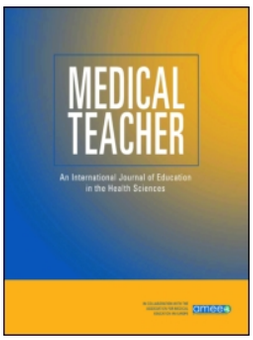

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BEME GUIDE

Developments in medical education in response to the COVID-19 pandemic: A rapid BEME systematic review: BEME Guide No. 63

Morris Gordon[a,b], Madalena Patricio[c], Laura Horne[a], Alexandra Muston[a], Sebastian R Alston[d], Mohan Pammi[e], Satid Thammasitboon[e], Sophie Park[f], Teresa Pawlikowska[g], Eliot L Rees[f,h], Andrea Jane Doyle[g] and Michelle Daniel[i]

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ABSTRACT

Background: The novel coronavirus disease (COVID-19) was declared a pandemic in March 2020. This rapid systematic review synthesised published reports of medical educational developments in response to the pandemic, considering descriptions of interventions, evaluation data and lessons learned.

Methods: The authors systematically searched four online databases and hand searched MedEdPublish up to 24 May 2020. Two authors independently screened titles, abstracts and full texts, performed data extraction and assessed risk of bias for included articles. Discrepancies were resolved by a third author. A descriptive synthesis and outcomes were reported.

Results: Forty-nine articles were included. The majority were from North America, Asia and Europe. Sixteen studies described Kirkpatrick's outcomes, with one study describing levels 1–3. A few papers were of exceptional quality, though the risk of bias framework generally revealed capricious reporting of underpinning theory, resources, setting, educational methods, and content. Key developments were pivoting educational delivery from classroom-based learning to virtual spaces, replacing clinical placement based learning with alternate approaches, and supporting direct patient contact with mitigated risk. Training for treating patients with COVID-19, service reconfiguration, assessment, well-being, faculty development, and admissions were all addressed, with the latter categories receiving the least attention.

Conclusions: This review highlights several areas of educational response in the immediate aftermath of the COVID-19 pandemic and identifies a few articles of exceptional quality that can serve as models for future developments and educational reporting. There was often a lack of practical detail to support the educational community in enactment of novel interventions, as well as limited evaluation data. However, the range of options deployed offers much guidance for the medical education community moving forward and there was an indication that outcome data and greater detail will be reported in the future.

KEYWORDS
Best evidence medical education; undergraduate; postgraduate; medicine; methods

Background

The novel coronavirus disease (COVID-19) is a highly contagious viral illness caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). COVID-19 was first reported in Wuhan, Hubei Province, China in December 2019. Within weeks of its emergence, it had spread to several countries. In January 2020, the World Health Organisation (WHO) declared the outbreak a Public Health Emergency of International Concern. By March 2020, COVID-19 had evolved into a pandemic (Bedford et al. 2020). According to the dashboard of the Center for Systems Science and Engineering at Johns Hopkins University (JHU 2020), Baltimore, USA, the disease has now been reported in 188 countries, affecting over 15,000,000 people worldwide, resulting in over 600,000 deaths.

The impact of COVID-19 on healthcare systems and medical education has been unprecedented. Huge numbers of campuses have gone into lockdown. The need to physically distance and conserve personal protective equipment (PPE) has resulted in the suspension of in-person learning in classrooms, and even the workplace. The effects of COVID-19 have been felt across the medical education continuum, necessitating a myriad of changes.

Practice points

- Remote synchronous and asynchronous educational developments were rapidly deployed and will likely persist beyond the pandemic. Learner engagement, structure and organization are key.
- Maintaining clinical exposure is important for learners impacted by COVID-19 and can be achieved using telehealth, PPE, physical distancing.
- Quality and detail of reporting educational developments must improve to promote replication in different contexts.

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Supplemental data for this article can be accessed here.

The educational community has rapidly adjusted their approach to meet these challenges, and a number of educational developments to support learning and educational progress have been reported.

Journals have expedited peer review to ensure COVID related innovations and adaptations reach educators in a timely manner. This has resulted in a large number of articles of varying quality being published in a very short timeframe. Busy educators trying to adapt their practices to the continually evolving pandemic need an up-to-date collated resource that discusses and evaluates these developments.

Dedeilia et al. (2020) previously conducted a systematic review of educational developments in response to COVID-19. At the time of their review, they noted a 'scarcity of available sources' and thus decided to include letters to the editor, commentaries, editorials and perspectives. Their search ended 18 April 2020 and there has been a significant increase in the quantity and quality of articles since that time.

The aim of the current systematic review is to identify the evidence concerning teaching, assessment or other educational developments in response to the COVID-19 pandemic within medical education. Our review will address three main questions:

- What developments or changes in medical education have been deployed? (i.e. description or 'what was done' (Cook et al. 2008)).
- What is the impact of these developments or changes? (i.e. evaluation or 'did it work?').
- What lessons to be applied in the future have been learned by the teams who deployed these developments or changes? (i.e. implications or 'what's next?').

Methods

This review was conducted as a 'rapid' review, meaning that the timeframe from inception to completion was $<$ 4 weeks. It is vital to note that the speed with which the review was conducted in no way impacted the methodological rigour of the approach. We embraced systematicity throughout, from the search strategy to the synthesis (Gordon, Daniel, et al. 2019). We aligned with both positivism (applying the principles of systematic reviewing) and constructivism (utilizing qualitative synthesis methods). A study protocol (Gordon et al. 2020) was completed a priori and uploaded into the study repository on the Best Evidence in Medical Education (BEME) website. We reported our findings in alignment with the STORIES (STructured apprOach to the Reporting In healthcare education of Evidence Synthesis) statement (Gordon and Gibbs 2014) and BEME guidance (Hammick et al. 2010).

Search strategy

We conducted an electronic search of four databases (MEDLINE, EMBASE, CINAHL and PsychINFO). We selected these 4 databases as they contain almost all the journals that publish on medical education and they are most commonly used in BEME reviews. We utilized 22 search terms and their Boolean combinations. The search was piloted on 18 May 2020 to check the appropriateness of the search strategy. This led to the addition of further terms, as the search was producing too many potential papers (roughly 1 paper meeting the inclusion criteria for every 10 titles) suggesting the search was too narrow. The final search was performed on 24 May 2020 using the following terms: (coronavirus OR covid19 OR covid-19 OR SARS-Cov-2 OR 2019-nCoV) AND (Medical education OR undergraduate medical OR medical student OR medical school OR training OR continuing medical education OR postgraduate medical education OR assessment OR teaching OR evaluation OR interview OR recruitment OR distance learning OR examinations OR OSCE OR PPE OR clinical skills). To identify additional relevant articles, we conducted a hand search of MedEdPublish. Due to the short timeframe between the advent of COVID-19 and this review being performed, forwards and backwards citation searching was not performed as this was not considered likely to identify any further relevant papers.

