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An Exploration of the Epidemiology, Quality and Methods of Systematic Reviews of Health Professional Behavior Change Interventions

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AN EXPLORATION OF THE EPIDEMIOLOGY, QUALITY AND METHODS OF SYSTEMATIC REVIEWS OF HEALTH PROFESSIONAL BEHAVIOUR CHANGE INTERVENTIONS

MICHELLE WEIR

Thesis submitted to the Faculty of Graduate and Postdoctoral Studies in partial fulfilment of the requirements for the MSc degree in Epidemiology

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Abstract

This thesis describes the epidemiology, quality and methods of systematic reviews of health professional behaviour change interventions. The epidemiology was explored using descriptive methods and the quality was assessed with the AMSTAR tool. 'Lumping' and 'splitting', which refers to how broad or narrow a systematic review question is framed, was explored by assessing a subset of reviews to see how review authors framed their systematic review question and justified this decision. The results indicate that there has been an increase in the number of systematic reviews published on professional behaviour change interventions, they are dispersed across various literature sources and the reviews were generally of poor quality. Furthermore, many reviews are 'split', with little justification for the authors' choice of research question. The overlapping subject areas in addition to the low methodological quality raise concern about the organization of the field, including redundancy of publications and potential duplication of efforts.

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I would like to show my gratitude to the following individuals for their contribution to this thesis project. Firstly, my supervisor Dr. Jeremy Grimshaw, whose dedication to the project and guidance encouraged me from the beginning to the final stages. Dr. Dean Fergusson, whose helpful suggestions during all phases of the thesis were much appreciated. I would also like to thank Alain Mayhew for his valuable feedback and recommendations. To Julia Worswick, I am grateful for both her commitment to the work of the *Rx for Change* project and her personal support. To the rest of the *Rx for Change* team, including Lev Bubis, Andre Bussières, and Kate Smith who were all a pleasure to work with. Thank you to my family, friends, and classmates for their support and advice throughout the course of the Master's program, and lastly, to the Department of Epidemiology and Community Medicine, for its permission to carry out this research.

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Preface

Access to a large set of systematic reviews through the *Rx for Change* project provided the opportunity to conduct a Master's thesis on the epidemiology, quality and methods of systematic reviews of professional behaviour change interventions.

The *Rx for Change* database (www.rxforchange.ca) summarizes research evidence about the effects of strategies to improve drug prescribing practices, which includes systematic reviews of professional behaviour change interventions. The identification and synthesis of systematic reviews of the professional interventions is conducted by the Effective Practice and Organisation of Care (EPOC) Group, a review group of the Cochrane Collaboration. Through comprehensive searches conducted for *Rx for Change* between 2006 and 2008, 19,265 systematic reviews were identified, of which 193 met the selection criteria. These 193 reviews were critically examined to explore their epidemiology, quality and methods.

Along with Jeremy Grimshaw, Alain Mayhew and Julia Worswick, I was part of the leadership team for the 2008-2009 update of the *Rx for Change* database, and was involved in all aspects of the planning and execution of the project. For a large majority of the reviews, I was one of the two individuals involved in the duplicate screening, quality assessment and data extraction process. Throughout the course of the project, I was also involved in problem-solving and refining of the project's methods. For this Master's thesis, I carried out all of the analyses and prepared the written report of the results for the entire thesis, including each of the results chapters.

1. Introduction

1.1 Rationale

1.1.1 Systematic Reviews

Primary medical research studies are abundant and are often spread across multiple sources. Systematic reviews are a valuable resource, synthesizing multiple studies to answer a single research question. (1;2) Systematic reviews use a clearly formulated question to identify, select, and critically appraise relevant research using systematic and explicit methods. (3) Data are collected and analysed from the identified studies and statistical methods such as meta-analysis are used if appropriate. (3) Various stakeholders, including clinicians, guideline developers and granting agencies use systematic reviews to stay informed of current and relevant evidence-based research. (4) In addition, systematic reviews are among the most cited reports, indicating their importance to researchers for staying abreast of developments in their field of study. (5)

However systematic reviews can be of variable quality, depending on the extent to which scientific review methods were used in their development to minimize error and bias. Studies have consistently shown that improvement in the quality of systematic reviews and meta-analyses is needed. (6-9) Due to this variability in quality, it is necessary to appraise a systematic review for its methods before the results are implemented into practice or policy. There are various quality tools in existence, but only some have used systematic and evidence-based methods in their development. (10) A description of the AMSTAR ('a measurement tool to assess systematic reviews') tool was published in 2007 and consists of 11 items to assess the methodological quality of systematic reviews. (11) This tool was developed systematically and has been shown to be reliable and valid. (12)

1.1.2 Professional Behaviour Change Interventions

Knowledge translation uses synthesis, dissemination and exchange to improve health and provide more effective health services. (13) A key component of knowledge translation involves changing behaviours of health professionals to utilize up-to-date evidence in the care of their patients. Therefore, understanding the effectiveness of professional behaviour change interventions can aid in implementing evidence into practice.

Many barriers exist in the translation of evidence into practice for health professionals, including lack of time, lack of ability to appraise research studies properly, or barriers related to implementing new strategies into practice. (14) Increased research has been conducted on the effectiveness of interventions to change professional behaviour, including the publication of numerous systematic reviews on the topic. (15) Implementing changes to clinical practice requires good planning and a combination of various interventions. With limited resources in the health care systems, decisions relating to the implementation of interventions need to maximize benefits and minimize costs. (16)

The Effective Practice and Organisation of Care (EPOC) Group is a review group of The Cochrane Collaboration which produces systematic reviews of educational, behavioural, financial, regulatory and organisational interventions designed to improve health professional practice and the organisation of health care services. (17) EPOC's scope of work is broad and covers any clinical area. There are currently over 6000 articles in its specialized register of intervention studies. EPOC classifies professional interventions according to a defined taxonomy which includes categories such as audit and feedback, reminders, educational outreach and educational meetings.

1.1.3 Overviews of Systematic Reviews of Professional Behaviour Change Interventions

To summarize the large number of systematic reviews in the area of professional behaviour change, an overview of systematic reviews of professional behaviour change interventions was published in 1998 in *BMJ*. The overview included 18 systematic reviews identified up to 1996. (15) In 2001, an update of this overview was published in *Medical Care* that included 41 reviews identified up to 1999. (18) Both of these reviews have been widely used and cited by various groups worldwide to inform decisions about the choice of quality improvement and professional education strategies.* In 2006, the COMPUS (Canadian Optimal Medication Prescribing and Utilization Service) directorate of the Canadian Agency for Drugs and Technologies in Health (CADTH) approached EPOC to update these overviews to provides guidance to provinces about interventions to promote optimal prescribing practices. In 2007, the results of this project were published in an online inventory of interventions database (www.rxforchange.ca), with interventions to improve evidence-based prescribing practice divided into categories of professional (e.g. audit and feedback), organizational (e.g. revision of professional roles), structural (e.g. changes in medical records systems), financial (e.g. target payment systems), and consumer (e.g. education) interventions. Included in the database are reviews that are considered most relevant for prescribing behaviour in addition to all systematic reviews that evaluate professional behaviour change interventions. When the database was launched it contained

* According to Scopus, the 1998 overview has been cited over 800 times, and the 2001 overview has been cited over 450 times.

51 systematic reviews and in 2008/2009, the process was updated to include a total of 86 systematic reviews.

1.1.4 Lumping and Splitting in Systematic Reviews of Professional Behaviour Change Interventions

A major advantage of systematic reviews compared to individual trials is that they can increase statistical power to allow for important questions to be posed and meaningful outcomes measured. (19) Debates on how broad or narrow to make the research question in a systematic review involve whether very narrow questions are less useful compared to whether very broad questions are too heterogeneous to be combined. This has been referred to as 'lumping' versus 'splitting'. (20;21) Lumping has a potential to reduce the chance of bias, and allows for generalizability across a wider range of populations and settings, but splitting can potentially make reviews more relevant for end users and makes reviews easier to conduct. (21)

Systematic reviews of professional behaviour change interventions are relatively complex, due to the variety of health professional population groups studied, complexity of interventions and the numerous behavioural outcomes which may be considered. In addition, compared to clinical subject areas, professional behaviour change reviews usually lack an obvious biological basis to support the lumping or splitting decision. Specifically, while clinical areas might have a biological model or mechanism that supports the decision to lump or split the review, professional behaviour change reviews have a tendency to base their decisions on hypotheses or theories that have less supporting evidence.

Although lumping and splitting has a substantial impact on the conduct and potential results of systematic reviews, there has been limited discussion about it to date in the scientific literature. (20;21) This thesis aims to raise awareness about the issue and provide insight into the potential impacts of lumping and splitting on systematic reviews of professional behaviour change interventions.

1.2 Objectives and Scope of Thesis

The three objectives of this thesis are:

1. To describe the epidemiology of systematic reviews of professional behaviour change interventions. This is addressed in chapter two, where the descriptive epidemiology of the 193 reviews is explored to determine where, when and how they were conducted.
2. To describe the quality of systematic reviews of professional behaviour change interventions. This is addressed in chapter three, where the quality of the reviews is assessed using the AMSTAR quality appraisal instrument and trends in quality are examined.
3. To descriptively explore the effects of lumping and splitting on professional behaviour change interventions looking at a subset of reviews. This is addressed in chapter four, where reviews on reminder interventions are analyzed to take a closer look at the issue of lumping and splitting, an important topic for reviews on professional behaviour change interventions.

Reference List

(1) Khan KS, Kunz R, Kleijnen J, Antes G. Five steps to conducting a systematic review. J R Soc Med 2003 Mar;96(3):118-21.

(2) Chalmers I, Haynes B. Reporting, updating, and correcting systematic reviews of the effects of health care. BMJ 1994 Oct 1;309(6958):862-5.

(3) The Cochrane Collaboration. Cochrane Handbook for Systematic Reviews of Interventions Version 5.0.1. 2008.

(4) Moher D, Tetzlaff J, Tricco AC, Sampson M, Altman DG. Epidemiology and reporting characteristics of systematic reviews. PLoS Med 2007 Mar 27;4(3):e78.

(5) Patsopoulos NA, Analatos AA, Ioannidis JP. Relative citation impact of various study designs in the health sciences. JAMA 2005 May 18;293(19):2362-6.

(6) Mulrow CD. The medical review article: state of the science. Ann Intern Med 1987 Mar;106(3):485-8.

(7) McAlister FA, Clark HD, van WC, Straus SE, Lawson FM, Moher D, et al. The medical review article revisited: has the science improved? Ann Intern Med 1999 Dec 21;131(12):947-51.

(8) Sacks HS, Berrier J, Reitman D, Ancona-Berk VA, Chalmers TC. Meta-analyses of randomized controlled trials. N Engl J Med 1987 Feb 19;316(8):450-5.

(9) Sacks HS, Reitman D, Pagano D, Kupelnick B. Meta-analysis: an update. Mt Sinai J Med 1996 May;63(3-4):216-24.

(10) Shea BJ, Bouter LM, Peterson J, Boers M, Andersson N, Ortiz Z, et al. External validation of a measurement tool to assess systematic reviews (AMSTAR). PLoS ONE 2007;2(12):e1350.

