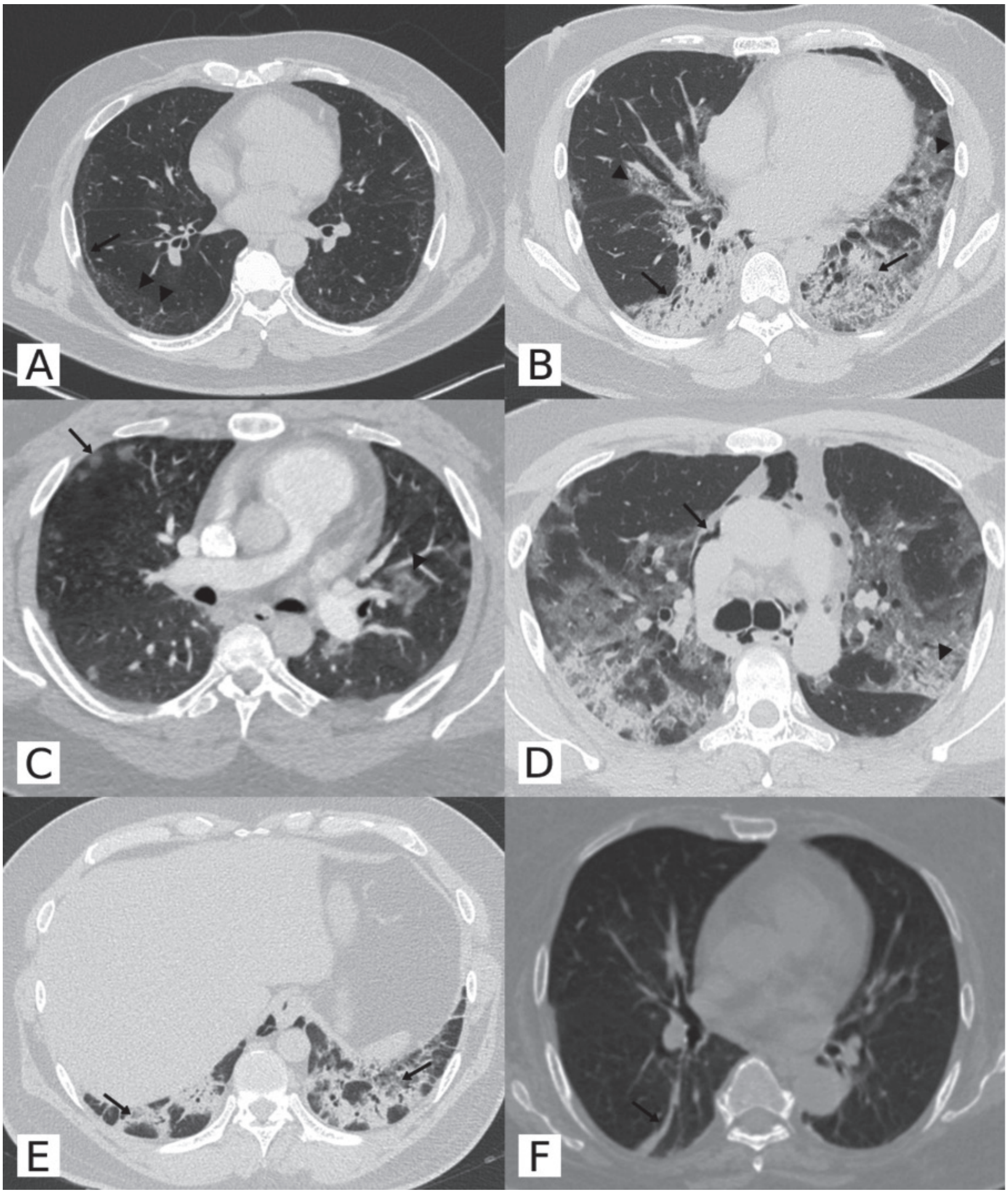

Figure I

(A) Mild ground-glass opacity (arrowhead) with mild reticular abnormality and subpleural bands (arrow). **(B)** Bilateral subpleural and bronchocentric consolidation (arrow) with bronchocentric ground-glass opacities (arrowhead). **(C)** Nodular ground-glass opacities (arrow) with atoll sign (arrowhead). **(D)** Pneumomediastinum (arrow) and crazy paving pattern (arrowhead). **(E)** Perilobular pattern (arrow) bilaterally with arcade-like or polygonal curvilinear opacities. **(F)** Band-like opacity (arrow).