Inclusion and exclusion criteria

The following inclusion criteria were used:

- Studies describing developments in medical education explicitly deployed in response to COVID-19.
- Studies in undergraduate, graduate or continuing medical education.
- Studies published after 1 December 2019, when COVID-19 was first identified.
- Studies in any language.

The following exclusion criteria were applied:

- Opinion pieces, commentaries, editorials, perspectives, calls for change, needs assessments and other studies where no actual development had been deployed.
- Studies that have Health Care Professionals but no medical students, residents, fellows, or physicians.
- Studies that describe the development as a minor part of a larger package of planned measures.

The original protocol stipulated that Kirkpatrick's outcomes needed to be reported for inclusion (Kirkpatrick and Kirkpatrick 2016). However, during the pilot phase, we identified several interventions of interest that had been executed, but not evaluated due to insufficient time prior to publication Consequently, we decided to amend the protocol and include such studies.

The titles and abstracts of all papers identified through the search were reviewed independently by two authors against the above inclusion and exclusion criteria. Inter-rater reliability was calculated using Cohen's Kappa. The full papers of all studies included after abstract screening were retrieved and again reviewed against our inclusion and exclusion criteria by two authors. Disputes at either stage were resolved through discussion, including a third author where necessary, until consensus was reached.

Table 1. Quality assessment/risk of bias of the interventions presented.

Bias source	High quality	Unclear quality	Low Quality
Underpinning bias (U)	Clear and relevant description of theoretical models or conceptual frameworks that underpin the development	Some limited discussion of underpinning, with minimal interpretation in the context of the study	No mention of underpinning
Resource bias (R)	Clear description of the cost / time / resources needed for the development	Some limited description of resources	No mention of resources
Setting bias (S)	Clear details of the educational context and learner characteristics of the study	Some description, but not significant as to support dissemination	No details of learner characteristics or setting
Educational bias (E)	Clear description of relevant educational methods employed to support delivery	Some educational methods mentioned but limited detail as to how applied	No details of educational methods
Content bias (C)	Provision of detailed materials (or details of access)	Some elements of materials presented or summary information	No educational content presented

Data extraction

Based on BEME Guidance (Hammick et al. 2010), we devised and piloted a data extraction form to be completed online within Google Sheets to allow synchronous review and sharing of extracted data.

Data extracted included:

- Paper identifiers (author(s), date)
- Context (geographic location, local COVID-19 specific details, education level, institutional setting, number of learners)
- Description of intervention (focus of development, purpose of deployment, brief summary of development, further description of development)
- Intervention outcome (Kirkpatrick outcome, summary of results, plans for future study)
- Risk of bias (underpinning bias, resource bias, setting bias, content bias, development limitations)
- Other details (key points for discussion, lessons learnt, summary of conclusions, appropriateness of conclusion, any other comments by extractor)

Two studies were extracted by all authors independently and a meeting was held to ensure appropriateness of the extraction forms and shared understanding of terms to enhance inter-rater reliability. Extraction was then completed by two authors independently and disputes were resolved by involving a third author (MG) and discussing until a full consensus was reached at regular research team meetings.

Quality assessment

While many methods have been utilised to assess quality and judge risk of bias in medical education reviews, no consensus method exists (Buckley et al. 2009; CASP 2014; Gordon et al. 2018). The review team postulated, in line with previous BEME reviews, that this is partly related to the complexity of educational developments and therefore requires an approach that can address and account for this complexity. Thus, we considered two distinct quality elements: 1) the risk of bias or quality of the study design when outcomes were reported (similar to the Cochrane tradition) *and* 2) the risk of bias or quality of reporting for the educational development itself (as previously used by Gordon, Farnan, et al. (2019) and Gordon et al. (2018), originally modified from Reed et al. (2005)). The latter is critically important, because only when the development is robustly described, can educators or researchers hope to replicate the results in other contexts.

For the first element, if sufficient data on study design and outcomes were provided, we used the risk of bias tool (i.e. Higgins criteria) for randomized-control trials (Sterne et al. 2019) and the ROBINS-I tool (Risk Of Bias In Non-randomized Studies of Interventions) for non-randomised trials (Sterne et al. 2016) in line with current Cochrane handbook advice. If no such details were given, the quality of the study design and outcomes were not assessed. For the second element, we considered whether the authors explicitly reported on five key areas related to the educational development. A visual ranking system (Gordon and Gibbs 2014) was used to report risk of bias for these five areas (e.g. underpinning bias, resource bias, setting bias, educational bias, and content bias). Items were judged to be of high quality and low risk of bias (green), unclear quality and risk (yellow) or high risk and low quality related to lack of reporting (red). This ranking system is shown in Table 1.

Thresholds for judgements were discussed during piloting of the data extraction form. All judgements were made independently by two authors and disagreements were resolved through discussion or involvement of a single third author (MG). No weighting or overall rank is given, as no item is more important than another. Rather the judgement in each area is presented so readers can assess areas of stronger and weaker reporting.

Of note, for both elements, poor reporting does not necessarily mean the educational development is of poor quality, but it increases the risk that such poor quality may exist, hence the use of the terminology 'risk of bias' in reporting. Importantly, poor reporting limits utility for readers, as they will struggle to determine if the educational development is transferable to their context.

Synthesis of evidence

A descriptive synthesis of included studies was completed utilizing data from the extraction form to summarize 'what was done.' This summary described the timing of publication, the setting (undergraduate, postgraduate, mixed), the geographical location and COVID-19 specific contextual

factors, the type and number of participants, the focus of the educational developments and the purpose of the deployments. Outcomes (when available) were classified in accordance with Kirkpatrick's model of evaluation to determine 'did it work' (Kirkpatrick and Kirkpatrick 2016). Quality assessment for the five areas were reported. We planned for meta-analysis; however, suitably homogenous outcome data was not found. We close with lessons learned (i.e. 'what's next') as stated in the primary papers by the authors.

Results

The search was performed on 24th May 2020. A total of 7448 titles were found, with a further 28 identified through hand searching MedEdPublish. After deduplication, 6215 remained. Through title and abstract screening, 6004 studies were excluded. A total of 213 studies were considered for full text screening and 164 were excluded. Inter-rater reliability at the screening phase was $\kappa = 0.933$ (95% CI 0.927–0.94), representing almost perfect alignment. The primary reasons for exclusion were as follows: the article represented an editorial or opinion piece without deployment of a change (90), the article described a theoretical development or idea with no actual intervention (71), and the article was restricted to other health care professionals and did not include medics (3). Forty-nine studies were included in the final analysis. The flow diagram for included studies is shown in Figure 1 (PRISMA. 2015).

Publications

The four earliest studies that were included in the review were published in March, 22 studies were published in April, and 23 studies were published in May. Of the 49 publications, 15 were published in a new virtual issue of *Medical Education* entitled 'Adaptations,' designed to rapidly share insights and innovations from health professions educators in response to COVID-19 (Eva and Anderson 2020).