(11) Shea BJ, Grimshaw JM, Wells GA, Boers M, Andersson N, Hamel C, et al. Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews. BMC Med Res Methodol 2007;7:10.

(12) Shea BJ, Hamel C, Wells GA, Bouter LM, Kristjansson E, Grimshaw J, et al. AMSTAR is a reliable and valid measurement tool to assess the methodological quality of systematic reviews. J Clin Epidemiol 2009 Feb 18.

(13) Canadian Institutes of Health Research. Knowledge Translation. 2009. Available from: URL: http://www.cihr.ca/e/29418.html

(14) Grimshaw JM, Eccles MP, Walker AE, Thomas RE. Changing physicians' behavior: what works and thoughts on getting more things to work. J Contin Educ Health Prof 2002;22(4):237-43.

(15) Bero LA, Grilli R, Grimshaw JM, Harvey E, Oxman AD, Thomson MA. Closing the gap between research and practice: an overview of systematic reviews of interventions to promote the implementation of research findings. The Cochrane Effective Practice and Organization of Care Review Group. BMJ 1998 Aug 15;317(7156):465-8.

(16) Grol R. Personal paper. Beliefs and evidence in changing clinical practice. BMJ 1997 Aug 16;315(7105):418-21.

(17) Mowatt G, Grimshaw JM, Davis DA, Mazmanian PE. Getting evidence into practice: the work of the Cochrane Effective Practice and Organization of care Group (EPOC). J Contin Educ Health Prof 2001;21(1):55-60.

(18) Grimshaw JM, Shirran L, Thomas R, Mowatt G, Fraser C, Bero L, et al. Changing provider behavior: an overview of systematic reviews of interventions. Med Care 2001 Aug;39(8 Suppl 2):II2-45.

(19) Littell JH, Corcoran J, Pillai V. Systematic Reviews and Meta-Analysis. New York: Oxford University Press; 2008.

(20) Gotzsche PC. Why we need a broad perspective on meta-analysis. It may be crucially important for patients. BMJ 2000 Sep 9;321(7261):585-6.

(21) Grimshaw J, McAuley LM, Bero LA, Grilli R, Oxman AD, Ramsay C, et al. Systematic reviews of the effectiveness of quality improvement strategies and programmes. Qual Saf Health Care 2003 Aug;12(4):298-303.

2. The Descriptive Epidemiology of Systematic Reviews of Professional Behaviour Change Interventions

Weir M, Grimshaw J, Mayhew A, Fergusson D, Worswick J, Bubis L, Bussières A*

2.1. Abstract

Background: Systematic reviews consist of a clearly defined question and use systematic and explicit methods to identify, select, and critically appraise relevant research, and to collect and analyse data from the studies that are included in the review. There are increasing numbers of systematic reviews addressing a broad range of questions in healthcare, including methods for improving quality of care. The objective of this study was to identify systematic reviews of health professional behaviour change interventions and to examine the epidemiology, descriptive characteristics and citation frequency of identified reviews.

Methods: Systematic reviews were identified from 1966 to 2008 from MEDLINE, EMBASE the Cochrane Database of Systematic Reviews, and DARE. Reviews were assessed if they evaluated a professional intervention and evaluated professional behaviour or clinical outcomes.

Results: One hundred and ninety-three systematic reviews published between 1977 and 2008 were included in the analysis. Publication of systematic reviews on professional behaviour change interventions have increased over time, and are highly cited compared to papers in the life sciences. Identified reviews were published in over 100 different journals and covered overlapping topic areas. There were potential flaws in the methodology for many of the reviews.

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*__Contributions of authors:__ Study conception and design: MW, JG, AM; acquisition of data: MW, JW, LB, AB, AM; analysis and interpretation of data: MW, JG, AM, DF; writing of paper: MW; commenting on drafts: JG, AM, DF, JW, LB, AB. Journal to be submitted to: *BMJ* or *CMAJ*

Conclusions: The wide dispersion of literature with overlapping subject areas may hinder the usability of reviews and indicate a potential redundancy of literature and duplication of efforts by reviewers. Authors of professional behaviour change reviews should consider the current body of evidence when planning systematic reviews in this area.

2.2. Introduction

2.2.1. Systematic Reviews

With the large number of primary studies being published in medical journals, effectively synthesizing research evidence is increasingly seen as an important precursor to disseminating and exchanging information for use in practice or policy. (1;2) Systematic reviews consist of a clearly defined question and use systematic and explicit methods to identify, select, and critically appraise relevant research, and to collect, analyse and summarize data from the studies that are included in the review. (3) Statistical methods, such as meta-analyses, may or may not be used to analyse and summarise the results of the included studies. (3) Various stakeholders, including clinicians, guideline developers and granting agencies use systematic reviews to stay informed of current, relevant evidence-based research. (4) In addition, systematic reviews are among the most cited reports, and have been placed at the top of several hierarchies of evidence. (5)

2.2.2. Professional Behaviour Change Interventions

Improving the health of individuals often requires changing behaviours, and improving health care often requires changing behaviours of health professionals. (6) Thus, interventions that aim to change professional behaviour can play an important role in

translating evidence into practice. Many barriers exist in the translation of evidence into practice for health professionals, including lack of time, lack of ability to appraise research studies properly, or barriers related to implementing new strategies into practice. (7) In recent years there has been increased primary and secondary research into the gap between evidence and practice, barriers to implementation and the evaluation of the effectiveness of methods to change professional behaviour. (8)

2.2.3. Systematic Reviews of Professional Behaviour Change Interventions

To summarize the large number of systematic reviews in the area of professional behaviour change, an overview of systematic reviews of professional behaviour change interventions was published in 1998 in *BMJ* by the Cochrane Effective Practice and Organization of Care (EPOC) Group, which included 18 reviews published up to 1996. (8) In 2001, an update of this overview was published in *Medical Care* that included 41 reviews published up to 1999. (9) Both of these reviews have been widely used and cited by various groups worldwide to inform decisions about the choice of quality improvement and professional education strategies.[†] In 2006, the COMPUS (Canadian Optimal Medication Prescribing and Utilization Service) directorate of CADTH (Canadian Agency for Drugs and Technologies in Health) approached EPOC to create syntheses of potential interventions to promote optimal prescribing practices in order to provide guidance to provinces. In 2007, the results of this project were published in an online inventory of interventions database, *Rx for Change* (www.rxforchange.ca), housing interventions to improve evidence-based

[†] According to Scopus, the 1998 overview has been cited over 800 times, and the 2001 overview has been cited over 450 times.

prescribing practice and interventions to change professional behaviour. The database was updated in 2009 to include reviews up to May 2008.

2.2.4. Objective and Research Questions

The objective of this study was to investigate the descriptive epidemiology of systematic reviews of professional behaviour change interventions. The following research questions were addressed:

1. How many reviews of professional behaviour change interventions have been published?
2. Has the number of publications of reviews in this area increased? Are they increasing in proportion to the amount of systematic reviews being produced in all health research areas?
3. Where are systematic reviews of professional behaviour change interventions published (i.e. journals, grey literature, The Cochrane Library)? How many reviews are being produced for each type of professional behaviour change strategy? Which health professional populations have been targeted most frequently for behaviour change interventions? Which countries are producing systematic reviews of professional behaviour change interventions?
4. Are certain types of reviews cited more frequently in the literature?
5. Are authors updating their reviews of professional behaviour change interventions?

2.3. Methods

2.3.1 Selection of Systematic Reviews

Systematic reviews of health professional behaviour change interventions were identified using a highly sensitive search strategy with methodological filters developed by an information specialist and applied to multiple bibliographic databases including MEDLINE, EMBASE, DARE and The Cochrane Library (see Appendices A and B for complete list of databases, dates searched and individuals involved). All reviews were independently screened by two individuals, with disagreements resolved by consensus, to confirm that they met the following selection criteria: was a systematic review (as defined by having explicit methods and selection criteria), had a primary focus to evaluate interventions targeting health professionals (see Appendix C for types of interventions), and evaluated professional behaviour outcomes or patient health outcomes.

If a review was an update to a previous systematic review, both versions were included and treated as two separate reviews if an updated search was conducted, as per the definition of an update by the Cochrane Handbook for Systematic Reviews of Interventions. (3) For example, Haynes and Walker published a paper on computer-assisted quality assurance in 1987, which was subsequently updated by Johnston et al. in their paper on computer-based clinical decision support systems in 1994, followed by Hunt et al. in 1998 and finally Garg et al. in 2005. (10-13) All four of these publications were treated as separate systematic reviews.

Publications of different versions of the same systematic review that were published in more than one source were treated as duplicate reviews. Publication information such as the journal and date of publication were noted for both versions of the review, however, data

was only abstracted and analyzed from whichever source provided more comprehensive information on the methods and included studies.

2.3.2 Data Collection and Analysis

Two individuals independently extracted data, with disagreements resolved by consensus. The following items were extracted from all systematic reviews: author, journal, year of publication, country of corresponding author, study question, number of included studies, study designs, target population, interventions, outcomes, and sources of funding. Authors' analysis of data was categorized for each review as either descriptive analysis only, vote counting, reporting of effect sizes, meta-analysis or meta-regression. Vote counting was defined as the tabulation of positive studies in the review based on the direction of effect or statistical significance, and a descriptive analysis was defined by only a narrative synthesis of the included studies. (14) Intervention, study design, target population, and outcomes were grouped according to pre-specified categories (see Appendix C). Impact factors of journals and citation frequencies were obtained primarily from ISI Web of Knowledge (www.isiknowledge.com) and Scopus (www.scopus.com). Scopus was used when citation frequencies were not available from ISI Web of Knowledge (n=54). The primary analysis was descriptive, with frequencies calculated and graphical representation utilized when appropriate.

