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Interprofessional Online Learning for Primary Health Care: Findings from a Scoping Review

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Abstract

Objectives: This article presents the findings from a scoping review which aims to explore the nature of interprofessional online learning in primary care. The study was informed by the following questions: What is the nature of evidence on online postgraduate education for primary health care interprofessional teams? What methods of interprofessional e-learning if identified work – i.e. improve learning outcomes?

Setting: The review explored interprofessional online learning in primary care settings and their international equivalents.

Participants: n/a

Primary and secondary outcome measures: n/a

Results: The review found that the 23 included studies employed a range of different e-learning methods with contrasting course durations, use of theory, participant mix, approaches to accreditation and assessment of learning. Most of the included studies reported outcomes associated with learner reactions and positive changes in participant attitudes/perceptions and improvement in knowledge/skills as a result of engagement in an e-learning course. In contrast, fewer studies reported changes in participant behaviours, changes in organisational practice and improvements to patients/clients.

Conclusions: A number of educational, methodological and outcome implications could be offered. E-learning enhances education experience, supports development, eases time constraints, overcomes geographic limitations and offers greater flexibility. However it also contributes to the isolation of learners and its benefits can be negated by technical problems.

Article Summary

Strengths and limitations of this study

Strengths

- The study performs a much needed review of the literature into an increasingly significant educational approach in primary healthcare.
- It enables the identification of effective educational interventions and where these interventions can be improved.

Limitations

- The search was limited to publications from 2000 onwards and included only those published in English. Any relevant publications which fall outside of this criteria will therefore not have been included.

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Background

Online (e-learning) has been a growing part of health professions education for well over a decade. Meta-analyses reporting the effects of e-learning studies have found that this type of education is effective for improving a range of professional competencies – attitudes, knowledge, skills and behaviours (1, 2). The advantages of e-learning in the for health professions education include diminishing logistical barriers (anytime, anyplace learning for busy health care providers working in different environments), and individualized, tailored, point-of-care learning that meet the varied needs of professional learners from multiple practice settings (3).

It has been reported that online learning can be as effective as physical attendance in a traditional classroom, however, consideration must be given to factors such as development of clear guidelines for educators regarding roles and responsibilities, clear learner competencies, even access to technology and sufficient funding (4). Applied learning approaches, such as scenarios and interactive 'second-life' programmes, can be engaging, although there is a need to ensure training is relevant to clinical evidence-based practice (5). Use of free web tools, such as Skype and Moodle have shown useful educational outcomes, while alleviating travel pressures and expenses for learners (6).

There is also evidence that the benefits of using online learning can result in less constrained discussion, as learners feel more able to engage in online discussions rather than verbal face-to-face conversations (7). It has also been found that e-learning can enhance the quantity, quality, cost and accessibility of health professions education (8), though technological problems can often a key disrupting factor (9)

However, it has been indicated that online learning may be viewed by some as isolating and disconnected when compared to traditional learning methods due to lack of a social connection (10). In addition, it has been noted that technological difficulties can undermine this method as well as a potential loss of collegiality linked to traditional forms of face-to-face learning (6).

When used to promote interactions and relations between different professional groups, an increasing number of studies have suggested that the use of e-learning technologies can enhance interprofessional collaboration (11, 12). While interprofessional e-learning can help with the logistics and costs of traditional face-to-face collaborative learning and can help overcome the isolating effects learners can feel when learning alone online, there is added complexity with

managing new software, a loss of nonverbal group cues and technological glitches which can undermine at times undermine its quality (13). Nevertheless, it has been found that this type of e-learning can support professionals to connect together online to discuss and co-create solutions to real-life issues for patients/clients from geographically disparate locations (3).

As indicated above, while there has been a growth of both professional and interprofessional e-learning in health professions education, to date, there has been no effort undertaken to explore the use of interprofessional e-learning for primary care teams. To fill this gap in knowledge, this review will attempt to provide an overview of the empirical literature in order to generate an insight into the nature of evidence of e-learning for primary care teams.

Methods

A scoping review methodology was selected as it provides a summative 'map' of the literature within a particular field (14, 15). Unlike systematic reviews, scoping reviews do not seek to answer a specific question, nor do they examine the quality of the reviewed literature (14-16). Rather, this methodology aims to capture an image of the breadth and depth within a particular field (15). The goal of a scoping review may be to "examine the extent, range, and nature of research activity, determine the value in undertaking a full systematic review, summarizing and disseminating research findings, or identify gaps in the existing literature" (15). This review specifically concerns the examination of the extent, range and nature of evidence for the use of interprofessional e-learning for primary care teams. Within this review, Arksey & O'Malley's (14) six-step framework for interpretive scoping literature reviews was utilised with modifications (15, 17) (See Table 1).

Review Stage	Description
1: Identifying the research question	Identifying the research question provides the roadmap for subsequent stages. Relevant aspects of the question must be clearly defined as they have ramifications for search strategies. Research questions are broad in nature as they seek to provide breadth of coverage.
2: Identifying relevant studies	This stage involves identifying the relevant studies and developing a decision plan for where to search, which terms to use, which sources are to be searched, time span, and language. Comprehensiveness and breadth is important in the search. Sources include electronic databases, references lists, hand-searching of key journals, and organizations and conferences. Breadth is important; however, practicalities of the search are as well. Time, budget and personal resources are potential limiting factors and decision need to be made upfront about how these will impact

	the search.
3: Study selection	Study selection involves *post hoc* inclusion and exclusion criteria. These criteria are based on the specifics of the research question and on new familiarity with the subject matter through reading the studies.
4: Charting the data	A data-charting form is developed and used to extract data from each study. A 'narrative review' or 'descriptive analytical' method is used to extract contextual or process oriented information from each study.
5: Collating, summarizing, and reporting results	An analytical framework or thematic construction is used to provide and overview of the breadth of the literature but not a synthesis. A numerical analysis of the extent and nature of studies using tables and chart is presented. A thematic analysis is then presented. Clarity and consistency are required when reporting results.
6: Consultation (optional)	Provides opportunities for consumer and stakeholder involvement to suggest additional references and provide insights beyond those in the literature.

Table 1: Overview of the framework for conducting a scoping study

Identifying the Relevant Research Question

Responding to the intention to formulate and establish an interprofessional e-learning model, the research questions should enable: the mapping of existing work which addresses interprofessional e-learning in primary care teams; an understanding of the influence of such work and the depth and breadth of 'the field'; and the identification of significant knowledge gaps and areas for improvement. With these points in mind the following research questions were posed:

- What is the nature of evidence on online postgraduate education for primary health care interprofessional teams?
- What methods of interprofessional e-learning if identified work – i.e. improve learning outcomes?

Online or e-learning can be described as both a pedagogical and technological approach (3). As a result, this report presents the research questions above in a way which focused on two elements. First, the characteristics of the interprofessional e-learning approaches/methods evaluated in included studies. Second, the range of reported consequences (outcomes) for primary care learners, their organisations and the care delivered to patients/clients.

Identifying Relevant Studies

Using the research questions as a guide, keywords were applied to a search strategy which was then preliminarily applied to the electronic databases Medline and Cinahl. This offered an indication of the relevance of the search terms and the subsequent feasibility of their application was based on the numerical results generated from this preliminary search. This process enabled the following search strategy to be adopted. (See Box 1)

#1 Primary Care #2 Care, Primary Care #3 Healthcare, Primary #4 Care Primary #5 General Practice #6 #1 or #2 or #3 or #4 or #5 #7 Interprofessional or Inter-professional #8 Interdisciplinary or Inter-disciplinary #9 Multidisciplinary or Multi-disciplinary #10 Team or Teamwork #11 #7 or #8 or #9 or #10 #12 E-learning #13 Electronic Learning #14 Learning, Electronic #15 Remote Learning #16 Learning, Remote #17 Learning, Blended #18 Video conferencing #19 #12 or #13 or #14 or #15 or #16 or #17 or #18 #20 #6 and #11 and #19

Box 1: Search terms

Following a consultation with university information scientists in an attempt to gauge the efficacy of the strategy and identify further databases, these key terms were applied to six electronic sources. Including studies from January 2000 to October 2015, the following databases were searched:

- Medline
- Cinahl
- British Educational Index
- Pubmed
- Scopus
- Web of Science

An additional search of online and grey literature through Google and Google Scholar, and a further hand search of the 10 journals which have published the most papers found in the searches (See Box 2).

British Journal of Community Nursing
BMC Public Health
BMC Medical Education
BMJ Quality and Safety
British Journal of General Practice
Education for Primary Care
Journal of Continuing Education in the Health Professions
Journal of Interprofessional Care
Medical Teacher
Trials

Box 2: Journals searched

From an initial yield of 1,568 potential sources (generated from electronic database and additional searches), which through a rigorous screening process (see below), the review yielded 23 included studies. (See Figure 1)

Study selection

In order to address the research question for this review, the following inclusion criteria were employed:

- Papers that describe evaluations of online/e-learning involving interprofessional teams based in primary care/family care
- All research evaluation designs (e.g. action research, case study, ethnographic, experimental, quasi-experimental studies)
- Any reported outcome from the online/e-learning evaluation (see outcomes typology below).

As the searches and screening of potential sources progressed, it became apparent that there was very little literature reporting online *postgraduate* education for primary health care *interprofessional teams.* As a result, two key modifications were made to the inclusion criteria. First, the scope of review was widened to include *postgraduate education* and *continuing education*. Second, the review was widened to include team-based interprofessional online learning as well as

general interprofessional e-learning (involving primary care practitioners, but not necessarily based in the same interprofessional team).