Many studies attempted to correlate the temporal changes in CT features and the duration of symptoms of COVID-19.[67,68,71,82–84] An analysis of these studies together (Figure II) shows that GGO and consolidation are the most common features during the earlier course the disease becoming less common with time along with an increment of band opacities or reticulation. Similar correlative studies for COP showed the most frequent initial CT findings are GGO, consolidation, nodules and reticulation.[85,86] Unfortunately, the widely differing intervals between the time when CT scan was done and symptoms onset in these studies prevent direct comparison between COVID-19 secondary OP and cryptogenic OP.

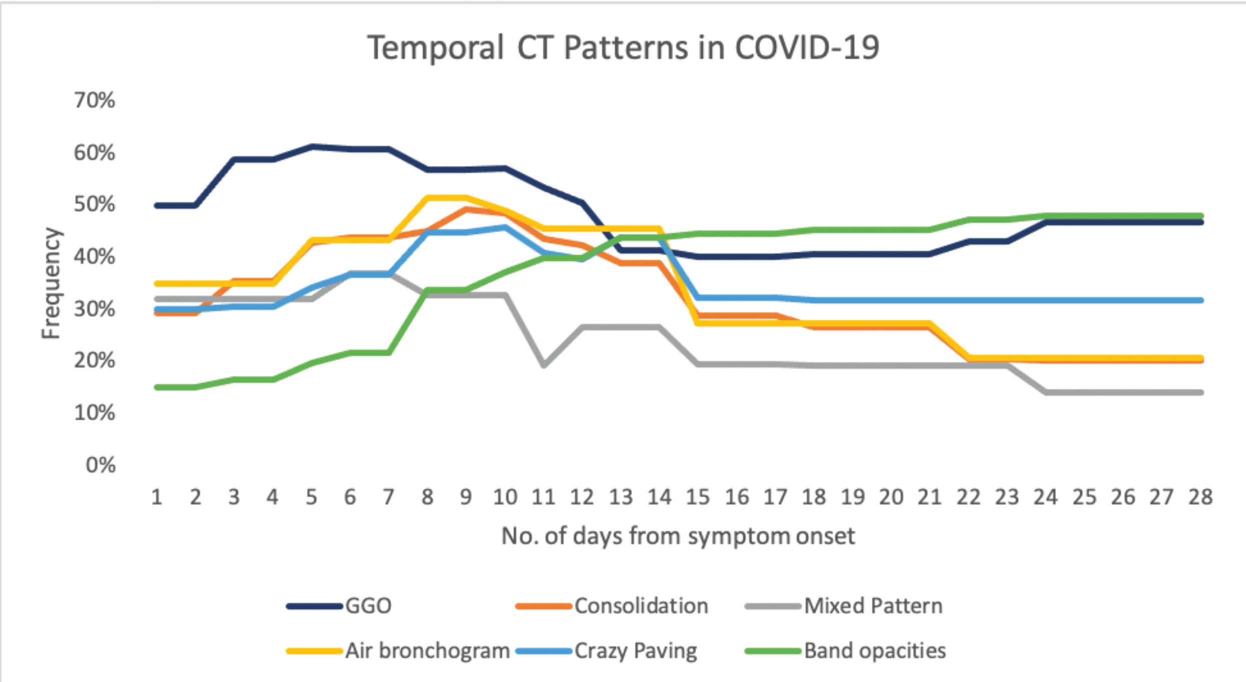

Figure II

Graph showing the temporal frequency of different CT findings (A combined analysis of multiple studies). Mixed pattern is referring to mixed GGOs with consolidations. Abbreviation: GGO: ground-glass opacity.