Publication frequencies were used to compare the epidemiology of professional behaviour change systematic reviews with systematic reviews in all health areas. In order to approximate the number of systematic reviews published in the same time period that professional behaviour change reviews were identified, a search was carried out in

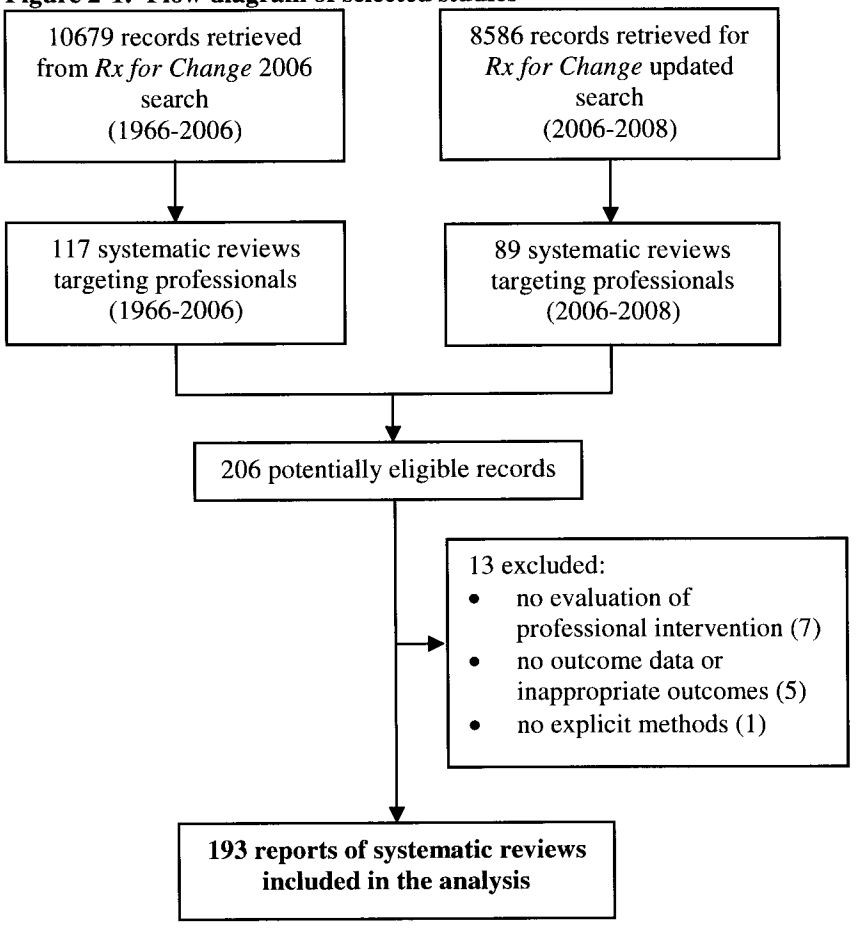
MEDLINE between 1977 and 2007 for titles and abstracts that included the term 'systematic review' and articles that had 'meta-analysis' in the title or identified as a publication type (systematic review.tw OR meta-analysis.pt.ti). Citation frequencies of all life science articles were determined using a paper published in 2005 by Eugene Garfield, the founder and chairman emeritus of ISI (Institute of Scientific Information). (15) Citations were managed using Reference Manager (version 12; www.refman.com). Data abstraction and analysis was conducted using Microsoft Excel (2007 version).

2.4 Results

2.4.1 Identification of Systematic Reviews

A total of 19,265 records were identified through searches for the *Rx for Change* project, with 193 systematic reviews meeting the selection criteria for professional behaviour change interventions (See Figure 2-1). Ten of these 193 were duplicate publications, and 23 were updates of previously conducted reviews (see Appendices D-F for lists of included reviews, duplicate reviews, and excluded reviews).

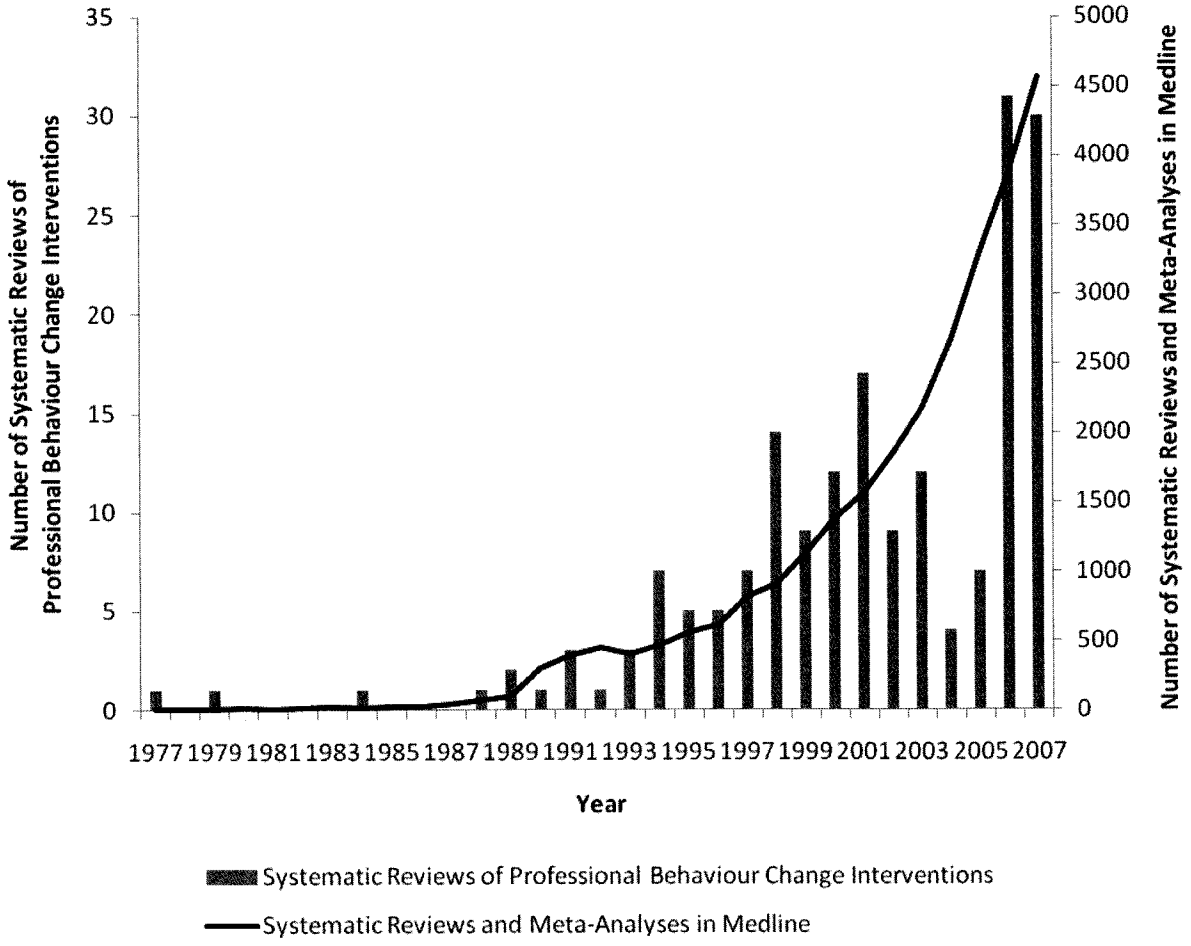
Figure 2-1: Flow diagram of selected studies



2.4.2 Publication Frequency

The first identified systematic review was published in 1977, with the majority published after 1988 (Figure 2-2). This parallels the trend for all systematic reviews and meta-analyses indexed in MEDLINE. In 2007, systematic reviews of professional behaviour change accounted for approximately 1% of all systematic reviews and meta-analyses indexed in MEDLINE.

Figure 2-2: Crude numbers of systematic reviews as publication types in MEDLINE, along with number of systematic reviews of professional behaviour change interventions, for years 1977-2008



2.4.3 Descriptive Characteristics

Most of the 193 reviews were published in paper-based journals (154 [79.8%]), with a small proportion published in the Cochrane Database of Systematic Reviews (32 [16.6%]) and as grey literature (7 [3.6%]) (Table 2-1). The country of the corresponding author was primarily the United States (57 [29.5%]), the United Kingdom (52 [26.9%]) and Canada (35 [18.1%]), with 16 countries represented in total. The most frequently evaluated interventions were educational meetings (116 [63.4%]), reminders (106 [57.9%]), multifaceted interventions (99 [54.1%]), educational materials (94 [51.4%]), and audit and feedback (89 [48.6%]). Physicians were the most targeted group of health professionals (159 [86.9%]),

followed by nurses (85 [46.4%]) and pharmacists (31 [16.9%]) with 25 (13.7%) of the reviews not clearly indicating which health professionals were targeted. The majority of reviews included randomized controlled trials (RCTs) in their systematic reviews (90.2%), with many including other designs such as controlled trials and controlled before-and-after studies. Twenty-four systematic reviews (13.1%) did not report on the designs of the included studies.

Few review authors undertook a meta-analysis (27 [14.8%]), with most using a vote counting (64 [35.0%]) or descriptive approach (65 [35.5%]). Most review authors assessed process of care (173 [94.5%]) or outcome of care (119 [65.0%]) outcomes, with approximately one-third documenting a cost outcome (56 [31.1%]) and one-fifth documenting patient or provider satisfaction (41 [22.4%]). In one-third of the systematic reviews, both funding and potential conflicts of interest of the review authors were disclosed (61 [33.3%]), with approximately the same number not mentioning either one (57 [31.1%]).

Most systematic reviews were published in journals with impact factors of five or less, with 16 (8.3%) published in journals with impact factors over ten, and over 100 journals being represented in total. Eighteen (9.3%) systematic reviews were published in journals which have not yet been assigned an impact factor, and seven (3.6%) systematic reviews were published in grey literature sources (e.g. health technology assessments).

Table 2-1: Epidemiology of systematic reviews of professional behaviour change interventions

Category	Characteristic	No.	%
Total number of systematic reviews		193	100.0
Type of publication	Non-Cochrane journal	154	79.8
	Cochrane Database of Systematic Reviews	32	16.6
	Grey literature	7	3.6
Impact factor of journal	0-5.0	130	67.4
	5.0-10.0	22	11.4
	>10.0	16	8.3
	Grey literature	7	3.6
	N/A	18	9.3
Country of corresponding author	USA	57	29.5
	UK	52	26.9
	Canada	35	18.1
	Netherlands	12	6.2
	Australia	11	5.7
	Other (<10 reviews/country, 11 countries)	26	13.5
Intervention category[a,b]	Educational meetings	116	63.4
	Reminders	106	57.9
	Multifaceted	99	54.1
	Educational materials	94	51.4
	Audit and feedback	89	48.6
	Educational outreach visits	54	29.5
	Patient mediated	24	13.1
	Local opinion leaders	24	13.1
	Local consensus process	14	7.7
	Marketing/tailored	7	3.8
	Mass media	6	3.3
Professional population targeted[a,b]	Physicians	159	86.9
	Nurses	85	46.4
	Pharmacists	31	16.9
	Other	66	36.1
	Unclear	25	13.7

