

Introduction

Cancer is an important healthcare challenge leading to significant mortality and morbidity worldwide with approximately 14 million new cases and 8.2 million related deaths annually [1]. Education and training remain key factors in ensuring health professionals are prepared to meet the varied, often long-term and end of life care needs of people affected by cancer and their families [2].

To ensure availability of innovative cancer education on a global scale, online learning can be considered as a platform for engaging, cost-effective, interactive, and flexible education to expand continuing professional education, enhance access and support inter-professional learning[2,3]. However, a systematic review [4] highlighted several barriers to online learning including: organisational and economic issues; use and accessibility of software and hardware; availability of support; pedagogical approaches; and educator skills. Recommendations emphasised the importance of well-designed, flexible programmes; global, national and local strategies to support successful e-learning; and evaluation research to identify the cost-effectiveness and cost benefits [4]. It has been recognised that evaluation must incorporate validated outcome measures, focus on student knowledge, skills, attitude and satisfaction, and determine different levels of impact for the student, educator and client outcomes[5]. For healthcare educators, translational research and education should focus on clinical effectiveness in terms of practice change or improving patient outcomes [6] including the need for rigorous evaluation of education methodologies and their influence on cancer outcomes.

In 2007, Wyatt [7] discussed the absence of evidence relating to the effectiveness of cancer programmes, suggesting there was a lack of conclusive evidence to support its impact on practice. By evaluating the impact, outcomes and pedagogical influence of online cancer education, future learning opportunities and course design can be shaped and delivered to better meet learner, educational, health care consumer and institutional needs[8].

In order to capture outcome measures this literature review has adopted Kirkpatrick framework for evaluation [9]. This framework seeks to clarify evaluation, and to facilitate clear and achievable goals, by breaking them down into the logical steps of: Reaction - how well did they like the programme; Learning - what principles, facts and techniques were learned; Behaviour - what changes in behaviour resulted; Results - tangible results for example reduced cost, improved quality or quantity of product. Kirkpatrick's saw the levels as different but complementary.

The Kirkpatrick evaluation model provided the reviewers a framework with which to place the relevant articles within categories/ levels to aid analysis and presentation of findings, with a view to identifying measurement of learning formats, outcomes and strategies that embed practice change.

This is the first review of the published literature focused on the effectiveness of online cancer education for nurses and allied health professionals. The purpose of this review was to explore the literature identifying what is known about the use of online learning and the outcome measures used to evaluate this education in order to propose recommendations.

Defining online education

For the purposes of this review, online education is defined as education and learning activities delivered electronically or involving the use of a computer or electronic device, either in combination with face-to-face contact or solely online format. This includes a range of media, delivery via the Web or a virtual learning environment such as Moodle or Blackboard, or hardware such as CD/DVD format.

Method

The overall aim of the review was to critically analyse the literature relating to online cancer education for nurses and allied health professionals. The specific objectives were to:

- Identify the nature of online education in cancer.
- Identify theory underpinning the online education in cancer.
- Identify the education and clinical outcome measures used to evaluate online cancer education.
- Determine the effectiveness of the measures used in online education in cancer.

Figure 1 outlines the various phases of the review.

Phase 1

A systematic search of the literature from 2000-2014 was undertaken in December 2014 using the sources: CINAHL, Medline, PsycInfo, ASSIA, Education-line, British Education Index, Australian Education Index, ERIC, Research into Higher Education Abstracts, Educational Research Abstracts, Education Research Theses, Australian Council for Education Research, NIHR Clinical Research Network Portfolio Database, Index to Theses, Web of Knowledge, Zetoc, Escalate [HEA], EvidenceNet [HEA], Google Scholar (the full search strategy article selection are available from the corresponding author). 101 literature sources were identified in Phase 1 (**Figure 1: Process and phases of the review**).

Phase 2

Each reviewer independently assessed each literature source against the inclusion and exclusion criteria. One hundred and one papers were sourced. A preliminary number (23) of sources were excluded on the basis of the abstract, and full text papers were retrieved for 78 papers to enable detailed screening, where 48 papers were excluded.

Inclusion criteria

- Education for health professionals with a recordable or registered professional qualification including nurses, and the professions allied to medicine (physiotherapists, occupational therapists, clinical psychologists, dieticians, social workers and complementary therapists)
- Evaluated an educational intervention relating to cancer care, delivered in an online or electronic format. This included: a fully online, blended (face-to-face and online); a computer educational programme available on the Web or CD-ROM.

