An overview of systematic reviews in medical education, and a focused review of prescribing interventions

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Abstract

Background

The increasing popularity of systematic reviews in medical education has led to the publication of several tertiary reviews (review of reviews) focusing on the continuing education of doctors and improving professional practice. This paper expands these existing reviews to all areas of medical education, including medical students and junior doctors. An in-depth focus on prescribing reviews is also included.

Methods

A systematic search using the key words 'medical education' AND ('systematic review' OR 'meta-analysis') was conducted and all reviews meeting the inclusion criteria were coded by educational intervention, curriculum/theme, participants, and outcomes—creating a systematic map or overview. All reviews coded as prescribing meeting the criteria for the tertiary review were data extracted and quality appraised.

Results

The systematic mapping exercise yielded 192 systematic reviews in medical education, of which the most popular intervention and curriculum reported were simulation (8%) and prescribing (8%), respectively. However, 27% reviews did not specify a curriculum/theme and 57% did not specify an intervention—but rather included any curriculum (to evaluate an intervention) or any intervention (to improve an outcome or curriculum). Most reviews included multiple participant types (69%) and sought to

include patient/health outcomes (64%). Twelve prescribing reviews were included in the tertiary review where active educational strategies were more effective than passive strategies. The quality of prescribing reviews was generally good, although no review fulfilled all of the quality appraisal criteria.

Discussion and conclusions

The systematic map served as a useful tool and identified gaps in the review-level evidence base. The map highlights topics and interventions reported in reviews, but further research should explore the cost-effectiveness of the reviews themselves. Active educational interventions can improve prescribing behaviours. Prescribing reviews tend to focus on doctors; more research into the acquisition of prescribing skills by medical students and junior doctors is required.

Background

Medical education

'Medical education' is a broad term used to describe the education and training of medical students, junior doctors, doctors and other health professionals with the ultimate goal of improving patient care.(1) Medical education as a research discipline began in the late 1950s and has expanded rapidly.(2;3) Kuper et al. attribute the rapid growth of medical education research to the increasing importance of scientific research in general and the resulting explosive growth in scientific knowledge, the availability of funding for research in the field and an increasing demand for public accountability of medical education.(3)

Systematic Reviews

Systematic reviews are important for synthesising research evidence and are becoming increasingly popular in the literature, including in the medical education literature. One of the primary goals of a systematic review is to collate research evidence in an unbiased, systematic and replicable way. The evidence can then be synthesised either quantitatively or qualitatively, providing an overview of literature on the topic and answering a specific research question. Systematic review methods are essential to synthesise the empirical findings from a large literature base to provide the highest level of evidence to clinicians, policy makers, and researchers in a relatively succinct manner.(4) However, systematic reviews do vary in quality and findings from lower quality reviews will be less reliable.(4)

Overview or Systematic Mapping

Systematic mapping is a way of making an inventory of available research (or systematic reviews in the case of this project) in a given topic or area. Systematic mapping topics can be much broader than systematic review topics and help to identify where research efforts have been or should be focused. Research is identified in a systematic and replicable way and is coded according to a priori inclusion criteria, such as participants, interventions, and outcomes. The map becomes a resource for additional and more in-depth analyses.

Tertiary Reviews

Tertiary reviews, or systematic reviews of systematic reviews, are helpful in providing an overview where a number of reviews have been undertaken in a topic area. A number of tertiary reviews in medical education have been published which focus on the continuing education of doctors and improving professional practice.(5-8)

Aims and Objectives

Our primary aim was to identify which educational interventions and/or curricula have been reported in medical education systematic reviews. We therefore undertook a systematic mapping exercise, expanding the existing tertiary reviews to look at medical education research including doctors, medical students and junior doctors. The map was used as a resource to identify prescribing reviews and to fulfil our secondary aim of conducting an in-depth review with the narrow focus of identifying educational interventions that improve prescribing behaviours.

We chose to focus on prescribing because it is often cited by medical students as an area they feel less confident in upon graduation (9) and the potential high stakes associated with prescribing errors. Prescribing errors account for 65% of medication errors in hospitals and are generally preventable.(10) One study found that preventable adverse drug events happened after 1.4% of medication orders and involved 14.8% of admitted patients.(11) Studies based in the United Kingdom, United States, and France have also identified a need to improve prescribing in primary care.(12-14)

Methods

Education and outcome definitions

The definition of what constitutes an educational intervention varies in the literature. For this project, we considered both active and passive education strategies. All of the following strategies were considered education: traditional education (e.g. lectures, group education, online learning); educational outreach visits or 'academic detailing'; educational materials; educational games and mentoring. We did not consider audit and feedback alone to be education, nor did we consider clinical or practice guidelines to be education. Assessment interventions were also not considered education, unless the assessment (usually formative) doubled as an educational tool (e.g. portfolio, mini clinical evaluation exercise).

