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A systematic review to compare the effectiveness of face-to-face versus online (including blended learning) delivery of CME/CPD for healthcare practitioners (HCPs).

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Abstract

Objectives: With the ever increasing use of online learning, a systemic review of randomized clinical trials from January 2000 to October 2014 was conducted to investigate the effectiveness of education delivery for CME/CPD between face-to-face and online (including blended) learning modalities in healthcare practitioners (HCPs).

Settings: Thirteen studies fit the inclusion criteria and of these four were from North America, two from Iran, two from Asia, four from Europe and one from Australia.

Populations varied with five of the studies being conducted amongst primary care physicians (GPs), one with occupational physicians, five with nurses, one with allied health including physiotherapists, occupational therapists and exercise physiologists and one with a mixture of scientists and physicians.

Interventions: The interventions used across the studies varied with eleven of the studies comparing face-to-face with online learning, and only two studies comparing blended with face-to-face learning. There were no studies comparing blended with online learning only.

Outcomes Measures: The predominant outcomes measured by ten of the thirteen studies focused on knowledge gain and skills with eight of these also reviewing acceptability and satisfaction with the course. Knowledge gain was mostly assessed through pre and post-testing of knowledge immediately before and immediately post-intervention although several of the studies did include additional post-testing at two weeks, three months and six months.

Only one study assessed preference for learning styles for future CME activities and found that all those in the web-based group (100%) and 97% of the face-to-face group wanted to stay with the same learning medium as they had experienced in the intervention.

Results: Of the eleven studies comparing online with face-to-face education, all found similar and usually lasting improvements in knowledge gain from baseline with both groups suggesting that online learning was comparable or at least as effective as onsite or face-to-face training. Increased knowledge, attitudes (perception of confidence) or change in practice were found in three of the studies [1-3] with another two assessing disease detection, diagnosis and management or concordance with guidelines.

Discussion: Although numerous studies have been conducted comparing the effectiveness of online learning or the effectiveness of face-to-face learning in CME/CPD delivery for HCPs, it appears this is the first review that has looked specifically at studies comparing the two modalities.

Conclusions: Further comparative research of the different delivery modalities is required. Any new studies should include those elements known to be effective in CME delivery (multimedia, multiple techniques and multiple exposures), should have similar populations, include case-based learning and be randomized. Further studies conducted with these elements should help to assure educators and learners that the time, energy and funds spent in developing and deploying effective continuing education for HCPs achieves the behavior outcomes required to enhance patient care.

Declaration by author

This thesis is composed of my original work, and contains no material previously published or written by another person except where due reference has been made in the text. I have clearly stated the contribution by others to jointly-authored works that I have included in my thesis.

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Keywords

continuing medical education, continuing professional development, face-to-face, online, blended, healthcare practitioner, education, learning

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List of Abbreviations

Abbreviation	Definition
CME	continuing medical education
CPD	continuing professional development
AMA	American Medical Association
VLE	Virtual Learning Environment
AMC	Australian Medical Council
MBA	The Medical Board of Australia
GPs	General Practitioner
EACCME	European Accreditation Council of Continuing Medical Education
WHO	World Health Organization
MCC	Medical Council of Cambodia
JMA	The Japan Medical Association
KMA	The Korean Medical Association
SMC	Singapore Medical Council
PCs	practicing certificates
CGPSL	College of General Practitioners of Sri Lanka
DVTS	digital video transport system
REN	research and education network
NPC	nasopharyngeal carcinoma
HCPs	healthcare practitioners
RDRB	Research and Development Research Base
EPs	emergency medicine practitioners
KAB	knowledge, attitude and behavior
IBL	internet based learning
PCPs	primary care practitioners
OPs	occupational physicians
UGVA	ultrasound-guided vascular access

Abbreviation	Definition
OSCE	objective structured clinical examination
EBM/N	evidence based medicine/nursing
LMS	Learning Management System
QCs	quality circles

Introduction

Continuing Medical Education (CME) and Continuing Professional Development (CPD) defined

Definitions and rationale

For many years, continuing medical education (CME) and continuing professional development (CPD) have been accepted as an integral part of a doctors working life for ensuring competence and fitness to practice. A doctor is an authorized practitioner of medicine, as one graduated from a college of medicine and licensed by the appropriate board [4]. Indeed, it has become a moral and ethical obligation for physicians to update their skills and knowledge through life-long learning [4].

There are many definitions explicit and implicit to CME and CPD. Filipe *et al.,* [5] compared the differences between CME and CPD through stating that CME consists of episodic interventions designed to address educational needs of a group of learners whilst CPD is lifelong and based on on-going assessment of an individual's needs. CME was viewed as teacher-driven, principally encompassing the clinical domain, is frequently lecture-based (passive learning) and conducted in formal settings such as lecture halls or conference rooms. CPD is generally learner-centered, is more comprehensive in scope, encompassing clinical domain as well as practice, management, administration, education, and an entire spectrum of professional activities. In addition, CPD can be conducted in a variety of formats and methods of delivery, encourages active learning and occurs in different venues including practice settings outside the lecture hall or conference room [5].

According to the European Union of Medical Specialists, CME can be defined as "educational activities serving to maintain, develop or increase knowledge, skills and professional performance and relationships used by physicians to provide services to patients, the public, and the profession" [6] whereas CPD is the "educative means of updating, developing and enhancing how physicians apply the knowledge, skills and attitudes required in their working lives" [6].

The American Medical Association (AMA) defines the content of CME as "the body of knowledge and skills generally recognized and accepted by the profession as within the basic medical sciences, the discipline of clinical medicine and the provision of health care to the public; CPD can consist of CME, continuing physician professional development, or clinical training [7].

The regional guidelines for CME/CPD activities published by the World Health Organization Regional Office for South East Asia 2010 stated that; "CME and CPD have more or less synonymous application" [8]. International literature includes a number of terms used interchangeably with CME/CPD. These include Continuing Professional Education, Continuing Education, Lifelong Learning, Professional Development and other derivatives [9].

The Singapore Medical Board defines CME as educational activities that serve not only to maintain, develop or increase the knowledge and skills of a doctor but also to develop the professional performance of a doctor.

Historically, CME has had a narrower definition than that used by WHO, and a number of authors have made a clear distinction between CME and CPD [10].

CPD has also been defined as 'the process by which health professionals keep updated to meet the needs of patients, the health service, and their own professional development. It includes the continuous acquisition of new knowledge, skills, and attitudes to enable competent practice … The term CPD acknowledges not only the wide ranging competences needed to practice high quality medicine but also the multidisciplinary context of patient care' [11].

The Medical Board of Australia (2014) requires doctors to undertake CPD that is 'relevant to their scope of practice in order to maintain, develop, update and enhance their knowledge, skills and performance to ensure that they deliver appropriate and safe care. CPD must include a range of activities to meet individual learning needs including practice-based reflective elements, such as clinical audit, peer-review or performance appraisal, as well as participation in activities to enhance knowledge such as courses, conferences and online learning.'

Although there are a number of definitions, for CME/CPD, the concept that continuing education is necessary for doctors to maintain or increase professional competence has been widely accepted for many years. There have been however, changes in acceptance of what should be covered, and also how the education should be delivered, often accompanied by a change in terminology from CME to CPD. Thus with the broadening of the meaning of the term CME, there has also been some examples where the terms are used interchangeably.

Historical context of CME/CPD

The first reported CME course took place in 1935 but it was only during the 1960s that it was discussed in literature [12] Historically, the CME learning model was viewed as an adjunct to daily

practice, where its purpose was restricted to knowledge rather than doing, changing behaviors, team management, and communication skills The term CPD better reflects where CME is currently heading [4]. The distinction between CME and CPD is becoming increasingly blurred over the last decade [11]. Many countries are now moving towards organized education programmes and individual learning activities that encompass the wide ranging competencies needed to practice high quality medicine, including medical, managerial, ethical, social and personal skills that CPD entails [13].

Theory of learning and the effectiveness of CME/CPD

How educational theory has shaped CME/CPD

Educational theory consists of frameworks, concepts, ideas and principles, which may be used to comprehend or clarify actions or experiences in an educational environment [14]. Such theory has helped us understand aspects of teaching and learning amongst physicians that is complex [15]. Educational theory offers the opportunity to predict effectiveness of an educational approach and create a framework for evaluation of both current practice as well as novel education strategies [16]. Moreover, such theory enables one to foresee potential incentives and obstacles in the implementation of new education strategies. Hence, educational theory relates to CME with three principal goals:

1. To improve health outcomes through improved practice.
2. To improve learning.
3. To reinforce competence [15].

The following details aim to describe the theories of learning and consider their implications in the application of CME.

Principles of adult learning

The adult learning theory explores the mechanism of adult learning together with the attitude and motivation for learning. Different adult learning behaviors have been identified. Knowles' five characteristics of adult learners are considered as guidelines on how to teach independent, self-directed learners. The five characteristics or assumptions are:

1. Adult learners are independent and self-directed in learning.
2. Adult learners have accrued a vast amount of experience that can be applied to their learning.
3. Adult learners value learning that is pertinent to their everyday life.
4. Adult learners prefer immediate, problem centric approaches to learning compared to those that are subject centered.
5. Adult learners have internal drivers of motivation rather than external ones [17].

These characteristics or assumptions have been expanded by Collins [18] as 'principles of adult learning' with suggestions as to how they may be applied (Appendix A).

How is CME/CPD for healthcare professionals different from general adult education?

Modern CME/CPD is designed to follow the premises of adult learning theory and shares similar emphasis on independent, self-directed learning. It appears that the difference between CME/CPD for HCPs compared with the general adult education is that the nature of these activities is designed to enable health care to evolve and have an impact on health outcomes. The nature of health and health care makes CME/CPD unique. HCPs have come to place more emphasis on accredited CME/CPD activities for the sake of recertification. More than a process to meet accreditation requirement or to be credit awarded, CME/CPD activities are now also required to demonstrate effectiveness in changing practice and patient outcomes [19]. HCPs who do not participate in CME/CPD are liable to face sanctions such as removal of the right to practice or a decrease in fees. Hence, CME/CPD has become more of an obligatory exercise, although some HCPs still claim to engage in CME/CPD learning purely for interest [20]. In a quantitative study by MacLeod [20] on how GPs learn, HCPs showed a pragmatic approach to learning and valued learning that gave them practical advice for patient-specific problems. The primary motivation for learning was the discomfort during their daily work if lack of knowledge or skills was perceived such as when faced with an uncertain diagnosis or unfamiliar disease, inability to answer a patient's questions and discussion of topics from more informed peers [20].

Theoretical perspectives in medical education

There are several perspectives that assist in the selection of principles which frame and guide educational practice, and which have significantly influenced medical education [21,22]. These perspectives can be grouped as [21,22]:

1. Behaviorist
2. Cognitive
3. Humanist
4. Social
5. Constructivist
6. Realist

Behaviorist perspective

According to behaviorist theories [23-25], behaviour is influenced and shaped by environmental stimuli, or operant conditioning. It assumes that the learner is passive and operates on a principle of "stimulus-response". Behaviorists believe that people are equipped with limited innate reflexes and that all of a person's learning is the result of interaction with the environment [26]. Hence the focus of this theory is observable behavior with key principles being that of contiguity as well as positive and negative reinforcement. Examples are evident in competency-based education, skills training and the use of feedback. Feedback, for example, can speed learning and also increase accuracy [27].

Cognitive perspective

The cognitive perspective examines an individual's internal process of perception, insight, meaning and memory [21,27]. In contrast to behaviorism, cognitive theory assumes that the locus of control is on the learner. These theories highlight the importance of well-organized knowledge and endeavor to explain ways in which information is processed. Moreover, cognitive theory elucidates the process of problem-solving skill development and the transfer of these skills across different situations. The cognitive theory also advocates learning that occurs in a relevant context [27].

Humanist perspective

The humanist perspective places great emphasis on the learner's choice and control over his learning process. It acknowledges the inherent developmental nature and needs of humans to become autonomous and self-directed in learning. This has led to the increasing importance of adult learning theory, self-directed learning, reflective practice and critical reflection, experiential learning and transformative learning in continuing education [27].

Social perspective

The social perspective focuses on learning that is affected by a continuous dynamic interaction of an individual with the learning environment [21,28]. The construction of knowledge occurs and resides in the environment. This is evident in the context of clinical learning, where content, processes and approaches to practical problems are learned in a clinical environment. Social learning highlights the importance of observational learning, and hence the powerful influence of role models on learners. This theory has thus assisted in the comprehension and use of influential educators in CME [27].

Constructivist approach

Constructivism views learning to be the construction process of understanding an experience based on prior experiences; hence the construction of knowledge in different individuals is varied [27]. This approach has several significant implications for teaching and learning. The first implication is that the teacher is viewed as a learning facilitator rather than a source of knowledge. The second is that teachers impart experiences that highlight inconsistencies between a learner's current comprehension and their new experiences, due to the fact that learning is connected to pre-existing knowledge. Thirdly, learners are actively engaged through the use of group interaction. Lastly, adequate time provision is required for the active acquisition of new knowledge [17].

Realist approach

The realist perspective refers to a worldview where reality exists independent of the human mind. Learning is aimed at understanding the material world through inquiry, with focus on the study of science and scientific methods. The realist curriculum emphasizes on the role of the teacher, and supports formal, systematic and organized ways of teaching [29]. Learners are taught about facts and methods to arrive at facts through critical reasoning and observation. In CME/CPD, realism can be used to explain education interventions may or may not work, for what kind of learners, in which contexts, to what degree and why [30].

How can educational theory improve CME/CPD in the future?

Adult learning theory has helped the practice of CME by highlighting the lifelong learning process of adults and the importance of relevant subject matter and active involvement of learners [27]. Educational theory may be viewed as a guide to educational practice rather than a set of rules[25][23]. It provides the means in which to explore central variables potentially involved in

educational practice, through a framework that can aid the conceptualization of issues around learning and teaching. To date, educational theory has not been consistently and systematically applied to CME activities, resulting in the inability to conclusively determine the effectiveness of such theory on educational practice [27]. With the use of theory, CME/CPD educators can expect which educational approaches will be effective, create a framework for evaluating current practices and develop new strategies that may be effective [25]. The relationship between theory and practice are mutually informing and can be viewed as a dynamic feedback loop [27].

Measuring effectiveness of learning in CME/CPD

Effectiveness in CME/CPD delivery

Effectiveness in CME/CPD is assessed across various levels and numerous studies have looked at effectiveness in both online and face-to face learning. In a systematic review by Marinopoulos *et al.,* [31] CME was found to be moderately effective in imparting knowledge to physicians, changing physician attitudes, acquiring skills, changing practice behavior, or changing clinical practice outcomes. Educational techniques identified in the studies that reported clinical outcomes are listed in Table 1 but no conclusion could be drawn regarding the differential effectiveness of specific education techniques.