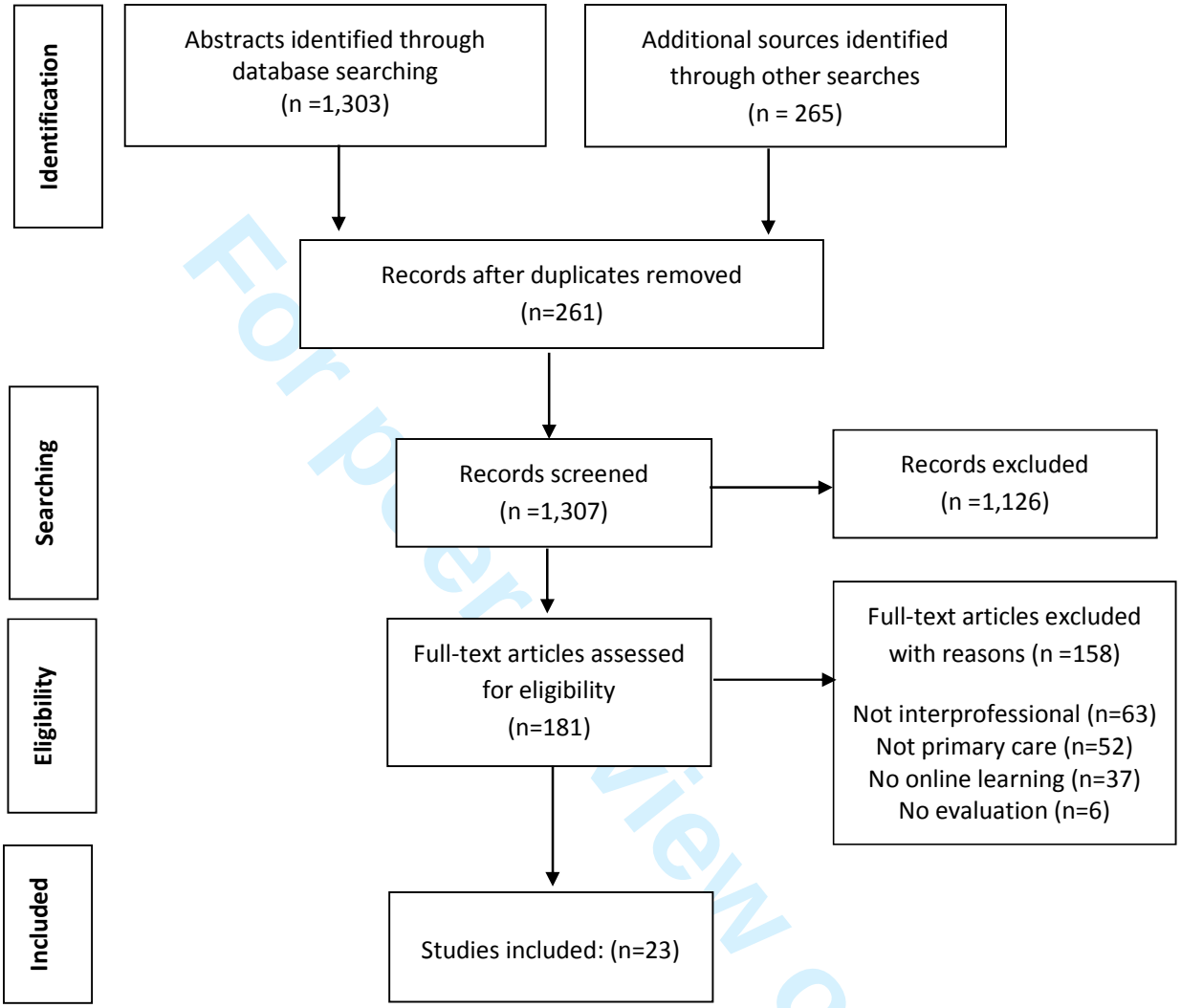

Figure 1: Searching and screening results

Charting the Data

Key information from the included studies was abstracted by combining a categorisation of e-learning methods (18) with an abstraction approach used in a previous systematic review (19).

Using this approach, the following information was elicited from each of the included studies:

- Study aims/objectives
- Research design, sampling, data collection/analysis

- Location and duration of the e-learning intervention/activity
- Professional mix of learners
- Methods of e-learning employed
- Technologies used to support e-learning
- Assessment/accreditation of learning
- All reported outcomes from the e-learning activity.

Collating, Summarizing, and Reporting the Results

Given the heterogeneous nature of the included studies, a thematic approach to the analysis was employed (20). This allowed the emergence of key issues (themes) from the literature, enabling in addition an insight into the characteristics related to online learning.

In addition, to capture the diversity of reported outcomes in the included papers, (19) extended version of Kirkpatrick's educational outcomes model, which has six differing but non-hierarchical levels, was utilised (see Table 2).

Outcome	Details
Level 1 – Reaction	These outcomes cover learners' general views and perspectives on the learning experience, its organisation, presentation, content, teaching methods and organisation (e.g. time-tabling, materials, quality of teaching)
Level 2a – Modification of attitudes/perceptions	These outcomes relate to changes in reciprocal interprofessional attitudes or perceptions between participant groups, towards patients/clients and their conditions, circumstances, care and treatment
Level 2b – Acquisition of knowledge/skills	These outcomes relate to the acquisition of concepts, procedures and principles of interprofessional collaboration. For skills, this relates to the acquisition of thinking/problem-solving, psychomotor and social skills linked to collaboration
Level 3 – Behavioural change	Outcomes at this level measure the transfer of interprofessional skills and learning to workplace, such as support for change of behaviour in the workplace or willingness of learners to apply new knowledge and skills about collaborative work to their practice style
Level 4a – Change in organisational practice	These outcomes relate to wider changes in the organisation/delivery of care, attributable to an education programme, such as, changes in organisational policies or clinical pathways that promote interprofessional collaboration, communication and teamwork
Level 4b – Benefits to patients/clients	These outcomes cover any improvements in the health and well-being of patients/clients as a direct result of a programme. Where

	possible, such as, health status measures, disease incidence, duration or cure rates, mortality, complication rates, readmission rates, adherence rates, patient or family satisfaction, continuity of care, costs to carer or patient/client.

Table 2: Key outcomes

Methodological Quality

All materials generated from database searches (n=1,303) and additional searches (n=265) were reviewed independently by two members of the review team to determine if they met the inclusion criteria (see above). The full text article was obtained (181 papers) if the abstract met these criteria. These articles were screened independently by two reviewers to determine if they met the inclusion criteria.

Review limitations

There are three key limitations to this review. First, only English-language articles were considered for inclusion in the study. As such, this review did not include potentially relevant materials written in other languages and published in non-English speaking countries. Secondly, the review searched for materials published from 2000, which means any papers published before this date will not have been included. Third, only a partial range of grey literature was searched. For example, the review did not search primary care conferences for possible materials. This restriction on grey literature was necessary to limit the volume of materials and maintain a focus on research studies.

Results

E-learning approaches

Of the 23 included studies, 12 were undertaken in the UK, four in North America (two in the USA and two in Canada) and two studies involved multiple countries (one study included The Netherlands, France and the UK, the other Germany, Austria and the UK). In addition, one study was undertaken in the following countries: Brazil, Australia, France, Germany and Mexico. In relation to professional involvement, medicine (14 studies) and nursing (13 studies) were the two predominant professional groups. Pharmacy was involved in three studies, physiotherapy (2 studies), social work (2 studies), community workers (1 study), nutrition (1 study), occupational therapy (1 study), podiatry (1 study) and psychology (1 study).

Appendix 1 goes on to provide an overview of key contents of the included papers in relation to a number of elements, including, aim of the e-learning course, participants involved, use of e-learning methods, course accreditation and assessment of learning. As this table indicates, the included studies report upon a variety of different primary care e-learning courses in relation to aims, duration and use of underlying educational theory. For example, in terms of course duration, this varied from hours, to a few days to weeks and even years. Similarly, there was a wide range of different numbers of participating professions involved in the studies – from 24 participants in one study to over 30,000 participants in another much larger study. In addition, while just over half of the studies did not mention the use of an underpinning theory in the development of their e-learning course, a variety of contrasting theories were employed by other studies, including, adult learning approaches, social learning theory, theory of planned behaviour and constructionist theory. This heterogeneity is also found in the mixture of differing e-learning approaches, types of interaction, course accreditation and assessment of learning (see Appendix 1).

Methodological approaches

Most studies employed quasi-experimental designs (e.g. pre/post intervention, post-intervention) and typically gathered data in the form of surveys that were not validated. Only one study employed an experimental design (randomised controlled trial) though this study also gathered un-validated survey data. There were also some use of mixed methods and qualitative methods (case study designs) with these studies gathering individual interviews and focus groups. Appendix 2 presents an overview of information relating to key elements of the methodological approaches employed in each of the 23 studies. These results also indicate a wide variety in the sample sizes reported for the included studies – ranging from 24 to over 16,000 participants. Most of the studies employed a convenience sampling technique.

Key educational issues

Based on the analysis and synthesis approach outlined above, a number of key educational issues emerged from the included studies. In total, the following eight issues were identified, including: realising the potential of e-learning, enhancing collaboration and communication, improving time pressures, overcoming geographic boundaries, economics, costs and effectiveness, convenience, flexibility and accessibility, learner isolation and technical challenges.

Realising the potential of e-learning

The review found that a number of the 23 included studies (n=8) provided reports of how the use of e-learning changed the way primary care professionals learned together. Among these, one study (21) stated that the use of e-learning technologies such as "interactive menus, on-line case studies and video-clips" (p.344) could improve the quality of collaborative learning for primary care providers. Another (22) explored the use of online blogs as a learning method in their evaluation of a postgraduate e-learning course found that the use of a blog platform promoted interprofessional interaction and learning which helped generate improved decision-making skills. One further study (23) found that "web-based learning has been identified as offering the potential for students to engage in rich and effective construction of knowledge" (p. 469).