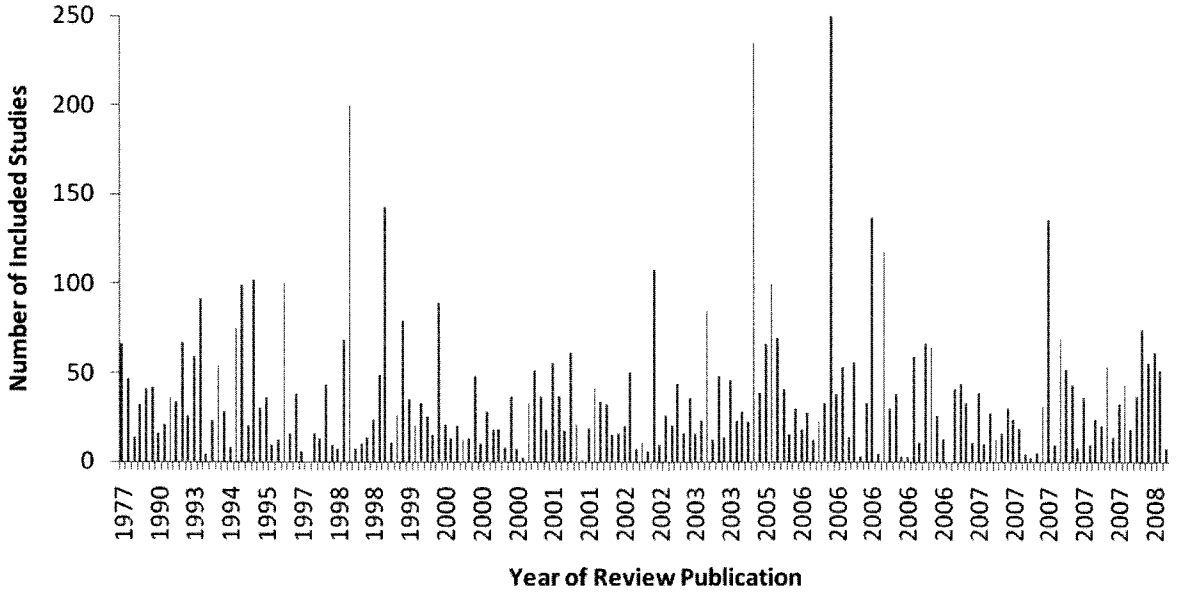
Study designs included in review[a,b]	Randomized controlled trials	165	90.2
	Controlled trials	73	39.9
	Controlled before-and-after studies	58	31.7
	Before-and-after studies	53	29.0
	Interrupted time series	35	19.1
	Other (observational, etc.)	32	17.5
	Not specified	24	13.1
Authors' analysis of data[a,b]	Descriptive	65	35.5
	Vote counting	64	35.0
	Effect sizes without pooling	33	18.0
	Meta-analysis	27	14.8
	Meta-regression	3	1.6
Outcomes[a,b]	Process	173	94.4
	Outcome	119	65.0
	Costs	56	30.6
	Provider or patient satisfaction	41	22.4
Funding[a]	Funding stated but potential conflicts of interest not disclosed	64	35.0
	Both funding and potential conflicts of interest disclosed	61	33.3
	Both funding and conflict of interest not stated	57	31.1
	Funding not stated but potential conflicts of interest disclosed	1	0.5

[a]Included data from 183 reviews, excluded 10 duplicate reviews

[b]Does not equal 100%, as reviews could fall into more than one category

The number of included studies within each systematic review varied from one to over 250, with an average of 37 and median of 27, with one not specifying the number of included studies in the review. Figure 2-3 indicates the number of included studies for all of the reviews over time.

Figure 2-3: Number of included studies by year of review



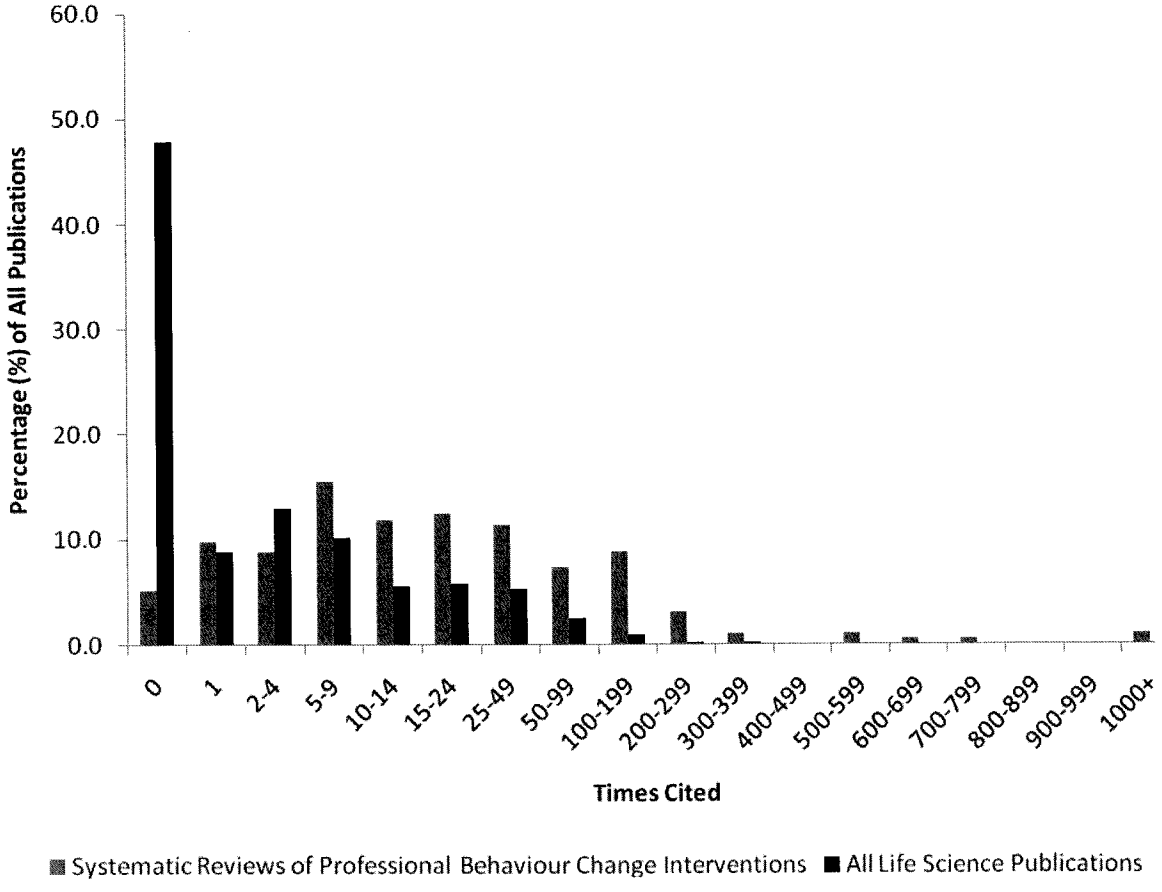
2.4.4 Citation Frequency

On average, systematic reviews of professional behaviour change interventions were cited by other publications 65 times. The most frequently cited review was referred to 1311 times; while ten were not cited at all (citation frequencies could not be determined for three reviews). In 2008, reviews of professional behaviour change interventions were cited an average of eight times. Of the 25 most frequently cited articles, reminder interventions were the most represented strategy. Six reviews focused on only reminder interventions only, with only two out of the 25 not evaluating reminder interventions in some capacity. As well, multifaceted interventions were frequently evaluated, with 11 of the 25 most cited reviews evaluating five or more different types of interventions.

As represented in Figure 2-4, systematic reviews of professional behaviour change interventions appear to be more frequently cited compared to all publications in the life sciences. According to Eugene Garfield's study, almost half of all life science publications

are not cited at all, whereas only 5% of professional behaviour change systematic reviews were never cited. (15) Additionally, of the professional behaviour change reviews, 1% (2/193) was cited over 1000 times, compared to the life science articles, of which 0.02% (5063/38,163,319) was cited over 1000 times.

Figure 2-4: Citation frequency distribution for systematic reviews of professional behaviour change interventions and papers in the life sciences



2.4.5 Updating Systematic reviews

Twenty-three systematic reviews were updates of previously conducted reviews of professional behaviour change interventions, seven of which were published in the Cochrane

Library (see Appendix G for list of updated reviews). The topic areas that contained updated reviews were:

- intervention categories: audit and feedback, continuing medical education, educational outreach, implementation of clinical guidelines, interprofessional education, local opinion leaders, mass media, patient-mediated, reminders;
- specific behaviours: medication use, prescribing, preventive services;
- specific conditions: breast cancer, overweight and obesity, venous thromboembolism prophylaxis, and;
- settings: primary care.

2.5 Discussion

This study demonstrates that there has been a substantial increase in the number of systematic reviews published on the effectiveness of professional behaviour change interventions, and that these publications are highly cited compared to papers in the life sciences. (15) In addition, many are published in high-impact journals, with 8% of the systematic reviews being published in journals with impact factors greater than 10.

Systematic reviews on professional behaviour change interventions were published in a broad range of literature sources, with over 100 different journals being represented in this sample. This dispersion of literature across various sources has the potential to create difficulties for end-users to identify and retrieve relevant publications. One potential solution to this problem is to conduct overviews of systematic reviews in topic areas where many systematic reviews exist. (8;9) This study also provides evidence that multiple reviews are being conducted in overlapping interventions and population groups. Certain

interventions, populations and study designs in this sample were frequently studied, with many evaluating the effectiveness of educational meetings, educational materials, reminders, and audit and feedback targeted towards physicians and using RCTs.

Systematic reviews on professional behaviour change interventions had a median number of included studies of 27, which is higher than a median of 16 included studies which was found in an investigation of all systematic reviews published over a one month period in 2004. (4) This suggests that systematic reviews on professional behaviour change interventions have a larger number of included primary studies, which may indicate an increased heterogeneity in types of studies and may lead to problems in the analysis. Indeed, 65 out of 193 reviews (35.5%) used a descriptive approach to analyze the results, and authors that did not attempt to pool the results quantitatively often justified doing so because of the heterogeneity of the studies included in the review. However, there has not been much development in descriptive methods and the lack of transparency often accompanied with this method can create difficulties for appraisal and interpretation of reviews for end-users. (16) Alternatively, vote counting was used in 64 of the 193 reviews (35.0%). Vote counting consists of tallying the number of positive studies and comparing this number to the total number of studies in the review. This approach has been criticized for its lack of efficiency, and is not recommended when effect sizes are provided. (14;16) Thus, the analytic methods used in these systematic reviews may be weak and require further investigation.

A portion of the systematic reviews left out information regarding the included studies of their review. Twenty-four (13.1%) were not clear on the designs of studies included, 25 (13.7%) did not clearly state which health professionals were targeted, and one did not specify the number of studies included in the review. Guidelines such as the

Cochrane Handbook and The PRISMA Statement (Preferred Reporting Items for Systematic reviews and Meta-Analyses) provide recommendations for the proper conduct and reporting of systematic reviews and state that the failure to adequately report the characteristics of the included studies can lower the quality of a systematic review. (3;17) These omissions lead to a lower quality of the review and make it difficult for users of the systematic reviews to establish whether the results might be generalizeable to their population or applicable to their particular interests.

A descriptive analysis of the epidemiology of systematic reviews of professional behaviour change interventions has not been conducted in the past, and this study provides a comprehensive analysis of the characteristics of all of the systematic reviews in this area. By using rigorous methods in the searching, screening and extraction, a reliable representation of systematic reviews of professional behaviour change interventions was captured.

A limitation to this analysis is the comparison of this group of systematic reviews to Garfield's. As noted above, Garfield's analysis included papers from 1900 to 2005, whereas professional behaviour change systematic reviews in the current study were published between 1977 and 2008. This lack of consistency in time periods might make the data less comparable; however, given the increase in publication outputs of medical journals in the recent years, it is reasonable to assume that the majority of the articles in Garfield's cohort were published in the later part of the 20th century. Another limitation relates to the reliance on author reporting of systematic reviews. It is possible that authors conducted a more thorough analysis than was reported, and certain omissions in the publications were due to the process of peer review or the editorial process.

Overall, numbers of systematic reviews of professional behaviour change interventions are increasing and represent a sizeable proportion of the medical literature. Given the overlap in content of the examined articles, the question is raised of whether the high number of reviews is warranted, and how methods could be improved to prevent unneeded repetition of effort and more appropriate use of resources in order to produce comprehensively reported and useable systematic reviews.