We used Kirkpatrick's hierarchy of outcomes to define the classification of educational effectiveness of an intervention.(15) In increasing order of validity, relevant outcomes

were therefore (I) participant reactions; (II) modification of attitudes or knowledge/skills; (III) behaviour change and (IV) change in organisational practise or benefits to patients (i.e. health care outcomes).

Search methods for map and in-depth review

One reviewer [KEG] searched six electronic databases in January 2012: Cochrane Database of Systematic Reviews; PubMed; Medline; Web of Science; Embase; The Educational Resources Information Centre (ERIC); and Biomed Central using the keywords ('systematic review' OR 'meta-analysis') AND 'medical education'. The search was started from the earliest available date and only papers written in English were considered. Additionally, the Best Evidence in Medical Education (BEME) website was 'hand searched' to locate relevant reviews that may have been missed. All electronic searches were exported into Reference Manager where duplicate articles were removed.

Inclusion/exclusion criteria

The inclusion criteria were:

(1) Reviews that described themselves as a systematic review, used the term 'systematic' to describe their search strategy , or included the basic elements of a systematic review (i.e. an explicit search strategy and pre-established inclusion/exclusion criteria, quality appraisal of included studies and evidence synthesis).(16)

(2) Reviews that had doctors, medical students, and/or doctors in training as participants were included. Studies that stated 'healthcare professionals', 'care providers', or another generic term for medical personnel that *may* includes doctors were also included.

(3) Reviews that examined educational interventions or outcomes (to any degree) were included. Reviews that aimed to include educational intervention(s) or outcome(s) were included, even if no studies that met the criteria were found (i.e. empty reviews).

(4) The review's inclusion criteria for study designs had to include: pre-experiments, quasi-experiments and/or true experiments, but could include other study designs as well.

The exclusion criteria were:

(1) Reviews that explicitly stated that it was not a 'systematic review' or where the review did not include the basic elements of a systematic review. (16)

(2) Reviews that did not include doctors, medical students or doctors in training.

(3) Reviews that did not examine educational interventions or outcomes.

(4) Reviews that did not aim to identify pre-experimental, quasi-experimental, or true-experimental designs .

Study selection – screening for inclusion in the map and the in-depth review

Systematic reviews of potential relevance were screened in three phases. Phase I was screening on titles and abstracts, using the pre-established inclusion criteria (see above). All three reviewers screened the same 10% sample of the abstracts as a training exercise. Once training was complete, one reviewer [KEG] screened all of the abstracts. The other reviewers [CAT, CJT] screened two additional 5% random samples to ensure

reliability, including a unique sample and a sample in common. All kappa statistics for all pairings of reviewers were above 0.8.

In Phase II, the full articles were retrieved. In order to narrow the scope and have more meaningful results a decision was made to adjust the inclusion criteria by only including articles that had an educational intervention AND an educational outcome. KEG screened all full articles and the other reviewers [CAT, CJT] each screened half full articles. . Reviews that were excluded because their inclusion criteria for study design included only systematic reviews (tertiary reviews) were citation searched to locate any reviews missed in the initial search. All of the systematic reviews were screened and subjected to the same criteria as described in Phase I and II above.

Reviews that were coded as a prescribing curriculum/theme (see below) were screened again for inclusion in Phase III, the tertiary review. The inclusion criteria remained the same, except studies needed to include at least one randomised controlled trial (RCT).. Where a review had been updated, only the most recent review was included, providing the search dates overlapped. Reviews that did not report results for education or draw conclusions specific to education were excluded at Phase III. KEG and either CAT or CJT screened all of the prescribing reviews.

Where there was disagreement or uncertainty during Phase II or III, the review was discussed amongst all reviewers until consensus was reached.

Data extraction and quality assessment

An initial data extraction was performed for all systematic reviews included after Phase II screening using a pre-established data extraction form which included: bibliographic details, participants, curriculum /theme for the review, educational intervention, and outcomes. All reviews were extracted by one reviewer [KEG] and another reviewer [CAT] extracted a 10% sample to ensure reliability.