Enhancing collaboration and communication

13 studies reported that the use of e-learning approaches could effectively support the collaborative efforts of participating primary care professionals. For these authors, the advantage of using e-learning methods is that it can foster a sense of collaborative community for participating learners. These authors (24) found that, "the opportunity to train as a whole team was valued […] allowed staff, as one manger said, 'to be singing from the same hymn sheet'. In addition one study (23) reports that, "the online environment has opened up enormous opportunities for interaction between students and tutors and between tutors, and has brought collaborative learning centre stage in distance education" (p. 470-471).

Improving time pressures

The ability of e-learning methods to alleviate some of the time pressures on the clinical workloads of primary care practitioners to engage in professional development activities was found to be an important issue within the included studies (n=5). A study (25) which explored the effect of online learning to support the diagnosis of chronic fatigue syndrome (CFS) in primary care found that, "an online approach (to practitioner education) was preferred as face to face training was thought to be too time consuming' (p.9). These authors go on to note that the convenience associated with online methods was particularly welcomed, as a combination of heavy workloads and the additional complexity of CFS diagnosis meant that ease of access and speed of information transfer was paramount.

Overcoming geographic boundaries

A number of included studies (n=4) found that use of e-learning methods could help to overcome traditional issues of having to deliver the educational content of interprofessional courses in the same geographic location. Exploring the potential of e-learning in the safe use of insulin for general practitioners, nurses and pharmacists, one study (26) reported that, "e-learning provides a practical solution to the provision of evidence based learning across many different staff groups and geographical boundaries" (p.210).

Economics, costs and effectiveness

Encouragingly, a number of studies (n=3) reported a range of positive attributes linked to the cost effectiveness of interprofessional e-learning. For instance, in their study of an online learning course for improving screening of amblyopia in US-based primary care practices, these authors (27) state that they selected an online learning approach "as the best delivery mode to implement facets of adult-based learning relevant to physicians as well as allowing low cost, wide spread dissemination of standardized information to individuals separated by time and distance" (p.7161).

However a number of studies (n=5) also noted other financial implications, some of which are not immediately obvious, that may impede the introduction and sustainability of online education. A small of number of studies acknowledged that there were uncertainties regarding the initial financial investment and subsequent funding of e-learning. For example, in their evaluation of online course for rural practitioners, one set of authors (28) reported that, "significant fiscal and human resource barriers were identified that included the uptake and retention of course participants" (p.635).

Convenience, flexibility and accessibility

Many, if not all of the included papers, indirectly acknowledged this issue related to the use of online interprofessional learning. However four studies made explicit reference to it. One study (29) that explored perceptions of interprofessional e-learning amongst primary healthcare workers in Canada found that, "internet based technology has enabled a more convenient and flexible learning option to meet the needs of busy working healthcare providers" (p. 265).

Learner isolation

Although, as outlined above, online learning has the potential to develop practitioners' professional and interprofessional competence, a small number (n=5) of studies found that the move from traditional approaches to delivering education – in the same space at the same time – to an online environment whereby interactions are virtual in nature can present a challenging transition for some

learners. There is an example of this from the authors mentioned above (29), as they report how "isolation of learners from each other" (p.266) impeded the effectiveness of their online course.

Technical challenges

4 of the included studies reported how technical difficulties linked to the delivery of the e-learning approaches they evaluated in their respective studies undermined the quality of the educational experience for participants. Whilst these studies reported technical issues, these were relatively minor and ultimately resolvable. It should also be noted that the low number of studies which described such issues suggests that this has not been a major cause for concern when compared to other difficulties.

Reported outcomes

Table 3 provides an overview of studies which reported outcomes across the six-point outcomes typology.

Outcome	Number of studies
Level 1 – Reaction	6
Level 2a – Attitudes/perceptions	8
Level 2b – Knowledge/skills	14
Level 3 – Behaviour	7
Level 4a – Organisational practice	4
Level 4b – Patient/client benefit	3
Total	**42**

Table 3: Overview of reported outcomes

As indicated in Table 3, of the total number of outcomes (n=42) reported across the included studies, most (n=28) were associated with individual changes at levels 1, 2a and 2b. In contrast, fewer studies (n=14) reported broader changes at levels 3, 4a and 4b.

Discussion

The evidence in favour of e-learning is significant. Not only do online learning approaches both facilitate and improve interprofessional collaboration, but their practicality and accessibility offer advantages which make them preferable to more 'traditional' educational methods. E-learning has the potential to facilitate complex and multi-faceted collaborative practice in primary healthcare and beyond. Taking place on a number of levels, these improvements can range from team-based relations to global communication between practitioners. Indeed, interprofessional e-learning can

offer a variety of useful opportunities to develop a range of collaborative competencies supported by a number of different e-learning technologies (e.g. online discussion forums, social media applications, message boards).

The review also identified that increasing intensity of primary care practice often creates a distinctly time-sensitive environment which can be alleviated by the use of e-learning methods. Difficulties associated with heavy workloads can be diminished as e-learning is easily accessible and flexible for practitioners. E-learning can therefore contribute to the development of practitioners' competence as they can, for example, incorporate a short online course during a busy working week with minimal disruption to their clinical schedules. As a result, e-learning can have a positive influence in the short and long term, benefitting practitioners as well as the care they deliver to patients/clients.

Given that e-learning approaches can be regarded as invaluable to the coherent and efficient implementation of healthcare practice, it is important to identify and attempt to respond to, any shortcomings or areas for improvement.

The review has reported the isolating potential of remote, computer based learning. The move from the traditional classroom-based approach has resulted in some learners feeling isolated and others noting a lack of support from their online educators. This is a direct consequent of diminishing face-to-face learner-to-learner and learner-to-educator interactions and the use of online learning may affect interprofessional interactions/dynamics which were more easily identifiable in previous contexts. To help overcome such issues, the use of blended approaches offer a useful means of transition between virtual and real educational contexts. Although this can be regarded as a 'solution' which merely serves to negate the beneficial capacity of e-learning, the gradual transition from classroom to computer screen rather than an abrupt relocation may make these changes less emotionally impactful.

Technical challenges have also been reported in a small but notable number of studies. Although these issues were usually linked to minor failures of software and connectivity problems they still combined to cause frustration and disappointment for learners. It is important to note that coherent technological functioning is paramount to the successful delivery of e-learning. If possible such minor faults should be prevented in the first instance as to not disrupt the quality of the e-learning experience. This will ensure that e-learning applications and software meet quality requirements in

enhancing the experience for the learner while fully realising the potential of (increasingly) sophisticated synchronous and asynchronous e-learning technologies.

Conclusion/implications

Overall, the scoping review identified number of key benefits related to the use of interprofessional e-learning for primary care practitioners. Its practicality was consistently reported to contribute to enhanced time management, the removal of geographic limitations and ease of access were found to help strengthen interprofessional collaboration and networking. It was also reported that economic savings could be made with the use of e-learning as reductions in travel costs, institutional overheads, etc. could be realised. However it was noted that e-learning could result in learner isolation, and some technical problems were also identified. These were however, relatively minor in comparison to the reported benefits.

Study outcomes

Collectively, the included studies indicated that the use of e-learning for primary care practitioners generated a range of positive outcomes for participant reactions (level 1), helped to generate improvements to their perceptions and attitudes (level 2a) as well as improvements to their knowledge and skills (level 2b). In addition, while the review indicated that the use of e-learning resulted in gains to participants' individual behaviour (level 3), improvements the way their organisations practiced (level 4a) and could generate benefit for patients/clients (level 4b), there were fewer studies reporting at these levels. While it is important to gather data for outcomes at levels 1, 2a and 2b, future e-learning evaluations should also focus on developing the evidence for its effects on levels 3, 4a and 4b (including data on cost-effectiveness) to help build a more robust insight into the longer-term outcomes for this type of primary care education.

Heterogeneity

While the included studies reported a promising number of outcomes associated to the use of e-learning, the wide range of e-learning activities/course do generate some limitations. Specifically, due to the heterogeneity nature of the e-learning approaches reported in the 23 studies, it is difficult to draw a set of robust implications that can identify which types of e-learning methods may be effective and which may be less so (a problem which is compounded by the use of a mixture of differing study designs and methods). Nevertheless, it is possible to note that studies which employed a variety of approaches such as online self-directed learning, interactive web-based

discussion supported by e-facilitator were well evaluated when compared to studies that only employed a single form of e-learning method. In addition, blended approaches (using online and traditional learning methods) were also well evaluated. However, as noted above, such approaches did increase costs due to the need to pay for learning space and travel expenses.

Self-report data

Another word of caution needs to be applied to the included studies. While the review indicated that these studies reported a range of positive related to the use of e-learning in primary care, most of the 23 studies gathered data in the form of un-validated surveys, individual interviews and focus groups. As a result, the bulk of reported outcomes are based on self-report data. This is a weak form of evidence as it is widely recognised that individuals are often inaccurate in assessing possible changes to their knowledge, skills and behaviours (30). As a result, such reports must be regarded as weak approaches to measuring change.