Various studies on the time of appearance of CT features of COVID-19 OP have reported varying time intervals. Jeong et al. and Cereser et al. reported an astounding >90% of COVID-19 patients developed CT features of OP within a mean and median time of 5.5 ± 2.7 and five days, respectively, from symptoms onset.[87,88] However, these numbers may be an overestimation as the CT features of organizing phase of DAD are not easily differentiated from OP, as discussed earlier. In addition, different CT definitions for OP may have been used in these studies. In contrast, other studies have reported a wider range of approximately 7 to 21 days for CT features of post-COVID-19 OP being present from symptoms onset.[89–91] Autopsy studies revealed a third of deceased COVID-19 patients had focal and diffuse OP between[5-34] days from symptoms onset with the majority of diffuse pattern occurring after more than ten days.[92]

We can conclude that CT findings alone is inadequate to diagnose post-COVID-19 OP. Studies comparing CT with histopathology findings in COVID-19 are needed to estimate the positive or negative predictive values of CT features in post-COVID-19 OP.

Is biopsy required for management of post-COVID-19 OP?

This is a tricky question. Although histopathology can confirm the diagnosis of OP, the heterogeneity of lung pathology in OP means highly selective and adequate biopsy sampling is required, which may not be feasible via the transbronchial approach. Hence surgically obtained lung biopsy is preferred over transbronchial biopsy but patients with ARDS or post-COVID-19 OP are often ill and may not be suitable for surgical biopsy.[93] Although there may be attempts to diagnose and treat OP without histopathology, for example in critically ill patients or whenever biopsy is not feasible; such an approach could lead to problems later if these patients do not respond to corticosteroid therapy.[2,94]

There are many success stories on the management of suspected post-COVID-19 OP without the need for biopsy [Table I]. The typical CT patterns and dramatic response to corticosteroid therapy lend credence to these 'clinically diagnosed' OP. An analysis of these cases suggests post-COVID-19 OP typically developed within 2-3 weeks after onset of first symptoms. However, it is important to know that OP may have developed earlier and was only diagnosed either by non-resolving or recurrence of respiratory failure after a period of improvement. A study by Rocha et al. on critically ill COVID-19 patients with CT features of OP without biopsy reported a very good response to high dose corticosteroid therapy.[95] These patients were at an average of 8.9 days from symptoms onset with a standard deviation (SD) of 3.9. However, there was no control group for comparison, and corticosteroid of OP dosage was started relatively late at an average of 13.0 ± SD 5.5 days from symptoms onset. The reported survival rate was 92%.

Since there are no randomized controlled trials for CT-only approach versus biopsy-diagnosed approach, it is impossible to predict which patient would fail to respond to corticosteroid therapy. Nevertheless, multiple cases of post-influenza OP have been reported, and these were often diagnosed solely on CT alone together with knowledge of disease progression. Since post-influenza OP and post-COVID-19 OP share similar disease progression, diagnosis by CT-only approach for the latter may be clinically feasible if the clinical scenario and timeline fit.[60,96,97] However, if there is an unsatisfactory response to corticosteroid, biopsy should be performed.

Management of post-COVID-19 OP

The mainstay of therapy for OP is corticosteroid. Typically in COP prednisolone is started at a dose of 0.75-1 mg/kg/day for 2-4 weeks and tapered gradually over 3-6 months.[38,98–100] Mild stable cases of COP can just be monitored carefully for spontaneous recovery or managed with macrolides.[101–103] Corticosteroid regimens in secondary OP varies as there are no large comparative trials for different treatment regimes. Evidences were largely based on case reports and observational studies, with some clinicians using the treatment regime for COP while others initiate prednisolone at a lower dose of 0.5mg/kg/day.[6,20,21,60,96,97,104–107]

Similarly, there are no randomized studies yet for post-COVID-19 OP. Most of the evidences are based on previous experience and from case reports. Different treatment regimens were used with a shorter duration of tapering dose. In a prospective observational study by Myall et al., 30 out of 35 patients diagnosed with OP with CT scan 6 weeks after COVID-19 infection were started with prednisolone 0.5mg/kg/day and weaned over three weeks.[108] The remaining five patients were considered unsuitable for corticosteroid therapy either due to comorbidity or, limited or improving symptoms. The patients who received prednisolone in this study showed significant clinical and radiological improvements although it is unclear if any relapses occurred. It is important to note that this cohort of patients had baseline characteristics that were different from those reported in case reports/series. They were comparatively less severe and were diagnosed 6 weeks later. Whether this treatment regimen would work for more severe cases or those with earlier onset of OP is unknown.