While different techniques seem to provide different outcomes, simulation training was generally effective in the dissemination of psychomotor skills such as procedures or physical examination with live media, multimedia activities and interactive techniques being more effective than print media, single media and non-interactive techniques, respectively. [31]. Multiple exposures to the CME activity were also more effective than a single exposure [31]. Similar themes were reported by Mazmanian *et al.,* [32] in a paper entitled *CME Effect on Clinical Outcomes.* The author recommended the use of multiple media (live, print or internet), multiple techniques of instruction and multiple exposures to content as a means to achieving CME objectives intended to improve clinical outcomes. Abrahamson *et al.,* [33] noted that CME effectiveness is increased by interactive activity, when the learner participates in a collaborative environment instead of learning in solitude, for example participating in a journal club as opposed to self-reading [33].

Education techniques	
Readings	Physician visits
Conference calls	Case-based learning
Academic detailing	Role-playing
Discussion groups	Standardized patients
Lectures	Demonstrations
Point of care CME	Clinical experiences
Feedback	Simulation
	Problem-based learning

Table 1 - Education techniques Identified by Marinopoulus et al., [31]

CME/CPD effectiveness on clinical outcomes

The impact of CME in relation to clinical outcomes is poorly defined [32]. There also appears to be no single standardized model for evaluating the effects of individual CME activities, and no single standardized model for evaluating clinical outcomes in healthcare [32]. Miller's pyramid [34], Moore's Outcome-based CME Evaluation Model [35], the Accreditation Council for CME framework [36] are some examples of popular evaluation models in medical education used to measure knowledge, clinical skills, competence and/or performance. Only Moore's Outcome-based CME Evaluation Model assessed changes in health status of patients and population due to change in practice behavior.

Patient outcomes are similarly defined using various events, such as blood glucose lowering, stroke, mortality or quality of life. One study by Zuckerman *et al.,* [37] found that educational print materials sent to physicians of post-acute myocardial infarction patients increased beta-blocker prescriptions by 1.4% and patient compliance by 8.3%. These findings were in contrast with another randomized controlled trial involving mailed CME materials on hypertension targeted at primary care physicians [38]. Results showed that although there was short term improvement in physician knowledge there was no lasting effect on physician knowledge (mean scores for post-CME test were 50% and 52% for study and control physicians, respectively) and no influence on performance in lowering the blood pressures of patients referred from screening (mean blood pressure drop for study patients, 12.2/10.4 mmHg vs. 13.0/10.6 mmHg for control patients). Here we see that although educational opportunities may be presented in a similar format, they may provoke different reactions in different learners, and subsequently different outcomes.

Factors affecting CME effectiveness in outcomes

Audience characteristics such as age, gender, practice setting, years in practice, specialty, foreign versus local medical graduate, country of practice, personal motivation, nonmonetary rewards and motivations, learning satisfaction, and knowledge enhancement are examples of intrinsic factors that contribute to CME effectiveness [39]. External factors such as regulation, state licensing boards, professional boards, hospital credentialing, external audits, monetary and financial rewards, academic advancement, provision of tools, public demand and expectations, and CME credit may play an important role in the design of effective CME [39]. Marinopoulos *et al.,* [31] in a systematic review on how audience characteristics and external factors influence CME effectiveness, was unable to reach a definitive conclusion due to the small sample size and heterogeneous nature of the studies.

E-Learning modalities and the role of the Internet in education

The use of the Internet for online CME/CPD is growing rapidly, providing physicians with unprecedented access worldwide. A US study reported a 10-fold increase in physician participation in online CME activities, from 305,410 to 4,365,014 from 2002 to 2008 [40]. Online CME represented 6.9% to 8.8% of total CME consumed in 2008 and is expected to take up 50% of all CME within the next 10 years. Most (60%) online CME is produced by medical publishing and education companies [41]. The majority of these companies use low-technology educational approaches, such as pure text and repurposed live lectures [41].

The internet provides a virtual learning environment (VLE) or platform where an e-learning system can be established. The term VLE describes "a range of integrated web-based applications that provide teachers, learners, parents and others involved in education with information, tools and resources to support and enhance educational delivery and management" [42]. Internet applications include web pages, email, message boards and discussion forums, text and video conferencing, shared diaries, online social areas, as well as assessment, management and tracking tools. The VLE models conventional classroom education by providing access to equivalent courses, content, tests, homework, grades, assessments, and other external resources. It is also a social space where students and teachers interact using threaded discussions or chat.

E-learning can take place synchronously and asynchronously. In synchronous systems, lecturers present lessons in virtual classrooms. Students can communicate through a microphone, messaging or chat. In asynchronous learning, students complete lessons and assignments independently

through the system, each at their own pace. Instructor-led group work can involve both synchronous and asynchronous events. Blended learning combines face-to-face learning with online learning [42].

E-learning modalities include any technology used to enrich learning, whether through the internet, CD-ROM, interactive multimedia, games/simulations or social networks. Online learning can include self-study using online tutorials, research and discovery learning events, self-study with subject matter experts (tutoring, mentoring, coaching), web-based tutorials (individual or groups using self-paced online resources), computer-based tutorials (individual or groups using CD-ROM resources), video and audio modalities (distributed by tape, CD, DVD, online streaming, download, or podcasts) [43].

Advantages and disadvantages of online CME modalities

Online CME offers numerous benefits to physicians, particularly those in rural and remote locations because it is convenient, readily available, reduces travel cost and time. It also allows for flexibility in independent, self-paced learning [44]. In spite of this, online CME may not be the method of choice for some physicians. In a study involving the use of an online programme on evidence-based medicine, only 3 out of 40 physicians completed the entire programme. Several barriers that hindered physician participation of online CME were identified including physicians' perceptions of time constraints, lack of personal discipline and unfamiliarity with computers [45].

In a pilot postgraduate medical education programme using virtual worlds technology (Second Life) to deliver CME topics on type 2 diabetes, participants were asked to rate their satisfaction of the activity. All participants, primary care physicians (n=12), agreed that this experience in Second Life was an effective method of medical education (increased confidence in starting insulin therapy), that the virtual world approach to CME was superior to other methods of online CME, that they would enroll in another such event in Second Life, and that they would recommend that their colleagues participate in a Second Life CME course. Only 17% (2/12) disagreed with the statement that this potential Second Life method of CME was superior to face-to-face CME [46].

In a survey examining the acceptability and use of social media for enhancing CME, participants expressed the most agreement that social media would be useful for disseminating information about CME opportunities, that the use of social media in CME is ethical and that it will be increasingly utilized for CME in the future. The majority of respondents (291/327 [89%]) reported having used social media, with the most common types being YouTube (189/327 [58%]), Facebook

(163/327 [50%]) and Skype (142/327 [43%]). Favorable attitudes towards social media were associated with younger age and frequent use of social media. Very few (54/322 [17%]) reported never using social media. A total of 251 (77%) respondents utilized social media for personal use, 64 (20%) for general education, 21 (6%) for CME purposes and 50 (15%) for other professional use. Social media appears to be a viable strategy for enhancing CME among more youthful, technology-savvy physicians, especially as junior physicians enter the profession [47].

With the use of powerful search engines and academic services that index countless journals by keywords, physicians now have access to abstracts and articles published since year 2000. However, researching and reviewing huge volumes of literature available can sometimes be too time-consuming and inefficient, especially when a question or problem at hand needs to be solved at the point of care. Here the internet provides an effective means for physicians to consult their peers online. There are online CME services that combine multimedia lectures by renowned speakers with blog format discussion forums. Some services offer rapid point of care information sources consisting of peer-reviewed summaries of various medical diseases that are well-organized and written by clinicians who are specialists in that field. These services include innovative solutions about a disease diagnosis when signs and symptoms are entered by the physician. The disadvantage is that some of these services require subscription, which can be quite costly (approximately USD 500 per year) [48].

Effectiveness of e-learning

Internet-based CME programmes are just as effective in imparting knowledge as traditional formats of CME [49]. In a meta-analysis by Cook *et al.,* [50], internet-based CME has been associated with favorable outcomes across a wide variety of learners, learning contexts, clinical topics and learning outcomes compared with no intervention. Results showed that that internet-based CME was at least as effective as traditional CME delivery formats for improving participant knowledge, skills and practice decisions [50]. Physicians who participated in varied formats of selected internet CME activities were also more likely to make evidence-based clinical choices than non-participants [40].

The effectiveness of online CME can be improved with increased interactive activities. For example, one study evaluated the outcomes of two differing formats of an Internet-based CME course - a scheduled group learning format that involved case-based asynchronous discussions with peers and a facilitator, and an ‘eCME On Demand’ format that did not include facilitated discussion and was not based on a schedule. Participants in the scheduled group learning format reported significantly higher mean satisfaction ratings in some areas, performed significantly higher on a

post-knowledge assessment and reported significantly higher post-confidence scores than participants in the 'eCME On Demand' format [51].

Effectiveness of e-learning on patient outcomes

In a systematic review examining the effectiveness of online CME targeted at general practitioners, only one randomized controlled trial looked at the impact of online CME on patient outcomes. Fordis *et al.,* [1] found that both internet-based CME and live, small-group, interactive CME workshops produced similar and significant immediate and 12-week knowledge gains. Both incorporated similar multifaceted instructional approaches demonstrated to be effective in live settings. There was no significant change in post-intervention screening rates in both groups. However, physicians who received internet-based CME were more likely to initiate cholesterol treatment in high-risk patients according to guidelines than those in the live CME group (preintervention, 85.3%; postintervention, 90.3%; P =.04).

Conditions influencing CME/CPD effectiveness and future considerations

The benefits of the Internet as an information repository, as a facilitator of global communication, and also individual interactive learning activities that may be audio-visually enhanced ensure that the internet will continue to play a major role in CME/CPD. The internet has expanded opportunities to provide flexible, convenient and interactive CME/CPD to practitioners who have difficulty attending formal education sessions. Online technology's potential to efficiently deliver CME/CPD to large numbers of health practitioners over geographically wide areas is a major factor in the continued expansion of on-line CME/CPD [51]. The fact that health practitioners can access Internet CME/CPD at any time without the need to travel is a major advantage for practitioners in remote areas, or for those whose work schedule does not allow them to attend particular face-to-face events. The increasing ease of language translation on the internet may become especially valuable in the future in sharing CME/CPD across regions.

A qualitative study [52] investigating what health care practitioners want in CME/CPD found that credibility, content/context, and control were important; in particular, credibility was valued. Affiliations with medical organizations and accreditation were suggested as methods by which online CME/CPD could gain credibility. Health care practitioners valued discussion of the content, indicating a continued place for traditional face-to-face CME. Health care practitioners also considered the ability to control the depth of learning and the time spent on learning to be important, as well as the ability to quickly find information that was in a format (e.g. podcast, video,

mobile device) that best suited their learning needs or preferences was another benefit of online CME/CPD.

At present, cost, poor Internet coverage and difficulties of Internet access may be a problem in some areas, and restrict the use of on-line CME/CPD, but technological advances may ensure that reasonably fast, reliable, low cost Internet access is available to healthcare practitioners worldwide. Because health practitioners also value face to face interaction with peers and experts, there will continue to be a place for non-Internet based CME/CPD in comprehensive CME/CPD programmes [53].

The Australian CME/CPD environment

History of CME/CPD in Australia

Until the 1930s, continuing professional development (CPD) was focused on acquiring knowledge and skills for the care of individual patients. Since then, CPD has come to include a broader range of professional attributes necessary to manage complex health care systems [54]. CPD programmes in Australia are currently delivered by the 27 specialist medical colleges [13]. including the Royal Australasian Colleges of Physicians, the Royal Australasian College of Surgeons and the Royal College of GPs to name but a few (further details of Australian colleges and their CPD requirements can be found at Appendix B). The Australian Medical Council (AMC) provides accreditation of CME/CPD activities organized by these colleges. The Medical Board of Australia (MBA), which was established in 2008, acts as a single national accreditation board that oversees the registration, education and training of all health professionals in Australia [13].

Changes since CME/CPD implementation

The Health Practitioner National Law Act 2009 made CPD a condition of ongoing registration for all health professionals in Australia; the National Registration and Accreditation Scheme for health professionals, introduced in July 2010, made CPD mandatory for doctors in Australia in order to maintain their registrations with the MBA [13,54]. Prior to that, CPD had been voluntary and provided by a wide range of organizations. Most colleges had introduced voluntary CPD programmes, although only the Royal Australian and New Zealand College of Obstetricians and Gynecologists had made CPD a condition of ongoing college fellowship [54]. The Royal Australian College of General Practitioners, the largest general practice representative body in Australia

formed in 1958, required doctors to undertake and continue approved postgraduate study while in general practice [55]. Until July 2010, doctors were regulated by state and territory boards, and there was no uniform, national system of CPD [54].

The single most important influence on CME/CPD is accreditation by the AMC [54]. Established in 1985, it was originally only responsible for accreditation of basic medical education but now extends its remit in the accreditation of CME/CPD activities organized by medical colleges. The AMC accreditation process includes the validation of CPD programmes and peer review of CPD programme providers against a set of standards set by the council [13]. According to the AMC, CPD programmes must be based on self-directed learning and educational quality, using appropriate educational methods and resources. The CPD programme provider is responsible for determining the formal structure of the CPD programme in consultation with stakeholders and adhering to the requirements set out by the MBA. The CPD programme provider is also responsible for documenting and monitoring CPD activities of participants in a systematic and transparent way, taking feedback from participants into consideration [13].

Face-to-face versus internet activities

The advent of new technologies such as the internet has changed the way CME/CPD can be delivered, and has provided a convenient and effective means for rural and time-poor doctors to fulfil their CPD requirements. Studies have shown that internet-based learning is as effective as other traditional learning methods in terms of knowledge gains [49]. There is limited evidence as to whether an increase in physician knowledge translates to better patient outcomes [1].

In a recent survey of preferences for CME activities among 2500 Australian general practitioners (GPs), it was found that most GPs (95%) preferred learning in a group to learning by themselves, with 83% preferring face-to-face, lecture-based formats; 70% preferring interactive group discussions; 66% preferring one-to-one learning with an expert; and 55% preferring online self-education [53]. The authors also found that older GPs and GPs working in solo practices were less likely to prefer online learning, particularly online self-education. This was because face-to-face group learning allows a degree of personal interaction and offers GPs an opportunity to network with other GPs and specialists, as well as to take a break from their normal routine.

Future development

Under the National Law which governs the operations of the National Boards and Australian Health Practitioner Regulation Agency, it became a legal requirement for all registered health practitioners to undertake CPD [56]. This requirement is likely to continue, although AMC's standards will be subject to further iterations over time.

In a randomized controlled trial reported by Shaw *et al.,* [57], online education following a live CME course can significantly increase the impact of a face-to-face course. Davis and Galbraith [58] observed that "CME, especially using live or multiple media and multiple educational techniques, is generally effective in changing physician performance." Therefore, the logical approach for future CPDs would be to combine different media of instructions to enhance outcomes.

Measuring CPD effectiveness is crucial for justifying the time and money spent on CPD programmes [5]. More studies are needed to examine CPD effectiveness, specifically in terms of patient and population health outcomes. The rapid growth of online CPD has led to the development of accreditation criteria for e-learning materials by the European Accreditation Council of Continuing Medical Education (EACCME) [59]. Until Australian guidelines are available, local CPD providers may need to customize the principles of the EACCME's accreditation criteria to ensure compliance to best practices.