Exclusion criteria

- Education solely aimed at medical doctors
- Non-English language sources
- Those that did not specify details of an evaluation process

Therefore, 30 papers were identified as relevant to the review and 71 papers were excluded (total 101 articles). Exclusion of papers fell into four main categories: the participants did not include nursing (n=18); not evaluation or limited data (n=41); not online education (n=6) and not cancer courses (n=9); more than one category (n= 3)

Phase 3

Three independent reviewers, using a developed data extraction tool, critically reviewed each data source. The extracted data were synthesised within evidence tables, grouped within levels of evaluation described by Kirkpatrick [9] the four levels are described below:

Level 1:	Assessment of learners' views
Level 2a:	Change in learners' views or attitudes
Level 2b:	Change in learners' knowledge or skills
Level 3:	Change in learners' behaviour
Level 4a:	Change in organisational practice

Level 4b: Change in benefit to patients

Findings

The thirty reviewed papers are presented in Table 1 (could be an online document)

Evidence reporting included qualitative thematic methodology [10, 11] and quantitative research involving pre and post-tests [12-22] and surveys [23-35] and clinical outcome measurements [36-39]. Only one randomised controlled trial [37] was available so unable to meta-analyse pooled data. The quality of statistical analysis was generally weak. The findings are, therefore, presented in narrative form aligned to the specific objectives of the review.

The nature of online education in cancer

Fig 2. Country of origin of articles, Fig 3. Categories of online Cancer Education Topics

Ranges of approaches to online education were apparent including unaccredited courses [11-16, 18-28, 34], modular courses provided from Higher Education Institutions [10, 22, 24, 30, 33, 37, 39]. The formats include synchronous, asynchronous learning and a variety of interactive self-directed methods and learning objects [12, 13, 19, 28-32, 34, 38].

For many, the reasons for adoption were to change practice [12-14, 23, 36, 37]. The reasons could also be associated with accommodating busy professionals with limited time and finance for travel [14, 15, 24]. The online approach was justified as a national education approach or geographical initiative [13, 16, 17, 23, 24]. Many of the authors were aiming to improve flexible access [24], whilst others were being driven to change delivery to accommodate numbers [14, 25], reduce the cost of delivery or enhance the ability to track training at organisational level [10, 24, 27]. The student experience [11, 18, 23, 26] and impact upon practice were also cited as a justification for a blended approach to learning [17, 27] and inter-professional learning [16, 19, 25, 28]. In one source, a digital object was developed to represent the service user perspective as learning and teaching strategy [29].

In regard to specific educational interventions, there were examples of case based scenarios and multiple choice education sent by email 'time spaced' at intervals [37, 38]. Student centred learning style selection was offered

by providing a choice of asynchronous web based material [23, 32, 35]. Using synchronous approaches to real time web-based seminars and video- conferencing was also reported [14, 16, 17, 24, 36].

Where much of the online education appeared to be developed by educators themselves, a CD Rom for cytotoxic chemotherapy administration in UK was developed by the expertise of a commercial company and expertise of four pharmacists [31]. A prototype online education resource developed by a US multi-media company was also described as providing health professionals with information on complementary and alternative therapies for men with prostate cancer, accessible from the Web [15].

Theory underpinning the online education in cancer

Eleven of the 30 papers described educational theory underpinning the design and/or delivery of the online learning. Several studies discussed being guided by *adult learning theory* [15, 17, 25, 26, 32]. Other theories informing the education were *interpretative pedagogy* [16]; *constructivism* [33] recognising the construction of knowledge as situated in relevant personal, social experience; *active learning* based on reflection, authentic tasks and assessments. Reflection was described as focusing on application to practice and relevant to work-based learning [23]. Only one source referred to online learning pedagogical frameworks for example: situation learning theory and legitimate peripheral participation and community of practice [14]. Other examples were the use of a three dimensional model of *cultural congruence* [10]; and a *competency framework* used to guide the development of a course on spirituality [26]. A *trans theoretical model* to measure changing behaviour [20] was also identified. Nineteen studies had no underpinning theoretical framework and it was difficult to identify a clear framework for analysis, reporting of the findings and a conclusion.

Outcome measures used to evaluate online cancer education

Research questions were underdeveloped in most papers suggesting few were planned as a research study or with an evaluation strategy developed prior to delivery. In one study [36] participants were randomised and established a control group, whilst in three studies [37, 17, 38] primary and secondary outcomes were specified.