Does routine corticosteroid therapy for COVID-19 pneumonia interfere with diagnosis of OP?

The landmark RECOVERY trial has defined the course of treatment for COVID-19 with the usage of dexamethasone 6 mg/day for ten days in patients requiring oxygen supplementation or mechanical ventilation.[109] An important sub-analysis from this study of patients with symptoms >7 days reported better response to dexamethasone than those with symptoms ≤7 days, with the median time of 13 days in ventilated patients. This raises the question of whether the better response rate in the former was due to the presence of OP rather than just simple pneumonia. Similar trends were found when we sub-analyzed the results from several other studies.[110–114] Studies that reported no benefit with corticosteroids either had a relatively earlier initiation of treatment from the onset of symptoms; or patients were given methylprednisolone pulse doses resulting in shorter treatment duration.[115–118]

There are no data or guidelines available on when to suspect OP for COVID-19 patients receiving dexamethasone therapy. Segala et al. reported a case series consisting of ten patients who developed post-COVID-19 OP diagnosed with CT scan after receiving the standard therapy of dexamethasone 6mg OD for ten days. In these patients, at least 20 days had transpired from symptoms onset before the diagnosis of post-COVID-19 OP. They were treated with methylprednisolone with gradual tapering of dosages every three days. Eight patients were successfully weaned off from oxygen supplementation and discharged within two weeks of treatment.[119]

In clinical practice, OP should be suspected when there is clinical deterioration and worsening hypoxia despite being on dexamethasone therapy, especially if the onset of the symptoms is more than two weeks. High-resolution CT scan is the preferred imaging, and other causes should be ruled out including ventilator-associated pneumonia. Lung biopsy is recommended when feasible and when patients failed to respond to standard OP therapy. A suggested approach is shown in Figure III.