The Asian CME/CPD environment

The Asian CME/CPD environment

There is no uniform CME/CPD system in Asia. Each country has its own framework and policies, so the CME/CPD environment will be discussed on a country by country basis. Countries generally regarded as Asian include all countries in the World Health Organization (WHO) South East Asian Region – Bangladesh, Bhutan, DPR Korea (North Korea), India, Indonesia, Maldives, Myanmar, Nepal, Sri Lanka, Thailand, Timor-Lest, and some countries in the WHO Western Pacific Region – Cambodia, China, Japan, Laos People's Democratic Republic, Malaysia, the Philippines, Republic of Korea (South Korea), Singapore and Vietnam. Taiwan and Hong Kong are not included specifically in any WHO region as separate entities, but will be included here, because CME in these places differs from CME in mainland China.

Between 1997 and 2003, the World Federation for Medical Education developed global standards for quality improvement of basic medical education, postgraduate medical education and CPD [60]. However, it is unclear to what extent these standards were adopted, or what influence they had on the development of CPD in Asian countries.

In 2010, the World Health Organization South-East Asian Division issued regional guidelines for CME/CPD [8]. These guidelines arose as an initiative of a meeting of the Regional Network of Medical Councils of South-East Asia, held in Thailand, and specify minimum standards for CME/CPD activities for registered medical doctors. These guidelines stated that CME/CPD activities may include structured teaching-learning activities such as training programmes; attending local or overseas scientific updates programmes, online or onsite programmes, conferences, symposia, seminars, workshops; distance learning programmes, presentations and publications of research. These would also include self-study and online education programmes with or without self-assessment, including informal modalities as well.

Although presumably the Asian countries involved in formulating regional guidelines have taken steps towards implementing them, it is difficult to determine to what extent these guidelines have been adopted throughout Asia. The large-scale differences in finance available to fund CME/CPD in various countries, the differences in size of countries and the relative proportion of the population in rural areas, as well as the difference in Internet coverage and accessibility, are factors that contribute to differences in CME/CPD content and delivery throughout Asia (Appendix 2: CME.CPD engagement in Asian countries).

To understand the process for CME development and delivery across different Asian countries some further detail is listed on a per country basis below:

Bangladesh

The Bangladesh Medical & Dental Council is the statutory body responsible for establishing and maintaining high standards of medical education and recognition of medical qualifications in Bangladesh. There is no information on CME/CPD on its website[61].

Bhutan

According to the Bhutan Medical and Health Council Regulation Guidelines on CME 2009 [62] the main goals of CME are:

1. To offer CME activities based on identified learners' needs and deficiencies;
2. To design CME activities to meet the stated learning objectives;
3. To present CME activities that enhance interdisciplinary synergy of health professionals;
4. To provide CME experience in knowledge, attitude, and behavioral skills that results in improved clinical performance and professional development'

The CME programme includes the primary and specialty clinical educational activities designed to address the current and emerging advances in medical science, technology, clinical education and research, and integrate, wherever appropriate, practice management and leadership educational programmes that would result in competent, effective and efficient healthcare practices[63].

Cambodia

CME/CPD is the responsibility of the Medical Council of Cambodia (MCC). There is a CME Subcommittee that evaluates the quality of CME for doctors, determines the conditions for the receipt of CME credit, sets up criteria for evaluating CME programmes, collaborates with professional associations to design and develop CME programmes and curricula, organizes and promotes participation in regional CME activities, promotes the importance of professional development and publishes CME materials on the MCC website [64].

China

CME became mandatory in China in 1991. In 1996, a CME Committee was founded with representatives from the Ministry of Health, provincial health bureaus, the Chinese Medical Association, medical schools, and medical research institutions. Hospitals and medical institutes

usually organize CME activities in China, for example, case reviews, paper presentations, and self-learning activities. Self-learning activities include reading medical journals and books and attending medical conferences and workshops [65].

In 2000, the Ministry of Health and the Ministry of Personnel jointly formulated and issued the *"Continuing Medical Education Regulations (Trial Version)",* and established the National Continuing Medical Education Committee. As of 2003, China had set up CME Committees in 31 provinces, autonomous regions and municipalities. National CME programmes covered medical, dental, nursing, pharmacy, public health and preventive medicine, health management and other disciplines. 1000-plus continuing medical education programmes were approved and released each year. The purpose of CME is to enable constant improvement of professional competence. CME includes seminars, training courses, conferences, lectures, workshops, writing academic treatises, and self-study. The use of modern technology for CME, e.g. multimedia coursework and distance education, and the use of software that will enable standardized management of CME is encouraged [66].

Hong Kong

CME/CPD is mandatory in Hong Kong and is the responsibility of the Medical Council of Hong Kong. The Hong Kong Academy of Medicine maintains the standard of specialist CME and CPD in Hong Kong. Other organizations offer programmes for general practitioners [65].

The Hong Kong Medical Association provides on-line CME on a wide range of topics on its '*CME online'* website. It also gives details of face-to-face CME held throughout the year. These are generally lectures, usually incorporating a question and answer session, or seminars, which cover a range of aspects of patient care from different healthcare professionals. Seminars also include an interactive question and answer component [67].

India

CME guidelines are issued by various State Medical Councils in India. CME courses are funded by a wide range of organizations including the Medical Council of India, international organizations such as UNICEF, and pharmaceutical companies, as well as the Indian Ministry of Health. Doctors in many rural areas have little or no access to CME [68].

The Medical Council of India (now reinstated after suspension) awards credits for CME. A minimum of 150 credit hours is needed to renew medical registration. Credit points are awarded

for attending conferences and workshops, and publishing articles in journals [69]. Online CME in India does not accrue any credits although this is presently under discussion.

Indonesia

In 2008, CPD became mandatory for all physicians in Indonesia. The Indonesian Medical Association required ten percent of CME credits to be obtained through nonclinical activities such as research. The objectives of the CPD programme conducted by IMA and its sub-organizations (Association of Specialist Medical Doctors and Association of Primary Services Medical Doctors) [65] are:

1. To maintain and promote the professionalism of doctors according to global standards of competence (upholding quality and ethics).
2. To guarantee the existence of quality medical services through a certification of doctors programme.

Japan

The Ministry of Health, Labor and Welfare registers all physicians and regulates the profession. However, it does not provide any system of CPD, and CPD is not mandatory. The Japan Medical Association (JMA), to which over 50% of doctors belong, conducts a voluntary certifying programme, undertaken by about 70% of its membership [7]. JMA established its voluntary CME programme in 1987 to 'address basic science and health-care issues, improve physician-patient relations, and improve the quality of medical care'. The CME committees of JMA and its related municipal and prefectural associations follow a curriculum covering medical science ethics and law health policy [65].

The JMA's CME curriculum was prepared in1992 as a guideline for physicians and specified general objectives and behavior objectives [70]. CME/CPD credits can be gained in the following ways:

1. Answering questions posted in JMA's official monthly Journal, Nippon Ishikai Zasshi (Journal of the JMA)
2. Answering questions posted on e-learning
3. Attending lectures, seminars, workshops, conferences
4. Hands-on learning (observations of autopsy and operation, clinical conferences, and other learning through hospital-clinic and clinic-clinic cooperation)

5. Serving as a supervisory physician in undergraduate and postgraduate clinical training programmes
6. Preparation for national medical exams
7. Writing medical papers and books

In regards to self or group learning, the JMA has developed various curricula for physicians to follow. These include basic healthcare courses, which are broad, non-specialty specific courses, covering, for example, medical ethics or social security. There is also a curriculum for medical topics, which has two sections, one on important medical practice procedures, and the other on important diseases. Physicians can study these curricula at workshops planned by the regional medical associations or can study them as self-learning. The prefectural medical associations also offer CME for GPs and specialists e.g. ophthalmologists, obstetricians/gynecologists, pediatricians, and orthopedic surgeons [13].

Laos PDR

There is no information about CME/CPD in Laos.

Malaysia

CME activities are conducted by both the medical schools and professional bodies. There is, as of 2008, no requirement for re-certification of doctors based on their participation in CME [71].

CME/CPD in Malaysia is voluntary, and sponsored by the Malaysia Medical Association. CPD activities include lectures, workshops, and conferences [65].

A national survey of a random sample of medical practitioners registered with the Malaysian Medical Council found that more than 70% wanted a CME/CPD programme that would provide them with new practical skills and new knowledge or advances in specific fields. Over 60% also wanted their skills in problem-solving to be developed. Reinforcement of communication skills was of secondary importance. Respondents wanted a CME programme to help them monitor and improve their diagnostic accuracy, investigative habits, prescribing pattern, skills in interpreting diagnostic tests and management of common illnesses. More than 90% preferred self-learning methods with some group-type activities [72].

Maldives

The Maldives Medical Council states that the core aspects of good medical practice are maintaining and developing knowledge, skills and professional behavior, which requires self-reflection and participation in relevant professional development and practice improvement (including adequate performance-appraisal processes). The Council advocates participating regularly in activities that maintain and further develop knowledge, skills and performance and regularly participating in CME. The Maldives Medical Council includes members from the Maldives Ministry of Health and also from a major hospital and higher education institutes. The Maldives Medical Council is responsible for physician registration. CME does not appear to be mandatory, however the Regulations state that: "Physicians should try continuously to improve medical knowledge and skill"[73].

Myanmar

The Myanmar Medical Council issues licenses to all medical graduates, but there is no regulatory system to assess or monitor the quality of care. The Myanmar Medical Association conducts many CME activities including conferences, workshops, seminars, lectures, after which certificates are issued to successful candidates [74]. Reportedly, there is a need for more CME/CPD programmes in this country [75].

Nepal

As of 2009, there was no structured system in Nepal for ongoing CME [76]. There is little information about CME/CPD in Nepal.

North Korea

There is little information available about CME/CPD in North Korea.

South Korea (Republic of Korea)

The Korean Medical Association (KMA) is the central representative body of physicians in Korea. KMA requires its members to undertake CME, and provides resources to members for this purpose, for example, self-study texts, and a touring lecturer system[77].

There is a variety of web-based CME available for orthopedic specialists in Korea provided by various Korean and international orthopedic societies (e.g. the Korean Orthopedic Association and the Korean Orthopedic Cyber-Society) including online lectures, video clips of surgical procedures,

interactive CME programmes, case discussions and other CME credit programmes [78]. A study of Korean orthopedic specialists published in 2014 showed that most had a high interest in web-based CME because of time and/or distance constraints [79]. There is little information about CPD for other specialties.

Pakistan

There are over fifty professional organizations that provide CPD in Pakistan, but their activities are not regulated and are not coordinated [13]. However, as a result of a series of conferences in 2009, the first steps were taken to launch a national CPD programme under the aegis of the Pakistan Medical and Dental Council responsible for formulating rules, regulations, and accreditation of CPD programmes. A survey taken in 2007 indicated that the most common CPD activities were professional reading and discussion with peers, and that major barriers were lack of time or lack of interest in the educational activity, and lack of finances [65].

Philippines

The Philippine Medical Association provides a range of CME activities including face- to-face symposia, workshops and lectures, and also some on-line CME [80].

Singapore

A CME system was launched in Singapore in 1989, and became mandatory for license renewal in 2005. CME is conducted by the Singapore Medical Council (SMC), a statutory board under the Ministry of Health, through a range of educational activities, including Internet CME [65].

CME is defined by the SMC as consisting of educational activities that serve to maintain, develop or increase the knowledge, skills and professional performance of a doctor. Doctor must keep themselves up to date current with changes in medicine generally and in areas relevant to their own practice in particular. Patients and society at large also want to be assured that the doctors they consult are practicing up-to-date medicine and offering them good quality care[81].

Since 1 January 2005, all fully and conditionally registered doctors renewing their practicing certificates (PCs) are required to meet the compulsory CME requirements for their CME qualifying period(s) [81]. The 2014 list of accredited activities includes 3 categories:

1. Participation in overseas conferences and congresses.

2. Authorship / Review / Self-study of original articles published in refereed journals / audio-visual discs
3. Distance-learning programmes with verifiable self-assessment

The SMC CME Coordinating Committee accredits CME programmes/activities and reviews CME policies and programmes. The Committee includes representatives from the Academy of Medicine Singapore, College of Family Physicians Singapore, Singapore Medical Association, as well as doctors working in both the public and private sectors [81].

Sri Lanka

During the past 30 years, the College of General Practitioners of Sri Lanka (CGPSL) has conducted CME and CPD for general / family practitioners. The main CME/CPD activity of the College has been the annual academic session, which is a forum for education and presentation of research work[82].

The Open University of Sri Lanka has offered an online CME course on cardiovascular health for physicians. The course, purchased from Monash University, Australia was updated and adapted to suit the Sri Lankan context. It was available in print format and was converted into an online format on the learning management system 'Moodle', and was enriched by using audio-visual material, discussion forums, self-assessment activities and an online reflective journal. Online assessments included a variety of assessment methods. Feedback by participants in the course indicated it was valuable for them [83].

Taiwan

CME courses are offered regularly to physicians and nurses at community hospitals and in private practice. The hospital is required to carry out assessments of the continuing education needs of physicians, conduct CME programmes that draw upon and highlight the College's institutional strengths, disseminate research findings, technologic advances, new clinical and health care information, and other new knowledge to help physicians enhance their professional competence, and discover, develop, and disseminate new modes of delivering CME [84].

Telemedicine services were introduced in 1995 with a particular focus on providing healthcare in rural areas and CME for physicians in these areas. Online CME, one of the important functions of the telemedicine system, led to physicians feeling less isolated, and enhances their confidence and that of their patients [85].

Thailand

In 2000, the Thai Medical Council announced the development of the Centre for Continuing Medical Education to organize and support the CME system. At present, CME in Thailand is voluntary though most physicians do participate in CME activities [11,86].

Timor-Leste

CPD/CME is not yet offered in Timor-Leste. At present there are no medical schools in Timor-Leste. However there are moves to establish the major hospital in Dili as a teaching hospital [87].

Vietnam

In Vietnam, there is a requirement that all practitioners participate regularly in CPD or their license can be revoked. However, the types of CPD required are not specified. National systems for CME were reported to be underdeveloped and underfunded, and additional capacity to provide continuing education for both public- and private-sector health professionals will be needed [88]. The Department of Science and Training in the Vietnam Ministry of Health provides for accreditation to all universities and medical colleges as CME providers. However they need to develop specific policies and administrative structures to strengthen CME in Vietnam [89].

The use of internet in Asian CME/CPD delivery

Shimuzu *et al.,* [90] in a paper entitled "*Ten-year experience of remote medical education in Asia*" described the use of a digital video transport system (DVTS) and the research and education network (REN) for telemedicine. Between 2003 and 2013, there were 360 programmes organized from Kyushu University Hospital, Japan connecting 221 hospitals or facilities in 34 countries in Asia and globally (Table 2). The two main areas were endoscopy and surgery, with 113 (31%) and 106 (29%) events, respectively followed by health care and nursing. Teleconferences made up 76% of the total events, with the remaining 24% being live demonstrations showing medical procedures. This paper showed that remote medical education has been well accepted in Asia, in line with changing CME/CPD needs and technological advancements. High-quality video transmission is a viable means for remote CME/CPD delivery, and collaborative efforts are already in place for this to occur.