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Appendix 1

Overview of e-learning approaches

Citation	Aim of e-learning / duration / theory	Participants	E-learning methods	Type of interaction	Accreditation / Assessment
Barber et al., 2010	-To improve knowledge and utilisation of occupational asthma guidelines in primary care -One hour duration -No theory identified	-783 primary care professionals (not specified)	-Online self-directed learning using web-based resources	Asynchronous	BMJ Accredited Formative assessment
Bekkers et al., 2010	-To enhance the quality of antibiotic prescribing amongst primary care practitioners -Duration not indicated -Theory of planned	-244 general practitioners and nurse practitioners	-Online self-directed learning, reflection, interactive presentations and practice-based seminars, simulated SPs,	Mixed: asynchronous & synchronous	-STAR programme accreditation -Formative assessment

	behaviour		web forum		
Buriak et al., 2015	-To improve education on cancer survivorship -Duration not indicated -Theory of planned behaviour	229 physicians, 213 nurse practitioners, 1,367 nurses	Online self-directed learning using patient based case scenarios	Asynchronous	-Professional body accreditation -Formative assessment
Cuggia et al., 2006	-To improve information sharing between primary care professionals -Duration not indicated -No theory identified	General practitioners and nurses (numbers not specified)	Online self-directed learning, real-time interactions and teleconsultations	Mixed asynchronous & synchronous	-Accreditation not mentioned -Formative assessment
Degryse et al., 2009	-to improve knowledge about the diagnosis of dementia -Five hour duration -Discovery learning theory	26 general practitioners and nurses	- Online self-directed learning Interactive software, simulated patient cases	Asynchronous	-Accreditation not mentioned -Formative assessment
Docherty & Sandhu, 2006	-To improve knowledge of interprofessional diabetes care -No duration indicated -No theory identified	35 general practitioners and nurses	-Online self-directed learning, residential workshop, online learning, interactive exercises	Mixed asynchronous & synchronous	-University accreditation -Summative assessment
Fox et al., 2001	-To improve understanding of change management concepts and principles for primary care professionals -12 week duration -Theories of change management	111 post primary care professionals (unspecified)	-Online self-directed learning exercises	Asynchronous	-Accreditation not mentioned -Formative assessment
Gensichen et al., 2009	To improve the understanding of e-learning approaches for primary healthcare professionals -No duration indicated -No theory identified	76 primary healthcare professionals (unspecified)	Unspecified	Asynchronous	-Accreditation not mentioned -Assessment not mentioned
Halabisky et al., 2010	-To enhance collaborative practice among healthcare	59 family physicians, nurses, nurse	Online activities, audio/video clips, worksheets, face-	Mixed asynchronous & synchronous	-Accreditation not mentioned

	teams in long term care homes -8½ hour duration -Change management	practitioners and pharmacists	to- face team contact)		-Formative assessment
Hannon et al., 2012	-Improve the diagnosis and management of Chronic Fatigue Syndrome (CFS) in primary care -Duration not indicated -No theory identified	44 participants (general practitioners, practice nurses CFS specialists, carers, patients	Blended learning, (podcasts, soundbites, diagnostic descriptions, patient interface, management options)	Asynchronous	-Accreditation not mentioned -Assessment not mentioned
James et al., 2011	-To educate practitioners in the safe use of insulin -One hour duration -No theory identified	31,089 participants (general practitioners, nurses, pharmacists, others – not specified)	Online self-directed learning using audio-visual resources	Asynchronous	-Accreditation not mentioned -Summative assessment
Jenkins et al., 2014	-To improve interprofessional pain management education in primary and community care settings -14 week duration -Theories of adult learning	24 general practitioners, 10 nurses, 10 pharmacists, four physiotherapists	Online self-directed learning using critical reflections, case studies, blog postings	Mixed asynchronous & synchronous	- University accreditation -Summative assessment
Kang et al., 2015	-To enhance the management of chronic disease for primary healthcare providers -13 week duration -No theory identified	27 family physicians and seven nurse practitioners	Blended learning (learning objectives, clinical rotations, mentorship)	Mixed asynchronous & synchronous	-Professional body accreditation -Summative assessment
Macfarlane et al., 2000	To increase understanding of epidemiology for primary care practitioners -Duration not indicated -No theory identified	Not clear	Online self-directed learning using interactive software	Asynchronous	-Accreditation not mentioned -Assessment not mentioned
Maloney et al., 2015	To improve knowledge and practice of using social media -Duration not indicated	317, physicians, physiotherapists , podiatrists and others (not specified)	Online self-directed learning using a range of web-based resources	Asynchronous	-Accreditation not mentioned -Assessment not mentioned

	-No theory identified				
Marsh-Tootle et al., 2011	To improve and sustain knowledge and screening for Amblyopia in primary care -Duration not indicated -Theories of adult learning	136 primary care providers (not specified)	Online self-directed learning using case based web-based modules, videos and animations	Asynchronous	-Accreditation not mentioned -Formative assessment
Pereira et al., 2015	-To improve the management of alcohol abuse in primary care -9 hour duration -No theory identified	67 primary care professionals (not specified)	Online self-directed learning, web-conferences, face-to-face conferences, videos, text, e-chats, audio chats	Mixed asynchronous & synchronous	-University accreditation -Summative assessment
Robinson et al., 2011	-To improve confidence and knowledge about providing rural healthcare -24 week duration -Constructivist theory	75 participants including nurses, occupational therapists, psychologists and social workers	Online self-directed learning, interactive exercises, moderated discussion forums, chat forums, telephone, video conferencing	Mixed asynchronous & synchronous	-Accreditation not mentioned -Formative assessment
Robson, 2009	-To combine learning strategies with published guidelines with the intention of changing practice -Duration not indicated -Theories of adult learning	45 general practitioners and practice nurses	Online self-directed learning (web-based resources)	Asynchronous	-Accreditation not mentioned -Formative assessment
Rudolf et al., 2010	To develop practitioners to work effectively with parents of babies and pre-school children in the prevention of childhood obesity -2 day duration -Family partnership model	137 primary practitioners (health visitors, nurses, outreach workers, centre managers, family support workers)	Online learning, using web-based activities, face-to-face interactions, website and resource toolkit	Asynchronous	-Accreditation not mentioned -Formative assessment
Russell et al., 2006	-To improve knowledge of primary care practice -1-2 year duration (part-time MSc)	Primary healthcare practitioners (not specified)	Online self-directed learning and e-based interactive learning	Mixed asynchronous & synchronous	-University accreditation -Summative assessment

	-Constructionist theory				
Sandars & Langlois, 2005	-To understand the role of e-learning approaches in primary care -Duration not indicated -No theory identified	Not mentioned	-Self-directed learning, online materials, resources	Mixed asynchronous & synchronous	-Accreditation not mentioned -Assessment not mentioned
Tapia-Coyner et al., 2013	-To improve knowledge of chronic kidney disease -Duration not indicated -No theory identified	-844 participants from medicine, nursing, nutrition, social work	-Online self-directed learning, virtual tutors, face-to-face interaction with health experts	Mixed asynchronous & synchronous	-Professional body accreditation -Summative assessment

Appendix 2

Overview of methodological information

Citation	Study Design	Data collected	Sample size
Barber et al., 2010	Pre/post intervention study	Surveys (not validated)	n=258
Bekkers et al., 2010	Case study	Individual interviews	n=31
Buriak et al., 2015	Post-intervention study	Survey (validated)	n=1,809
Cuggia et al., 2006	Longitudinal study	Surveys (not validated)	Not reported
Degryse et al., 2009	Post-intervention study	Survey (not-validated)	n=30
Docherty & Sandhu, 2006	Case study	Individual interviews	n=35
Fox et al., 2001	Pre/post intervention study	Surveys (not validated)	n=68
Gensichen et al., 2009	Delphi study	Surveys (not validated)	n=76
Halabisky et al., 2010	Mixed methods study	Surveys (validated), focus groups, interviews	n=51
Hannon et al., 2012	Case study	Interviews	n=44
James et al., 2011	Longitudinal study	Surveys (not validated)	n=16,540
Jenkins et al., 2014	Case study	Course documents	n=48

Kang et al., 2015	Post-intervention study	Surveys (not validated)	n=24
Macfarlane et al., 2000	Post-intervention study	Survey (not validated)	Not reported
Maloney et al., 2015	Mixed methods study	Surveys (not validated), individual interviews	n=173
Marsh-Tootle et al., 2011	Randomised controlled trial	Surveys (not validated)	n=65
Pereira et al., 2015	Pre/post intervention study	Surveys (not validated)	n=33
Robinson et al., 2011	Mixed methods	Survey (validated), Interviews	n=28
Robson, 2009	Mixed methods study	Surveys (not validated), individual interviews	n=45
Rudolf et al., 2010	Mixed methods study	Surveys (not validated), interviews	n=137
Russell et al., 2006	Case study	Unspecified	Not clear
Sandars & Langlois, 2005	Post-intervention study	Survey (non-validated)	Not clear
Tapia-Coyner et al., 2013	Post-intervention study	Course documents	n=362

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Contributor ship statement

Given the ordered task oriented nature of a scoping review the following presents a list of the duties undertaken by the research team and the respective personnel who contributed to completion:
Establishment of research question/s – KP, SR
Development of search strategy – SR, KP
Database search – SR, SF, CM, AY
Record screening – SR, CM, SF, AY
Full text assessment – CM, SF, SR
Thematic analysis – SR, SF
Discussion construction – SR, SF, KP

Competing interests
We have read and understood BMJ policy on declaration of interests and declare that we have no competing interests

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Data sharing statement

Dataset available from the Dryad repository

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PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	n/a
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6, 7
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	6
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	7, 8, 9
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	8, 9
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	n/a
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	n/a
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	n/a
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	10

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	10
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	n/a
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	8
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	10
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	n/a
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	n/a
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	n/a
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	n/a
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	n/a
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	10, 11, 12, 13
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	10
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	16, 17
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	22

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

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Interprofessional Online Learning for Primary Health Care: Findings from a Scoping Review

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Interprofessional Online Learning for Primary Health Care: Findings from a Scoping Review

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Word count: 4005

Abstract

Objectives: This article presents the findings from a scoping review which explores the nature of interprofessional online learning in primary health care. The review was informed by the following questions: What is the nature of evidence on online postgraduate education for primary health care interprofessional teams? What learning approaches and study methods are used in this context? What is the range of reported outcomes for primary health care learners, their organisations and the care they deliver to patients/clients?

Setting: The review explored the global literature on interprofessional online learning in primary health care settings.

Participants: n/a

Primary and secondary outcome measures: n/a

Results: The review found that the 23 included studies employed a range of different e-learning methods with contrasting course durations, use of theory, participant mix, approaches to accreditation and assessment of learning. Most of the included studies reported outcomes associated with learner reactions and positive changes in participant attitudes/perceptions and improvement in knowledge/skills as a result of engagement in an e-learning course. In contrast, fewer studies reported changes in participant behaviours, changes in organisational practice and improvements to patients/clients.