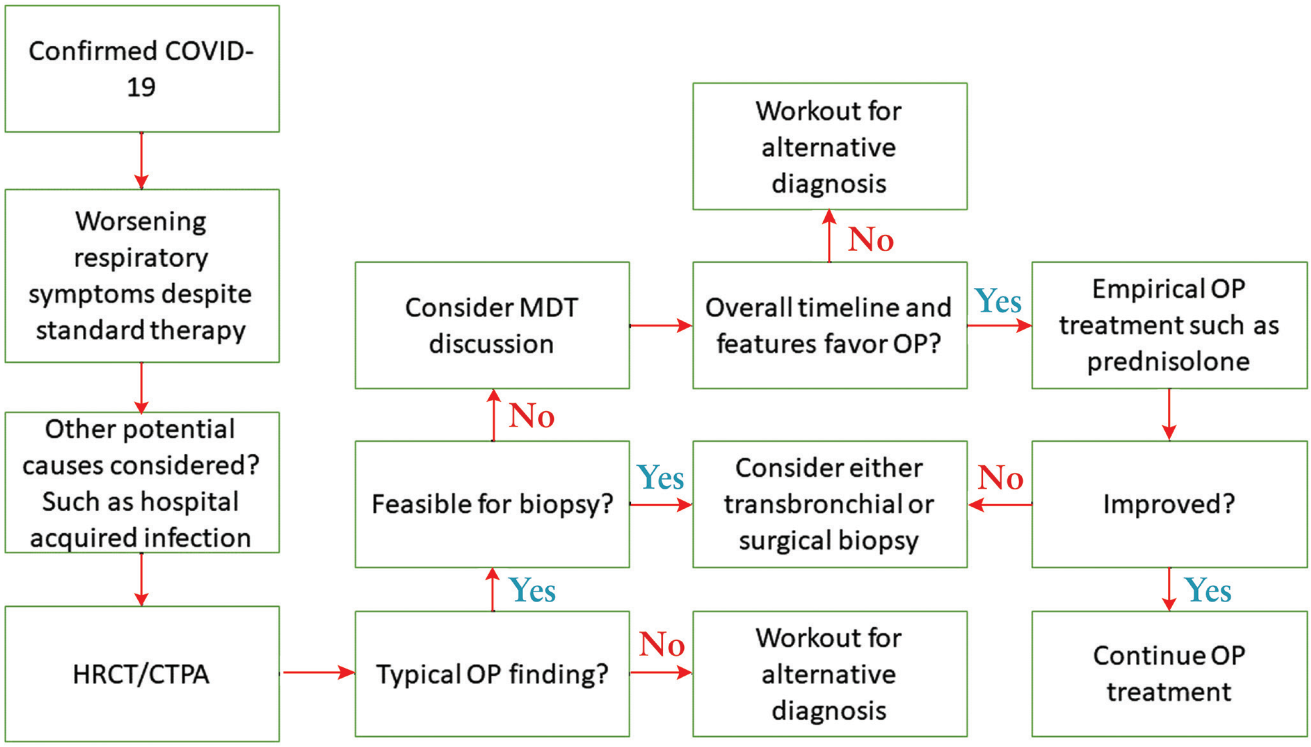

Figure III

Flow diagram on suggested approach for post-COVID-19 OP.

Abbreviations: **HRCT:** high-resolution computed tomography. **CTPA:** computed tomography pulmonary angiography. **OP:** organizing pneumonia. **MDT:** multidisciplinary team.

Conclusion

In summary, post-COVID-19 OP should not be diagnosed from CT alone without clinical context because DAD can show similar CT features. However, OP should be suspected when there is no clinical improvement or worsening hypoxia especially after 1-2 weeks from the onset of symptoms. When lung biopsy is not feasible, a trial of prednisolone 0.5-1.0 mg/kg od (or equivalent) is justifiable. If there is no clinical improvement, biopsy should be considered, preferably with a multidisciplinary team involving infectious disease physician, respiratory physician, radiologist, and pathologist.

Conflict of interest

The authors declared that they each have no conflict of interest.

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Impact of cardiac life support training on retention of knowledge measured by pretest, immediate posttest, and 6-months posttest

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ABSTRACT

Introduction: Cardiac resuscitation skills are a necessity for newly graduated doctors as they are first responders during a crisis. Despite undergraduate exposure, interns still struggle in an actual crisis. We evaluated final year medical students' long- term retention of knowledge following cardiac life support training prior to exit from medical school to determine the need to revise and re-strategize.

Methods: Thirty-seven final year medical students participated in a quasi-experimental research after a cardiac life support (CLS) course where results of their one best answer assessment-pretest, immediate posttest and 6 months posttest were analyzed.

Results: A repeated measure ANOVA was conducted on mean test scores of 30-items one best answer (OBA) questions, measured as pre-test, immediate and 6 months posttests after the course. The result showed significant time effect, Wilks Lambda = 0.126, F (2,35) = 121.468, *P* = <.001. Follow up comparison indicated that each pairwise comparison difference was significant (p ≤ 0. 05). Both immediate and after 6 months post-course test scores were statistically better than the pretest scores suggesting that there was improvement in knowledge after the course despite the decay.

Conclusion: Our results showed that retention of knowledge as a short-term memory worked well immediately after the hands-on cardiac resuscitation course. However, though there was improved knowledge even after 6 months compared to before the course, there was decay in knowledge. There is a need to re-strategize to improve knowledge retention.

Keywords: *Long term retention, knowledge, cardiac resuscitation, strategy, simulation*

INTRODUCTION

There are some skills that students must master before graduating from medical school and resuscitation of a collapsed or acutely ill patient is one of them. Medical students in the final year are expected to be able to take history, perform clinical examination and suggest management of a condition or disease to be able to graduate. However, when they graduate, they are expected to also identify and initiate some form of management especially during a crisis since they are, as house officers, the first responders.[1-4]

In the recent years, there has been an increase in the number of medical graduates in Malaysia beyond the available posts in the country thus causing a delay in starting work as interns, with waiting time now reaching almost a year. Considering this and the fact that there is a 6 months' period of none or minimal exposure to cardiac resuscitation situations during the clinical postings, before exiting medical school, we feared a significant decay in knowledge and practical skills. Our aim was to determine the long-

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term retention of knowledge of final year students on cardiac resuscitation 6 months following completion of CLS training and identify if there was a need to revise or re-strategize. We hoped to obtain an insight on the effectiveness of the one-and-a-half-day course conducted to prepare students on resuscitation skills.