Reference List

(1) Lau J, Ioannidis JP, Schmid CH. Summing up evidence: one answer is not always enough. Lancet 1998 Jan 10;351(9096):123-7.

(2) Chalmers I, Haynes B. Reporting, updating, and correcting systematic reviews of the effects of health care. BMJ 1994 Oct 1;309(6958):862-5.

(3) The Cochrane Collaboration. Cochrane Handbook for Systematic Reviews of Interventions Version 5.0.1. 2008.

(4) Moher D, Tetzlaff J, Tricco AC, Sampson M, Altman DG. Epidemiology and reporting characteristics of systematic reviews. PLoS Med 2007 Mar 27;4(3):e78.

(5) Patsopoulos NA, Analatos AA, Ioannidis JP. Relative citation impact of various study designs in the health sciences. JAMA 2005 May 18;293(19):2362-6.

(6) Grimshaw J, Eccles M, Tetroe J. Implementing clinical guidelines: current evidence and future implications. J Contin Educ Health Prof 2004;24 Suppl 1:S31-S37.

(7) Grimshaw JM, Eccles MP, Walker AE, Thomas RE. Changing physicians' behavior: what works and thoughts on getting more things to work. J Contin Educ Health Prof 2002;22(4):237-43.

(8) Bero LA, Grilli R, Grimshaw JM, Harvey E, Oxman AD, Thomson MA. Closing the gap between research and practice: an overview of systematic reviews of interventions to promote the implementation of research findings. The Cochrane Effective Practice and Organization of Care Review Group. BMJ 1998 Aug 15;317(7156):465-8.

(9) Grimshaw JM, Shirran L, Thomas R, Mowatt G, Fraser C, Bero L, et al. Changing provider behavior: an overview of systematic reviews of interventions. Med Care 2001 Aug;39(8 Suppl 2):II2-45.

(10) Haynes RB, Walker CJ. Computer-aided quality assurance. A critical appraisal. Arch Intern Med 1987 Jul;147(7):1297-301.

(11) Johnston ME, Langton KB, Haynes RB, Mathieu A. Effects of computer-based clinical decision support systems on clinician performance and patient outcome. A critical appraisal of research. Ann Intern Med 1994 Jan 15;120(2):135-42.

(12) Hunt DL, Haynes RB, Hanna SE, Smith K. Effects of computer-based clinical decision support systems on physician performance and patient outcomes: a systematic review. JAMA 1998 Oct 21;280(15):1339-46.

(13) Garg AX, Adhikari NK, McDonald H, Rosas-Arellano MP, Devereaux PJ, Beyene J, et al. Effects of computerized clinical decision support systems on practitioner

performance and patient outcomes: a systematic review. JAMA 2005 Mar 9;293(10):1223-38.

(14) Bushman BJ. Vote-counting procedures in meta-analysis. In: Cooper H, Hedges L, editors. The Handbook of Research Synthesis.New York: Russell Sage Foundation; 1994. p. 194-213.

(15) Garfield E. The agony and the ecstasy: The history and meaning of the journal impact factor. International Congress on Peer Review and Biomedical Publication. 2005.

(16) Littell JH, Corcoran J, Pillai V. Systematic Reviews and Meta-Analysis. New York: Oxford University Press; 2008.

(17) Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. J Clin Epidemiol 2009 Jul 22.

3. The Quality of Systematic Reviews of Professional Behaviour Change Interventions

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3.1. Abstract

Objective: To assess the quality of systematic reviews of professional behaviour change interventions.

Study Design and Setting: Systematic reviews were identified that assessed interventions of health professional behaviour change by searching multiple databases up to May 2008. Methodological quality was assessed using AMSTAR, 'a measurement tool to assess the methodological quality of systematic reviews'.

Results: One hundred and eighty-three systematic reviews were found, including 32 Cochrane reviews. The average AMSTAR score was 4 out of a possible 11, with Cochrane reviews scoring an average of 7.5 out of 11. Certain quality criteria were rarely met in reviews.

Conclusion: Methodological quality of systematic reviews of professional behaviour change interventions, as assessed by a validated quality assessment instrument, is generally low with little change over time. Cochrane reviews are of higher methodological quality than non-Cochrane reviews. There is a need for the improvement of the methodological quality of systematic reviews of professional behaviour change interventions.

3.2. Introduction

With the increasing number of journal articles being published each year in medical journals, systematic reviews are being used as a way to obtain a comprehensive and less

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*__Contributions of authors:__ Study conception and design: MW, JG, DF, AM; acquisition of data: MW, JW, AM; analysis and interpretation of data: MW, JG, AM, DF; writing of paper: MW; commenting on drafts: JG, AM, DF, JW. Journal to be submitted to: *Journal of Clinical Epidemiology*

biased summary of a large amount of evidence. The number of systematic reviews being published each year is increasing; however, the quality of these reviews is variable and not consistently based on rigorous methodology. (1;2) Given this variation in quality, it is necessary to appraise the methods of systematic reviews. In 2007, AMSTAR, a measurement tool to assess the methodological quality of systematic reviews, was developed in order to provide a useable appraisal tool for systematic reviews that is grounded in evidence. (3)

Paralleling the increase in publication of systematic reviews, there has been an increase in reviews published in the area of professional behaviour change interventions, with numerous reviews often evaluating the same intervention. (4) When multiple reviews are published on the same clinical question, it not only results in a redundancy of literature and duplication of efforts by reviewers, but also calls for the evaluation of the methods used in the reviews to distinguish between results that were derived from rigorous methodologies from those that may be flawed.

Previous articles have evaluated the reporting and quality of systematic reviews, (5;6) but none have utilized the AMSTAR tool to critically appraise the methodological quality of systematic reviews of professional behaviour change interventions. Through the recent development of an online database of systematic reviews in this topic area (www.rxforchange.ca), the opportunity arose to comprehensively assess the quality and methods of all systematic reviews of professional behaviour change interventions.

The *Rx for Change* project began in 2006 when COMPUS (The Canadian Optimal Medication Prescribing and Utilization Service) approached the Cochrane Effective Practice and Organisation of Care (EPOC) Group to create syntheses of potential interventions to

promote optimal prescribing practices in order to provide guidance to provinces. In 2007, the results of this project were published in an online database (www.rxforchange.ca); including interventions to improve evidence-based prescribing practice in addition to all interventions targeting professional behaviour change. The database was then updated in 2008.

The primary objective of this study was to assess the quality and methods of systematic reviews of professional behaviour change interventions. The following research questions were addressed:

1. What methods have been used in systematic reviews of professional behaviour change interventions?
2. How variable is the quality of systematic reviews of professional behaviour change interventions and what is the prevalence of high-quality reviews?
3. What are the differences in quality between Cochrane and non-Cochrane systematic reviews of professional behaviour change interventions?
4. Has the quality and methods of systematic reviews of professional behaviour change interventions changed over time?

3.3. Methods

3.3.1. Selection of Systematic Reviews

Systematic reviews of health professional behaviour change interventions were identified using a highly sensitive search strategy, with methodological filters, developed by an information specialist and applied to multiple bibliographic databases including MEDLINE, EMBASE, DARE and The Cochrane Library (see Appendices A and B for

complete list of databases, dates searched and individuals involved). All reviews were independently screened by two individuals, with disagreements resolved by consensus, to confirm that they met the following selection criteria: was a systematic review (as defined by having explicit methods and selection criteria), had a primary focus to evaluate interventions targeting health professionals, and evaluated professional behaviour outcomes or patient health outcomes (see Appendix C for types of interventions).

If a review was an update to a previous systematic review, both versions were included and treated as two separate reviews if an updated search was conducted, as per the definition of an update by the Cochrane Handbook. (7) For example, there were several updates of reviews on computer-assisted quality assurance interventions, which were each treated as separate systematic reviews. (8)-(9)

Systematic reviews that were published in more than one source were treated as duplicate reviews. Out of the two sources, quality was assessed on the report that provided more comprehensive information on the methods and included studies.

3.3.2. AMSTAR and Quality Assessment

AMSTAR is 'a measurement tool to assess the methodological quality of systematic reviews'. (3) It provides an overall quality rating on a scale of 0 to 11, and asks quality assessors to answer 'yes', 'no', 'can't answer' or 'not applicable' to each item in the instrument, with the total equalling the number of items receiving a 'yes' (see Appendix H). The AMSTAR tool was developed after an appraisal of existing instruments was conducted and these instruments were all found to be suboptimal. (10) The tool was developed by building on empirical evidence from previous validated tools and expert opinion. It has been

internally and externally validated and was found to have good reliability and agreement with a mean interobserver kappa for the 11 items of 0.70 and an interobserver intraclass correlation coefficient of the sum scores of 0.84. (3;11;12)

Each included professional behaviour change systematic review was independently quality assessed by two individuals with disagreements resolved by consensus. When disagreements could not be resolved, the opinion of a third reviewer was sought (see Appendix B for names of quality assessors). To maintain consistency in the AMSTAR scoring, decision-rules were created through discussions with two of the AMSTAR co-creators (BS, JG) to determine criteria for each item that was sufficient to score a 'yes' (Appendix I).

3.3.3. Data Analysis

Citations were managed using Reference Manager (version 12; www.refman.com). Data abstraction and analysis was conducted using Microsoft Excel (2007 version) and Epi Info (version 3.5.1; www.cdc.gov/epiinfo). The following analyses were conducted:

1. Descriptive analysis: Proportions of systematic reviews scoring 'yes' were calculated for the overall AMSTAR score and for individual items. Bar and line graphs were used to illustrate proportions and to illustrate trends over time.
2. Subgroup analysis: Based on previous research demonstrating higher quality of Cochrane reviews compared to non-Cochrane reviews (13;14), a subgroup analysis was conducted to evaluate whether Cochrane reviews had significantly different AMSTAR scores compared to non-Cochrane reviews in the area of

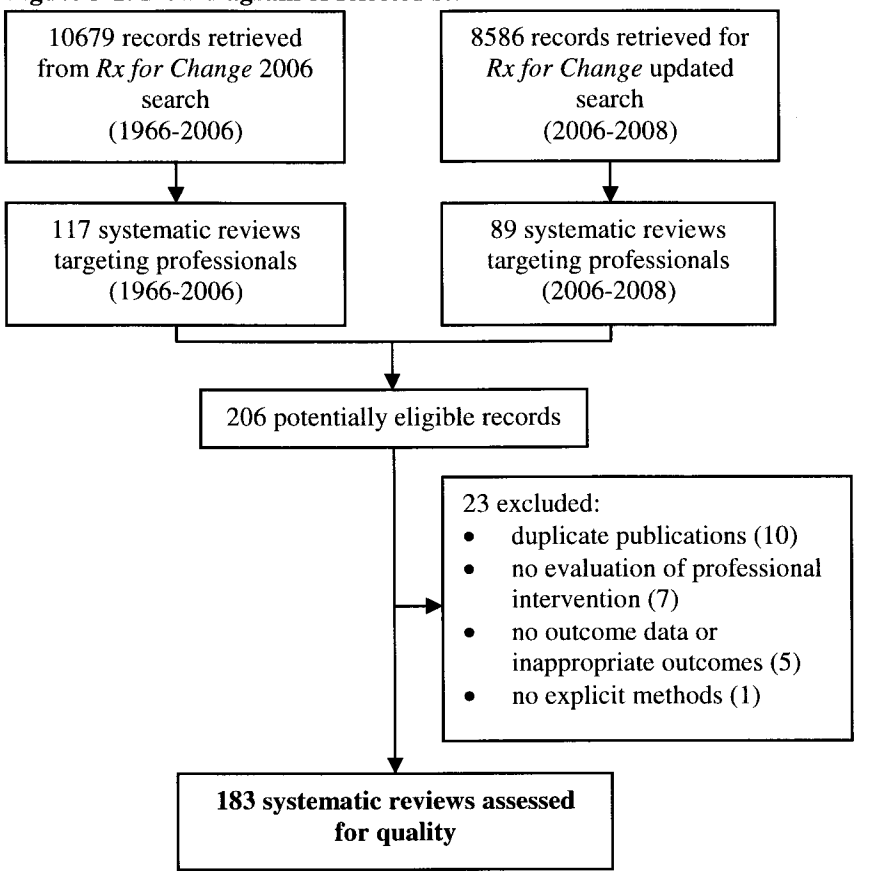
professional behaviour change interventions. Two-tailed Fisher's exact tests were conducted.