Conclusions: A number of educational, methodological and outcome implications could be offered. E-learning enhances education experience, supports development, eases time constraints, overcomes geographic limitations and offers greater flexibility. However it also contributes to the isolation of learners and its benefits can be negated by technical problems.

Article Summary

Strengths and limitations of this study

Strengths

- The study performs a much needed review of the literature into an increasingly significant educational approach in primary healthcare.
- It enables the identification of effective educational interventions and where these interventions can be improved.

Limitations

- The search was limited to publications from 2000 onwards and included only those published in English. Any relevant publications which fall outside of these criteria will not have been included.

This work was supported by iheed

We have read and understood BMJ policy on declaration of interests and declare that we have no competing interests

Background

Online (e-learning) has been a growing part of health professions education for well over a decade.[a] Meta-analyses reporting the effects of e-learning studies have found that this type of education is effective for improving a range of professional competencies – attitudes, knowledge, skills and behaviours (1, 2). The advantages of e-learning for health professionals include diminishing logistical barriers (anytime, anyplace learning for busy health care providers working in different environments), and individualized, tailored, point-of-care learning that meets the varied needs of professional learners from multiple practice settings (3).

It has been reported that online learning can be as effective as physical attendance in a traditional classroom, however, consideration must be given to factors such as development of clear guidelines for educators regarding roles and responsibilities, clear learner competencies, access to technology and sufficient funding (4). Applied learning approaches, such as scenarios and interactive 'second-life' programmes, can be engaging, although there is a need to ensure training is relevant to clinical evidence-based practice (5). Use of free web tools, such as Skype and Moodle have shown useful educational outcomes, while alleviating travel pressures and expenses for learners (6).

There is also evidence that the benefits of using online learning can result in less constrained discussion, as learners feel more able to engage in online discussions rather than verbal face-to-face conversations (7). It has also been found that e-learning can enhance the quantity, quality, cost and accessibility of health professions education (8).

However, it has been indicated that online learning may be viewed by some as isolating and disconnected when compared to traditional learning methods due to lack of a social connection (9). In addition, it has been noted that technological difficulties can often be a key disrupting factor (10), for example, its use can result in a loss of collegiality typically associated with traditional forms of face-to-face learning (6).

When used to promote interactions and relations between different professional groups, an increasing number of studies have suggested that the use of e-learning technologies can enhance interprofessional collaboration (11, 12). While interprofessional e-learning can help with the

logistics and costs of traditional face-to-face collaborative learning and can help overcome the isolating effects learners can feel when learning alone online, there is added complexity with managing new software, a loss of nonverbal group cues and technological glitches which can undermine its quality (13). Nevertheless, it has been found that this type of e-learning can support professionals to connect online to discuss and co-create solutions to real-life issues for patients/clients from geographically disparate locations (3).

As indicated above, while there has been a growth of both professional and interprofessional e-learning in health professions education, to date, there has been no effort undertaken to explore the use of interprofessional e-learning for primary health care teams.[b] To fill this gap in knowledge, this review will attempt to provide an overview of the empirical literature in order to generate an insight into the nature of evidence of e-learning for primary health care teams.

Methods

Scoping reviews are being used increasingly by researchers to explore health care evidence (14). Scoping reviews enable the clarification of complex areas of inquiry and refine subsequent research studies (14-16). The overall goal of a scoping review is to "examine the extent, range, and nature of research activity, determine the value in undertaking a full systematic review, summarizing and disseminating research findings, or identify gaps in the existing literature" (15).

We adopted a scoping review methodology to specifically examine the extent, range and nature of evidence for the use of interprofessional e-learning for primary health care teams. Within this review, Arksey & O'Malley's (14) six-step framework for interpretive scoping literature reviews was utilised with modifications (15, 17) (See Table 1).

Review Stage	Description
1: Identifying the research question	Identifying the research question provides the roadmap for subsequent stages. Relevant aspects of the question must be clearly defined as they have ramifications for search strategies. Research questions are broad in nature as they seek to provide breadth of coverage.
2: Identifying relevant studies	This stage involves identifying the relevant studies and developing a decision plan for where to search, which terms to use, which sources are to be searched, time span, and language. Comprehensiveness and breadth is important in the search. Sources include electronic databases, references lists, hand-searching of key journals, and organizations and

	conferences. Breadth is important; however, practicalities of the search are as well. Time, budget and personal resources are potential limiting factors and decision need to be made upfront about how these will impact the search.
3: Study selection	Study selection involves *post hoc* inclusion and exclusion criteria. These criteria are based on the specifics of the research question and on new familiarity with the subject matter through reading the studies.
4: Charting the data	A data-charting form is developed and used to extract data from each study. A 'narrative review' or 'descriptive analytical' method is used to extract contextual or process oriented information from each study.
5: Collating, summarizing, and reporting results	An analytical framework or thematic construction is used to provide and overview of the breadth of the literature but not a synthesis. A numerical analysis of the extent and nature of studies using tables and chart is presented. A thematic analysis is then presented. Clarity and consistency are required when reporting results.
6: Consultation (optional)	Provides opportunities for consumer and stakeholder involvement to suggest additional references and provide insights beyond those in the literature.

Table 1: Overview of the framework for conducting a scoping study

Identifying the Relevant Research Question

Responding to the intention to explore the literature on interprofessional e-learning within primary health care, our research questions could focus on the following: map existing work which addresses interprofessional e-learning in primary health care teams; generate an understanding of the influence of such work and the depth and breadth of 'the field'; and identify significant knowledge gaps and areas for improvement. With these initial ideas in mind the following research questions were generated:

- What is the nature of evidence on online postgraduate education[c] for primary health care interprofessional teams?
- What learning approaches and study methods are used in this context?
- What is the range of reported outcomes for primary health care learners, their organisations and the care they deliver to patients/clients?

Identifying Relevant Studies

Using the research questions as a guide, keywords were applied to a search strategy which was then preliminarily applied to the electronic databases Medline and CINAHL. This offered an indication of the relevance of the search terms and the subsequent feasibility of their application was based on the numerical results generated from this preliminary search. This process enabled the following search strategy to be adopted. (See Box 1)

#1 Primary Care #2 Care, Primary Care #3 Health Care, Primary #4 Care Primary #5 General Practice #6 #1 or #2 or #3 or #4 or #5 #7 Interprofessional or Inter-professional #8 Interdisciplinary or Inter-disciplinary #9 Multidisciplinary or Multi-disciplinary #10 Team or Teamwork #11 #7 or #8 or #9 or #10 #12 E-learning #13 Electronic Learning #14 Learning, Electronic #15 Remote Learning #16 Learning, Remote #17 Learning, Blended #18 Video conferencing #19 #12 or #13 or #14 or #15 or #16 or #17 or #18 #20 #6 and #11 and #19

Box 1: Search terms

Following a consultation with university information scientists in an attempt to gauge the efficacy of the strategy and identify further databases, these key terms were applied to six electronic sources. Including studies from January 2000 to October 2015, the following databases were searched:

- Medline
- CINAHL
- British Educational Index
- PubMed
- Scopus
- Web of Science

An additional search of online and grey literature through Google and Google Scholar, and a further hand search of the 10 journals which have published the most papers found in the searches also took place (See Box 2).

British Journal of Community Nursing
BMC Public Health
BMC Medical Education
BMJ Quality and Safety
British Journal of General Practice
Education for Primary Care
Journal of Continuing Education in the Health Professions
Journal of Interprofessional Care
Medical Teacher
Trials

Box 2: Journals searched

From an initial yield of 1,568 potential sources (generated from electronic database and additional searches), which through a rigorous screening process (see below), the review yielded 23 included studies. (See Figure 1)

Study selection

In order to address the research question for this review, the following inclusion criteria were employed:

- Papers that describe evaluations of online/e-learning involving interprofessional teams based in primary health care/family care
- All research evaluation designs (e.g. action research, case study, ethnographic, experimental, quasi-experimental studies)
- Any reported outcome from the online/e-learning evaluation (see outcomes typology below).

As the searches and screening of potential sources progressed, it became apparent that there was very little literature reporting online *postgraduate* education for primary health care *interprofessional teams.* As a result, two key modifications were made to the inclusion criteria. First, the scope of review was widened to include *postgraduate education* and *continuing education*. Second, the review was widened to include team-based interprofessional online learning as well as

general interprofessional e-learning (involving primary health care practitioners, but not necessarily based in the same interprofessional team).

INSERT FIGURE. 1 ABOUT HERE

Charting the Data

Key information from the included studies was abstracted by combining a categorisation of e-learning methods (18) with an abstraction approach used in a previous systematic review (19).

Using this approach, the following information was elicited from each of the included studies:

- Study aims/objectives
- Research design, sampling, data collection/analysis
- Location and duration of the e-learning intervention/activity
- Professional mix of learners
- Methods of e-learning employed
- Technologies used to support e-learning
- Assessment/accreditation of learning
- All reported outcomes from the e-learning activity.

Collating, Summarizing, and Reporting the Results

Given the heterogeneous nature of the included studies, a thematic approach to the analysis was employed (20). This allowed the emergence of key issues (themes) from the literature, enabling insight into the characteristics related to online learning.

In addition, to capture the diversity of reported outcomes in the included papers, (19) extended version of Kirkpatrick's educational outcomes model, which has six differing but non-hierarchical levels, was utilised (see Table 2).