Reviews that were retained after Phase III (identified as a 'prescribing' curriculum or theme and included at least one RCT) were extracted in more detail using the following additional criteria: country; number of studies; number and design of studies related to education; setting(s); results related to education; conclusions related to education; pooled effect sizes.

For both the initial and full extractions, only studies that included interventions related to the education of doctors, junior doctors, and/or medical students were extracted (patient education and interventions not related to education were not extracted). Data were also extracted on the quality of each review using a pre-established quality appraisal form derived using recommendations from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Statement (PRISMA), as shown in Appendix D.(4)

The full extraction and quality appraisal were performed by the two reviewers who were allocated the review for screening. All discrepancies were discussed amongst those

reviewers. If there was disagreement the third reviewer was consulted until consensus was reached.

Data synthesis

The reviews included after Phase II screening were included in a systematic map showing curriculum/theme against educational intervention. The number of reviews considering each participant group and type of outcome were also identified.

Data from the reviews included after Phase III were extracted including any pooled effect sizes, by intervention and/or outcome. Due to the small number of reviews that reported pooled effect sizes, no meta-analysis was conducted. Instead, results are summarised in a narrative synthesis.

Results

Results from searching and screening

A flow diagram for papers included at each phase is provided (Appendix A). After Phase II, 192 papers reporting 187 unique reviews were retained and included in the systematic map (a full list of reviews is available from the corresponding author). The five studies that were reported more than once (in sufficient detail to be included after Phase II) include: a journal version and an update of an audit and feedback review; an update of a hypertension review; a shorter version of a full prescribing review; and an update of a review on early experience.

Fifteen papers were identified with the curriculum/theme of prescribing during the initial data extraction. Twelve were retained after Phase III for full data extraction (Table 2).(17-28) Three papers were excluded because of the additional exclusion criteria: did not include any RCTs (29); was a journal version (30) of a full review that was included (26), and did not report results or conclusion for education (31).

Characteristics of included reviews

The majority of the 192 reviews sought to include the highest level of Kirkpatrick's Hierarchy — patient outcomes (64.6%) (Table 1). Some reviews (11.5%) were exploratory, rather than hypothesis testing and did not seek specific educational outcomes. Although most reviews (68.8%) sought multiple participants (e.g. health professionals), these were dominated by doctors and an additional 30 (15.6%) reviews were specifically dedicated to doctors (Table 1).

Fifty one (26.6%) reviews did not have a specific curriculum or theme; the aim of most of these reviews was to evaluate the effectiveness of a specific intervention (e.g. is internet-based learning effective?) (Appendix B). Similarly there were 109 (56.8%) reviews that included any educational intervention, which therefore focused on the curriculum/theme (e.g. prescribing skills) or outcome (e.g. reducing antibiotic use) (Appendix C).

The 12 prescribing reviews retained after Phase III (Table 2) cite a total of 384 papers, of which 312 were unique and 220 included educational interventions. None of the prescribing reviews were restricted to a single educational intervention . In general, the prescribing reviews were of good quality (Appendix D). However, no review addressed

all of the criteria on the quality appraisal form. Only two reviews failed to address the risk of bias within studies (19;20), while just one review addressed the risk of bias across studies (18).

Summary of findings of included reviews

All studies comparing active and passive strategies found active strategies (particularly educational outreach) to be the most effective (Table 2), although passive strategies may serve as a useful adjunct/reminder to the active education. However, use of active strategies alone did not guarantee success. Interventions need to be developed with the local context, prescribing behaviour to be addressed and participants in mind. As with other educational interventions it is easier to change knowledge than prescribing behaviour and health outcomes.

Discussion

This systematic mapping exercise enabled us to identify and categorise a large number of systematic reviews in medical education. This methodology can be applied to other disciplines and types of research design. For example, a similar map including only randomised controlled trials in medical education would be useful to see where efforts have been made to use the most rigorous study designs. The map can be updated when necessary and used as a resource for additional in-depth analysis.

Our map identified 192 systematic reviews in medical education meeting our inclusion criteria. The most popular topic/intervention combinations were simulation

interventions in clinical/surgical skills and any intervention in prescribing. The dominance of these review categories may be due to the amount of primary evidence available such that a review is necessary to provide high-level evidence in a succinct way.(4) An alternative explanation is the increasing provenance of prescribing errors or the relatively revolutionary way in which simulation training is changing the traditional *see one, do one, teach one* model of medical education. In addition, both prescribing and simulation in surgical skills are broad topics themselves and could be further categorised (e.g. cadavers in laparoscopic surgery).