Asian countries	Western countries
Australia	Belgium
China	Brazil
Fiji	Chile
India	Czech Republic
Indonesia	Egypt
Korea	France
Malaysia	Germany
Mongolia	Italy
Nepal	Lithuania
New Zealand	Mexico
Philippines	Morocco
Singapore	Norway
Sri Lanka	South Africa
Taiwan	Spain
Thailand	Turkey
Vietnam	United Kingdom
	United States

Table 2 - Countries participating in remote CME/CPD [90]

Effectiveness of CME/CPD in Asia

Most studies that have been published reported effectiveness of CME/CPD programmes in physician knowledge, skills, satisfaction and behavior change. Very few examined the effect of CME/CPD on patient/population health outcomes. In Indonesia, training in the form of lectures and symposiums on nasopharyngeal carcinoma (NPC) improved the knowledge of general practitioners on early symptoms of NPC. Whether this translated to improved patient outcomes was not explored [91]. Following a short post-graduate training course for general practitioners in Hong Kong, participants reported increased confidence, attitudes and skills in treating common dermatological problems, resulting in lower referral rates to dermatologists [88]. In Singapore, oncology nurses who underwent a training programme on psychosocial care as part of their continuing nursing education curriculum demonstrated sustained positive gains in applied knowledge and practice behaviors in screening cancer patients for distress and providing timely intervention. Whether these gains led to improved quality of life in cancer patients was not measured [92]. A pilot internet-based CME course on pediatric HIV diagnosis and treatment was implemented in Pune, India. Although participants showed significant increases ($p<0.05$) in mean knowledge scores on the global knowledge assessment, limited internet access prevented optimal course utilization. Barriers to implementing knowledge to clinical practice were identified as being stigma that prevented patients from seeking medical treatment and financial resource limitations affecting physician practice [93]. In Taiwan, surgical nurses who received pain management education showed

improved knowledge about, attitude towards and application of relaxation therapy compared to those who did not receive training. Relaxation therapy was applied to nearly all (97.5%) of the patients cared for by the study group nurses. All of the instructed patients performed this technique one to three times per day post-surgery [94]. In Phnom Penh, Cambodia, telemedicine was used as a combination of CME and seeking consultation from experts in developed countries. The use of case conferencing was found to alter patient care in 69% of cases. All Cambodian staff reported learning from the conference and 78% reported changes in their care for patients in daily practice [95].

Future directions

International collaboration and cooperation between medical associations, medical schools and Ministries of Health in, for example, producing regional guidelines, could result in greater emphasis on evidence-based clinical content, requirements for nonclinical education in ethics and health policy, and approaches to multi-media learning methodologies [65]. The use of on-line CME, depends to some extent on the reliability, cost and availability of Internet access in particular countries, but its use may increase in particular in countries with large rural populations where physicians may have difficulty attending face-to-face meetings because of time and distance constraints. Sharing and adaptation of existing on-line CME/CPD programmes, between developed and developing countries could improve the overall quality of CME/CPD.

Summary

In summary, CME can be viewed as a part of CPD, the latter which involves not only educational activities to expand medical knowledge and skills, but also multiple facets of professionalism such as management, team building, interpersonal communication, technology, teaching and ethics. The sharp division between the two terminologies is becoming less distinct as many countries are seeking to incorporate a broader range of competencies into their CME/CPD system.

Comprehension of physician learning through theoretical perspectives such as behaviorism, cognitivism, social learning, humanism, constructivism and realism enables one to better plan CME activities that can facilitate and augment the natural process of learning. To quote Amin *et al.,* [15] "CME interventions are more likely to be fruitful if they are modelled with strong theoretical background, catered towards individual learning needs and preferences, and focused on the learning component of education" [22]. Effective learning should be measured according to patient and

population health outcomes, in addition to physician knowledge, skill, satisfaction and change in behavior.

The use of internet-based CME/CPD is growing rapidly as it offers greater flexibility and accessibility. Studies have shown that internet-based CME/CPD programmes are just as effective as traditional formats in improving physician knowledge and patient outcomes. Paradoxically, some studies have also found that physicians prefer face-to-face meetings over online CME/CPD. When combined together, online education following a live CME course has greater impact on changing physician performance compared with a standalone programme.

CME/CPD is mandatory in Australia and structured CME/CPD frameworks are implemented nationwide. Unlike Australia, there is no uniform system in which CME/CPD is developed and implemented in Asian countries. Although global and regional guidelines have been formulated, an accreditation system that harmonizes CME/CPD activities across Asian countries is absent. Future developments should aim at improving international and regional collaboration to refine existing frameworks and uptake of best-practice recommendations in these countries.

Research Objective

A systematic review to compare the effectiveness of face-to-face versus online (including blended learning) delivery of CME/CPD for healthcare practitioners (HCPs).

Research Questions

What is the difference in patient outcomes when using either face-to-face or internet (or both) delivery modalities for CME/CPD in HCPs?

What are the critical components for online/blended delivery to insure improved patient outcomes?

Methods

Search

A comprehensive literature search for randomized controlled trials was carried out using **PUBMED, CINAHL, ERIC** and **RESARCH & DEVELOPMENT RESEARCH BASE (RDRB)** published between January 2000 and October 2014. The rationale for commencing the search from 2000 only was based on the knowledge that online learning was rarely considered or utilised in CME/CPD delivery before this time. The keywords used are reported earlier in this document with the results of the search process shown in *Figure 1 - Search process and included studies.* Bibliographies of retrieved articles were also visually searched for additional references.

Study selection/Eligibility criteria

Two reviewers independently reviewed the titles and abstracts of all identified citations as per the inclusion criteria.

Papers were included after review of the full text if they met the following inclusion criteria:

1. Randomized controlled clinical trial
2. Compared at least two modes of CME/CPD delivery (online versus face-to-face, blended versus online or face-to-face or both)
3. Participants were healthcare professionals
4. Published in English

Studies were excluded if the control arm had no intervention.

Data extraction and management

Data were extracted from each study (and reviewed by my principal supervisor) to include the study authors and the year of publication, settings and aims, design and participants (both type of participants and number) plus interventions, outcomes and follow-up.

The key elements within each study were also documented with similar review from my principal supervisor; created by reviewing specific study elements that were either comparable or entirely different and then listing these together with how the element was incorporated into each study.

We also looked at the different educational elements included in each study, in what context that element was incorporated and within which population.

Results

Results of the search

The search identified 566 journal articles, of which 293 remained once duplicates were removed. Discarded papers on the basis of the title and/or abstract amounted to 240, leaving 53 remaining for which full texts were searched. Forty three of these did not meet the inclusion criteria and so were subsequently excluded. Reference lists were also searched and this identified a further 3 papers. Hence 13 original studies were eligible for inclusion - *Figure 1 - Search process and included studies.* Further detail of the included studies is below.

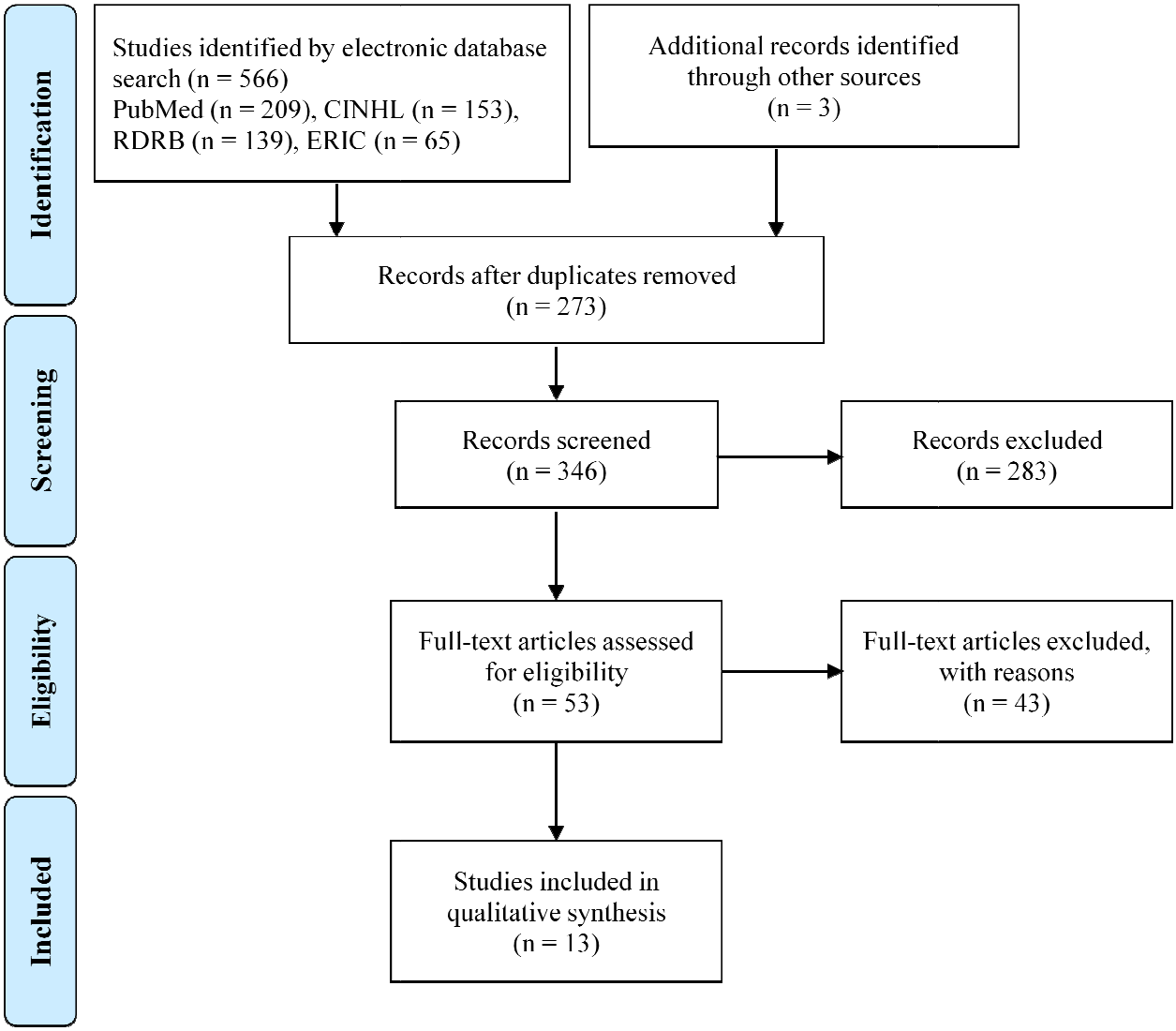

Figure 1 - Search process and included studies

Characteristics of included studies

Settings:

Of the thirteen studies, four were conducted in North America. These consisted of one,[96] being conducted in Canada through the emergency department of the University of Toronto, one,[97] being conducted through the University of Arizona College of Medicine, one,[1] through primary care centers in Houston, Texas and one,[98] through the North Carolina community hospital in Arizona.

Two of the studies were from Tehran, Iran with one,[99] being conducted with general physicians from the Kermanshah University of Medical Sciences and one,[100] with nurses from different hospitals associated with the Tehran Medical University.

There were 2 studies from Asia with the first [101], being conducted amongst medical graduates or postgraduates in Lucknow, India and the second,[102] with nurses from the Tokyo Japan Nursing College.

Four studies were from Europe, with one,[103] being conducted amongst general practitioners (GPs) from central London and Scotland, another, [3] with GPs working in the NHS across Spain, the third,[104] through primary care quality circles in Western Germany and the last[105] being conducted with occupational physicians through the Amsterdam University, Netherlands.

Only one of the thirteen studies,[2] was conducted with physiotherapists, occupational therapists and exercise physiologists in Victoria, Australia[2].

Populations:

Primary care was the most commonly studied population; however, it is important to note that different countries use different terminologies for physicians working in the primary care setting. In the USA[1,97], PCPs included internal medicine, family practice doctors or community based practitioners while in the UK and Europe[3,103,104], GPs was the predominant term. In the OPs study, [105] the authors explained that the “occupational health context differs from the clinical context or primary health care because OPs must, next to medical issues, consider the working situations of their patients, management priorities and legislation.”. Aggarwal’s [101] Indian study included the most differentiated groups due to the eligibility criteria, which included numerous options such as being a graduate of medicine or having a masters in science, having received the

graduate or postgraduate degree within the past 10 years and/or having at least one year of research experience in clinical or social research.

Five of the studies included nurses [2,98,100,102,103] with only two studies [2,103] being based in the community (private practice or community health centers) and the other three studies [98,100,102] being in the hospital setting.

The Australian study [2] included various allied health practitioners such as physiotherapists, occupational therapists and exercise physiologists (together with nurses), all from private practice or community health centers.

Interventions:

Of the thirteen studies that fit the inclusion criteria, eleven studies [1-3,96,97,99-103,105] compared face-to-face with online learning, and only two studies [98,104], compared blended with face-to-face learning. There were no studies comparing blended with online learning only.

Of the two blended learning studies, one study [98], included a discussion session with the online learning group while the other [104], had a structured discussion included in both the online and face-to-face groups.

In Aggarwal's [101] design, the students in Arm 1, travelled to Luknow to attend 3.5 days of onsite training in biostatistics after which they returned to their homes/offices and one week later were required to access the 3.5-week online research ethics course. Arm 2 commenced with the 3.5 weeks online training in biostatistics and then they travelled to Luknow for the onsite 3.5 days Research Ethics course. All materials utilized across both arms were identical. The biostatistics course included seventeen lectures to be delivered across 13.5 hours plus students participated in 8 interactive group exercises of 45-60 minutes each. Online students were provided with the same exercises to discuss with other students or with their course faculty during 8 interactive sessions. All lectures delivered online were pre-recorded.

There were 8 online sessions in statistics where each topic was divided into 2 sessions to allow flexibility for student attendance. This meant students were required to attend 4 online sessions.

The research ethics course was delivered across 15 lectures with 8.75 hours of instruction plus an additional 5 one-hour interactive case discussions. There were 3 sessions for each case discussion

and students were provided with a set of questions for each case that they were required to answer before the case discussion.

In addition to this, students were also required to view and discuss a 20-minute video on ethical challenges in community based research. All interactive sessions online (60 minutes each) were presented at pre-recorded times and were moderated by at least one faculty member. These online 'classroom' sessions were not compulsory however students were encouraged to log onto the sessions via the internet. Student questions appeared in windows on the faculty computer screen to enable them to answer for all students' benefit. Faculty could also share their computer screen on which they could write or draw.

Chenkin's study [96] with EPs and EP residents, was a non-inferiority trial to evaluate the effectiveness of an online tutorial versus a didactic lecture in ultrasound-guided vascular access (UGVA) skill acquisition. A specific website was created with active learning through the use of videos, animations, self-assessment quizzes and non-linear navigation was encouraged. Prior to starting the training, all participants (n= 22) completed a pre-course written examination to test their knowledge in this topic. The online group were given access to the website and told to spend one hour on the training materials while the face-to-face group attended a 1-hour classroom lecture. Following this training both groups practiced their skills for 2 hours independently with no faculty support. Following the practice session, the participants were given a 2-week rest period during which time the online group could access the website and the lecture group had access to the study guide provided to them during the training. It was only after the rest period that both groups were given the objective structured clinical examination (OSCE) together with a written test. Participants were also asked to complete a satisfaction questionnaire regarding the training sessions.