Fig 4. Kirkpatrick Levels of Evaluation

Kirkpatrick level 1

Quality and accessibility of course and learning materials

The quality and accessibility of learning materials were evaluated in several papers relating to format, readability, content, ease of access to materials and graphics [30-32], accessibility of activities [27], and quality of materials [33]. Student experience of access to and navigation within the VLE, were evaluated alongside technical and administrative issues [26]. Evaluations were collated relating to preference of learning format and technological challenges with accessing Web-based programmes [24].

IT use and confidence

IT use and confidence also featured in evaluation measured by a previously developed questionnaire [33]. This included a pre- post-test evaluation of IT use and confidence and preference for e-learning. Qualitative methodology was used to obtain the participants' perception of an online module in paediatric oncology studies [11].

General module evaluation

Several studies drew on standard module evaluations undertaken routinely once a module was complete by using a 25-item questionnaire and open-ended questions relating to appropriateness, relevance, and satisfaction with the module. Evaluations were undertaken immediately following the module completion and at two, six and 12 months [32]. Others used simple evaluation tools to explore areas such as: the quality of module support [33]; assessment outcomes or examination results [30]; number of hits on different areas of the module VLE [23]; and an online post-course moderator evaluation [34]. Several studies also used focus groups or individual interviews to gather qualitative evaluation data [10-12, 26, 36].

Cost-effectiveness of Web-based learning format

A small number of papers considered cost-effectiveness, not in terms of detailed economic evaluations but rather an assessment of the influence of the online course on reducing demands on supervisors time [25] or as enhancing access to education out of work hours when staff had no protected study time, or limited budgets for education [24].

Kirkpatrick level 2a, 2b and 3

One study reported measuring attitudes specifically [19]. A number of studies evaluated changes in knowledge and confidence using pre- and post-tests completed by students which asked them to rate their achievement of learning goals on a five-point Likert scale in areas of perception of meeting learning needs, understanding, approach, pain assessment, and confidence [13-15, 17, 21]. Two studies examined student confidence in communicating before and after the course [15, 34] one study undertook pre and post-testing of knowledge and skills using multiple choice questions and vignettes [12]. Three studies built in a follow up of the knowledge and

skills in estimating the impact and potential behavioural change of the student over differing lengths of time; after 3 months [19], after a year [22]; and after a period not reported after the course [16, 18, 20].

Kirkpatrick level 4

In a small number of papers there was evidence of attempts to evaluate clinical impact. For example, the uptake of mammogram was measured in women aged 50-65 in one study where an online education programme for nurses had been instigated [36]. Similarly, the number of prostate screening tests ordered by practitioners receiving educational emails was recorded [37], whilst face-to-face teaching was compared with online delivery of cervical smear education by recording the rates and quality of smears in the two groups [39]. Finally, evaluation of using a mobile application of 'spaced education' as an intervention for pain assessment learning included audit data which suggested a significant reduction in pain ratings [38]

In summary, the literature reviewed indicated different level of evaluation with limited evidence of validated tools in use. Some evaluation methods were not clearly stated or at a very early stage, and tools were not always included in the papers. Many papers incorporated different methods of evaluation, although none considered the synthesis of evaluation data. Mostly, data were qualitative in nature or developed as descriptive statistics, which were not always robust or clearly presented.

Discussion

The overall aim of this systematic review was to critically analyse the literature relating to the effectiveness of online cancer education for nurses and allied health professionals. To achieve this, Kirkpatrick's model of evaluation [9] was utilised as a framework for analysis, reporting of findings and structuring of the discussion. Thirty papers were examined giving rich information on the education that is internationally relevant.

In this section we will discuss the studies in general and then group by the Kirkpatrick level of evaluation, concluding by comparing the levels in terms of key indicators for a rigorous evaluation in online cancer education.

From this review it is apparent that there is no singular reason to develop and deliver an online or blended education intervention. The reasons ranged from the geographical to the numbers of students attending the course. In arguing for the impact of the education intervention in terms of increasing knowledge and skills, including confidence or actual clinical outcomes, there is no evidence to suggest that online delivery of the education is better or worse in education terms than face-to-face delivery. The advantage of online delivery is the potential to engage more health care professionals in education. This is reported in the four education Kirkpatrick level 4

interventions delivered [36-39] that all used clinical patient referral rates, change of practice in screening as there outcome measure. These studies identify that the online delivery does not hinder the achievement of clinical outcomes. Furthermore, these studies also indicate that the education intervention can be delivered using different, innovative formats to achieve a similar aim, focused on improving knowledge about cancer screening [36, 37, 39] and symptom assessment [38].