METHODS

A pretest posttest experimental research method was designed to analyze the effectiveness of a CLS hands-on training using simulations (high and low fidelity). The hypothesis was that there is a significant change in students' mean achievement scores before, during and after attending the cardiac life support training.

Participants' pre and post course knowledge was measured using a 30-items OBA test administered at three different times - pre-course, immediate post-course, and 6 months post-course. A convenience method of sampling was used and 37 participants who met the inclusion criteria were recruited in the study. Data collected as OBA test scores at the three different times was analyzed using one-way repeated ANOVA statistical method in Microsoft SPSS version 20 and result is reported.

The research was carried out in accordance with the Declaration of Helsinki, there was no potential harm to students, the anonymity of participants was ensured, and informed consent was obtained. As this was a study evaluating quality of an ongoing curriculum delivery, it was not brought to the ethical board for approval.

Course framework/programme

The CLS course is compulsory for all final year students and is conducted in the clinical skills and simulation labs at the clinical campus of International Medical University during the anesthesia posting. A cardiac life support manual prepared with reference to the latest American Heart Association (AHA) guidelines is provided online in the university's e-learning portal to help students prepare for the test and course.[5] Also available on the e-learn portal are videos on the right and wrong ways to resuscitate a patient and practice quiz to help students prepare for the course.

Students generally complete a pre-test, an introductory lecture, video demonstration of a right and wrong team resuscitation followed by rotation through 4 stations manned by faculty: (1) airway devices and part-trainer for chest compression (2) defibrillator (3) drugs and delivery (4) Mega code – hands-on training on human patient simulator (high fidelity). Included in the course on the same day is an interactive practice session on interpretation of ECG of commonly encountered cardiac emergency rhythms and mega code practice session where students are given sample scenarios to practise among themselves under the guidance of an instructor.

For this research, assessment was carried out 1-week post-course using a checklist to assess performance during mega code (practical skills) and post-course OBA (knowledge). Six months after the course and not having had any interventions in place to maintain knowledge and skills in resuscitation, the students completed the same 30-items OBA test.

RESULTS

There was a significant change in participants' mean achievement scores before (16.62) and after (23.59) attending the cardiac life support workshop. However, the mean score (18.54) at 6 months posttest was lower than at immediately after training but higherthan the pretest score. (Table I)

Table I: Descriptive statistics with mean and standard deviation

		Test Scores	
Test time	n	Mean	SD
Pretest scores	37	16.62	3.538
Immediate posttest scores	37	23.59	1.723
6 months Delayed Posttest Scores	37	18.54	2.950

To check the assumption of repeated measure ANOVA, we referred to Mauchly's test of sphericity and the output data of this condition showed that the variance of repeated measure is equal across time (p = 0.233), which means homogeneity of variance is not violated (Table II).

Table II: Homogeneity of variance using test of sphericity

Mauchly's Test of sphericity							
					Epsilon[b]		
Within Subject Effect	Mauchly's W	Approx Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Time	.920	2.917	2	.233	0.926	.974	0.500

Having met the equality of variance across the dependent variables using sphericity test, multivariate output data of Wilk's Lambda was chosen to determine the test significance and its effect size. (Table III)

Table III: Inferential statistics as multivariate test of Wilk's Lambda and its effect size

Multivariate Test[a]							
Effect		Value	f	Hypothesis df	Error df	Sig.	Partial Eta Squared
Time	Wilks' Lambda	.126	121.468[b]	2.000	35.000	<0.001	0.874

In the pairwise comparison table, numbers 1, 2 and 3 represent the pretest, immediate posttest and delayed posttest respectively (Table IV).