Downs *et al.,* [103] tested three different training mediums: "electronic tutorial on CD ROM, decision support software and practice based workshops with a standard curriculum designed by a multidisciplinary expert group".

The electronic tutorial (8 practices) was structured like a book and indexed to allow easy access of different clinical problems. The training material was based on case analysis allowing reflection on challenging clinical problems.

The decision support software, (8 practices) was driven by real cases, and produced prompts within the existing practice software to encourage the user to investigate and manage dementia.

The face-to-face workshops (10 practices) also based around case-based learning, were conducted by two experienced GPs and were delivered to GPs and nurses.

In Fordis *et al.,* [1] the study design set out to compare online with face-to-face training amongst primary care physicians in the delivery of education on cholesterol management as compared with the National Institutes of Health guidelines. The instructional elements amongst the 2 groups were similar but not identical and included predisposing activities, application exercises, enabling activities and reinforcement. Each participant in the live CME arm had the option to attend one small interactive workshops of 1.5 to 2-hours duration. All participants completed survey forms and pre-intervention assessments upon arrival and then post intervention surveys and knowledge assessments at the conclusion of the workshop. Each workshop consisted of a lecture (plus questions and answers) followed by interactive case discussions as the enabling component.

The online arm had 2 weeks in which to complete the online programme, with similar components as the live workshops. The pre-intervention assessment form and surveys were identical to those used by the workshop arm and participants had access to tutors through email.

Although the online education was delivered in a fixed sequence analogous to the live CME event, the participants online could return to the learnings at any time within the 2 weeks. Following completion of the online modules the users were still required to complete the post intervention survey and knowledge assessments. Both groups had access to faculty through email in the post intervention study phase but the online group also had access to an online 45-minute web conference that was offered several times around 1-month post intervention. This web conference was very interactive enabling the faculty to pose multiple choice questions and conduct polls together with sharing the poll results with the audience.

Harris *et al.,* [97] used a pre-test post-test design in 2 different GP groups to assess knowledge, attitudes and behaviors (KAB) in pain management delivered through either online or face-to-face training. Participants were allocated into either a live lecture on pain management or an online programme using laptop computers with each being 4-hours and occurring during the second day of a 2-day CME event on geriatric care. Participants were also given CME credits for successful completion of the pre and post-test questionnaires provided at the event and were also provided with payment of $200 for those agreeing to complete the second identical post-test at 3-months post intervention. Content for the online and face-to-face programmes were similar but not identical as the content was adjusted to maximize the delivery medium.

Hammati and Omrani [99] studied CPR training in physicians through either online or lecture based education. The internet based intervention were PowerPoint presentations which included text, photography, video, narrative and animation permitting interaction with the learning and the participants could access the programme at any time as the learning was not scheduled. The 6-hour classroom intervention was conducted by a prominent university professor who used the same content developed for the internet but could only present the content through text and photography.

The satisfaction questionnaire administered immediately post intervention consisted of 15 evaluative questions (via a Likert scale) and was designed to evaluate programme quality, content satisfaction, interaction and preferred method for future CME delivery.

Horiuchi *et al.,* [102] used a two-group design with web-based learning versus face-to-face lectures to teach the principles of evidence based medicine/nursing (EBM/N) to nurses and midwives. Once accepted into the study all participants were provided with a basic knowledge pre-test for completion (paper based) which had to be emailed back to the study coordinators within one week of receipt. The education programme for both groups consisted of a four-part series entitled 'How is EBN applied clinically'? The web-based group were required to complete 4 classes over 1 month each of 30 minutes while the face-to-face group attended one evening lecture each week for 4 weeks at a nursing college in Tokyo with evening class being 90-minutes duration. Subsequent lectures were made available for those face-to-face participants who could not attend an evening session.

Another nursing study designed to increase AIDS knowledge amongst nurses in Tehran, Iran, [100] was based on a pre and post-test design comparing online with face-to-face learning. Data collection was arranged through 2 questionnaires; the first asking demographic questions and the second, the knowledge questionnaire, consisting of 24 multiple choice questions. Content and course materials were the same for both groups with the online course consisting of self-study texts and interactive multiple choice questions that participants could access for one week only. Access to tutors and other learners was available through internet based chat, email and telephone. For the face-to-face group the intervention consisted of attending an interactive 3-hour lecture delivered by the same tutor who was responsible for the online groups at which time students could take notes and participate in discussions. Course resources were not available to lecture participants following the course.

Post-test knowledge questionnaires were provided immediately post intervention to both groups.

In the falls prevention study by Maloney *et al.,* [2] physiotherapists, occupational therapists, exercise physiologists and nurses were grouped into either web-based or traditional 'live' education to deliver the complex clinical skills of exercise prescription. Content for this education programme was created using three scoping activities (review of falls prevention literature, phone interviews with leaders in the field plus phone interviews with six target audience representatives) and had learning objectives for both interventions mapped to relevant materials and tasks and were matched in content and time requirements. Both web-based facilitators and face-to-face lecturers were trained using the same DVD so that content was the same.

Participants in the face-to-face group, were sent a support package consisting of seminar slides, references to further reading and a DVD of the assessment procedure after which they attended a 1 day (7 hour) seminar, scheduled outside work hours and facilitated by a renowned expert in falls prevention.

The web-based group was required, at their own pace, to attend an estimated 7 hours of learning across 4 weeks and had access to the tutor through web-based discussions and phone if required. They were also provided with a DVD consisting of the multimedia components of the programme to assist should they experience technical issues with the web. The web-based learning activities included interactive skill-practice sessions, self-directed reading and formative quizzes with feedback being provided through tutor assessment of the student's uploaded digital footage of their skills-mastery. Following this feedback, students were provided with tutor feedback on the group performance on the task submissions so they could benchmark expectations of performance competency.

In Spain, a GP training programme on palliative care [3], created based on the requirements of the Spanish Ministry for primary care practitioners, was distributed in four modules to the intervention group online while the control face-to-face group obtained general palliative care training either through hospital rotation, personal courses, self-study, clinical session and one who did online study. Financial incentives (80 euros per patient included) and credit points were also provided to participants. The Moodle Learning Management System (LMS), a popular e-learning platform, was used for the online group enabling the inclusion of images, videos, interactive web-pages and more. The online training lasted 75 days with 15-20 days per module for a total of 96 hours. Fifteen CME credits were given for completion.

The attitude questionnaire (provided at baseline and completion of the intervention) was a 5-point Likert scale exploring "perception of confidence in symptom management, perception of

confidence in communication and a score was assigned to the statement: “palliative care for advanced cancer patients should be part of the care offered by PCPs”.

Sherman *et al.,* [98] being one of only two blended learning studies, developed a programme to ascertain the effectiveness of a blended learning format versus lecture based learning in the area of critical care pharmacology with nurses. Participants were given a pre-test (10 of the 46 items taken from the post-test) and demographic questionnaire prior to delivery of the education which for online learners consisted of 4.5 hours of interactive critical care pharmacology delivered through the hospital’s LMS followed by a 2-hour discussion following module completion. The lecture group attended ‘the traditional 6.5-hour lecture offered to nurses new to critical care”. The 46 item post-test was provided 2 to 3 weeks post intervention to allow participants time for study, after which focus groups were also convened to assess feedback and general information. As attendance at these focus groups was poor, randomly chosen participants were approached to request additional feedback (11 in total).

The second blended learning study, on dementia management, was conducted through German quality circles (QCs) [104], which are traditional regional GP meetings held across Germany to discuss clinical topics, guidelines and other means of improving patient care. The programme participants were required to attend one more QC meeting as well as have internet access. CME credits were the only reimbursement provided for attendance at the extra QC meeting and or for completing the online modules. The study was cluster based with Arm 1 completing online modules plus discussions at the QC meeting with Arm B attending the normal QC lecture plus discussion at the meeting. A 20 item pre-test on dementia knowledge was provided before commencement. Study Arm A participants were informed that their additional QC meeting would be case-based (around 45 minutes) and that they were required to complete the online modules before attending this meeting (which was held around 9 weeks post commencement of the study). There was no lecture as part of this second QC meeting. For study Arm B, the second QC meeting consisted of a 30-minute lecture followed by the same 45-minute case discussion as was held for study Arm A, similarly held around 9 weeks post commencement. Immediately following the education at this second meeting the participants were given a knowledge post-test (20 multiple choice questions on dementia diagnosis and management) and evaluation form for completion in addition to a printed pocket version of the guideline with their CME credits.

This same knowledge post-test was again administered 6-months post intervention to both groups.

Outcomes:

The predominant outcomes measured by ten of the thirteen studies [1-3,96-102] focused on knowledge gain and skills with eight of these also reviewing acceptability and satisfaction with the course [1-3,96,97,99,101,102]. Knowledge gain was mostly assessed through pre and post testing of knowledge immediately before and immediately post intervention although several of the studies did include additional post testing at two weeks [96], three months [1,97,101] and six months [104].

Only Khatony *et al.,* assessed preference for learning styles for future CME activities and was surprised to find that all those in the web-based group (100%) and 97% of the face-to-face group wanted to stay with the same learning medium as they had experienced in the intervention.

Fordis *et al.,* [1] in his pre and post tests used a knowledge assessment instrument which consisted of 39 multiple choice, fixed answer questions covering case vignettes and was administered immediately before (pre-test), immediately after (post-test 1) and again 12 weeks after the intervention (post-test 2) and although the questions were the same for each test the item ordering changed. All participants were also asked to complete a satisfaction survey giving their opinion of relevance to clinical practice. His was also the only study that conducted chart audits of 25 eligible patients per participant, 5 months before and 5 months after the interventions.

Harris *et al.,* [97] used a standardized 50 item survey delivered immediately pre, post and again 3 months post intervention (the KAB instrument).

Hammati and Omrani [99] collected their data from a 20 item knowledge test administered pre and post intervention (in similar order) together with a demographic questionnaire and a post intervention satisfaction questionnaire.

In the study by Maloney *et al.,* [2] similar outcomes were measured by utilizing the Kirkpatrick hierarchy of educational outcomes to assess self-reported change in practice. To review more details on the Kirkpatrick summative evaluation criteria please see Table below.

Test	Test
Learner satisfaction (reaction)	This level of evaluation evaluates how well participants liked a program. It usually provides data concerning participants' perceptions, satisfaction with program objectives, content, instruction, delivery, and/or instructors
Learning outcomes (learning)	This level of evaluation involves some form of assessment of changes in skills, knowledge, or attitudes among learners; it is most commonly conducted through pre and post-test study designs
Performance improvement (behavior)	This level of evaluation provides information on the extent to which learning has influenced the post-learning behavior or performance in the practice setting
Patients/health outcomes (results)	This level of evaluation measures tangible results which are influenced by the learner performance as a result of participation in the continuing education activity.

Table 3 - Kirkpatrick Model

Modified version of Kirkpatrick's model for summative evaluation taken from Curran et.al. 2005

To acquire the data for the Kirkpatrick Level 3 outcomes (change in practice) in the study, Maloney *et al.,* included open ended questions of participants and found that the web-based group suggested their changes related to improved application of motivational interviewing techniques with a feeling of competency in patient assessments, while the face-to-face group concluded their practice changes were more aligned to exercise prescription and assessment changes.

Pelayo *et al.,* [3] assessed outcomes using questionnaires that assessed attitudes to palliative care, knowledge gains and satisfaction with the teaching activity. The knowledge questionnaires were based on 33 single correct answer questions provided at baseline and again immediately post intervention. A final evaluative questionnaire regarding technical issues with the LMS were also provided at the conclusion of the online programme. His study found "a significant increase in knowledge and confidence in communication (in the intervention group) but not in confidence in symptom management".

The Canadian study of EPs and EP trainees [96] included a four-station OSCE as part of the post intervention assessment together with a written examination.

All study characteristics and elements of the interventions are summarised in Table 4 and Table 5.

.	Study name, author and year	1. Setting, 2. Country	Study Aims	Study design	Participants 1. Type 2. Total number	Intervention Descriptions	Type of outcomes assessed	Follow-up period
1.	A comparison of online versus on-site training in health research methodology: A randomized study. Aggarwal R., *et al* 2011 [101]	1. Sanjay Gandhi Postgraduate Institute of Medical Sciences 2. Lucknow, India,	Improvement in knowledge in biostatistics and research ethics	RCT	1. Postgraduates or graduates in medicine along with one year of research experience 2. 60 enrolled and randomized	Arm 1: 3.5 day onsite learning of Biostatistics followed by 3.5 week online research ethics course. Arm 2: 3.5 week online Biostatistics course followed by 3.5 day onsite research ethics learning Traditional onsite course included structured live group activities with case discussions. Online courses included slide presentations and pre-recorded sessions by experts. Following each intervention the groups crossed over and participated in the other delivery format and topic.	1. Knowledge tests to assess knowledge gain immediately prior, immediately post intervention and again at 3 months. 2. Satisfaction	3 months

.	Study name, author and year	1. Setting, 2. Country	Study Aims	Study design	Participants 1. Type 2. Total number	Intervention Descriptions	Type of outcomes assessed	Follow-up period
2.	Procedures can be learning on the web: A randomized study of ultrasound-guided vascular access training. Chenkin J., *et al* 2008. [96]	1. University of Toronto 2. Toronto, Canada	Determine whether web-based tutorial is at least as effective as didactic lecture for teaching knowledge and skills for ultrasound -guided vascular access (UGVA)	RCT Non-inferiority	1. Emergency medicine practitioners (EPs) and residents 2. 22 participants	1. Web group to do 1 hour using the training website 2. Didactic group attended a 1 hour classroom lecture Each group then spent 2 hours practicing their learnings independently Following practice sessions there was a 2 week rest period – both groups could access information based on their group	1.Improvements in practical (OSCE) and written test scores (knowledge) 2. Psychomotor skills 3. Satisfaction.	2 weeks
3.	Effectiveness of educational interventions in improving detection and management of dementia in primary care: a cluster randomized controlled study. Downs D., *et al* 2006. [103]	1 General practices 2 Central Scotland and London, UK	Test effectiveness of educational interventions in improving detection, diagnosis and management of dementia in primary care.	Cluster RCT	1. Primary care (GPs) 2. 36 GP practices from 124 practices entered with 25 practices completing the study	1. 8 practices assigned to an electronic tutorial on CD ROM 2. 8 practices assigned to decision support software 3. 10 practices assigned to practice based workshops 4. 10 practices as control (collecting data only)	1. Detection rates 2. Concordance with guidelines 3. Intention to treat analysis	Before and 9 months after intervention

.	Study name, author and year	1. Setting, 2. Country	Study Aims	Study design	Participants 1. Type 2. Total number	Intervention Descriptions	Type of outcomes assessed	Follow-up period
4.	Comparison of the instructional efficacy of internet-based CME with live interactive CME workshops. Fordis M *et al,* 2005. [1]	1. Primary Care2. Houston, Texas, USA	Determine if online CME can produce 1. Changes in physician knowledge compared with live CME and 2.changes in behavior have an impact on patient care in cholesterol management	RCT	1.Internal medicine (47), family practice (47), family practice and internal medicine (1), family practice and obstetrics and gynaecology (obs and gynae (1), 2. 97 primary care practitioners (PCPs)	1.Single, live, small-group, interactive CME workshop2. Internet based CME intervention with multiple sessions over 2 weeks	1. Knowledge 2. Percentage of high-risk patients who had appropriate lipid panel screening 3. Pharmacotherapeutic treatment according to guidelines were documented with chart audits. 4. Participant satisfaction.	Knowledge immediately before, immediately after and then again at 3 months post intervention. Assessing appropriate lipid screening and pharmacothe rapeutics assessed over 5 month period before and after intervention.
5.	Educating generalist physicians about chronic pain: Live experts and online education can provide durable results. Harris JM., *et al* 2008. [97]	1. University 2. Arizona, USA	Compare lectures and online training for improvement in knowledge, attitudes and behaviors in chronic pain management through a standardized self administered questionnaire	Pre-post randomize d design	1. Community based physicians (family or internal medicine) 2. 154 physicians	1. Live pain lecture 2. Online Pain programme 3. Control group of live lectures on palliative care	1. Knowledge, attitude and behavior (KAB) together. 2. Satisfaction.	Immediately before and at 3 months post intervention. Opinion questions were also administered immediately post intervention.