Classification of studies

Table 2 presents the number of studies in terms of geographical location, the level of medical education and the institutional setting.

Geographical location and local COVID-19 specific details

Twenty-three studies (47%) were conducted in North America, including fourteen studies in the United States, eight studies in Canada and one study in Mexico. A further twelve studies (25%) were conducted in Asia, ten studies (20%) in Europe, two studies (4%) in Africa, and one study (2%) in South America. Only one study (2%) was international.

In Canada, local COVID-19 restrictions limited group gatherings (Keegan et al. 2020) and learners were withdrawn from clinical placements (Boodman et al. 2020; Haines et al. 2020; Johnston et al. 2020). In the United States, the Centre for Disease Control and Prevention recommended implementation of physical distancing and cancellation of all gatherings of more than 10 people (Almarzooq et al. 2020; Murdock et al. 2020). Face-to-face didactic education was suspended first (Calhoun et al. 2020; Hannon et al. 2020) and then, the Association of American Medical Colleges recommended suspension of all direct patient contact responsibilities for medical students (Soled et al. 2020). Some hospitals were at capacity, requiring redeployments of the workforce (Balanchivadze and Donthireddy 2020) and cancellation of elective surgical procedures (Chick et al. 2020; Roy and Cecchini 2020). In Asia, studies reported government enforced lockdowns and restrictive measures, including the closure of medical campuses (Singh et al. 2020; Srinivasan 2020; Veasuvalingam and Goodson 2020). Studies in Singapore reported the escalation of the national pandemic alert to Disease Outbreak Response System Condition (DORSCON)-Orange resulting in quarantining, temperature screenings and visitor restrictions at hospitals (Boursicot et al. 2020; Kanneganti et al. 2020; Samarasekera et al. 2020). In Europe, countries implemented national restrictions on non-essential activities, invoked lockdowns and moved all educational activities online (Finn et al. 2020; Moszkowicz et al. 2020; Torres et al. 2020). Some governments (e.g. Italy and Denmark) responded to the pandemic by boosting the workforce through expedited graduation or temporary voluntary employment of medical students (Lapolla and Mingoli 2020; Rasmussen et al. 2020). In Central America, South America and Africa, studies described the suspension of face-to-face education and the move to online teaching (Fernandez-Altuna et al. 2020; Gaber et al. 2020; Parisi et al. 2020).

Level of medical education, institutional setting and number of participants involved

Twenty-four studies (49%) described developments and changes in undergraduate medical education (UME) programs in response to the COVID-19 pandemic. Eighteen studies (37%) reported developments in postgraduate education programs, including within graduate medical education (GME) or continuing medical education (CME). Six studies (12%) described mixed learners. One study (2%) did not describe the learner level. Twenty-five studies (51%) were conducted in universities, twenty-one studies (43%) in hospital settings, and three (6%) were unspecified or multi-site.

Seven studies (Boodman et al. 2020; Fernandez-Altuna et al. 2020; Keegan et al. 2020; Lapolla and Mingoli 2020; Murdock et al. 2020; Rose et al. 2020; Samarasekera et al. 2020) describe educational interventions with large participant groups of over 1000. Thirteen studies (Blake et al. 2020; Boursicot et al. 2020; Calhoun et al. 2020; Choi et al. 2020; Cleland et al. 2020; Gaber et al. 2020; Haines et al. 2020; Hannon et al. 2020; Kang et al. 2020; Kanneganti et al. 2020; Rasmussen et al. 2020; Singh et al. 2020; Soled et al. 2020) describe interventions with participant groups between 26 and 1000 (min = 32, max = 906, median = 108). Nine studies (Almarzooq et al. 2020; Burns and Wenger 2020; Buonsenso et al. 2020; Balanchivadze and Donthireddy 2020; Christensen et al. 2020; Roy and Cecchini 2020; Hofmann et al. 2020; Johnston et al. 2020; Srinivasan 2020) describe interventions with participant