The map can also be used to identify areas where a systematic review may be fruitful. For example, we did not find any reviews evaluating lectures, despite their continued widespread use in medical education.

Most reviews sought the highest level of Kirkpatrick's hierarchy (i.e. patient outcomes, organisation change). Most medical education studies tended to look at change in knowledge or attitudes and occasionally at a behavioural change. Future research should explore whether a change in knowledge, attitudes, or behaviour during training or education (eventually) translate to better patient outcomes.

The systematic map was used so that our secondary goal of conducting a tertiary review in prescribing could be carried out. None of the prescribing reviews we located focused on a specific educational intervention, but instead included any intervention to improve prescribing behaviours. Many studies that use education are multifaceted and include non-educational interventions. It is sometimes difficult for researchers to determine

which aspects of the interventions contributed to any successes. However most of the prescribing reviews were able to draw conclusions on education alone.

Dissemination of educational materials, group education, educational meetings and educational outreach visits appeared in most of the reviews and met with mixed success. Active strategies (e.g. one-to-one outreach) were more effective than passive strategies (e.g. dissemination of educational materials). Only one review found the dissemination of education materials effective, but drug samples were included with the educational materials.(23) Passive strategies may be less effective because participants do not fully read the information or because the information is dismissed more easily than if it was given verbally. Overall the quality of the prescribing reviews was good, though most failed to assess the risk of bias across studies. Most of the reviews described their findings by explaining each study individually, and did not synthesize the findings quantitatively. This may have been due to the heterogeneity of the included studies, but in turn limited our ability to synthesize the findings of the reviews.

Only one prescribing review focused on medical students and/or junior doctors: this may be an indicator of the focus on prescribing education after qualification. It may also be attributed to the difficulty of conducting 'rigorous' research on students who cannot legally prescribe medications yet, only allowing for educational outcomes typically classified at Level I or II of Kirkpatrick's hierarchy. Further research could explore the prescribing curricula during medical school and foundation training, and whether the suggestions above (e.g. active strategies) could be applied or adapted to

medical students. Longitudinal studies to examine how prescribing education during medical school affects future patient outcomes would also be useful.

Limitations

Though our search strategy was intentionally broad to include as many reviews for potential inclusion as possible, it is possible that some reviews were missed. Tertiary reviews by their nature have an additional lag time since the publication of the original research, beyond a traditional systematic review. It is possible new published studies are not yet included in any systematic review; hence they would be excluded from this review.

The abundance of systematic reviews that have been published in the field of medical education is impressive. However, we did not explore the cost-effectiveness of these reviews. Future research should explore if the quality of reviews is sufficient to yield reliable results, if there are actionable conclusions provided and what effect (if any) the reviews have actually had on changing the practice of medical education or the generation of additional high quality primary research. Few reviews consider the cost of providing the education, which is at odds with the need for accountability which helped drive the field of medical education research.(3)

Reference List

(1) Harden RM, Grant J, Buckley G, Hart IR. Best Evidence Medical Education. *Adv Health Sci Educ* 2000;**5**(1):71-90.

(2) Regehr G. Trends in Medical Education Research. *Acad Med* 2004;**79**(10).

(3) Kuper A, Albert M, Hodges B. The Origins of the Field of Medical Education Research. *Acad Med* 2010;**85**(8).

(4) Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche P, Ioannidis JPA, Clarke M, Devereaux PJ, Kleijnen J, Moher D. The PRISMA Statement for Reporting Systematic Reviews and Meta-Analyses of Studies That Evaluate Health Care Interventions: Explanation and Elaboration. *PLoS Med* 2009;**6**(7):e1000100.

(5) Bloom BS. Effects of continuing medical education on improving physician clinical care and patient health: A review of systematic reviews. *Int J Technol Assess Health Care* 2005;(3):380-5.

(6) Sohn W, Ismail AI, Tellez M. Efficacy of educational interventions targeting primary care providers' practice behaviors: an overview of published systematic reviews. *J Public Health Dent* 2004;**64**(3):164-72.

(7) Robertson MK, Umble KE, Cervero RM. Impact studies in continuing education for health professions: update. *J Contin Educ Health Prof* 2003;**23**(3):146-56.

(8) Yen BM. Engaging physicians to change practice. *J Clin Outcomes Manag* 2006;**13**(2):103-10.

(9) Heaton A, Webb DJ, Maxwell SRJ. Undergraduate preparation for prescribing: the views of 2413 UK medical students and recent graduates. *Br J Clin Pharmacol* 2008;**66**(1):128-34.