.	Study name, author and year	1. Setting, 2. Country	Study Aims	Study design	Participants 1. Type 2. Total number	Intervention Descriptions	Type of outcomes assessed	Follow-up period
6.	A comparison of internet-based learning and traditional classroom lecture to learn CPR for continuing medical education. Hemmati N., *et al* 2013. [99]	1. University 2. Tehran, Iran	To compare satisfaction and effectiveness of internet based learning and classroom lecture comparing exam results for CPR guidelines training	Randomly assigned pre-test, pot test quasi experimental study	1.Postgraduate general physician trainees 2. 80 physicians	1. Internet Based Learning (IBL) divided into 3 sections with time taken varying between 125 minutes to 182 minutes. 2. Traditional classroom – 6 hours	1. Knowledge. 2. Satisfaction.	Immediately pre and post-test
7.	Evaluation of a web-based graduate continuing nursing education program in Japan: A randomized controlled trial. Horiuchi S., *et al* 2009. [102]	1. Nursing College 2. Tokyo, Japan	1. Compare learner outcomes of web-based vs face-to-face learning in EBN 2. Explore methods to maximize web-based delivery	RCT	1. Nurses and midwives 2. 93 randomized	Web-based learning Both the web-based learning and the face-to-face groups learning comprised a four-part series entitled, 'how is EBN applied clinically' with the online group requiring 30 minutes for each part over a one month period and the face-to-face group requiring 90 minutes through an evening class once each week for 4 weeks.	1. Knowledge. 2. Satisfaction.	Face-to-face group assessed immediately post last physical meeting; web group assessed 1 month following intervention.
8.	Effectiveness of e-learning in continuing medical education for occupational physicians. Hugenholtz N., *et al* 2008. [105]	1. University 2. Amsterdam, Netherlands	Evaluate the effect on knowledge of e-learning vs lecture based learning on mental health care for occupational physicians	RCT	1.Occupational physicians (OPs) 2. 74	1. Lecture based 2. Online group 3. both groups received 30 minutes learning	1. Knowledge.	Immediately pre and post intervention

.	Study name, author and year	1. Setting, 2. Country	Study Aims	Study design	Participants 1. Type 2. Total number	Intervention Descriptions	Type of outcomes assessed	Follow-up period
9.	The effectiveness of web-based and face-to-face continuing education methods on nurses' knowledge about AIDS: a comparative study. Khatony A., *et al* 2009. [100]	1. University 2. Tehran, Iran	Compare effectiveness of web-based and face-to-face continuing education in improving knowledge about AIDS	RCT with pre and post test	1. Hospital based nurses 2. 140 nurses	1.Three hour face-to-face interactive lecture 2. One week access to the online course including chat, telephone and email access followed by post test	1. Knowledge.	Immediately before and 1 week post intervention.
10.	Effectiveness of web-based versus face-to-face delivery of education in prescription of falls-prevention to health professionals: Randomized trial. Maloney S., *et al* 2011. [2]	1. University 2. Victoria, Australia	Compare 2 approaches (face-to-face seminar format with web-based delivery) in falls prevention	RCT	1. Physiotherapists, occupational therapists, nurses, exercise physiologists 2. 135	1. One day seminar with extra video and written support materials 2. Web-based delivery of equivalent materials over 4 weeks with remote remote tutor facilitation	Using Kirkpatrick's hierarchy of educational outcomes across 4 levels of impact: 1. participant reaction 2. participant knowledge 3. participant change in behavior 4. change in health outcomes	Approximately 1 week post intervention.
11.	Effects of online palliative care training on knowledge, attitudes and satisfaction on primary care physicians. Pelayo M., *et al* 2011. [3]	1. Primary care 2. Country wide, Spain.	Comparing online education with traditional face-to-face for palliative care for advanced cancer patients	RCT	1.Primar care physicians 2. 169 PCPs	1. Online training was in 4 modules with tutoring 2. Face-to-face training was not mandatory but they could have the usual palliative care training offered in the working area	1. Knowledge. 2. Attitude 3. Satisfaction 4. Confidence in communication 5. Confidence in symptom management	Immediately post intervention

.	Study name, author and year	1. Setting, 2. Country	Study Aims	Study design	Participants 1. Type 2. Total number	Intervention Descriptions	Type of outcomes assessed	Follow-up period
12.	Blended versus lecture learning. Sherman H., *et al* 2012. [98]	1 Hospital 2. North Carolina, USA.	Identify learning outcomes and student satisfaction with blended vs traditional lecture classroom learning of critical care pharmacology for nursess	RCT	1. Staff registered nurses in hospitals¶ 2. 70 participants	1.Blended learning group was assigned 4.5 hours of interactive critical care pharmacology learning modules delivered via the hospital's learning management system and a 2-hour discussion session following module completion 2. Control group attended traditional face-to-face 6.5 hour lectures	1. Knowledge 2. Satisfaction	Immediately pre and post intervention
13.	Knowledge transfer for the management of dementia: a cluster-randomized trial of blended learning in general practice. Vollmar H., *et al* 2010. [104]	1. Primary care 2. Rural and urban areas, western Germany	Compare knowledge acquisition about dementia management between blended learning using online modules in addition to quality circles (QCs) vs. quality circles alone	Cluster RCT	1. GPs 2. 389 GPs	1. Arm A = blended learning – online modules and a structured discussion during a QC meeting 2. Arm B = lecture and structured discussion during a QC meeting	1. Knowledge Immediate and after 4 months results by intention to treat analysis. 2. Knowledge Immediate and after 4 months results by per protocol analysis.	Almost 4 months for intervention groups and almost 5 months for control (classical) group

Table 4 - Included Study Characteristics

Element	Context – How was the element incorporated into the intervention	Participants	Reference(s)
Assessment of internet skills for online participation	Short course about online learning methods	Doctors and scientists with masters degree	(Aggarwal et al., 2011)
Financial incentive provided for participation	Funds provided to practices for covering costs of data collection Funds provided to participating doctors	Practices of general practitioners and nurses Primary care physicians	(Downs et al., 2006) (Pelayo et al., 2011, Fordis et al., 2005)
Pre and/or post tests	Immediately before intervention Immediately after intervention 2 weeks after intervention Additional test 3 months post intervention 6 months after intervention	Primary care physicians, doctors, scientists with masters, emergency physicians and emergency residents, general physicians, occupational physicians, nurses Primary care physicians, doctors, scientists with masters, emergency physicians and emergency residents, general physicians, occupational physicians, nurses Emergency physicians and emergency medicine residents Doctors and scientists, general practitioners, General practitioners	(Aggarwal et al., 2011, Chenkin et al., 2008, Fordis et al. 2005, Harris et al., 2008, Hemmati et al., 2013, Horiuchi et al., 2009, Hugenholtz et al., 2008, Khatony et al., 2009, Sherman et al., 2012) (Aggarwal et al., 2011, Fordis et al.,2005, Harris et al., 2008, Horiuchi et al., 2009, Hugenholtz et al., 2008, Khatony et al., 2009, Maloney et al., 2011, Sherman et al., 2012, Vollmar et al., 2010) (Chenkin et al., 2008) (Aggarwal et al., 2011, Fordis et al.2005, Harris et al., 2008) (Vollmar et al., 2010)
Chart audits	Chart audits at 5 months post intervention	General practitioners	(Fordis et al., 2005)
Data collection format	Individuals Practice (cluster) based	Primary care physicians, doctors, scientists with masters, emergency physicians and emergency residents, general physicians, occupational physicians General practitioners	(Aggarwal et al., 2011, Chenkin et al., 2008, Fordis et al., 2005, Harris et al., 2008, Hemmati et al., 2013, Hugenholtz et al., 2008, Khatony et al., 2009, Maloney et al., 2011) (Downs et al., 2006, Vollmar et al., 2010)

Element	Context – How was the element incorporated into the intervention	Participants	Reference(s)
Outcome measures	Increased knowledge, skills Increased knowledge, attitude (perception of confidence), or change in practice Disease detection, diagnosis and management, concordance with guidelines Acceptability and satisfaction with the course Preference for learning style	Primary care physicians, doctors, scientists with masters, emergency physicians and emergency residents, general physicians, occupational physicians, nurses Physiotherapists, occupational therapists, exercise physiologists Emergency physicians and emergency residents, physiotherapists, occupational therapists, nurses, exercise physiologists Primary care physicians Primary care practitioners and nurses Nurses	(Aggarwal et al., 2011, Chenkin et al., 2008, Fordis et al., 2005, Harris et al., 2008, Hemmati et al., 2013, Horiuchi et al., 2009, Hugenholtz et al., 2008, Khatony et al., 2009, Maloney et al., 2011, Pelayo et al., 2011, Sherman et al., 2012) (Fordis et al., 2005, Maloney et al., 2011, Pelayo et al., 2011) (Downs et al., 2006, Fordis et al., 2005) (Aggarwal et al., 2011, Chenkin et al., 2008, Fordis et al., 2005, Harris et al., 2008, Hemmati et al., 2013, Horiuchi et al., 2009, Maloney et al., 2011, Pelayo et al., 2011) (Khatony et al., 2009)
Remote tutor or faculty for online courses	Web-based discussions and telephone support	Physiotherapists, occupational therapists, nurses, exercise physiologists, primary care physicians	(Maloney et al., 2011, Fordis et al., 2005, Pelayo et al., 2011)

Table 5 - Elements of the interventions

Risk of bias assessment of included studies

A detailed diagram on a per study basis for risk of bias is depicted in Table 6.

Random sequence generation (selection bias)

Eight studies had a low risk of bias for random sequence generation [1-3,96,100-103], as they reported randomization using computer-generated random number sequencing or other techniques (such as block randomization). Harris 2008 used blind name draw for the randomization (unclear risk), while the remaining four studies [98,99,104,105] did not describe the method of randomization used thus increasing their risk of bias.

Blinding of outcome assessment (detection bias)

Only three studies [2,96,103] with low risk of bias used blinded assessed outcomes while all others [1,3,97-102,104,105], did not assess outcomes in a blinded fashion, thus increasing their risk of detection bias. In Chenkin *et al.,* [96], OSCE examiners and written test examiners were blinded to participant groups plus a second examiner double-scored 20% of all exams "yielding an interrater reliability of 0.86." Downs *et al.,* [103] used the practice identity as the random effect for all quantitative responses by performing the analysis through a general linear model with arm and time as the fixed effects. Maloney *et al.,* [2] used electronic scoring through the online system that delivered the exam to both groups with assignment submissions being provided to a blinded assessor who used a pre-prepared assessment criteria. Open text questions were also verified using two assessors and a third if there was any lack of consensus from the initial two.

Incomplete outcome data (attrition bias)

Maloney *et al.,* [2] had the highest attrition bias with "attrition from randomization to participation in the trial (n = 67 web-based, n = 68 face-to-face), to completion of the educational content (n = 44 web-based, n = 50 face-to-face), to completion of post education knowledge test (n = 43 web-based, or 36% attrition from initial random allocation, and n = 49 face-to-face or 28% attrition from random allocation). Harris *et al.,*[97] also had high attrition bias with a drop-out rate from initial randomization of 29-31% across the three intervention arms.

Horiuchi *et al.,* [102] also reported a relatively high attrition bias following randomization of 8/45 in the web-based group (17.8%) and 15/48 in the face-to-face group (31%).

Vollmar *et al.,* [104] had high attrition bias with three hundred and five GPs completing the baseline knowledge test, one hundred and sixty-six completing the second knowledge test at the end of the second meeting and only ninety-seven completing the final knowledge test at six months post intervention.

Study	Random sequence of generation (selection bias)	Blinding of outcome assessment (detection bias)	Similarity in baseline primary outcome	Incomplete outcome data (attrition bias)
Aggarwal 2011	+	−	+	
Chenkin 2008	+	+	+	
Downs 2006	+	+	+	
Fordis 2005	+	+	+	
Harris 2008		−	+	−
Hemmati 2013			+	+
Horiuchi 2009	+		+	−
Hugenholtz 2008		−	+	+
Khatony 2009			+	
Maloney 2011	+	+	+	−
Pelayo 2011	+	+	+	
Sherman 2012		+	+	+
Vollmar 2010	+	−	+	−

+	Low Risk	−	High Risk		Unclear Risk

Table 6 - Risk of bias summary

Intervention formats:

A summary table was created, Table 7, showing whether the interventions were online versus face-to-face or blended versus online or face-to-face.

Online versus face-to-face

Of the eleven studies comparing online with face-to-face education [1-3,96,97,99-103,105], all found similar and usually lasting improvements in knowledge gain from baseline with both groups suggesting that online learning was comparable or at least as effective as onsite or face-to-face training [96,97,99,101-103,105].

Increased knowledge, attitudes (perception of confidence) or change in practice were found in three of the studies [1-3] with another two assessing disease detection, diagnosis and management or concordance with guidelines [1,103].

Aggarwal *et al.,* [101] found that the median knowledge gain (from baseline) in biostatistics was higher in the onsite training group compared with the online group while for the research ethics groups the medium knowledge gain from baseline to immediate post intervention was similar for the 2 groups. Although both the biostatistics and research ethics groups showed knowledge gain increases after 3 month compared to baseline, there was no significant difference between the onsite and online groups. The research ethics group did however sustain knowledge gains over the 3 month timeframe.

In contrast, Fordis *et al.,* [1] reported that both interventions (online and onsite) produced similar pre to post intervention knowledge gains although the online group scored slightly higher when averaged over 3 testing sessions for the group main effect. The twelve-week post intervention assessments showed comparable knowledge gains across both intervention arms. This study also included chart audits (for periods of 5 months before and after intervention) with the result that there was a slight though statistically significant increase (5.0% [95% CI, 1.0%-9.1%]) in the online study group compared to the face-to-face group but only regarding drug treatment for high risk patients. In the screening of lipid abnormalities there was no significant difference between the online and face-to-face groups seen in the chart audits. The authors concluded that this was the first study to show that physicians using online delivery for CME actually produced comparable or superior measureable changes in behavior and knowledge gains over 12 weeks compared to those from the live activities group.