Table IV: Pairwise comparison of mean difference and the 95% confidence interval

(I) Test Time	(J) Test Time	Mean Difference (I-J)	Std Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-6.973	488	< .001	-8.198	-5.748
	3	-1.919	.602	.009	-3.431	-.407
2	1	6.973	.488	< .001	5.748	8.198
	3	5.054	.498	< .001	3.804	6.304
3	1	1.919	.602	.009	.407	3.431
	2	5.054	.498	< .001	-6.304	-3.804

DISCUSSION

Participants demonstrated good short-term memory as shown by the immediate post-test scores that had good correlation with the pre-test score. The main effect of time was statistically significant (Table III) showing that a difference existed along the time span of achieved scores.

In the current study, the passage of time had a significant effect on the participants' knowledge as measured by pretest and two posttests scores at different times. A high effect size was found (Table III) with partial Eta squared = 0.874 using the Cohen's criteria (Cohen's large effect size = 0.18).[6]

Course design and delivery influences cognitive retention of long-term memory especially if designed in keeping with the principles of experiential learning. Experiential learning practised with features of brainstorming of prior knowledge, experience and reflective practice during the course followed by immediate feedback to identify gaps in knowledge and skills to acquire new knowledge for a contextualised future practice will improve the likeliness that information gathered move into the long- term memory.[7]

Pairwise comparison also indicated a significant difference between pretest and the immediate posttest (Time 1 and 2), pretest and delayed posttest (Time 1 and 3) as well as between the immediate posttest and the delayed posttest (Time 2 and 3), significant at $p \leq 0.05$. (Table IV) The loss of effect between Time 1 and 3 compared to Time 1 and 2 suggests that effective design implementation strategies will be needed as an interphase to move the acquired knowledge and skills from short term memory to long term memory. One such strategy would be to utilize the principles illustrated by Gibb's reflective cycle which offers a framework for examining experiences. Currently, immediate feedback is provided to students as soon as they complete the mega-code assessment, and they are encouraged to reflect and apply the skills when they are in the wards. However, in the actual environment, a chance to assist or observe management of cardiac resuscitation is rare and inconsistent. This lack of follow through and consistency of exposure after the course will contribute to the decay in the knowledge and skills as students progress through all postings to complete medical school as noted in our study and several others.[8]

Resuscitation skills are important skills that are required to be achieved upon graduation from medical school as part of preparation for real life practice. These skills will translate to better patient outcome when a crisis is encountered in the wards.[2] Universities are not uniform in the weightage provided in honing these skills.[9] Cardiac resuscitation is not a skill to be learnt after graduation and practised on patients for the first time. Exposure at an early stage in the medical school will prepare them for challenges as junior doctors.[1,10]

The results of our study clearly show that the CLS course has an impact on knowledge and skills immediately after the training. The available evidence suggests that acute life support (ALS) knowledge and skills decay by 6 months to 1 year after training and that skills decay faster than knowledge.[7,11-14] Looking into the possible causes for this decay, we note that our course is conducted in the first half of the final year of study and the exposure in the second half is random and opportunistic. Students do not get to observe or participate in a cardiac resuscitation situation consistently until they exit medical school. They do not start working as doctors immediately and while waiting for work placement there is complete cessation of exposure to clinical work which will undoubtedly contribute to the continued decay of the knowledge and skills of resuscitation.

Prior clinical experience could be a factor that affects retention of knowledge and skills acquired during the resuscitation course. Medical students during their clinical years, do not have the luxury of experiencing regular cardiopulmonary resuscitation exposure during all postings. Random and by chance opportunity to observe or participate in a resuscitation activity is the most many have. Our students, however, had completed the basic life support course early in year 3. That being so, many who come for the cardiac resuscitation course have had minimal if any exposure after that initial exposure in year 3 as they were then in the basic sciences phase and did not have much hospital exposures. Preparing for the course by reading the CLS manual and watching the videos of mega-code on the e–learning portal would be their first proper delve into the advanced theory component of the cardiac resuscitation knowledge.

Literature shows that attempts have been made by many researchers to overcome the problem of decay and reduced retention of knowledge and skills: (1) Planned re-test after 6 months; (2) Low dose spaced ACLS); (3) Timing of training; (4) Use of simulated training with or without high fidelity manikin or computer-based simulation; (5) Refresher training every six months.