(10) Kohn L, Corrigan J, Donaldson M. To err is human: building a safer health system. Washington, DC: National Academy Press; 2000.

(11) van Doormaal JE, van den Bemt PMLA, Mol PGM, Zaal RJ, Egberts ACG, Haaijer-Ruskamp FM, Kosterink JGW. Medication errors: the impact of prescribing and transcribing errors on preventable harm in hospitalised patients. *Qual Saf Health Care* 2009;**18**(1):22-7.

(12) Fleetcroft R, Cookson R. The relationship between prescribing expenditure and quality in primary care: an observational study. *Br J Gen Pract* 2006;**56**(529):613-9.

(13) Coste J, Venot A. An epidemiologic approach to drug prescribing quality assessment: a study in primary care practice in France. *Med Care* 1999;**37**(12):1294-307.

(14) Fischer MA, Avorn J. Economic implications of evidence-based prescribing for hypertension: can better care cost less? *JAMA* 2004;**291**(15):1850-6.

(15) Kirkpatrick D. Evaluation of training. In: Craig R, Mittel I, editors. In Training and Development Handbook. R. Craig & I. Mittel ed. New York: McGraw Hill; 1967. p. 87-112.

(16) Cochrane Handbook for Systematic Reviews of Interventions. John Wiley & Sons, Ltd; 2008.

(17) Arnold SR, Straus SE. Interventions to improve antibiotic prescribing practices in ambulatory care. *Cochrane Database Syst Rev* 2005;(4):CD003539.

(18) Figueiras A, Sastre I, Gestal-Otero JJ. Effectiveness of educational interventions on the improvement of drug prescription in primary care: a critical literature review. *J Eval Clin Pract* 2001;**7**(2):223-41.

(19) Gurwitz JH, Soumerai SB, Avorn J. Improving medication prescribing and utilization in the nursing home. *J Am Geriatr Soc* 1990;**38**(5):542-52.

(20) Kaur S, Mitchell G, Vitetta L, Roberts MS, Gallagher P. Interventions that can Reduce Inappropriate Prescribing in the Elderly: A Systematic Review. *Drugs Aging* 2009;**26**(12):1013-28.

(21) Lu CY, Ross-Degnan D, Soumerai SB, Pearson S-A. Interventions designed to improve the quality and efficiency of medication use in managed care: A critical review of the literature - 2001-2007. *BMC Health Serv Res* 2008;**8**(75).

(22) Ostini R, Hegney D, Jackson C, Williamson M, Mackson JM, Gurman K, Hall W, Tett SE. Systematic review of interventions to improve prescribing. *Ann Pharmacother* 2009;**43**(3):502-13.

(23) Pearson SA, Ross-Degnan D, Payson A, Soumerai SB. Changing medication use in managed care: a critical review of the available evidence. *Am J Manag Care* 2003;**9**(11):715-31.

(24) Ranji SR, Steinman MA, Shojania KG, Gonzales R. Interventions to Reduce Unnecessary Antibiotic Prescribing: A Systematic Review and Quantitative Analysis. *Med Care* 2008;**46**(8):847-62.

(25) Ross S, Loke YK. Do educational interventions improve prescribing by medical students and junior doctors? A systematic review. *Br J Clin Pharmacol* 2009;**67**(6):662-70.

(26) Soumerai SB, McLaughlin TJ, Avorn J. Improving drug prescribing in primary care: a critical analysis of the experimental literature. *Milbank Q* 1989;**67**(2):268-317.

(27) Steinman MA, Ranji SR, Shojania KG, Gonzales R. Improving antibiotic selection: a systematic review and quantitative analysis of quality improvement strategies. *Med Care* 2006;**44**(7):617-28.

(28) Wilton P, Smith R, Coast J, Millar M. Strategies to contain the emergence of antimicrobial resistance: a systematic review of effectiveness and cost-effectiveness. *J Health Serv Res Policy* 2002;**7**(2):111-7.

(29) Ross S, Bond C, Rothnie H, Thomas S, MacLeod MJ. What is the scale of prescribing errors committed by junior doctors? A systematic review. *Br J Clin Pharmacol* 2009;**67**(6):629-40.

(30) Soumerai SB, McLaughlin TJ, Avorn J. Quality Assurance for Drug Prescribing. *Int J Qual Health Care* 1990;**2**(1):37-58.

(31) Davey P, Brown E, Fenelon L, et al. Interventions to improve antibiotic prescribing practices for hospital inpatients. *Cochrane Database Syst Rev* 2009;(2).