Using Kirkpatrick's model of evaluation to structure the analysis of the evidence, has afforded the review team a lens to identify that the majority of papers (n=15) are evaluating at level 1 of Kirkpatrick's model; assessing the views of the quality and accessibility of the content and the IT infrastructure [13, 23-25, 29]. Here the predominant approach to measurement of views is survey's including open-ended questions [28, 32, 33, 35] evaluation questionnaires [27, 30, 31], or a qualitative research approach utilising focus groups and individual interviews [10,11, 26].

Twelve papers at level 2a, b, and 3 of the Kirkpatrick model of evaluation we can see the introduction of pre and post questionnaires, developed specifically to study changes in knowledge, confidence attitudes and self-efficacy [19]. There is a trend of larger numbers of students being involved in these studies [14-18, 20, 21] than those representing level 1 evaluation. The rigour was enhanced due to cohort comparisons of student populations [14, 18]. However a number of studies had low participant numbers [12, 13, 19, 22] with high attrition and low response rates limiting their findings [12, 22].

The trend of higher numbers of participants can also be seen in the evidence relating to Kirkpatrick's level 4 grouping with one exception [36]. The relationship between the education and clinical impact is measured in referral rates to services; audit of appropriate smear [39] and pain medication [38] received, and reported patient pain scales. It is acknowledged that trying to find a causal link between the education and the clinical outcomes data is challenging there is a sense that, in these studies, the research is trying to move this educational evidence base forward.

Education and theoretical models were seen at all the levels of the Kirkpatrick evaluation model. At level 4a and b a new theoretical model evaluation was represented by 'spaced education' [37, 38] and two studies used specific online education theoretical models; one study representing level 2a, b, and 3 evaluations identified *situational learning theory* and *legitimate peripheral participation of community of practice* [14]. The other study represented level 1 evaluation used the *5 stages Salmon Model* [33]. Each of these theoretical models,

and others, are important to embrace, to underpin the design and participation, to enhance the online learning experienced.

Given the limited outcome measures above, the scope for assessing effectiveness of online education from the literature identified in this review is challenging. Additionally, the research methodologies used within studies indicate a need for caution in accepting claims. For example, that online education influenced the uptake of mammograms in a rural area [36] or reduced the number of prostate screening test ordered by clinician receiving emails incorporating clinical scenarios [37]. Adapting a face-to-face course for online delivery did not appear to influence the quality of smear-taking [39], although there are many other variables that might influence the outcomes in such as study.

There are several examples in the literature of the use of pre- post-test tools, which suggest some evidence of effect, however poor responses to post tests in some studies indicate a further need for caution in interpreting results. A study of an online cancer education format for 107 nurses in 12 regions of Canada, reported outcomes such increased knowledge and confidence but only had a 31% response rate in the final evaluation whilst also recording an exam success rate of 94% [17]

Limitations of this review

There are several limitations within this review, firstly the review team had a focus on Nursing and Allied Health Care Professionals, consideration of other professionals were given, in fact the theoretical framework ‘ spaced education’ has been translated from the medical education field into these education initiatives for Nursing and Allied health professionals. However the team felt that a focus specifically upon Nursing and Allied Health Care professional would give a robust and focused view to enable of the development of education for current educational practice. Secondly, the review only incorporated English reported studies, which could exclude a number of online cancer educational evaluations. Thirdly, studies were included from the year 2000 onwards as there is an indication that this evaluation and research was in its infancy before this date. Fourthly, it could be argued that by using Kirkpatrick evaluation model [9] the review team limited the lens on the articles, however the use of Kirkpatrick model is not viewed as a hierarchical level of success rather an attempt to analyse the studies and categorise them according to the reported level of evaluation: views, knowledge, attitudes, organisational change and clinical outputs. Therefore this review provides an overview of methods used to evaluate on-line learning at different Kirkpatrick levels.

Conclusion

To determine the effectiveness of the methods of evaluation used in online education in cancer care this review concludes that understanding participants views/experiences and identifying changes in participants' values and attitudes, knowledge and skills are being reported for groups educated over a wide geographical and/or rural areas. Evidence for clinical and educational effectiveness is weak, offering insights into experiences/satisfaction and participant perceptions rather than concrete quantitative/impact data and patient reported outcomes.

Therefore, key indicators/ recommendations are for more clinical educational research, which incorporates and demonstrates the longer term effectiveness and impact of online cancer education on patient reported outcomes, underpinned by theoretical frameworks and using more rigorous methods i.e standardized evaluation tools or randomized control trials to build upon and enhance the quality of evidence.

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