1. Planned re-test

Su *et al* used re-test as a tool for knowledge retention but found that knowledge exam and mock resuscitation scenarios given after 6 months to some groups, resulted no difference in knowledge between intervention and non-intervention groups at 12 months.[15] The results suggested that periodic knowledge or skills retesting did not aid in the retention of pediatric resuscitation knowledge. Planned re-test may not be an appropriate sole strategy to be implemented for our students but it could be one component of a strategy.

2. Low dose, spaced, high frequency cardiac resuscitation

Some researchers found low dose spaced cardiac resuscitation training to be effective.[2,16] Short-duration, distributed CPR training on a manikin with real-time visual feedback is effective in improving CPR performance, with monthly training more effective than training every 3, 6, or 12 months.[17] However, there are other logistics that need to be considered like support staff, timetabling into an already packed schedule and availability of faculty since this has to be done regularly and consistently.

3. Timing of training

The timing of resuscitation training is important as maturity and exposure during ward learning may contribute to retention. Course conducted close to exit from medical school will reduce the period of no exposure to clinical work in our graduates. This is to pace training based on the workforce situation in our country now.

(4) Simulation based training

The effectiveness of simulation training for promoting retention of skills has been validated among other skills training courses.[18,19] Simulation based training for resuscitation has been shown to be highly effective by some researchers.[20-24] Simulation could range from low fidelity using task trainers to high fidelity manikins (human patient simulators). Computer based simulation is an example of high technology simulation that may be helpful for knowledge acquisition more than hands on skills. Computer based simulation or simulation using high fidelity manikin may be alternatives to help reduce the rate of decay after resuscitation course.[25,26] It has been suggested that timely and recurrent incorporation of simulation training may bridge the gap to emergent clinical situations.[25]

I) Computer based simulation

There is literature suggesting that computerized ACLS simulation program improves retention of ACLS guidelines better than textbook review.[23,24]

II) High fidelity manikin

Traditional training involving power point presentations and demonstration on a static manikin is an effective teaching strategy; however, study using simulation as a teaching tool found it significantly more effective than traditional training in helping to improve nursing students' knowledge acquisition, retention, and confidence about ACLS. [25,27]

(5) Repeat training/refresher

Repetition after initial learning stimulates retrieval of information from another part of the brain, which augments deeper processing of the information into memory.[18,28] A study with nurses who underwent cardiopulmonary resuscitation training indicates that a 6 monthly refresher may be needed to maintain knowledge and skills after training.[12]

In a systematic review of randomized controlled trials on improvement of skills retention, it was noted that simulation-based interventions, refresher courses and adjustments to the content of delivery of advanced structured resuscitation training courses were found to have the greatest impact on skills retention.[18]

One technique may not be the answer to improving retention of knowledge and skills. We will perhaps in future, resort to a combination of techniques; courses with high fidelity simulators, followed by a refresher using a computer-based simulation and a retest over intervals until exit from medical schools. Beyond this, faculty coaching is crucial, and instruction might benefit from gamification, social and digital media to help learners of this century retain what they are taught.[29,30]

After graduation, the onus is on students to continue to keep updated while waiting for placement as failing to do so will undo all the efforts put in during the final year of medical school to maintain knowledge and skills. What we can foresee are challenges in the implementation as the curriculum is already packed with a lot of other learning content and students may see this as added load and stress.

CONCLUSION

Cardiac life support course without doubt has an impact on acquiring skills of resuscitation among students. However, there was significant decay in knowledge when reassessed after a period of 6 months. There is a high possibility of further decay, which will mean that the sessions conducted in medical school become futile unless some preventive measures are undertaken. The results of the study clearly indicate a need for intervention.

The plan underway is to have short intermittent online refreshers in the form of quizzes and cardiac resuscitation practice scenarios using simple virtual platform until students graduate. This would allow application of knowledge albeit online and promote retention. Future research will need to be conducted to evaluate the effectiveness of the measures currently being put in place to improve retention of knowledge and skills.

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