3.4. Results

3.4.1. Identification of Systematic Reviews

A total of 19,265 records were identified through searches conducted for the *Rx for Change* project, with 193 systematic reviews meeting the selection criteria for professional behaviour change interventions (Figure 3-1). Ten of these 193 were duplicate publications, leaving a total of 183 unique reviews (see Appendix E). Reasons for exclusion of reviews are provided in Appendix F. Twenty-three of these were updates to previously conducted reviews (see Appendix G). Thirty-two systematic reviews were published in the Cochrane Database of Systematic Reviews (17%) and seven were found in the grey literature (4%), with the remaining published in paper-based journals (80%). Details of the descriptive characteristics of these 183 reviews are reported elsewhere (Chapter 2).

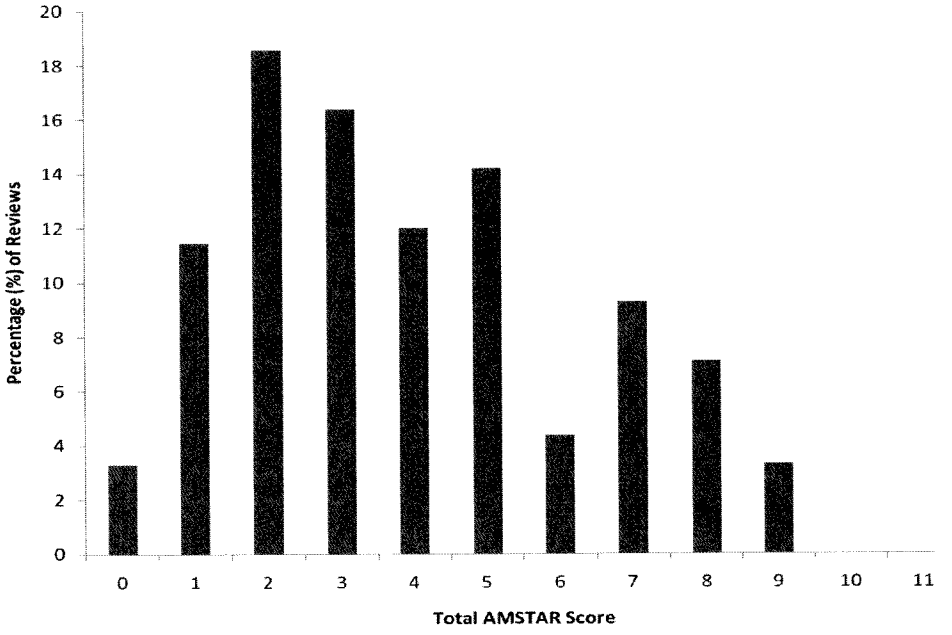
Figure 3-1: Flow diagram of selected studies



3.4.2. Quality Assessment of Systematic Reviews

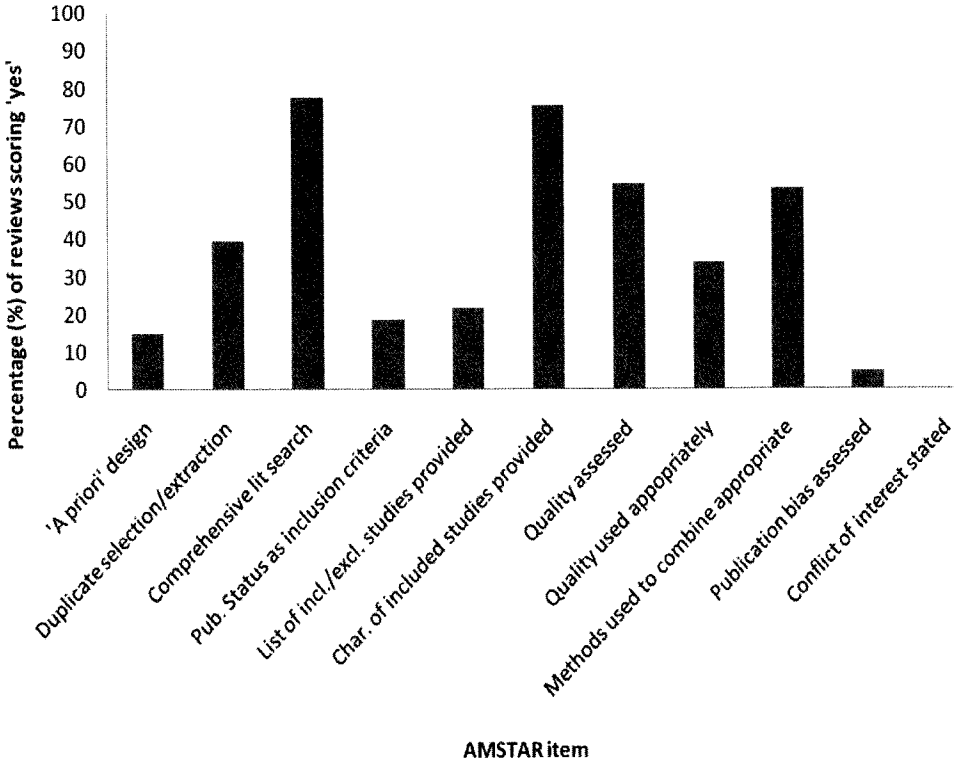
A total of 183 systematic reviews were quality assessed using the AMSTAR tool. The average total AMSTAR score was 4, and ranged from 0-9 (Figure 3-2).

Figure 3-2: Distribution of total AMSTAR scores



For individual AMSTAR items, the number of reviews scoring a 'yes' ranged from 0% for statement of conflict of interest to 77.6% (142/183) for use of a comprehensive literature search (Figure 3-3). Other low-scoring items included assessment of publication bias (174/183 or 95.0% of reviews did not score 'yes'), a priori design (156/183 or 85.2% of reviews did not score 'yes'), using publication status as inclusion criteria (149/183 or 81.4% of reviews did not score 'yes'), and providing a list of included and excluded studies (143/183 or 78.1% of reviews did not score 'yes'). Higher-scoring items included assessment of quality of individual studies (100/183 or 54.6% of reviews scored 'yes'), and using appropriate methods combine studies (98/183 or 53.5% of reviews scored 'yes').

Figure 3-3: AMSTAR scores by item



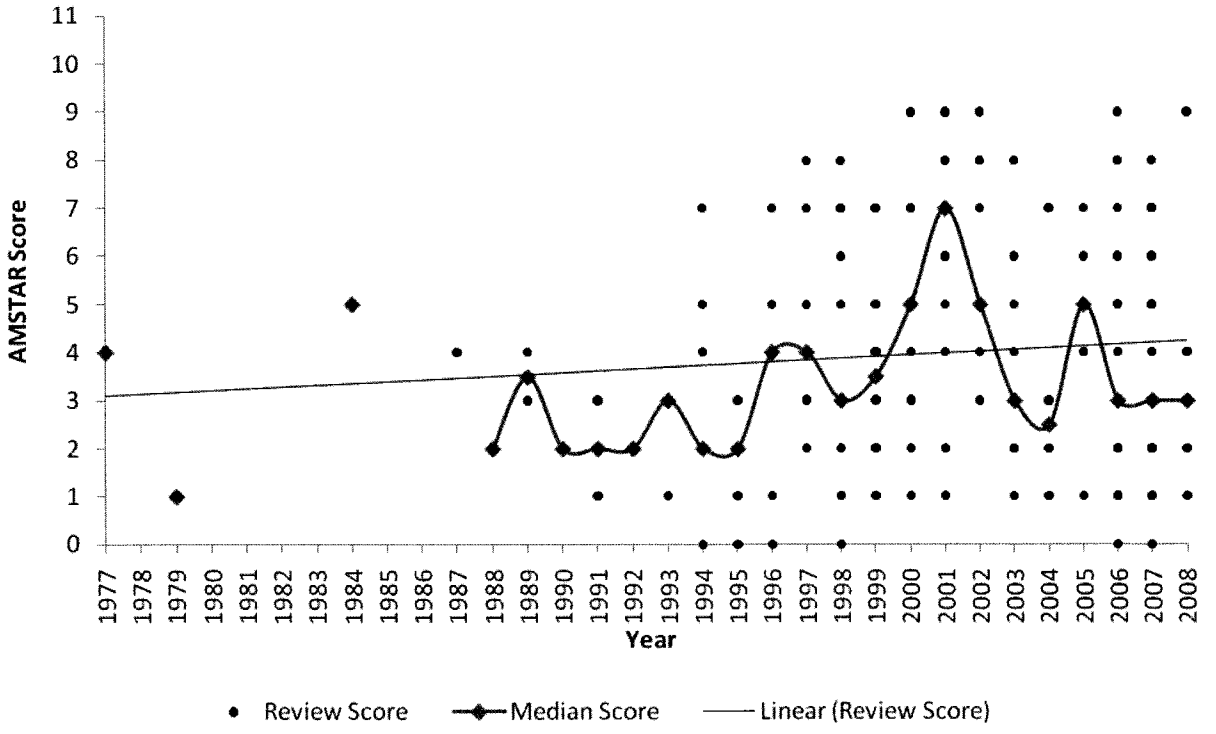
The average non-Cochrane AMSTAR score was 3.2 and the average Cochrane AMSTAR score was 7.5, out of the possible total of 11. For eight items, Cochrane reviews had a significantly greater proportion of scoring 'yes' than non-Cochrane reviews (Table 3-1).