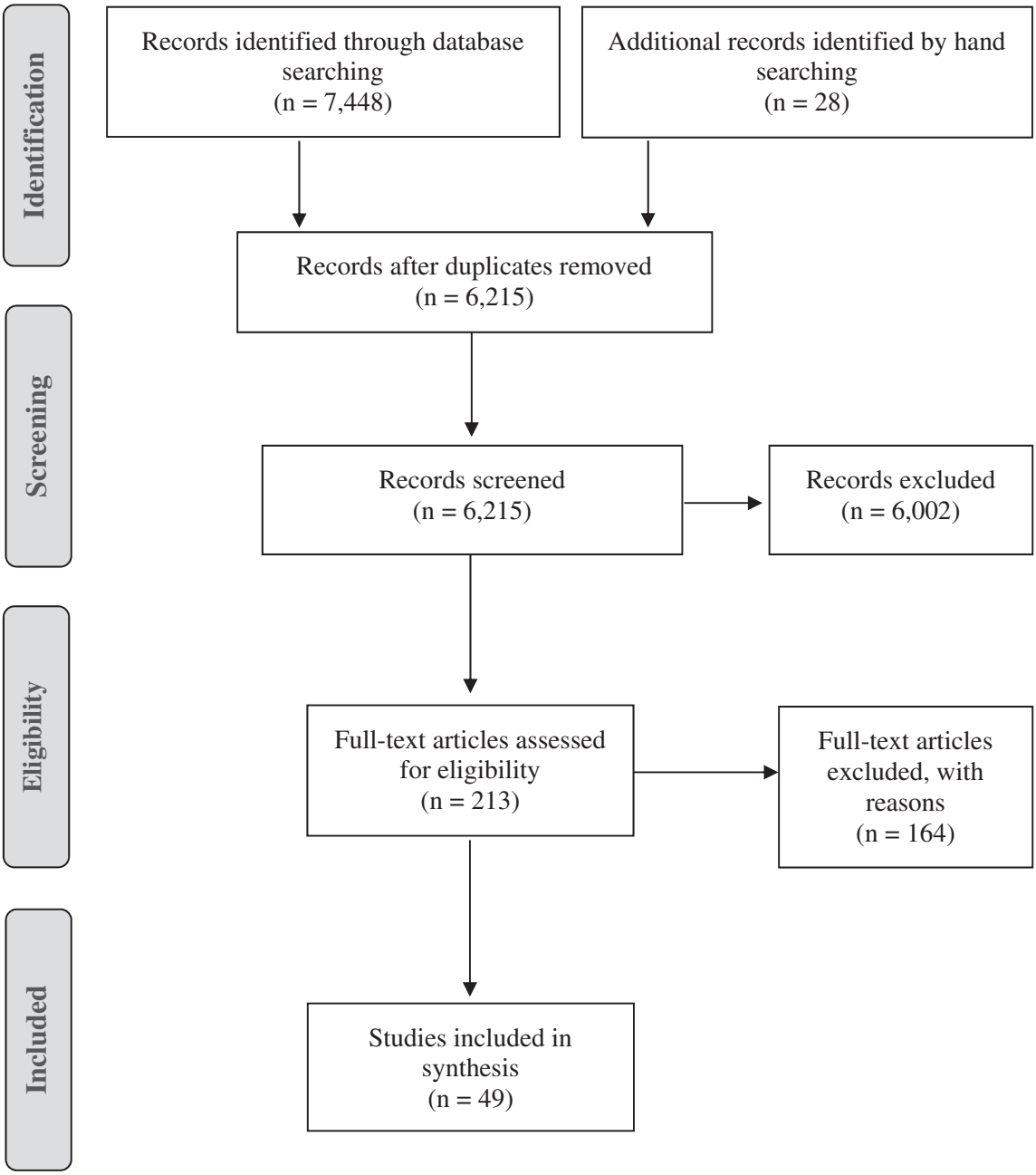

Figure 1. PRISMA flow diagram for included studies.

Table 2. Origin characteristics of included studies.

	Number of Studies						
	Level of medical education*				Institutional Setting		
Location	U	P	M	ND	Hospital	University	Unspecified
United States	5	8	1		10	3	1
Canada	4	2	1	1	3	5	–
Central America	–	–	1	–	–	1	–
South America	1	–			–	1	–
Europe	5	3	2		5	4	1
Africa	1	1	–		–	2	–
Asia	8	4			3	9	–
International	–	–	1		–	–	1
Totals: 49	24 (49%)	18 (37%)	6 (12%)	1 (2%)	21 (43%)	25 (51%)	3 (6%)

*U: undergraduate; P: postgraduate (GME/CME); M: mixed; ND: not described

groups between 1 and 25 (min = 1, max = 25, median = 14). The remaining twenty studies did not specify the number of participants involved in the educational intervention described. The Blake et al. (2020) study not only reported on 55 participants in the initial study, but also reported on early dissemination metrics, noting that the intervention was accessed by 17,633 users globally within one week of the digital launch.

Educational outcomes

While not all studies used the term 'Kirkpatrick's outcomes,' sixteen studies reported them and one study described multiple levels. Thirteen studies described level 1 (i.e. reaction), four studies (8%) described level 2 (i.e. learning) and one study (2%) described level 3 (i.e. behavioural change). Thirty-three studies (67%) did not report any Kirkpatrick's outcomes, however, seven of these articles explicitly stated a plan for future evaluation of educational effectiveness. One study described three levels of Kirkpatrick's outcomes (Blake et al. 2020). They utilized 'agile methodology,' a robust three-step process for rapid program development and were able to conduct a comprehensive program evaluation within three weeks of the outbreak in the United Kingdom. Impressively, eighty-two percent of users ($n = 55$) in the pilot study reported applying the information (i.e. changing behaviour) in their work or home lives after engaging with the digital resource.

Quality assessment/risk of bias

Quality of the study design when outcomes were reported

There was one Randomised controlled trial (Christensen et al. 2020). This was judged for methodological quality using the Cochrane Higgins criteria (Sterne et al. 2019). Randomisation, allocation concealment, incomplete outcome reporting, selective reporting and other sources were all of low risk of bias with high quality reporting. As this was an open label trial, detection bias was high risk. There were no other trials reported. The majority of papers (67%) did not offer interventional outcome data and those that did can best be described as 'educational case studies' rather than other study designs. As such, ROBINS-I evaluation was not undertaken to assess quality of these studies.

Quality of reporting for the educational development

The risk of bias framework for the reporting quality of the developments was applied. There was only one study considered at low risk of bias and high quality in all five domains (Blake et al. 2020). There were a further six studies that whilst not having full reporting of detail, did report in all areas with varying amounts of detail (Brown et al. 2020; Buonsenso 2020; Choi et al. 2020; Johnston et al. 2020; Murdock et al. 2020; Samarasekera et al. 2020). There were six studies that did not report on any of the five domains that were judged at high risk of bias and low quality for all (Ahmed et al. 2020; Boodman et al. 2020; Burns and Wenger 2020; Haines et al. 2020; Keegan et al. 2020; Lubarsky 2020). Within each study and within each domain, the distribution of reporting was capricious with no particular area systematically reported in a different manner to others. Supplementary Table illustrates the individual ratings for each area for all the studies and will support the reader in considering which primary studies may offer reporting for future replication of developments.

Given the heterogeneity of reporting within the majority of studies, it is hard to comment on any patterns or correlation. However, it is worth noting that the one paper judged at low risk of bias was well-reported and well-designed in all areas, at all stages, with details provided on its design, as well as outcomes at several levels of Kirkpatrick's hierarchy (Blake et al. 2020). Conversely, for the six studies judged at high risk of bias, the quality was pervasively poor, with missing information in all extracted areas and no details of any educational outcomes. What is not clear, is if these studies simply represent poor reporting or poor-quality educational research. Fortunately, these papers make up a minority (12%) of the studies included. Full details of the quality assessments and other characteristics of included studies are described in Supplementary Table and a visual representation of key results is presented in an infographic (Figure 2).

Summary of educational developments

Forty-nine educational developments were described. Of these, 40 utilised online learning approaches in whole or in part. Thirty-three papers described adaptations to existing educational programmes, and sixteen described new educational offerings. The focus of the developments were broadly categorised as follows:

- Pivoting to online education delivery (53%).
- Training for treating patients with COVID-19 (16%).
- Clinical service reconfigurations to support response to COVID-19 (12%).
- Assessment (12%).
- Faculty development (6%).
- Learner support, mental health and wellbeing (4%).
- Selection and admissions (4%).

A small proportion of papers (6%) addressed multiple of these categories.

Pivoting education delivery

Twenty-six papers described delivering existing educational programmes through online platforms in response to local restrictions imposed including limitations on gatherings and physical distancing. Of these, thirteen were targeted at undergraduate medical students, ten at postgraduate medical trainees, two at both undergraduate and postgraduate, and one did not describe their population.

These papers have been sub-categorised into three groups based on their context and focus:

A. Using video conferencing to deliver the same teaching approaches for non-clinical learning (e.g. seminars, simulated sessions, team-based learning).
B. Replacing clinical placement based learning with other teaching methods online.
C. Supporting continued experiential learning/clinical contact without physical presence in clinical workplaces (e.g. supervised phone or video consultations).