Outcome	Details
Level 1 – Reaction	These outcomes cover learners' general views and perspectives on the learning experience, its organisation, presentation, content, teaching methods and organisation (e.g. time-tabling, materials, quality of teaching)
Level 2a – Modification of	These outcomes relate to changes in reciprocal interprofessional

attitudes/perceptions	attitudes or perceptions between participant groups, towards patients/clients and their conditions, circumstances, care and treatment
Level 2b – Acquisition of knowledge/skills	These outcomes relate to the acquisition of concepts, procedures and principles of interprofessional collaboration. For skills, this relates to the acquisition of thinking/problem-solving, psychomotor and social skills linked to collaboration
Level 3 – Behavioural change	Outcomes at this level measure the transfer of interprofessional skills and learning to workplace, such as support for change of behaviour in the workplace or willingness of learners to apply new knowledge and skills about collaborative work to their practice style
Level 4a – Change in organisational practice	These outcomes relate to wider changes in the organisation/delivery of care, attributable to an education programme, such as, changes in organisational policies or clinical pathways that promote interprofessional collaboration, communication and teamwork
Level 4b – Benefits to patients/clients	These outcomes cover any improvements in the health and well-being of patients/clients as a direct result of a programme. Where possible, such as, health status measures, disease incidence, duration or cure rates, mortality, complication rates, readmission rates, adherence rates, patient or family satisfaction, continuity of care, costs to carer or patient/client.

Table 2: Key outcomes

Methodological Quality

All abstracts generated from database searches (n=1,303) and additional searches (n=265) were reviewed independently by two members of the review team to determine if they met the inclusion criteria (see above). The full text article was obtained (181 papers) if the abstract met these criteria. These articles were again screened independently by two reviewers as a second check to determine if they met the inclusion criteria.

Review limitations

There are three key limitations to this review. First, only English-language articles were considered for inclusion in the study. As such, this review did not include potentially relevant materials written in other languages and published in non-English speaking countries. Secondly, the review searched for materials published from 2000, which means any papers published before this date will not have been included. Third, only a partial range of grey literature was searched. For example, the review did not search primary health care conferences for possible materials. This restriction on grey literature was necessary to limit the volume of materials and maintain a focus on research studies.

Results

E-learning approaches

Of the 23 included studies, 12 were undertaken in the UK, four in North America (two in the USA and two in Canada) and two studies involved multiple countries (one study included The Netherlands, France and the UK, the other Germany, Austria and the UK). In addition, one study was undertaken in the following countries: Brazil, Australia, France, Germany and Mexico. The professions represented included: medicine (14 studies), nursing (13 studies), pharmacy (3 studies), physiotherapy (2 studies), social work (2 studies, community workers (1 study), nutrition (1 study), occupational therapy (1 study), podiatry (1 study) and psychology (1 study).

Appendix 1 provides references for all included studies and Appendix 2 offers an overview of key content of the papers reviewed, including, aim of the e-learning course, participants involved, use of e-learning methods, course accreditation and assessment of learning. As this table indicates, the included studies report upon a variety of different primary health care e-learning courses in relation to aims, duration and use of underlying educational theory. For example, in terms of course duration, this varied from hours, to a few days to weeks and even years. Similarly, there was a wide range of different numbers of participating professions involved in the studies – from 24 participants in one study to over 30,000 participants in another much larger study. In addition, while just over half of the studies did not mention the use of an underpinning theory in the development of their e-learning course, a variety of contrasting theories were employed by other studies, including, adult learning approaches, social learning theory, theory of planned behaviour and constructionist theory. This heterogeneity is also found in the mixture of differing e-learning approaches, types of interaction, course accreditation and assessment of learning (see Appendix 2).

Methodological approaches

Most studies employed quasi-experimental designs (e.g. pre/post intervention, post-intervention) and typically gathered data in the form of surveys that were not validated. Only one study employed an experimental design (randomised controlled trial) though this study also gathered un-validated survey data. There were also some use of mixed methods (studies that gather qualitative and quantitative data), and qualitative methods (e.g. case study designs) that gather interview and focus group data. Appendix 3 presents an overview of information relating to key elements of the methodological approaches employed in each of the 23 studies. These results also indicate a wide

variety in the sample sizes reported for the included studies – ranging from 24 to over 16,000 participants. Most of the studies employed a convenience sampling technique.

Key educational issues

Based on the analysis and synthesis approach outlined above, a number of key educational issues emerged from the included studies. In total, the following eight issues were identified, including: realising the potential of e-learning, enhancing collaboration and communication, improving time pressures, overcoming geographic boundaries, economics, costs and effectiveness, convenience, flexibility and accessibility, learner isolation and technical challenges.

Realising the potential of e-learning

The review found that a number of the 23 included studies (n=8) provided reports of how the use of e-learning changed the way primary health care professionals learned together. Among these, one study (21) stated that the use of e-learning technologies such as "interactive menus, on-line case studies and video-clips" (p.344) could improve the quality of collaborative learning for primary health care providers. Another (22) explored the use of online blogs as a learning method in their evaluation of a postgraduate e-learning course found that the use of a blog platform promoted interprofessional interaction and learning which helped generate improved decision-making skills. One further study (23) found that "web-based learning has been identified as offering the potential for students to engage in rich and effective construction of knowledge" (p. 469).

Enhancing collaboration and communication

13 studies reported that the use of e-learning approaches could effectively support the collaborative efforts of participating primary health care professionals. For these authors, the advantage of using e-learning methods is that it can foster a sense of collaborative community for participating learners. These authors (24) found that, "the opportunity to train as a whole team was valued […] allowed staff, as one manger said, 'to be singing from the same hymn sheet'. In addition one study (23) reports that, "the online environment has opened up enormous opportunities for interaction between students and tutors and between tutors, and has brought collaborative learning centre stage in distance education" (p. 470-471).

Improving time pressures

The ability of e-learning methods to alleviate some of the time pressures on the clinical workloads of primary health care practitioners to engage in professional development activities was found to be an important issue within the included studies (n=5). A study (25) which explored the effect of online learning to support the diagnosis of chronic fatigue syndrome (CFS) in primary health care found that, “an online approach (to practitioner education) was preferred as face to face training was thought to be too time consuming’ (p.9). These authors go on to note that the convenience associated with online methods was particularly welcomed, as a combination of heavy workloads and the additional complexity of CFS diagnosis meant that ease of access and speed of information transfer was paramount.

Overcoming geographic boundaries

A number of included studies (n=4) found that use of e-learning methods could help to overcome traditional issues of having to deliver the educational content of interprofessional courses in the same geographic location. Exploring the potential of e-learning in the safe use of insulin for general practitioners, nurses and pharmacists, one study (26) reported that, “e-learning provides a practical solution to the provision of evidence based learning across many different staff groups and geographical boundaries” (p.210).

Economics, costs and effectiveness

Encouragingly, a number of studies (n=3) reported a range of positive attributes linked to the cost effectiveness of interprofessional e-learning. For instance, in their study of an online learning course for improving screening of amblyopia in US-based primary health care practices, the authors (27) stated that they selected an online learning approach “as the best delivery mode to implement facets of adult-based learning relevant to physicians as well as allowing low cost, wide spread dissemination of standardized information to individuals separated by time and distance” (p.7161).

However a number of studies (n=5) also noted other financial implications, some of which are not immediately obvious, that may impede the introduction and sustainability of online education. A small of number of studies acknowledged that there were uncertainties regarding the initial financial investment and subsequent funding of e-learning. For example, in their evaluation of online course for rural practitioners, one set of authors (28) reported that, “significant fiscal and human resource barriers were identified that included the uptake and retention of course participants” (p.635).

Convenience, flexibility and accessibility

Many, if not all of the included papers, indirectly acknowledged these issues. However four studies made explicit reference to them. One study (29) that explored perceptions of interprofessional e-learning amongst primary healthcare workers in Canada found that, "internet based technology has enabled a more convenient and flexible learning option to meet the needs of busy working healthcare providers" (p. 265).

Learner isolation

Although, as outlined above, online learning has the potential to develop practitioners' professional and interprofessional competence, a small number (n=5) of studies found that the move from traditional approaches to delivering education – in the same space at the same time – to an online environment whereby interactions are virtual in nature can present a challenging transition for some learners. There is an example of this from the authors mentioned above (29), as they report how "isolation of learners from each other" (p.266) impeded the effectiveness of their online course.

Technical challenges

Four of the included studies reported how technical difficulties linked to the delivery of the e-learning approaches they evaluated in their respective studies undermined the quality of the educational experience for participants. Whilst these studies reported technical issues, these were relatively minor and ultimately resolvable. It should also be noted that the low number of studies which described such issues suggests that this has not been a major cause for concern when compared to other difficulties.

Reported outcomes

Table 3 provides an overview of studies which reported outcomes across the six-point outcomes typology (as presented in Table 2).

Outcome	Number of studies
Level 1 – Reaction	6
Level 2a – Attitudes/perceptions	8
Level 2b – Knowledge/skills	14
Level 3 – Behaviour	7
Level 4a – Organisational practice	4
Level 4b – Patient/client benefit	3
Total	**42**

Table 3: Overview of reported outcomes

As indicated in Table 3, of the total number of outcomes (n=42) reported across the included studies, most (n=28) were associated with individual changes at levels 1, 2a and 2b. In contrast, fewer studies (n=14) reported broader changes at levels 3, 4a and 4b.

Discussion

Considering our research questions (see above), the review indicated that the evidence in favour of e-learning is significant. Not only do online learning approaches both facilitate and improve interprofessional collaboration, but their practicality and accessibility offer advantages which make them preferable to more 'traditional' educational methods. E-learning has the potential to facilitate complex and multi-faceted collaborative practice in primary healthcare and beyond. Taking place on a number of levels, these improvements can range from team-based relations to global communication between practitioners. Indeed, interprofessional e-learning can offer a variety of useful opportunities to develop a range of collaborative competencies supported by a number of different e-learning technologies (e.g. online discussion forums, social media applications, message boards).