In Harris *et al.,* [97] the testing was slightly wider than knowledge alone and included attitudes and behaviors across pain management. This 50 item pain management KAB survey found that both intervention groups (onsite and online) had similar KAB scores immediately post intervention which were sustained over the 12-week period between tests. Immediate post intervention mean KAB scores for the live pain lecture group showed an increase from 138.0 (SD = 17.51) to 150.6 (SD = 21.38) with a maintained increased score at 3-months post-test of 151.0 (SD = 19.43). The online group commenced with pre-test scores of 143.6 (SD = 19.78) which increased to 150.4 (SD = 18.63) immediately post intervention and remained at 149.5 (SD = 21.44) at 3 months. Participant assessment using a 1-5 Likert-type scale of both interventions was interesting with a mean satisfaction score of ≥ 4 showing that all programmes were well received. An additional questionnaire was provided to the online users asking for their use of the materials in the allocated four hours. The results showed that all participants completed at least four of the case studies with 78% of them completing all six. The authors specifically noted that the online users were engrossed in the activities with the most telling effect being the user's absorption in the online learning with comments from users that the "online education programme was intense".

In Downs *et al.,* [103] the two principal outcome measures were detection rates and concordance with guidelines around dementia management based on a case finding exercise conducted pre and nine months post intervention. Effects of the interventions were calculated on a practice basis due to the data being clustered with the analysis being intention to treat. The detection rate results showed that the case based workshops identified 31% of all cases with dementia post intervention with 20% from the electronic arm and 30% from the decision support software group. Concordance with guidelines showed no significant difference between and all 3 interventions.

In the study by Maloney *et al.,* the Kirkpatrick hierarchy of educational outcomes was employed and the authors found that test results in knowledge (level 2) were comparable between the face-to-face and web-based groups (median (IQR) for web-based, 90.00 (70.89-90.67) and face-to-face, 80.56 (70.67-90.00); rank sum $P = .07$ with exercise assignment median (IQR) scores also being comparable with web-based, 78.6 (68.5-85.1) and face-to-face, 78.6 (70.8-86.9); rank sum $P = .61$. Maloney also measured change in practice (level 3) and found mean (SD) scores similar between the online and face-to face groups. The authors also looked at thematic responses to open text comments to find that participants in the web-based group commented that they were changing their application to motivational interviewing techniques (8/22) while the face-to-face group, commented on changes in assessment (10/21) and exercise prescription (12/21).

Variances to these findings by Maloney were found in the cholesterol management study [1], where the authors reported significantly higher outcomes in the online group with respect to treating high-risk patients with pharmacotherapeutics (85.3% pre-intervention vs 90.3% post intervention; *P*=0.04) while in all study groups (≥ 93%) screening rates were already high with no significant post intervention change.

Horiuchi *et al.,* [102] found that nurses had similar results in their pre and post-test knowledge results for both groups (web and face-to-face) however the outcome evaluations showed that the face-to-face group showed a statistically significant difference in satisfaction with tutor support (3.63 (SD = 0.554) then did the web-based group (3.31 (SD = 0.549), $p = 0.03$.

In both the Hemmati and Hugenholtz studies, [99,105] no significant knowledge difference was found between the intervention groups (online and face-to-face) however Hemmati *et al.,* [99] also conducted a satisfaction survey to discover that the internet based group had a higher mean rating (62.5 ± 2.32) compared to the face-to-face group (54.6 ± 2.18) ($p = .001$).

In the Spanish study amongst GPs [3], the online group saw a substantial increase in knowledge gain (between 14% and 20% with p = 0.0001), increased confidence in symptom management (p = 0.02) and increased confidence in communications (p = 0.038) together with a high satisfaction rating for the medium. The control group had no significant change in communication confidence while their symptom management confidence increased but their knowledge decreased.

In the nurses AIDS training in Iran, Khatony *et al.,* [100] looked at between as well as within group differences with the online versus face-to-face education, and found no significant difference in knowledge scores between groups (pre-test, $t_{(138)} = -1.7$, $p = 0.096$; and post-test, $t_{(138)} = -1.4$, $p = 0.163$) while the change in pre- and post-test knowledge scores within each group was significant (web-based $t_{(69)} = 26$, $p < .001$; face-to-face $t_{(69)} = 24.3$, $p < .001$).

Blended (online versus face-to-face)

In the German QC study [104], differences in knowledge gain between the online group (47) and the face-to-face group (82) showed a significant increase in knowledge gain at the first test with 4.77 correct answers for the "user' group (those using the online modules in addition to attending the meeting) and 3.60 correct answers for the face-to-face group (mean difference 1.17: CI 0.20 to 2.14; $p = 0.019$). In an additional analysis, the non-users of online modules in the online group were found to perform significantly worse than the GPs in the face-to-face group (adjusted mean difference = -1.529; CI -2.617 to -0.441; $p = 0.009$).

The only other blended learning study, Sherman *et al.,* [98] showed no significant differences between groups with average pre-test scores for the blended learning group at 62.6 and the lecture group at 60.9 with a resulting *p* value of 0.68. The post-test scores (89.7 in the blended learning group and 88.3 in the lecture group) were also similar between groups and when adjusted with pre-test scores a *p* value of 0.58 showed no significant difference between groups. Furthermore the overall changes in scores between pre-test and post-test resulted in nearly identical values [98].

Study	CD Rom	Online	Face-to-face	Blended	Control/usual care
Aggarwal et al. 2011					
Chenkin et al. 2008					
Downs et al. 2006					
Fordis et al.,2005					
Harris et al., 2008					
Hemmati et al., 2013					
Horiuchi et al., 2009					
Hugenholtz et al., 2008					
Khatony et al., 2009					
Maloney et al., 2011					
Pelayo et al., 2011					
Sherman et al., 2012					
Vollmar et al., 2010					

Table 7 - Intervention formats

Discussion

Main findings

With 13 studies eligible for inclusion in this review, eleven [1-3,96,97,99-103,105] compared online with face-to-face learning, with only two comparing blended with face-to-face learning [98,104]. There were no studies comparing blended with online learning only. Eleven of the studies focused on knowledge gain as the primary outcome [1-3,96-102,105], with three of these studies including attitudes (perception of confidence) or change in practice as additional outcome measures [1-3]. Two of the thirteen studies assessed disease detection, diagnosis and management/ concordance with guidelines [1,103].

Knowledge gain was the most common outcome assessed across all populations with twelve of the studies concluding comparable knowledge gains between online and face-to-face delivery in CME/CPD [1,2,96-105]. Pelayo *et al.,* [3] was the only study to find an increase in knowledge gain in the online intervention group versus the traditional face-to-face training control group. In the Vollmar *et al.,* [104] blended learning study those GPs who actually accessed the online components of the blended learning course did have slightly higher knowledge gains than those who only participated in the face-to-face workshops however the numbers who accessed the online modules were small and so the authors concluded no significant difference between the two delivery modalities.

In regards to attitude change, only three of the studies considered this as an important outcome with Pelayo *et al.,* [3] confirming a significant increase in perception of confidence in symptom management and communication for the online group. Fordis *et al.,* [1] concluded comparable changes in knowledge and attitudes in both the online and face-to-face groups however was the only study to demonstrate behavior change in the online group. Maloney *et al.,* [2] in his allied health groups of physiotherapists, occupational therapists exercise physiologists and nurses, found change in practice to be similar for both internet and face-to-face groups.

When assessing what elements of online learning elicit change, only Fordis *et al.,* [1] was clear in delineating these characteristics. He concluded that online learning that is “appropriately designed, evidence based can produce objectively measured changes in behavior” and this he achieved offering the online intervention group various learning choices including “interactive cases with feedback, enabling tools and supporting resources and access to expert advice throughout the post

intervention period". There were no other studies that provided this breadth of variation in the online intervention group.

Comparing online with face-to-face learning – different view points

Numerous studies have been conducted comparing the effectiveness of online learning or the effectiveness of face-to-face learning in CME/CPD delivery but it appears this is the first review that has looked specifically at studies comparing the two modalities.

Davis *et al.,* [106] in his review of various face-to-face methods of delivery found that "interactive CME sessions that enhance participant activity and provide the opportunity to practice skills can effect change in professional practice and on occasions, health care outcomes".

Mazmanian and Davis [107] reconfirmed that hands-on practice sessions are more significant in changing behaviors and patient outcomes and that didactic lectures alone are unlikely to change practice. They also concluded that chart audits with feedback are an effective tool for changing clinical behaviors as we saw in the Fordis *et al.,* [1] study.

With this review showing similar effectiveness in knowledge gain, attitudes and clinical practice change between face-to-face and internet based learning, one must look towards the advantages of the web in regards to ease of access for the learner, the ability for the learning to be accessed at any time, enhancing the learning through further web research together with preference especially in the younger generation who are so "internet-connected'. Cost is also a consideration for internet based learning as although there are costs involved in the initial set-up of effective online learning systems, these are quickly overcome with the ease of content updates, more extensive access by many and the reduction or removal of travel costs to participate in the learning.

With only two of the thirteen studies including blended learning as a modality [98,104], it is difficult to draw conclusions as to the effectiveness of blended learning compared to either face-to-face alone or in combination with internet based learning. Vollmar *et al.,* [104] had a very small number of participants who, in addition to attending traditional face-to-face workshops, had the opportunity to access the available online learning modules and these participants did have higher

knowledge gains than those who only participated in the face-to-face workshops. Although this would suggest blended learning has advantages, the numbers were too small to be conclusive.

In the Sherman *et al.,* [98] blended learning study, the pre and post-test scores on knowledge gain showed no significant differences between the groups with the authors concluding "gender, age, nursing experience, educational preparation or online learning experience of participants did not influence the effectiveness of the learning method and post-test score."

Elements of online learning

For understanding the principles of effective web-based learning, Cook and Dupras [108] suggested a 10 step approach to online learning development with recognition that to be effective one must utilize the capabilities of the web by using multimedia, hyperlinks and online communications. The authors specifically state that the first step to effective online learning must be to perform a needs assessment which includes problem identification and assessment of learner needs.

The hyperlinks and searching ability of online learning fits the constructionist learning theory allowing the learner to search out and create their own knowledge bases. Few of the studies in my review considered this as important although Fordis did suggest that multiple exposures to the learning may have accounted for the increased rate of pharmacotherapy for the high risk patients.

Three of the studies, [1-3] included tutorials or faculty for the online learners to enhance the learning experience and to provide discussion around issues either with the learning materials or the interface.

Downs *et al.,* [103] used three different approaches to adult learning theory with the workshops allowing peer reflection around real cases, electronic tutorials for self-directed learning and decision support software for case based learning in real time. Fordis *et al.,* [1] also incorporated similar interactive multifaceted instructional designs in each of the two delivery mediums to allow for different adult learning approaches.

Strengths and weaknesses of the included studies

All studies were RCTs which is a rigorous design and all studies except for two [3,103] used a pre and post-test method for assessing knowledge gain. Three of these, [1,97,101] included an additional test at three months post intervention while Chenkin *et al.,* [96] conducted his post test at two weeks rather than immediately post intervention.

All studies also found similar increases in knowledge gain for both delivery modalities with a high degree of acceptability and satisfaction being reported for both formats in more than half the studies.

Although web-based learning is sometimes branded as challenging due to different learner experiences with the web, this was not reported in any of the studies in this review.

Pre-testing of knowledge will sometimes be deemed a needs assessment but although these will alert the teacher to gaps in knowledge they do not provide evidence of learning needs or gaps in domains outside knowledge. Knowledge retention was also assessed immediately post intervention in all but five of the studies [1,96,97,101,104] with only Vollmar *et al.,* [104] reassessing knowledge at six months. This lack of follow-up to the learning diminishes our ability to confer longevity of knowledge retention and therefore suggests a lack of generalisability.

Although both Fordis and Maloney assessed change in practice, only Fordis reported an increase in the online group for prescribing therapy for high risk patients.

Populations were heterogeneous between studies making comparisons difficult while population size between studies also differed hugely. Seven of the studies [1,96,98,99,101,102,105] had participant numbers of less than one hundred which due to small statistical differences may account for the lack of difference in effectiveness between the modalities. The precision provided in many of the studies is unwarranted considering the small population numbers however this review has included numbers as reported by the authors.

Strength and weaknesses of the review process

The method of study selection in this review was strong through the inclusion of the main healthcare databases however as technology databases were not included some studies may have been missed.

Including only English studies also reduces the strength of this review although grey literature was also included in the hope of diminishing the absence of important data.

Studies were also reviewed by myself and my supervisor to ensure all studies fitted the selection criteria.

My career, based on the development and deployment of CME/CPD for healthcare professionals in Australia and Asia, lends an immediate bias to this review due to my own anecdotal expectation that blended learning, a format we regularly use, would be superior to either face-to-face or online delivery alone for showing improvements across domains.

Quality of the evidence

With only three studies [2,96,103] using blinded outcomes assessment the majority of the studies in this review would be categorized as having a high risk of detection bias. Selection bias was of a much lower risk as eight of the studies [1-3,96,100-103] included computer generated random number sequencing or other techniques such as block randomization. Four of the studies [2,97,102,104] had high attrition bias due to relatively high participant drop-outs from randomization to completion.

Findings in relation to other studies

In his systematic review of the effectiveness of CME delivery, Marinopoulos *et al.,* [31] set out to answer several questions, the first of which was based around assessing which particular methods of delivering CME are more effective in: “a) imparting knowledge to physicians, b) changing physician attitudes; c) acquiring skills; d) changing physician behavior, or e) changing clinical practice outcomes”.

Although the studies he included were heterogeneous, he believed that "the trends demonstrated that CME is effective at producing short and long-term knowledge gains and that, when possible, multimedia, multiple techniques and multiple exposures should be used". He also concluded a trend that multimedia appears better than a single media intervention to improve attitudes, with case-based learning being more likely to be associated with attitude improvements. For practice behaviors, multimedia was deemed advantageous over single media for this outcome.

In a very recent systematic review assessing the effectiveness of online, blended and face-to-face learning of clinical skills acquisition in student nurses, McCutcheon *et al.,* [109] suggested that the improved performance of the online or blended learning students as compared to the traditional face-to-face group might be due to those student's ability to repeat the online activities and review the contents at their own pace.

This reflects the same suggestions made by Fordis *et al.,* [1] in his review regarding the ability of the online learner to frequently access and review the learning materials.

In McMahon's [110] viewpoint, he suggested that clinicians need to "take responsibility for choosing educational activities that meet their educational needs, rather than choosing activities that are merely convenient". This would suggest that some activities may need to be delivered face-to-face while others would be as effective through online delivery. If learners are to choose activities that meet their needs then surely education activities should not be considered until the needs are assessed, something sadly lacking from the studies in my review.