A. Same teaching approaches, online. Fifteen papers described replacing face-to-face teaching in the classroom with online learning using similar educational approaches (Agarwal et al. 2020; Almarzooq et al. 2020; Balanchivadze and Donthireddy 2020; Durrani 2020; Fernandez-Altuna et al. 2020; Gaber et al. 2020; Khan 2020; Parisi et al. 2020; Rose et al. 2020; Singh et al. 2020; Srinivasan 2020; Sudhir

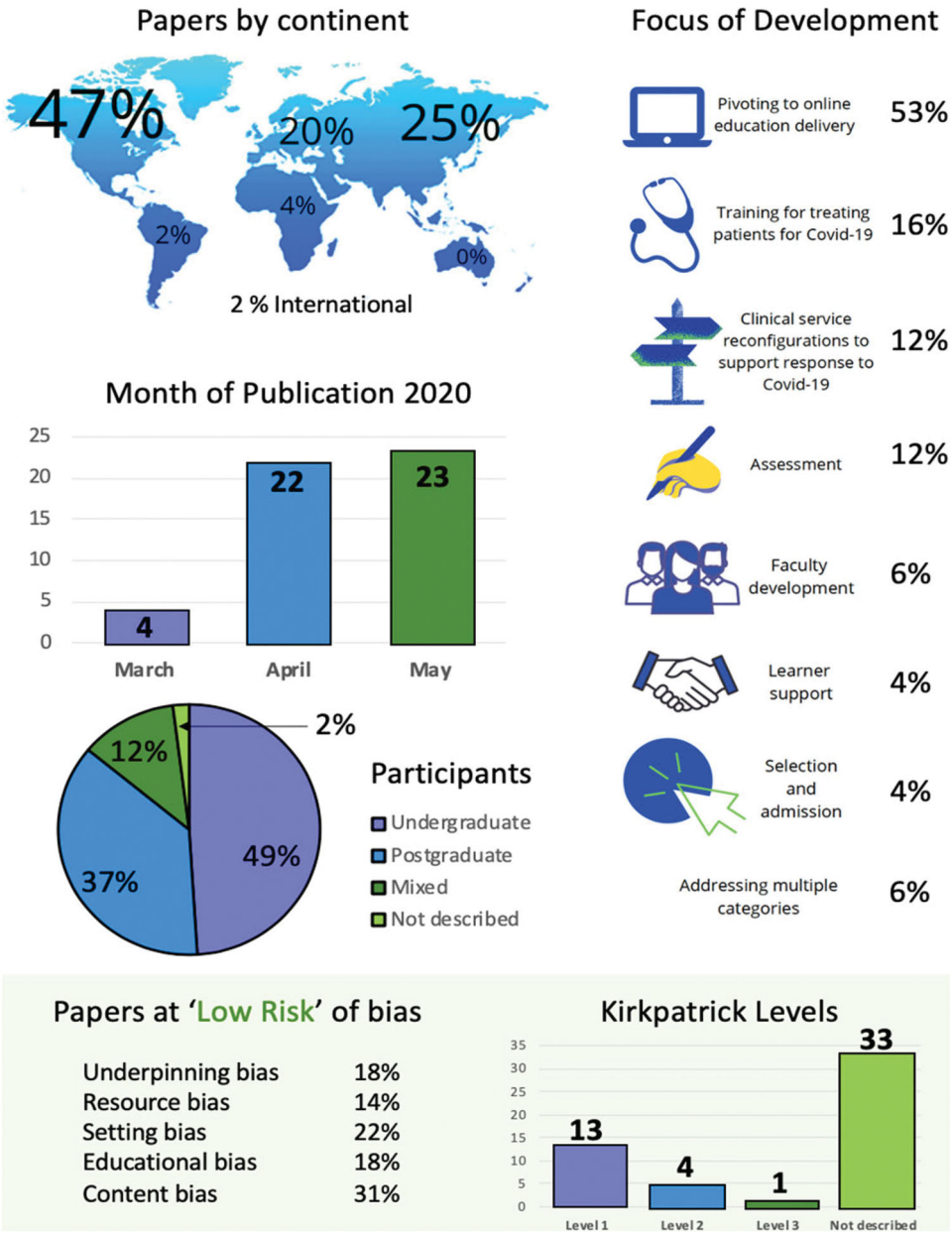

Figure 2. Infographic summarizing key findings.

et al. 2020; Taylor et al. 2020; Torres et al. 2020; Veasuvalingam and Goodson 2020). Twelve of these employed synchronous learning on video conferencing platforms. These included delivering seminars (Agarwal et al. 2020; Almarzooq et al. 2020; Balanchivadze and Donthireddy 2020; Rose et al. 2020; Singh et al. 2020; Srinivasan 2020), debates (Durrani 2020), team-based learning (Gaber et al. 2020), simulation sessions (Torres et al. 2020), and clinical skills sessions (Khan 2020; Parisi et al. 2020; Sudhir et al. 2020). The authors of studies that utilized synchronous learning formats often talked about the importance of learner engagement. In the studies that utilized a seminar or debate format, learner engagement was promoted using online chat features, electronic 'hand-raising' for questions, and online polling. In the one paper that discussed team-based learning, engagement was promoted using breakout rooms to host groups of 25 students completing the team readiness assessment test. In the simulation and clinical skills sessions, engagement was facilitated through skill building interactions, and instructor, standardized patient or peer feedback. Three papers used a combination of synchronous and asynchronous teaching approaches, although details of the balance were not reported. The synchronous components of these were similar to those described above. The asynchronous components involved making recordings of previous lectures available and making additional learning resources available through curation or de novo creation (Taylor et al. 2020; Veasuvalingam and Goodson 2020). In the papers that used asynchronous approaches, emphasis was placed on the need for organization and structure to support learning in the virtual environment. No developments reported exclusively asynchronous learning, and the overwhelming emphasis was on synchronous remote learning. One paper described moving a whole curriculum online for a university in Mexico of 8,000 students, 18,000 residents, and 5,000 faculty (Fernandez-Altuna et al. 2020). They adopted a new digital distance learning platform for online delivery of virtual classrooms and academic consultancies and supporting work from home.

B. Replacing clinical placement based learning. Seven papers described replacing or supplementing clinical placement based learning with other teaching approaches (Burns and Wenger 2020; Calhoun et al. 2020; Chick et al. 2020; Kanneganti et al. 2020; Lubarsky 2020; Moszkowicz et al. 2020; Roy and Cecchini 2020). Authors noted that while these interventions were important for continued learning they could not replace certain face-to-face activities (e.g. time in the operating room (Chick et al. 2020). Two papers described replacing clinical placements in surgery with a mix of online synchronous and asynchronous teaching using a combination of videoconferencing, flipped classrooms with question and answer time, video review of surgical procedures, and surgical simulators (Chick et al. 2020; Kanneganti et al. 2020). One paper outlined videoconferencing of anatomy content for surgery students, though the exact nature of the intervention (i.e. if there were dissections) was unclear (Moszkowicz et al. 2020). One paper described an entirely virtual clinical elective using a combination of synchronous seminars, small group discussions, and role-plays (Burns and Wenger 2020). Four papers described replacing or supplementing clinical placements with asynchronous learning opportunities. These included practice questions (Chick et al. 2020), independent projects (Lubarsky 2020), interpretation of example slides for postgraduate pathology trainees (Roy and Cecchini 2020), procedural videos (Kanneganti et al. 2020), and videoconferencing and e-learning modules (Kanneganti et al. 2020). One paper described a redesigned undergraduate curriculum to accommodate for a shortened academic year (assuming learners will be able to return to clinical placements). They reduced the duration of all placements by a third and supplemented selected placements with online virtual placements (Calhoun et al. 2020).