The review also identified that increasing intensity of primary health care practice often creates a distinctly time-sensitive environment which can be alleviated by the use of e-learning methods. Difficulties associated with heavy workloads can be diminished as e-learning is easily accessible and flexible for practitioners. E-learning can therefore contribute to the development of practitioners' competence as they can, for example, incorporate a short online course during a busy working week with minimal disruption to their clinical schedules. As a result, e-learning can have a positive influence in the short and long term, benefitting practitioners as well as the care they deliver to patients/clients. These findings resonate with research reporting the positive effects of e-learning in the wider literature (1-4, 10).

Given that e-learning approaches can be regarded as invaluable to the coherent and efficient implementation of healthcare practice, it is important to identify and attempt to respond to, any shortcomings or areas for improvement. Importantly, the review has reported the isolating potential of remote, computer based learning. The move from the traditional classroom-based approach has resulted in some learners feeling isolated and others noting a lack of support from

their online educators. This is a direct consequence of diminishing face-to-face learner-to-learner and learner-to-educator interactions and the use of online learning may affect interprofessional interactions/dynamics which were more easily identifiable in previous contexts. To help overcome such issues, the use of blended approaches offers a useful means of transition between virtual and real educational contexts (30, 31). Although this can be regarded as a 'solution' which merely serves to negate the beneficial capacity of e-learning, the gradual transition from classroom to computer screen rather than an abrupt relocation may make these changes less emotionally impactful.

Technical challenges have also been reported in a small but notable number of studies. Although these issues were usually linked to minor failures of software and connectivity problems they still combined to cause frustration and disappointment for learners. It is important to note that coherent technological functioning is paramount to the successful delivery of e-learning (32, 33). If possible such minor faults should be prevented in the first instance to avoid disruption of the quality of the e-learning experience. This will ensure that e-learning applications and software meet quality requirements in enhancing the experience for the learner while fully realising the potential of (increasingly) sophisticated synchronous and asynchronous e-learning technologies.

Conclusion/implications

Overall, the scoping review identified a number of key benefits related to the use of interprofessional e-learning for primary health care practitioners. Its practicality was consistently reported to contribute to enhanced time management, the removal of geographic limitations and ease of access were found to help strengthen interprofessional collaboration and networking. It was also reported that economic savings could be made with the use of e-learning as reductions in travel costs, institutional overheads, etc. could be realised. However it was noted that e-learning could result in learner isolation, and some technical problems were also identified. These were however, relatively minor in comparison to the reported benefits. Such findings resonate with the wider literature on e-learning in the health professions and interprofessional literature (3, 13, 34).

Study outcomes

Collectively, the included studies indicated that the use of e-learning for primary health care practitioners generated a range of positive outcomes for participant reactions (level 1), helped to generate improvements to their perceptions and attitudes (level 2a) as well as improvements to their knowledge and skills (level 2b). In addition, while the review indicated that the use of e-

learning resulted in gains to participants' individual behaviour (level 3), improvements the way their organisations practiced (level 4a) and could generate benefit for patients/clients (level 4b), there were fewer studies reporting at these levels. While it is important to gather data for outcomes at levels 1, 2a and 2b, future e-learning evaluations should also focus on developing the evidence for its effects on levels 3, 4a and 4b (including data on cost-effectiveness) to help build a more robust insight into the longer-term outcomes for this type of primary health care education. This focus on 'lower-level' outcomes is echoed in the wider interprofessional education literature, which also found a propensity for studies to report on levels 1-2b so overlooking 'higher-level' outcomes (levels 3-4b) (35, 36).

Heterogeneity

While the included studies reported a promising number of outcomes associated with the use of e-learning, the wide range of e-learning activities/course does generate some limitations. Specifically, due to the heterogeneity of the e-learning approaches reported in the 23 studies, it is difficult to identify a set of robust implications that can identify which types of e-learning methods may be effective and which may be less so (a problem which is compounded by the use of a mixture of differing study designs and methods). The problem of heterogeneity of interventions and evaluation approaches has been reported elsewhere in the interprofessional education literature (37). Nevertheless, it is possible to note that of the included studies, those which employed a variety of approaches such as online self-directed learning, interactive web-based discussion supported by an e-facilitator were well evaluated when compared to studies that only employed a single form of e-learning method. In addition, blended approaches (using online and traditional learning methods) were also well evaluated. However, as noted above, such approaches did increase costs due to the need to pay for learning space and travel expenses.

Self-report data

Another word of caution needs to be applied to the included studies. While the review indicated that these studies reported a range of positive outcomes related to the use of e-learning in primary health care, most of the 23 studies were gathered data in the form of un-validated surveys, individual interviews and focus groups. As a result, the bulk of reported outcomes are based on self-report data. This is a weak form of evidence as it is widely recognised that individuals are often inaccurate in assessing possible changes to their knowledge, skills and behaviours (38). As a result, such reports must be regarded as weak approaches to measuring change.

End notes

[a] E-learning is a term that relates to learning that uses electronic technologies to access educational curriculum outside of a traditional classroom. In most cases it refers to a course or program delivered on an online basis.

[b] Primary health care team is a term that relates to a group of practitioners who work together as the first point of contact in a health care system. The source of primary care is general practice or family medicine.

[c] The term postgraduate education refers to formal learning health professionals receive after they graduate (qualify) as practitioners. As such, we regard this term as including continuing education.

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Contributor ship statement

Given the ordered task oriented nature of a scoping review the following presents a list of the duties undertaken by the research team and the respective personnel who contributed to completion:
Establishment of research question/s – SR, KP
Development of search strategy – SR, KP
Database search – SR, SF, CM, AY
Record screening – SR, CM, SF, AY
Full text assessment – CM, SF, SR
Thematic analysis – SR, SF
Discussion construction – SR, SF, KP

Competing interests

We have read and understood BMJ policy on declaration of interests and declare that we have no competing interests

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Data sharing statement

Dataset available from the Dryad repository

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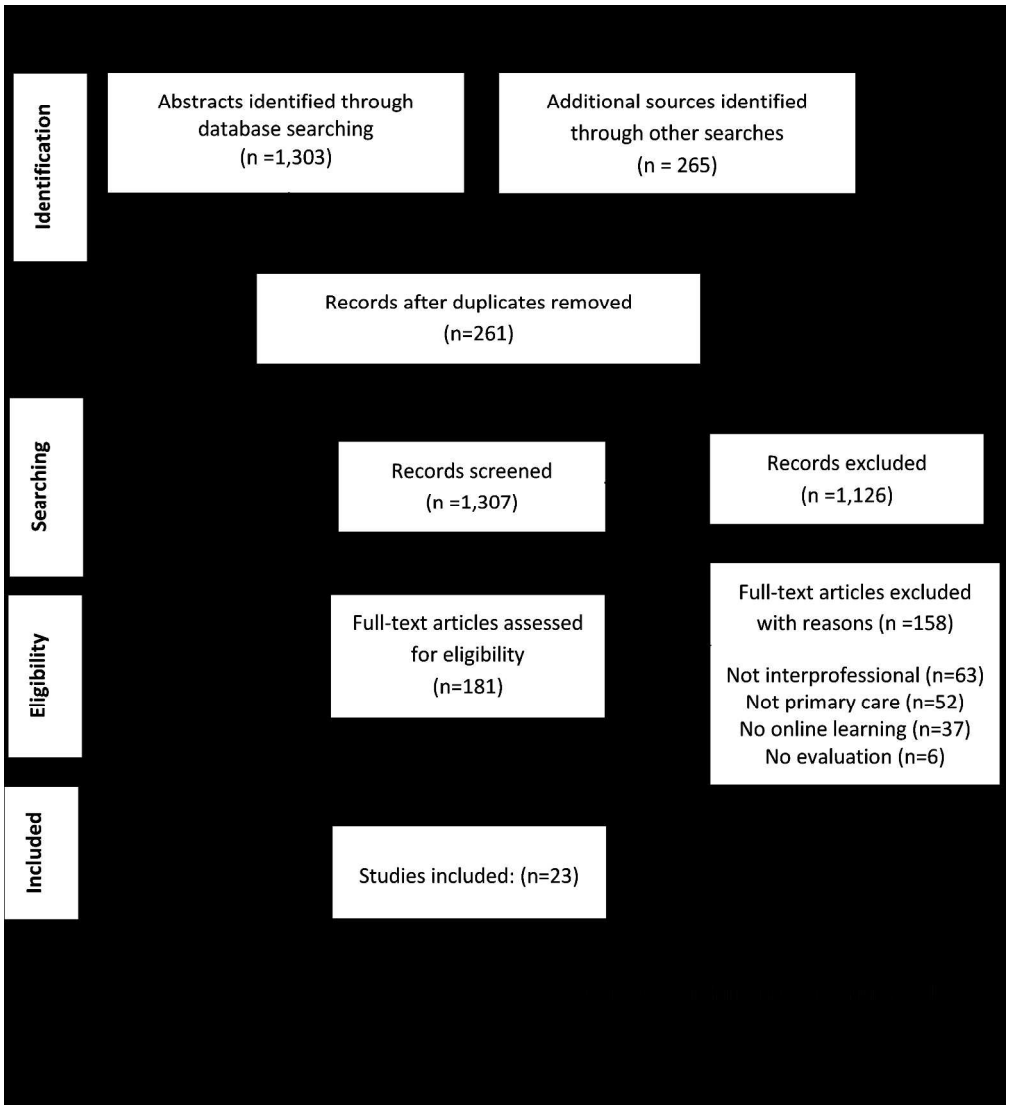
Identification
Abstracts identified through database searching (n =1,303)
Additional sources identified through other searches (n = 265)
Records after duplicates removed (n=261)
Searching
Records screened (n =1,307)
Records excluded (n =1,126)
Eligibility
Full-text articles assessed for eligibility (n=181)
Full-text articles excluded with reasons (n =158)
Not interprofessional (n=63)
Not primary care (n=52)
No online learning (n=37)
No evaluation (n=6)
Included
Studies included: (n=23)

Appendix 1
List of references for included studies

Barber C, Frank T, Walsh, K, Burton, C, Bradshaw, L, Fishwick, D, Knowledge and Utilisation of occupational asthma guidelines in primary care. *Primary Care Respiratory Journal* 2010; 19(3):274-280