Cervero and Gaines [111] in their updated synthesis of systematic reviews in assessing the effectiveness of CME (taking into account all delivery methods), concluded that "CME leads to improvement in physician performance and positive health outcomes if it is more interactive, uses more methods, involves multiple exposures, is longer, and is focused on outcomes that are considered important to physicians". One could surmise from this conclusion that blended learning should be more effective than online or face-to-face alone as blended allows extensive interactivity, requires using more methods and allows for multiple exposures. Although these elements were available in the two blended learning studies in my review the evidence did not suggest superiority in knowledge transference or patient outcomes.

In general, this review failed to find a statistically significant difference between online versus face-to-face delivery for knowledge acquisition. We did however see confirmation through Fordis's study that appropriate educational components can show improved outcomes through behavior change.

What does my review mean for educators and developers of education?

The challenge for educators moving forward will be to effectively create educational offerings which are needs based, are more interactive, involve multiple delivery methods and allow multiple exposures. Although most of these elements of effective education can be delivered through online learning alone, consideration is required for those learners who prefer face-to-face learning. Although this would suggest that blended learning environments that combine online and face-to-face should be more effective, this review did not find this result.

In regards to outcomes and the most common being knowledge gain, educators have perhaps more flexibility in their choice of delivery formats due to them all being as effective as each other. Long term knowledge retention though was similarly not included in the selected studies and therefore no decisions around this important outcome can be made. Practice change which is usually the desired outcome for CME/CPD cannot be assumed from this review either as this simply was not covered sufficiently to draw conclusions.

Recommendations for research

Future research should be needs based with the inclusion of outcomes of more than simply knowledge gain. Attitudes and change in practice are essential if CME/CPD is to continue to hold value for the learner and the patient. Studies need to be more learner-centric than teacher-centric to be more needs and learner gap oriented.

Future studies should also endeavor to include longer timeframes of learning with further assessments than only immediately post intervention. What is the point in education if the learning does not linger so the learner considers and has the opportunity to act upon the learning in the context of their patient management?

It is interesting to consider if some of the known elements of successful learning outcomes had been included in these studies, would the results have been different? Would the blended learning approach be more effective if known successful methodologies were included?

For my own working life this review has provided me with tools to understand that there is more to successful education delivery that the actual delivery tool. Educational design, based on learner needs and gaps, focusing on their preferences for learning and outcomes that are important to the learner are key to the development and delivery of effective education.

Conclusions

Although my expectation upon commencement of this review was that blended learning would prove to be more effective than either face-to-face or online learning alone, this was not evidenced by the papers included. Face-to-face and online learning have almost identical outcomes with respect to knowledge and only when additional elements are included in the online component does there seem to be a minor benefit in terms of additional outcome measures.

I believe further research is required to truly test the concept of the effectiveness of blended learning versus both online and face-to-face so that educators and content developers can better utilize these different delivery methods to their best advantage. It seems unlikely that delivery of education through a face-to-face medium will decline in the coming years, however understanding how this delivery can be enhanced through the inclusion of effective online components should help to increase knowledge and its retention, satisfaction and outcomes generally in the learner population.

Educators need evidence to confirm that the way things are done is effective and what else needs to be included to enhance this effectiveness. Time poor clinicians need to be assured that the education they access online is of the highest standard and is designed to enable better learning and behavior change than is presently evidenced in the literature.

This review is important because it shows that more research is required to help answer the burning question around how clinicians can enhance their learning and how their behaviors can best be modified for the good of the patient in the advancing technological world.

I hope that in the coming years I am able to focus further on evidence based research to confirm the value of online learning, combined with face-to-face learning to enhance outcomes in the HCP populations of Australia and Asia.

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Appendices

Appendix A - Principles of adult learning

- Adults have accumulated a foundation of life experiences and knowledge. The educational implication is that life experiences and prior learning should be connected to new information.
- Adults are autonomous and self-directed and therefore involvement of participants in the learning process, with educators serving as facilitators may be desirable
- Adults are goal-oriented therefore it would be appropriate to provide educational programmes that are organized with clearly defined elements, clearly showing how the programme will help participants reach their goals.
- Adults are relevancy-oriented and practical, therefore an educational programme be relevant and applicable to participants' practice.
- Adult learners need to be respected allowing for opinions to be voiced freely, so the experiences that adult participants bring to the learning environment should be acknowledged.
- Adults are motivated to learn by both intrinsic and extrinsic motivation and it could be beneficial if learners are shown how the learning will benefit them, and a comfortable and appropriately challenging learning environment is provided.
- Adults learn best when they are active participants in the learning process, so opportunities should be provided for sharing experiences, questions, also activities that require participants to practice a skill or apply knowledge.
- Not all adults learn the same way, therefore different learning styles could be accommodated by offering a variety of training methods (e.g. group discussion, lecturing, case studies etc.) and also varying the media used to deliver the programme
- Adults learn more effectively when given timely and appropriate feedback and reinforcement of learning, so providing opportunity for feedback from self, peers, and instructor could be beneficial
- Adults learn better in an environment that is informal and personal, so group interaction should be promoted.

Appendix B - Australian Medical Colleges and their CME/CPD requirements

Royal Australasian College of Surgeons [112]

No longer a triennial programme since 2013, the college changed to an annual requirement for CPD. Fellows who meet the annual requirements of the programme are eligible to receive a Statement of Compliance. The ultimate sanction under the policy is loss of Fellowship.

Requirements for different types of surgical practice include:

1. Operative practice in hospitals or day surgery units
    - Undertake peer reviewed surgical audit and participate in an audit of surgical mortality (Category 1)
    - Accrue 10 points for Clinical Governance – Quality Improvement, Evaluation of Patient Care and Professional Advocacy (Category 2)
    - Accrue 60 points from Performance Review (Category 3) and/or Maintenance of Knowledge and Skills (Category 4)
2. Operative procedures in rooms only
    - Undertake a peer reviewed surgical audit and participate in and audit for surgical mortality where appropriate (Category 1)
    - Accrue 60 points from Performance Review (Category 3) and/or Maintenance of Knowledge and Skills (Category 4)
3. Operative practice as a locum only
    - Undertake a peer reviewed surgical audit and participate in and audit for surgical mortality where appropriate (Category 1)
    - If a peer reviewed audit is unavailable, maintain a logbook of surgical procedures and present this for review for the Locum Evaluation and Peer Review Committee.
4. Clinical consulting practice only
    - Accrue 60 points from Performance Review (Category 3) and/or Maintenance of Knowledge and Skills (Category 4)
5. Other practice type (research, administration, academic, teaching, assisting)
    - Accrue 60 points from Performance Review (Category 3) and/or Maintenance of Knowledge and Skills (Category 4)

Royal Australasian College of Physicians [113]

Fellows must record at least 100 credit hours a year in order to receive a Certificate of Completion.

Framework:

Category 1: Educational development, teaching and research (1 credit per hour; maximum 50 credits)

Category 2: Group learning activities (1 credit per hour; maximum 50 credits)

Category 3: Self-assessment programmes (2 credits per hour)

Category 4: Structured learning projects (3 credits per hour)

Category 5: Practice review and appraisal (3 credits per hour)

Category 6: Other learning activities (maximum 50 credits)

Royal Australian and New Zealand College of Radiologists [114]

Based on a three-year cycle; candidates should accrue a minimum of 180 points in the 2013-2015 triennium; or a minimum 30 points per CPD year and no more than 90 points will be credited to any one year; participants should accrue CPD points from a minimum of 3 categories in each: teamwork, communication skills, patient support and advocacy, professionalism, management and administrative skills, research and education.

Skill set:

1. Medical expert
    - Expert radiology knowledge
    - Clinical decision making skills
    - Interventional expertise and judgment
2. Communicator
    - Publications and presentations
3. Professional
    - Audit activities and quality assurance activities
    - Professional and clinical governance
    - Self-directed learning
    - Conferences and meetings
4. Patient support and advocacy
    - Audit and quality assurance activities
    - Professional and clinical governance
5. Collaborator and teamwork
    - Audit and quality assurance activities
    - Radiology research
6. Manager
    - Professional and clinical governance
    - Conferences and meetings
7. Researcher/Scholar (Educator)
    - Education
    - Radiology research
    - Publications and presentations
    - Self-directed learning

Royal College of Pathologists Australasia [115]

Participation in continuing professional development programme (CPDP) or an equally structured program was made mandatory from January 2006. Fellows who have not been participating in CPDP, or equivalent, will not be given a Certificate of Good Standing.

The CPDP requirement is for 500 hours over a 5-year cycle, commencing from the Fellow's first submission since the new program began in 2003 with a maximum of 200 hours accredited in any one year.

Category A: Group Activities/Meetings (minimum 20 hours per annum)

Category B: Personal Study (minimum 20 hours per annum)

Category C: Quality Activities (minimum 10 hours per annum)

Royal Australian College of General Physicians (RACGP) [116]

The RACGP Quality Improvement and Continuing Professional Development (QI & CPD) triennnial programme. The 2014–16 triennium requirements include:

1. 130 points
2. 1 x cardiopulmonary resuscitation (CPR) course
3. 2 x Category 1 activities (including 1 x Quality Improvement activity)

Category 1 Accredited Activity options

1. Inherent quality improvement activities
    - Clinical audit (40 points)
    - Plan Do Study Act cycles (40 points)
    - Small group learning (40 points)
    - Evidence based medicine journal club 40 points)
    - Supervised clinical attachment (40 points)
    - General Practitioner (GP) research (40 points)

Other Category 1 Options

- Active learning module (40 points)
- Peer review journal article (40 points)

Higher education relevant to general practice

- Graduate Certificate courses (60 points)
- Graduate Diploma courses (90 points)
- Masters Degree (120 points)
- PhD (150 points)
- RACGP Assessment (150 points)

Category 2 options

- CPR course (5 points)
- Cultural awareness training
- Accredited Activity Provider Category 2 Accredited Activities (capped to a maximum of 30 points per activity)
- Individual GP Category 2 unaccredited (two points per 1 hour and capped at 20 points per triennium)

Quality improvement reflection

- Capped at 5 points per activity per year

Australasian College of Dermatologists [117]

Triennium system; all Fellows and CPD participants who meet the requirements of the programme will be issued a certificate at the conclusion of the triennium.

The CPD Program requires a minimum of 300 points to be accumulated over a three-year cycle. Participants must gain at least 50 points per year, and no more than 150 points per year will be counted towards the total.

Category 1: Clinical and education: maintenance of contemporary clinical knowledge and skills/research learning and teaching.

Category 2: Quality assurance: quality improvement and risk mitigation

Category 3: Professionalism, cultural awareness, ethics and advocacy

Royal Australian and New Zealand College of Ophthalmologists (RANZO) [118]

Annual cycle; at the end of each cycle, CPD Compliant Fellows will receive a Certificate of Continuing Professional Development. Fellows must complete a minimum of 80 points per year including 30 points from Clinical Expertise Level 2; part-time fellows must complete a minimum of 50 CPD points per year.

The RANZO framework consists of three categories reflecting the seven key roles and attributes of a specialist ophthalmologist - Medical Expert, Communicator, Manager, Collaborator, Health Advocate, Scholar and Professional.

- Category 1: Clinical Expertise
- Category 2: Risk Management and Clinical Governance
- Category 3: Professional Values

Within each category, two levels of activities are recognized:

- "Level 1" activities include traditional, passive learning activities such as lectures, conferences and journal reading.
- "Level 2" activities are those that focus on implementing or facilitating changes in practice and health outcomes. Examples of such activities include clinical and surgical audits, practice visits, and patient satisfaction surveys.

Royal Australian and New Zealand College of Obstetricians and Gynecologists (RANZCOG) [119]

In 1986 RANZCOG fellowship become linked to a mandatory programme of continuing education and recertification and in 1999 it became a three year cyclic CPD program.

Participants need to gain a total of 150 CPD points over your 3-year period, of which a minimum of 25 must be obtained in the practice review and clinical risk management (PR&CRM) category.

Alternatively, all 150 CPD points in the PR&CRM category.

- Participants can claim in the PR&CRM category for attending clinical meetings such as peer or case review including morbidity and mortality meetings, quality assurance, health improvement, and infection control relating to obstetrics and gynaecology.
- Attendance at these meetings can be claimed at a rate of 1 point per hour of participation or presentation an extra 1 point per hour in PR&CRM if the participant is presenting a case for the preparation time.

Participants can only claim a maximum of 75 points in each of the following categories: Educator Activities, Meeting/Conference Attendance and Self Education Activities.

Appendix C - CME/CPD engagement in Asian countries

Countries	CME/CPD organization(s)
Bangladesh	Bangladesh Medical and Dental Council http://bmdc.org.bd/
Bhutan	Bhutan Medical and Health Council Regulation Guidelines on Continuing Medical Education 2009. http://www.bmhc.gov.bt/downloads/cme_guidelines.pdf.
Cambodia	Medical Council of Cambodia. http://www.mcc.org.kh/ws/index.php?lan=en
China	China Ministry of Health. Report on Continuing Medical Education http://cme1.91huayi.com/pages/news_article.aspx?info_id=3021d47d-26f0-4ad6-b702-0ca91f3e8038&&KeyLink=zcfg
Hong Kong	Hong Kong Medical Association http://www.hkma.org/english/cme/cme.htm
India	Bulletin of the World Health Organization. 5 February 2004. Continuing medical education in India. http://www.who.int/bulletin/volumes/82/2/feature0204/en/.
Indonesia	Indonesian Medical Association (Not in English) http://www.idionline.org Universitas Indonesia http://cme.fk.ui.ac.id/ Trisakti Univeristy http://cpdfkusakti.com/en
Laos People's Democratic Republic	Lao Medical Association http://masean.wordpress.com/lma/
Japan	Japan Medical Association http://www.med.or.jp/english/index.html
Malaysia	Malaysian Medical Association http://www.mma.org.my/
Maldives	Maldives Medical Council Good Medical Practice: A code of conduct for doctors in Maldives. http://mmc.gov.mv/ethicals-codes-and-guidelines/good-medical-practice/.
Myanmar	Myanmar Medical Association. http://mmacentral.org/.
Nepal	Doctors Society of Nepal http://drsocietyofnepal.blogspot.com/
Philippines	Philippine Medical Association. https://www.philippinemedicalassociation.org/index.php.
Singapore	Singapore Medical Council. Continuing Medical Education 2011. http://www.healthprofessionals.gov.sg/content/hprof/smc/en/leftnav/information_for_registereddoctors/continuing_medical_education.html.
Sri Lanka	College of General Practitioners of Sri Lanka. http://cgpsl.org/.
Republic of Korea (South Korea)	Korean Medical Association. http://www.kma.org/english/7_activities.php?imagename=Image19&newimage=images/b_m7b.gif

Countries	CME/CPD organization(s)
Taiwan	National Taiwan University Hospital. https://www.ntuh.gov.tw/en/EDU/Continuing%20Medical%20Education/Home.aspx.
Thailand	Medical Association of Thailand http://www.med.or.jp/english/journal/pdf/2012_01/087_093.pdf
Timor-Lest	Ministry of Health Timor-Leste http://www.moh.gov.tl/
Vietnam	Vietnam Medical Association (Not in English) http://yhocvietnam.com.vn/