C. Supporting continued clinical contact. Four papers described supporting some form of continued clinical contact using approaches to mitigate risk for learners missing out on in-person patient care opportunities (Chick et al. 2020; Hofmann et al. 2020; Johnston et al. 2020; Oldenburg and Marsch 2020). Activities included supervised telephone or video consultations for undergraduate medical students (Johnston et al. 2020) or postgraduate trainees (Chick et al. 2020; Oldenburg and Marsch 2020), with feedback from the supervisor either offline or with the patient present, and virtual ward rounds for undergraduate medical students using an iPad on wheels (Hofmann et al. 2020) to see, hear and interact with COVID-19 patients and their physicians. Clearly, these studies are not workplace-based in the traditional sense, but they do use authentic patient interactions separate from other forms of learning.

Assessment

Seven papers described adaptations to assessment processes (Ahmed et al. 2020; Boursicot et al. 2020; Eltayar et al. 2020; Hannon et al. 2020; Lapolla and Mingoli 2020; Samarasekera et al. 2020; Veasuvalingam and Goodson 2020). Three of these described adaptations to assessing clinical skills through objective structured clinical examinations (OSCEs) in the context of physical distancing. All three were for undergraduate medical students. Two redesigned the logistics in order to persevere with face-to-face OSCEs (Boursicot et al. 2020; Samarasekera et al. 2020). By using PPE, expanding the number of sites for testing, cohorting learners, and removing real patients from the assessments, the authors were able to successfully implement the exams. The third delivered an online OSCE using Zoom, replacing physical examination with a narration of what they would do (Hannon et al. 2020). The authors concluded that remote OSCEs were not as effective as in-person for assessing clinical skills. Three papers described written assessments (Samarasekera et al. 2020; Lapolla and Mingoli 2020; Veasuvalingam and Goodson 2020). The first split the candidates from one site to six smaller sites in order to enable in-person examinations with physical distancing. The second cancelled their national licensing exam in order to support early graduation of final year medical students (Lapolla and Mingoli 2020). The third transitioned to formative on-line quizzes and short tests with feedback to enhance and promote remote learning (Veasuvalingam and Goodson 2020). The other two papers described assessment item writing workshops that were both delivered online using Zoom instead of face-to-face (Ahmed et al. 2020; Eltayar et al. 2020).

Training for treating patients with COVID-19

Eight papers described new educational interventions designed for doctors (including postgraduate trainees) that were treating patients with confirmed or suspected COVID-19 (Boodman et al. 2020; Buonsenso et al. 2020; Choi et al. 2020; Christensen et al. 2020; Gardiner et al. 2020; Hanel et al. 2020; Kang et al. 2020; Merali et al. 2020). These papers varied in their focus: either on particular groups of providers or on particular procedures. Four papers described training in safe endotracheal intubation for COVID-19 positive patients or persons under investigation (Choi et al. 2020; Gardiner et al. 2020; Hanel et al. 2020; Kang et al. 2020). One paper described the use of ultraviolet fluorescent powder during simulated intubation in order to demonstrate aerosol generation during this procedure (Gardiner et al. 2020). One paper described a 10-week online course in internal medicine for doctors redeployed from sub-speciality services (Merali et al. 2020). Another paper described training in lung ultrasound for obstetrics and gynaecology consultants with existing ultrasound expertise to facilitate the care of pregnant patients with COVID-19 (Buonsenso et al. 2020). Three papers described in situ simulation programmes to train doctors in new protocols for intubation in the emergency department (Hanel et al. 2020), in obstetric emergencies (Kang et al. 2020), and in the intensive care unit (Choi et al. 2020). One paper described an approach to training medical students and junior doctors in donning and doffing personal protective equipment (PPE) (Christensen et al. 2020). These authors conducted a randomised control trial comparing in-person instructor led training with remote video-based instruction. Finally, one paper described the development of a newsletter to disseminate evidence-based responses to clinical questions raised by doctors treating COVID-19 patients (Boodman et al. 2020).

Clinical service reconfiguration

Six papers described retraining or redeploying learners to support the response to increased clinical service pressures. These included the accelerated graduation of medical students (Lapolla and Mingoli 2020), redeployment of postgraduate clinical trainees (from haematology and oncology to general medicine) to support care of COVID-19 patients (Balanchivadze and Donthireddy 2020), and reconfiguration of routine speciality care in order to avoid trainee viral exposure (Agarwal et al. 2020). Three papers described using medical students to support clinical care, including launching medical student response teams to support physicians and public health agencies (Haines et al. 2020; Soled et al. 2020) and training medical students to work as ventilator or nursing assistants (Rasmussen et al. 2020).

Faculty development

Three papers described faculty development programmes (Cleland et al. 2020; Finn et al. 2020; Keegan et al. 2020). Two focused on supporting medical educators involved in adapting programmes in response to COVID-19. These included the curation of a set of resources (Keegan et al. 2020) and the delivery of an online webinar aimed at sharing best practice (Cleland et al. 2020). One paper described the development of a twitter community of practice for medical education researchers (Finn et al. 2020).

Learner support, mental health and wellbeing

Two papers described interventions targeted at supporting learners' wellbeing (Blake et al. 2020; Brown et al. 2020). The first used Barnet et al. (2014) seven-step framework to implement an online community for doctoral students in medical education in order to mitigate against social isolation (Brown et al. 2020). The second described the development of a digital package to support health professions workers' and students' mental health and wellbeing (Blake et al. 2020).

Selection and admissions

Two papers described revised admissions procedures for medical school (Ungtrakul et al. 2020; Samarasekera et al. 2020). The first describes replacing face-to-face multiple mini interview (MMI) with an online version using a video conferencing platform that required omission of their teamwork scenario (Ungtrakul et al. 2020). The second changed the content of their admissions interviews and held them via Zoom instead (Samarasekera et al. 2020). They also adjusted their Focused Skills Assessment (which assesses non-cognitive skills) from 5 stations to 2, eliminating the teamwork scenario and focusing instead on a portfolio station and a new scenario-based station similar to a Situational Judgement Test.