Table 3-1: Comparison of Cochrane and non-Cochrane review AMSTAR scores with p-values

AMSTAR Item	Cochrane, n=32	Non-Cochrane, n=151	P-value
	Number of reviews scoring yes (%)		
A priori design	23 (71.9)	4 (2.6)	<.001
Duplicate study selection/data extraction	30 (93.8)	42 (27.8)	<.001
Comprehensive literature search	31 (96.9)	111 (73.5)	<.01
Publication status as inclusion criteria	9 (28.1)	25 (16.6)	0.15
List of included/excluded studies provided	32 (100.0)	8 (5.3)	<.001
Characteristics of included studies provided	32 (100.0)	106 (70.2)	<.001
Quality assessment	32 (100.0)	68 (45.0)	<.001
Quality used appropriately	25 (78.1)	37 (24.5)	<.001
Methods used to combine appropriate	25 (78.1)	73 (48.3)	<.001
Publication bias assessed	1 (3.1)	8 (5.3)	0.52
Conflict of interest stated	0 (0.0)	0 (0.0)	1.00

The average AMSTAR score for each year of publication ranged from 1-6, with a slight increasing trend over the years as shown by the linear regression line (Figure 3-4). The change represented an increase from a score of 3 to 4 between 1977 and 2008. No systematic reviews were found to be published in 1978, 1980-1983 or 1985-1986. To examine the impact of scores from early years, the scores were analyzed only including scores after 1989; however the trend did not change.

Figure 3-4: AMSTAR score by year, with median and linear trend line



3.5. Discussion

This study assessed the quality of 183 systematic reviews of professional behaviour change interventions, and showed that the methodological quality, as assessed by a validated quality assessment instrument, is generally low. As well, the quality has not increased substantially over time. Certain items assessed by the 11-item AMSTAR tool rarely scored a 'yes', showing that authors infrequently prepare a review protocol, search grey literature, provide lists of included and excluded studies, assess publication bias and disclose funding and conflict of interest for both the review and individual studies. Cochrane reviews were of higher methodological quality than non-Cochrane reviews, although Cochrane reviews represented a small portion of all reviews in this sample. The items on which Cochrane reviews consistently scored higher were likely due to the standardized methods and

standardized approach to reporting as well as the flexibility in publication length allowed by the online format. In addition, the Cochrane Handbook provides guidance for authors about the conduct of Cochrane reviews. (15)

The higher quality of Cochrane reviews has been reported elsewhere. Jadad et al. compared 36 Cochrane reviews with 36 paper-based reviews published between 1996 and 1997 and found that the Cochrane reviews followed more rigorous methods. (14) Jadad et al. also compared 12 Cochrane reviews to 38 paper-based reviews in asthma and found Cochrane reviews to have a fewer serious methodological flaws. (16) Shea et al. looked at 52 Cochrane systematic reviews and 52 paper-based systematic reviews published between 1990 and 1996 and found that while both groups were of low quality, Cochrane reviews were better at reporting included and excluded studies, ranges of patients' characteristics, sources of support, and use of appropriate statistical methods and subgroup analysis, but less likely to adequately report on their search methods and methods used to combine findings. (13) In this study, Cochrane reviews scored higher in all of these categories, which indicates a possible improvement in quality of Cochrane reporting, given that the pool of systematic reviews were published up to ten years later than the Shea et al. study.

Previous evaluations of systematic reviews in the fields of nephrology (17), surgery (18), critical care (19), cancer diagnostic tests (20), oncology (21), emergency medicine (22), asthma (16), anxiety disorders (23), gastroenterology (12), and anaesthesia (24) have shown that most systematic reviews are methodologically flawed. However, to the authors' knowledge, this is the first study to assess the quality of systematic reviews in the field of health professional behaviour change interventions. The increasing numbers of systematic reviews in this topic area coupled with the consistent low quality of reviews raises the

question of whether the numbers of publications of systematic reviews in this area are warranted.

The limited improvement in quality over the years corresponds with other research on the topic of systematic review quality. Moher assessed the methods and quality of 300 systematic reviews published in November of 2004, and identified many problems similar to the ones in this study in the areas of updating, assessing publication bias, working from a protocol, searching grey literature, assessing heterogeneity, and disclosing conflict of interest.

This study is limited by the fact that no attempt was made to blind the assessors to the identity of the review authors or the journal of publication. As well, four authors of this paper are involved with the Cochrane EPOC Group. Possible bias could have entered the assessment from this due to pre-conceived notions about the quality of articles from specific sources or written by certain individuals; however, all assessments using AMSTAR were aimed to be as standardized and objective as possible.

Although there are examples of high quality systematic reviews of health professional behaviour change interventions, most have serious methodological issues. Hopefully as the awareness of AMSTAR becomes more widespread in the research community, it will serve as a learning tool to guide review authors and journal editors to follow evidence-based recommendations for the conduct and reporting of systematic reviews, and thus improve the quality of systematic reviews of professional behaviour change interventions in subsequent years.

Reference List

(1) Mulrow CD. The medical review article: state of the science. Ann Intern Med 1987 Mar;106(3):485-8.

(2) McAlister FA, Clark HD, van WC, Straus SE, Lawson FM, Moher D, et al. The medical review article revisited: has the science improved? Ann Intern Med 1999 Dec 21;131(12):947-51.

(3) Shea BJ, Grimshaw JM, Wells GA, Boers M, Andersson N, Hamel C, et al. Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews. BMC Med Res Methodol 2007;7:10.

(4) Weir M, Grimshaw J.G., Mayhew A., Fergusson D. The epidemiology of systematic reviews of professional behaviour change interventions. 2009.
Ref Type: Unpublished Work

(5) Moher D, Tetzlaff J, Tricco AC, Sampson M, Altman DG. Epidemiology and reporting characteristics of systematic reviews. PLoS Med 2007 Mar 27;4(3):e78.

(6) Wen J, Ren Y, Wang L, Li Y, Liu Y, Zhou M, et al. The reporting quality of meta-analyses improves: a random sampling study. J Clin Epidemiol 2008 Aug;61(8):770-5.

(7) The Cochrane Collaboration. Cochrane Handbook for Systematic Reviews of Interventions Version 5.0.1. 2008.

(8) Haynes RB, Walker CJ. Computer-aided quality assurance. A critical appraisal. Arch Intern Med 1987 Jul;147(7):1297-301.

(9) Garg AX, Adhikari NK, McDonald H, Rosas-Arellano MP, Devereaux PJ, Beyene J, et al. Effects of computerized clinical decision support systems on practitioner performance and patient outcomes: a systematic review. JAMA 2005 Mar 9;293(10):1223-38.

(10) Shea B, Dubé C, Moher D. Assessing the quality of reports of systematic reviews: the QUOROM statement compared to other tools. In: Egger M, Smith GD, Altman DG, editors. Systematic Reviews in Health Care: Meta-analysis in context.London: BMJ Books; 2001. p. 122-39.

(11) Shea BJ, Hamel C, Wells GA, Bouter LM, Kristjansson E, Grimshaw J, et al. AMSTAR is a reliable and valid measurement tool to assess the methodological quality of systematic reviews. J Clin Epidemiol 2009 Feb 18.

(12) Shea BJ, Bouter LM, Peterson J, Boers M, Andersson N, Ortiz Z, et al. External validation of a measurement tool to assess systematic reviews (AMSTAR). PLoS ONE 2007;2(12):e1350.

(13) Shea B, Moher D, Graham I, Pham B, Tugwell P. A comparison of the quality of Cochrane reviews and systematic reviews published in paper-based journals. Eval Health Prof 2002 Mar;25(1):116-29.

(14) Jadad AR, Cook DJ, Jones A, Klassen TP, Tugwell P, Moher M, et al. Methodology and reports of systematic reviews and meta-analyses: a comparison of Cochrane reviews with articles published in paper-based journals. JAMA 1998 Jul 15;280(3):278-80.

(15) Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. J Clin Epidemiol 2009 Jul 22.

(16) Jadad AR, Moher M, Browman GP, Booker L, Sigouin C, Fuentes M, et al. Systematic reviews and meta-analyses on treatment of asthma: critical evaluation. BMJ 2000 Feb 26;320(7234):537-40.

(17) Mrkobrada M, Thiessen-Philbrook H, Haynes RB, Iansavichus AV, Rehman F, Garg AX. Need for quality improvement in renal systematic reviews. Clin J Am Soc Nephrol 2008 Jul;3(4):1102-14.

(18) Dixon E, Hameed M, Sutherland F, Cook DJ, Doig C. Evaluating meta-analyses in the general surgical literature: a critical appraisal. Ann Surg 2005 Mar;241(3):450-9.

(19) Delaney A, Bagshaw SM, Ferland A, Manns B, Laupland KB, Doig CJ. A systematic evaluation of the quality of meta-analyses in the critical care literature. Crit Care 2005 Oct 5;9(5):R575-R582.

(20) Mallett S, Deeks JJ, Halligan S, Hopewell S, Cornelius V, Altman DG. Systematic reviews of diagnostic tests in cancer: review of methods and reporting. BMJ 2006 Aug 26;333(7565):413.

(21) Vigna-Taglianti F, Vineis P, Liberati A, Faggiano F. Quality of systematic reviews used in guidelines for oncology practice. Ann Oncol 2006 Apr;17(4):691-701.

(22) Kelly KD, Travers A, Dorgan M, Slater L, Rowe BH. Evaluating the quality of systematic reviews in the emergency medicine literature. Ann Emerg Med 2001 Nov;38(5):518-26.

(23) Bereza BG, Machado M, Einarson TR. Assessing the reporting and scientific quality of meta-analyses of randomized controlled trials of treatments for anxiety disorders. Ann Pharmacother 2008 Oct;42(10):1402-9.

(24) Choi PT, Halpern SH, Malik N, Jadad AR, Tramer MR, Walder B. Examining the evidence in anesthesia literature: a critical appraisal of systematic reviews. Anesth Analg 2001 Mar;92(3):700-9.

4. Lumping and Splitting of Systematic Reviews of Reminder Interventions: A Descriptive Analysis

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4.1. Abstract

Background: A key issue for systematic reviewers is how broad or narrow to frame the research question, which may have implications on the findings and generalizability of the review. Health professional behaviour change interventions can be lumped or split according to population groups (physicians, nurses); interventions (educational materials, reminders); study designs (randomized controlled trials, interrupted time series), and outcomes (prescribing, test ordering). Differing opinions exist regarding the best approach. This study explored the effects of lumping and splitting on systematic reviews of reminders. The study also explored how review authors cited other systematic reviews in the field and justified the need for a review on their chosen topic.

Methods: A descriptive and exploratory methodology was taken to examine how reviews were 'lumped' or 'split' across reminder interventions and how authors chose to cite other reviews and justify the conduct of their own review. References and text were examined in detail to address these issues.

Results: Authors generally split their reviews across at least one category (population, intervention, study design, outcome). Review authors tended not to cite other similar reviews or provide adequate justification for their reviews.

Conclusions: This analysis demonstrates that for systematic reviews of reminder interventions, splitting is more common than lumping, with most reviews split by condition

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or targeted behaviour. Review authors poorly justify the need for their review and do not cite relevant literature to put their reviews in the context of the available evidence. These factors lead to a proliferation of systematic reviews and an overall disorganization of the literature.