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Marsh-Tootle, W, McGwin, G, Kohler, C, Kristofco, R, Datla, R, Wall, T, Efficacy of a Web-Based Intervention to Improve and Sustain Knowledge and Screening for Amblyopia in Primary Care Settings. *Investigative Ophthalmology and Visual Science* 2011; 52(10): 7160-7167

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Appendix 2
Overview of e-learning approaches

Citation	Aim of e-learning / duration / theory	Participants	E-learning methods	Type of interaction	Accreditation / Assessment
Barber et al., 2010	-To improve knowledge and utilisation of occupational asthma guidelines in primary health care -One hour duration -No theory identified	-783 primary health care professionals (not specified)	-Online self-directed learning using web-based resources	Asynchronous	BMJ Accredited Formative assessment
Bekkers et al., 2010	-To enhance the quality of antibiotic prescribing amongst primary health care practitioners -Duration not indicated -Theory of planned behaviour	-244 general practitioners and nurse practitioners	-Online self-directed learning, reflection, interactive presentations and practice-based seminars, simulated SPs, web forum	Mixed: asynchronous & synchronous	-STAR programme accreditation -Formative assessment
Buriak et al., 2015	-To improve education on cancer survivorship -Duration not indicated -Theory of planned behaviour	229 physicians, 213 nurse practitioners, 1,367 nurses	Online self-directed learning using patient based case scenarios	Asynchronous	-Professional body accreditation -Formative assessment
Cuggia et al., 2006	-To improve information sharing between primary health care professionals -Duration not indicated -No theory identified	General practitioners and nurses (numbers not specified)	Online self-directed learning, real-time interactions and teleconsultations	Mixed asynchronous & synchronous	-Accreditation not mentioned -Formative assessment
Degryse et al., 2009	-to improve knowledge about the diagnosis of dementia -Five hour duration -Discovery learning theory	26 general practitioners and nurses	- Online self-directed learning Interactive software, simulated patient cases	Asynchronous	-Accreditation not mentioned -Formative assessment
Docherty & Sandhu, 2006	-To improve knowledge of interprofessional diabetes care -No duration indicated -No theory identified	35 general practitioners and nurses	-Online self-directed learning, residential workshop, online learning, interactive exercises	Mixed asynchronous & synchronous	-University accreditation -Summative assessment
Fox et al., 2001	-To improve understanding of	111 post primary health care	-Online self-directed learning	Asynchronous	-Accreditation not mentioned

	change management concepts and principles for primary health care professionals -12 week duration -Theories of change management	professionals (unspecified)	exercises		-Formative assessment
Gensichen et al., 2009	To improve the understanding of e-learning approaches for primary healthcare professionals -No duration indicated -No theory identified	76 primary healthcare professionals (unspecified)	Unspecified	Asynchronous	-Accreditation not mentioned -Assessment not mentioned
Halabisky et al., 2010	-To enhance collaborative practice among healthcare teams in long term care homes -8½ hour duration -Change management	59 family physicians, nurses, nurse practitioners and pharmacists	Online activities, audio/video clips, worksheets, face-to- face team contact)	Mixed asynchronous & synchronous	-Accreditation not mentioned -Formative assessment
Hannon et al., 2012	-Improve the diagnosis and management of Chronic Fatigue Syndrome (CFS) in primary health care -Duration not indicated -No theory identified	44 participants (general practitioners, practice nurses CFS specialists, carers, patients	Blended learning, (podcasts, soundbites, diagnostic descriptions, patient interface, management options)	Asynchronous	-Accreditation not mentioned -Assessment not mentioned
James et al., 2011	-To educate practitioners in the safe use of insulin -One hour duration -No theory identified	31,089 participants (general practitioners, nurses, pharmacists, others – not specified)	Online self-directed learning using audio-visual resources	Asynchronous	-Accreditation not mentioned -Summative assessment
Jenkins et al., 2014	-To improve interprofessional pain management education in primary and community care settings -14 week duration -Theories of adult learning	24 general practitioners, 10 nurses, 10 pharmacists, four physiotherapists	Online self-directed learning using critical reflections, case studies, blog postings	Mixed asynchronous & synchronous	- University accreditation -Summative assessment
Kang et al., 2015	-To enhance the management of chronic disease for primary	27 family physicians and seven nurse	Blended learning (learning objectives, clinical	Mixed asynchronous & synchronous	-Professional body accreditation

	healthcare providers -13 week duration -No theory identified	practitioners	rotations, mentorship)		-Summative assessment
Macfarlane et al., 2000	To increase understanding of epidemiology for primary health care practitioners -Duration not indicated -No theory identified	Not clear	Online self-directed learning using interactive software	Asynchronous	-Accreditation not mentioned -Assessment not mentioned
Maloney et al., 2015	To improve knowledge and practice of using social media -Duration not indicated -No theory identified	317, physicians, physiotherapists , podiatrists and others (not specified)	Online self-directed learning using a range of web-based resources	Asynchronous	-Accreditation not mentioned -Assessment not mentioned
Marsh-Tootle et al., 2011	To improve and sustain knowledge and screening for Amblyopia in primary health care -Duration not indicated -Theories of adult learning	136 primary health care providers (not specified)	Online self-directed learning using case based web-based modules, videos and animations	Asynchronous	-Accreditation not mentioned -Formative assessment
Pereira et al., 2015	-To improve the management of alcohol abuse in primary health care -9 hour duration -No theory identified	67 primary health care professionals (not specified)	Online self-directed learning, web-conferences, face-to-face conferences, videos, text, e-chats, audio chats	Mixed asynchronous & synchronous	-University accreditation -Summative assessment
Robinson et al., 2011	-To improve confidence and knowledge about providing rural healthcare -24 week duration -Constructivist theory	75 participants including nurses, occupational therapists, psychologists and social workers	Online self-directed learning, interactive exercises, moderated discussion forums, chat forums, telephone, video conferencing	Mixed asynchronous & synchronous	-Accreditation not mentioned -Formative assessment
Robson, 2009	-To combine learning strategies with published guidelines with the intention of changing practice -Duration not indicated -Theories of adult	45 general practitioners and practice nurses	Online self-directed learning (web-based resources)	Asynchronous	-Accreditation not mentioned -Formative assessment

	learning				
Rudolf et al., 2010	To develop practitioners to work effectively with parents of babies and pre-school children in the prevention of childhood obesity -2 day duration -Family partnership model	137 primary practitioners (health visitors, nurses, outreach workers, centre managers, family support workers)	Online learning, using web-based activities, face-to-face interactions, website and resource toolkit	Asynchronous	-Accreditation not mentioned -Formative assessment
Russell et al., 2006	-To improve knowledge of primary health care practice -1-2 year duration (part-time MSc) -Constructionist theory	Primary healthcare practitioners (not specified)	Online self-directed learning and e-based interactive learning	Mixed asynchronous & synchronous	-University accreditation -Summative assessment
Sandars & Langlois, 2005	-To understand the role of e-learning approaches in primary health care -Duration not indicated -No theory identified	Not mentioned	-Self-directed learning, online materials, resources	Mixed asynchronous & synchronous	-Accreditation not mentioned -Assessment not mentioned
Tapia-Coyner et al., 2013	-To improve knowledge of chronic kidney disease -Duration not indicated -No theory identified	-844 participants from medicine, nursing, nutrition, social work	-Online self-directed learning, virtual tutors, face-to-face interaction with health experts	Mixed asynchronous & synchronous	-Professional body accreditation -Summative assessment

Appendix 3

Overview of methodological information

Citation	Study Design	Data collected	Sample size
Barber et al., 2010	Pre/post intervention study	Surveys (not validated)	n=258
Bekkers et al., 2010	Case study	Individual interviews	n=31
Buriak et al., 2015	Post-intervention study	Survey (validated)	n=1,809
Cuggia et al., 2006	Longitudinal study	Surveys (not validated)	Not reported
Degryse et al., 2009	Post-intervention study	Survey (not-validated)	n=30
Docherty & Sandhu, 2006	Case study	Individual interviews	n=35
Fox et al., 2001	Pre/post intervention study	Surveys (not validated)	n=68
Gensichen et al., 2009	Delphi study	Surveys (not validated)	n=76
Halabisky et al., 2010	Mixed methods study	Surveys (validated), focus groups, interviews	n=51
Hannon et al., 2012	Case study	Interviews	n=44
James et al., 2011	Longitudinal study	Surveys (not validated)	n=16,540
Jenkins et al., 2014	Case study	Course documents	n=48
Kang et al., 2015	Post-intervention study	Surveys (not validated)	n=24
Macfarlane et al., 2000	Post-intervention study	Survey (not validated)	Not reported
Maloney et al., 2015	Mixed methods study	Surveys (not validated), individual interviews	n=173
Marsh-Tootle et al., 2011	Randomised controlled trial	Surveys (not validated)	n=65
Pereira et al., 2015	Pre/post intervention study	Surveys (not validated)	n=33
Robinson et al., 2011	Mixed methods	Survey (validated), Interviews	n=28
Robson, 2009	Mixed methods study	Surveys (not validated), individual interviews	n=45
Rudolf et al., 2010	Mixed methods study	Surveys (not validated), interviews	n=137

Russell et al., 2006	Case study	Unspecified	Not clear
Sandars & Langlois, 2005	Post-intervention study	Survey (non-validated)	Not clear
Tapia-Coyner et al., 2013	Post-intervention study	Course documents	n=362

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	n/a
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6, 7
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	6
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	7, 8, 9
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	8, 9
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	n/a
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	n/a
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	n/a
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	10

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	10
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	n/a
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	8
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	10
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	n/a
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	n/a
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	n/a
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	n/a
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	n/a
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	10, 11, 12, 13
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	10
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	16, 17
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	22

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

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