Conclusions of study authors

This section is a summary of the lessons learned and conclusions by the primary study authors, rather than the review authors views. Most authors described the introduced changes in positive terms, using statements such as 'overwhelmingly positive,' 'very positive,' 'high quality,' 'highly satisfied' in 7 studies (Ahmed et al. 2020; Almarzooq et al. 2020; Blake et al. 2020; Eltayar et al. 2020; Finn et al. 2020; Khan 2020; Rose et al. 2020), 'positive' or 'valuable' or 'useful' in 4 studies (Choi et al. 2020; Gaber et al. 2020; Lubarsky 2020; Taylor et al. 2020), 'successful' or 'sufficient' or 'equivalent' in 7 studies (Buonsenso et al. 2020; Burns and Wenger 2020; Christensen et al. 2020; Hanel et al. 2020; Rasmussen et al. 2020; Torres et al. 2020; Ungtrakul et al. 2020). No study was reported by the authors as wholly unsuccessful or unfeasible, however, some developments were noted to be less desirable than in-person activities, most notably among activities replacing clinical placements (Chick et al. 2020). In two studies the authors reported that students preferred the teaching and assessment method pre-COVID, namely in an online instruction using Google Classroom with a mix of lectures, practical demonstrations and case discussions (Singh et al. 2020) and an online OSCE (Hannon et al. 2020).

Positive aspects of remote learning highlighted by authors included enhanced effectiveness, flexibility, efficiency, engagement, communication and community (Almarzooq et al. 2020; Blake et al. 2020; Durrani 2020; Keegan et al. 2020; Rose et al. 2020). Videoconferencing tools were generally noted to be easy for facilitators and students to use in a personalized and intuitive manner due to their user-friendly interfaces (Sudhir et al. 2020), however, some encountered challenges with novel technologies and struggled with issues related to WiFi access and bandwidth (Chick et al. 2020). A few papers did discuss problems and challenges that could prove helpful to groups attempting to build on these experiences: faculty and learners need to be oriented to video-conferencing platforms (e.g. mute microphones in large group but not small group meetings, utilize the chat or hand raising function to speak or participate); restructuring is time intensive and requires communication, teamwork and the collective support of all members of the staff (Veasuvalingam and Goodson 2020); not all simulations can be replaced virtually or online, so pre-briefing and preparation are critical to success (Sudhir et al. 2020); remote platforms may support technical skill development, but they may not support non-verbal communication or physical exam skill development (Eltayar et al. 2020; Hannon et al. 2020).

Many study authors noted that these activities were developed, analysed, and published within a very short period and emphasized the potential of setting the stage for subsequent investigation and studies as time allowed. They noted that many of these developments (e.g. increased online learning, precepting clinical care via telehealth) were likely here to stay. Seven studies highlighted the sustainability of interventions beyond the pandemic (Boodman et al. 2020; Kanneganti et al. 2020; Keegan et al. 2020; Oldenburg and Marsch 2020; Srinivasan 2020; Ungtrakul et al. 2020; Veasuvalingam and Goodson 2020), with the last study stating that 'the shift online is transformational' and 'though not all will be different, this turning point has increased faith in technology sparking a change in behaviour away from traditional approaches.'

Discussion

Summary of results

The forty-nine included papers describe a variety of ways to pivot education to virtual spaces which was previously

classroom or patient-based. Whilst these developments were forced into fruition by the COVID-19 pandemic, the likelihood is that many will persist for the foreseeable future. In this first wave of papers, several developments were described that support online learning across the continuum with important implications for practice: Educators using video conferencing to deliver instruction synchronously should attend to learner engagement (akin to active learning strategies in the classroom). As noted by Ahmed et al. (2020), promoting engagement requires both raising awareness of the importance of engagement and filling educator's toolboxes with adaptations to existing teaching strategies 'rephrased in light of the virtual platform.' Educators using remote platforms for asynchronous instruction need to create organization and structure to support learning. Short-term supplementation of clinical placement-based learning is clearly feasible, as is continued experiential learning without physical presence, such as engagement of learners in telehealth. Means of maintaining meaningful clinical contact are to date underexplored, particularly amongst undergraduates.

This review revealed a fundamental paradox. Whereas service and workplace-based learning have previously been closely integrated, these have now become more discreet, and the purpose and associated risks more explicit for each. Service delivery itself has been transformed by the COVID-19 pandemic. While much of patient care remains in person, a significant portion has shifting to a virtual environment. In order to enable future sustainability of service, we need to enable on-going patient-based training for learners with an appropriate balance of telehealth and in-person activities. A few studies in this review focused on the incorporation of trainees into telehealth appointments (Chick et al. 2020; Johnston et al. 2020; Oldenburg and Marsch 2020), yet more studies of this type are urgently needed given the rather seismic shift in clinical care. Most undergraduate papers focused on removing medical students from the clinical context to minimise risk. This cannot be a long-term strategy. Three papers described medical student contributions to service delivery (Haines et al. 2020; Rasmussen et al. 2020; Soled et al. 2020). A few postgraduate papers highlighted ways in which physical (face-to-face) patient contact could be maintained while mitigating risk using PPE and physical distancing (Choi et al. 2020; Hanel et al. 2020; Kang et al. 2020). Future undergraduate developments might draw on lessons learned from these studies to ensure that medical students can continue to engage in safe, in-person clinical learning.

Based on this review, it appears that assessment developments and adjustments were quite different across undergraduate and postgraduate sectors, likely reflecting the discreet progression of undergraduates prior to licensing and independent clinical practice. Undergraduate programmes have had to rapidly adapt their assessment processes, or progress students without summative assessment (Lapolla and Mingoli 2020) in order to license new graduates. Postgraduate assessment has tended to be postponed and/or regulations adjusted to reflect COVID-related delays. Since in-person (e.g. physically present) assessments may not be able to resume soon, further studies that address assessment, particularly those further exploring remote OSCE examinations would and formative (low-stakes) and summative (high stakes) assessment in unproctored or remote proctored contexts are urgently needed. This is particularly critical in the United States and other places where national bodies (e.g. the National Board of Medical Examiners) have implemented significant assessment changes (e.g. suspension of the United States Medical Licensing Examination Step 2 Clinical Skills exam; move to remote proctored, summative clinical subject exams at the end of clerkships.)

Quality and completeness of the evidence base

Despite the hurdles that included the very short time since the advent of COVID-19, a few papers were very well done and represented excellent scholarship, with high quality reporting of developments, impressive evaluation of impact or in one case, both (Blake et al. 2020). Blake et al. (2020) developed a digital learning package with the purpose of mitigating the impacts of COVID-19 on mental health by protecting and promoting the psychological wellbeing of healthcare workers during and after the outbreak. The digital package was notable for its usability, practicality, and effectiveness at meeting providers well-being needs, while being delivered at an acceptable cost. The authors followed a rigorous three-step iterative design process in developing the package that can serve as a model for rapid development and deployment of an educational intervention. Another paper (Christensen et al. 2020) conducted a randomized control trial of PPE donning and doffing comparing live instructor-led training with video-based instruction. The results led to the conclusion of equivocal educational effectiveness, with the implication that PPE training can be safely conducted virtually, a critically important finding for training and safety of the healthcare workforce. When evaluated using Kirkpatrick's outcomes scale, these two studies reached Levels 1–3 (Blake et al. 2020) and Level 2 (Christensen et al. 2020) and were considered to have no or relatively low risk of bias.

The majority of papers, however, focussed on sharing experiences, rather than robust evaluation or research enquiry. As with all educational research, it is hard to decide whether this reflects primary educational and research weaknesses or reporting issues. Such research weaknesses could be understandable given the rapid developments when it comes to outcome evaluation but are harder to justify when considering the reporting of developments. Any high-quality development should clearly define the underpinning theoretical frameworks, articulate the resources needed for the development, define the setting, describe the educational methods, and the content of the development to promote replicability across different contexts. It is therefore disappointing and highlights a clear gap in the evidence base, that many did not present this.

This observed educational quality has implications for the continuation and extension of these developments, which may well persist beyond the end of the pandemic as independent or as hybrid innovations (i.e. integrated with traditional educational experiences). The rapid nature of the developments likely contributed to the relative absence of significant conclusions/discussion about long-term effects and again represents a current gap in the evidence

base for educators and other stakeholders. Clearly, as evidenced by Blake et al. (2020) and Christensen et al. (2020), both quality scholarship and reporting thereof is possible, and authors should look to their work as models for future work.

Comparison with existing literature

This is a new and rapidly evolving situation that has resulted in very rapid deployment of educational developments. Much of the literature (per our criteria) is reflected in this review. One previous systematic review has been published on medical education developments during COVID-19 (Dedeilia et al. 2020). That review was performed on articles published before 18th April 2020. Due to differing methodologies and the rapid expansion of the evidence base, only three of the included articles in our review were included in their review (i.e. Chick et al. 2020; Moszkowicz et al. 2020; Soled et al. 2020). Of note, we specifically excluded letters to the editor, commentaries, editorials, and perspectives, which comprised the bulk of their review. They concluded that their review 'summarized the available literature on the issue, which mostly consist(ed) of anecdotal communications without empirical evidence, due to the short time window and unexpectedness of the COVID-19 pandemic.' Clearly the evidence base has somewhat improved since their review, and there are examples of quality scholarship (e.g. Blake et al. 2020).

Strengths and limitations

The strengths of this rapid review include an 'a priori protocol,' reporting using a STORIES approach (Gordon and Gibbs 2014), a comprehensive search strategy developed through piloting, risk of bias assessment including an easy visual tool for representation, and timeliness of the review to inform other educators in the pandemic. We aimed to ensure rigor was not sacrificed by the rapidness of the review, yet there were limitations. Our selection of 4 electronic databases was less than other reviews may select, but in line with other reviews within BEME. Future reviews may include a wider selection. Whilst we hand searched MedEdPublish, we did not hand search all non-indexed medical education journals. Our study selection and extraction was all done in duplicate but by multiple author pairs to allow a rapid turnaround. This reduced the scope for measures of inter-rater reliability and potentially increased the risk of inconsistent judgements during data extraction. Future reviews must consider this issue. Finally, we refined our inclusion and exclusion criteria to ensure the practicality and feasibility of a rapid review, focusing on studies describing developments that had already been deployed, as well as on studies involving medics (i.e. physicians or physicians in training). Important innovations may have been missed in opinion pieces or editorials. Literature focused on other health professions certainly warrants its own review in the future. As we are still early in the pandemic, the literature base is rapidly evolving. By the time this article is published, several additional reviews will likely already be warranted.

Concerning the literature base, we noted a tendency of groups to largely report successful developments. This likely reflects the increased willingness of groups to report and editors to publish successful (vs. unsuccessful) developments. We strongly recommend more balanced reporting and publication, as there is much to learn from failures.

The risk of bias related reporting the development details is very telling within this review. This does not in any way disadvantage papers for not presenting outcomes, but rather is guided by the principle that when reporting a development in education, sufficient detail must be given to allow readers to judge the quality of an intervention themselves, compare with other developments and possibly replicate. Reporting was lacking in all key areas, with the majority of studies in all categories rated as high risk, meaning no material of any form was given to judge these key areas. Whilst some studies were capricious, providing details in some key areas that can still offer value to readers, it is limiting to this rapidly evolving field to not have details of underpinning theory, resources needed, content used, the settings for deployment or teaching methods employed. Robust reporting does not confer any added cost to the authors or ethical considerations and can add much for educators and researchers trying to advance the field. The barriers to including such content are not clear, and this limits the strength of the evidence overall.

Recommendations for future research and practice

This review provides some helpful direction for future publications. Based on this review, we have identified ample description of shifts to on-line platforms to deliver existing content (e.g. using on-line seminar instead of classroom delivery). There is, however, less detailed literature around supporting traditional and new clinical workspace-based learning, particular for undergraduate learners. We argue that this is where a focus for future research should lie. This review has synthesised postgraduate and undergraduate literature and there may be some helpful insights to inform undergraduate patient-based learning in the future.

There are some obvious gaps identified in this review. Gaps in assessment were noted above. Admission and selection to medical school are not yet well explored, and studies on selection into postgraduate training are entirely lacking. Further research is urgently needed to examine these important fields, particularly in relation to retaining equity and diversity principles in a virtual environment. Similarly, despite literature describing a range of innovative ways to deliver teaching, there is relatively little existing literature focusing on faculty development or support. The identified literature did not make visible any fundamental opportunities or theories for change within medical education. This review focuses on a relatively short time frame of publication and future publications may explore in more detail potential opportunities for change and innovation produced by this global crisis.

There are also some more generic and methodological points to be made regarding the evidence base within this review. Our review has sought to gather useful data on developments that could guide future educators, yet in this area, many papers were lacking. We would invite authors, peer reviewers and editors to consider the importance of such reporting in future studies to answer vital and simple

questions–'what?,' 'so what?,' 'now what?' This can support dissemination and replication, and further research, building on methods and ensuring iterative evolution within the field.

Conclusions

This review highlights a number of areas of change in the immediate aftermath of the educational response to the COVID-19 pandemic. A rapid shift to synchronous and asynchronous remote learning occurred that will likely persist beyond the pandemic, and attention must be paid to learner engagement, structure and organization in the future. Early developments supported alternatives to clinical placements or continued clinical exposure using telehealth, PPE, and physical distancing. A few articles of exceptional quality, most notably a digital learning package to support well-bring (Blake et al. 2020) were identified that can serve as models to guide future educational developments and reporting. Gaps in the literature were identified with additional studies needed in the areas of assessment, admissions and selection to post-graduate training, and faculty development. While there was often a lack of practical detail to support the educational community in enactment of novel interventions and limited evaluation data, the range of options deployed offers much guidance for the medical education community. There were indications that outcome data and additional details will be reported and therefore an update review may be warranted in the near future.

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