4.2 Introduction

4.2.1 Lumping and Splitting of Systematic Reviews

There are various advantages of systematic reviews compared to individual trials, including their increased statistical power to allow for important questions to be posed and meaningful outcomes measured, with more generalizable conclusions made possible. Yet it has been said that this combining of studies from varying settings, populations and conditions is analogous to comparing "apples to oranges". This has been countered by the fact that since apples and oranges are both fruit, they should be combined, and that grouping together multiple studies across a large number of individuals and settings is a powerful tool for supporting general causal inferences. (1;2) Furthermore, in Smith and Glass' 1977 meta-analysis of psychotherapy outcome studies, evidence of efficacy for psychotherapy interventions was shown across 375 controlled evaluations with little variation between different types of therapies, which powerfully illustrated causal inference and further supports the "fruit" vs. the "apples and oranges" defence. (1)

When conducting a systematic review, defining the question is an integral part of framing the review, which involves determining which populations, interventions/exposures, study designs and outcomes are to be investigated. (3) A key issue for review authors when conceptualizing their systematic review is how broad or narrow these categories will be, as

this will have a substantial impact on the conduct and generalizability of the review. (4) The rationale for taking a broad approach (lumping) is that because systematic reviews aim to identify the common generalizable features within similar interventions, minor differences in study characteristics may not be important. The rationale for taking a narrower approach (splitting) is that it is only appropriate to include studies which are highly similar in design, study population, intervention characteristics, and outcome recording. (4) Lumping allows the generalizability and consistency of research findings to be assessed across a wider range of settings and study populations which may reduce chance results and allow for exploration of effects across different interventions, settings and study populations. (4;5) However, split reviews have fewer and more homogeneous included studies, which leads to a more manageable review with a higher likelihood of meta-analysis, leading to a numerical interpretation of the data. This interpretation has the potential to be more relevant due to the specificity of the research question (Table 4-1).

Table 4-1: Arguments for lumping and splitting

Arguments for Lumping	Arguments for Splitting
Greater potential to reduce chance findings	Easier to conduct
Allows generalizability and consistency of research findings across wider range of settings, populations and behaviours	More specific research question
Facilitates exploratory analyses	Increased homogeneity of included studies

4.2.2 Lumping and Splitting of Systematic Reviews of Professional Behaviour Change Interventions

In the area of professional behaviour change interventions, the scope of the research question can be lumped or split according to population group (e.g. physicians, nurses); intervention (e.g. educational materials, reminders); study design (e.g. randomized controlled

trials, controlled-before-and-after studies), and outcome (e.g. physician prescribing, test ordering) (Table 4-2). Whether professional behaviour change interventions are lumped or split according to these groups likely has an effect on how the results can be utilized in a clinical setting. Although all systematic reviews are 'split' to a certain degree, the decisions on the extent to which it will be split are sometimes more logical than others. For example, clinical questions could be grouped based on disease physiology; however, the theoretical grounding of professional behaviour change interventions provides a less clear basis for systematic review question development.

Table 4-2: Clinical and non-clinical examples of lumping and splitting

Lumping and splitting: clinical example	Lumping and splitting: non-clinical example
• Interventions for the treatment of hypertension (lumped) • Pharmaceutical interventions for the treatment of hypertension (split on intervention) • Effects of beta blockers for hypertension (further split on intervention)	• Effects of audit and feedback to health professionals on health care (lumped) • Effects of audit and feedback to improve diabetes care (split on patient population) • Effects of audit and feedback to improve diabetes care within primary care (split on patient population and setting)

Current lumping and splitting practices are explored in this paper, along with their implications for the conduct and interpretation of reviews. One such professional behaviour change intervention, reminders, has been widely implemented and evaluated in hospital and clinical settings in order to change health professional behaviour. As defined by the Cochrane Effective Practice and Organisation of Care (EPOC) Group, reminders are 'patient or encounter specific information, provided verbally, on paper or on a computer screen, designed or intended to prompt a health professional to recall information'. (6) Reminder interventions can be implemented within electronic health systems with a relatively low cost of operation and have been increasingly evaluated in the field of health professional

behaviour change interventions. (7) They have also been evaluated in various settings and populations, with a combination of lumped and split systematic reviews.

4.2.3 Objective

Lumping and splitting is an important issue in systematic reviews but has scarcely been discussed in the literature. This paper explores this gap by investigating the effects of lumping and splitting on reminder interventions. The following research questions are addressed:

1. How are systematic reviews of reminder interventions 'lumped' or 'split' according to population, intervention, study design and outcome?
2. How do review authors justify the framing of their research question?
3. Are authors putting their reviews in the context of the evidence by citing previously conducted reviews in the same areas?

4.3 Methods

4.3.1 Selection of Systematic Reviews

Relevant systematic reviews of reminder interventions were identified using a highly sensitive search strategy developed and implemented by an information specialist and applied to multiple databases including MEDLINE, EMBASE, DARE and the Cochrane Library (See Appendices A and B for all databases and dates searched). All reviews were independently screened by two individuals, with disagreements resolved by consensus to establish whether the publication was a systematic review, as defined by having explicit methods and selection criteria, which had a primary focus to evaluate reminder interventions

targeting health professionals. If any of the following words were present in the title it was considered a potential reminder intervention: reminder, decision support, computer, electronic, information technology, decision aids and computerized physician order entry.

4.3.2 Data Analysis

Systematic reviews were categorized as lumped or split on population, study design, outcomes, setting, and condition/targeted behaviour. A lumped review was defined as a systematic review that assessed the effect of reminder interventions for all health professionals on all outcomes, settings, conditions and study designs, and a split review was defined as one that specified a certain subgroup in any of the five categories. For example, the title 'Improving preventive care by prompting physicians,' would be considered split by population (physicians) and condition or targeted behaviour (preventive care).

An assessment was made on whether appropriate rationale was provided for the investigation of the specific research question. In order to assess this, each review was categorized on their level of justification provided. 'Clear justification' included reviews that provided supporting evidence that their subset of studies needed to be assessed in isolation of all reminder intervention studies with suggested effect modifiers. 'Partial justification' included reviews that stated differences in effects likely existed but provided no clear evidence or rationale. 'No justification' included those that did not provide any rationale or justification for their review question.

In addition to the justification of the conduct of the review, we assessed whether review authors were putting their study in the context of other research. To assess this, it was observed whether reviewers were citing other systematic reviews on reminders by

examining the reference list of each review to see if previously published systematic reviews were referred to in the text.

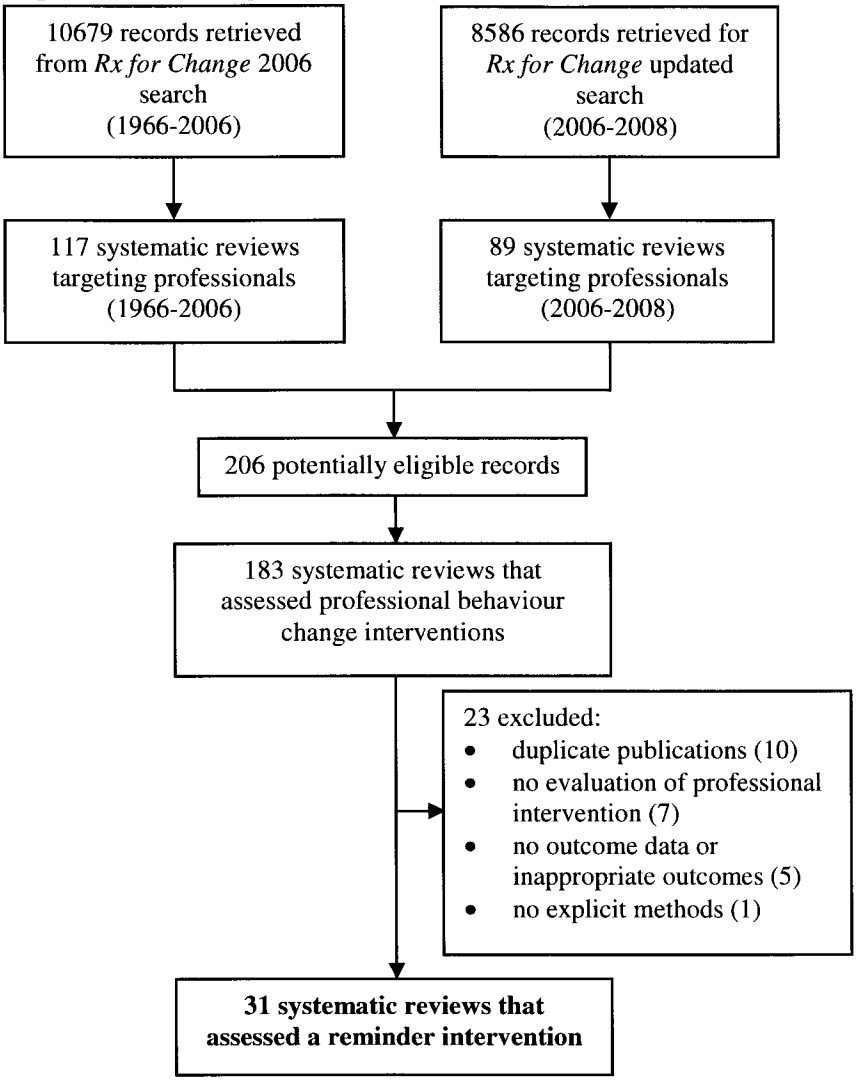
If a review was an update to a previous systematic review, both versions were included and treated as two separate reviews if an updated search was conducted, as per the definition of an update by the Cochrane Handbook. (8)

4.4 Results

4.4.1 Description of Systematic Reviews

Through a search for all systematic reviews of health professional behaviour change interventions, 19,265 records were identified, with 183 systematic reviews evaluating health professional behaviour change interventions and 31 evaluating the effectiveness of reminder interventions (Figure 4-1). These 31 reviews were published between July 1987 and May 2008 in 19 different journals, ranging from having seven included studies to over 250 included studies in the review and with the contact author most likely being from the United States. (7;9-38)

Figure 4-1: Flow diagram for selected studies



4.4.2 Frequency of Lumping and Splitting in Reminder Reviews

Seven systematic reviews were categorized as lumped (not split in any category), (15;20;22;23;26;31;34) and 24 reviews were categorized as split (split in at least one category). (7;9-14;16-19;21;24;25;27-30;32;33;35-38) Of those considered split, 17 were split in one category, five were split in two categories and two were split in three categories (Table 4-3). Of the seven lumped reviews, four were part of a series of updated reviews on computerized clinical decision support systems, (20;22;23;26) one was a conference

proceeding on computerized decision support systems embedded in computerized physician order entry, (31) one looked at all health information technology, (15) and one looked at computer-based guideline implementation. (34)

Table 4-3: Combinations of splits in systematic reviews of reminder interventions

Number of Splits	*Characteristic of Split*	*No.*		*%*
One	Condition (14;19;21;25;27;30;33;37;38)	9		
	Setting (18;24;29)	3		
	Study design (10;28)	2		
	Population (32;36)	2		
	Outcome (35)	1		
	Total		**17**	**54.8**
Two	Condition + study design (12;16;17)	3		
	Population + condition (11)	1		
	Setting + condition (13)	1		
	Total		**5**	**16.1**
Three	Population + condition + study design (9)	1		
	Setting + condition + study design (7)	1		
	Total		**2**	**6.5**

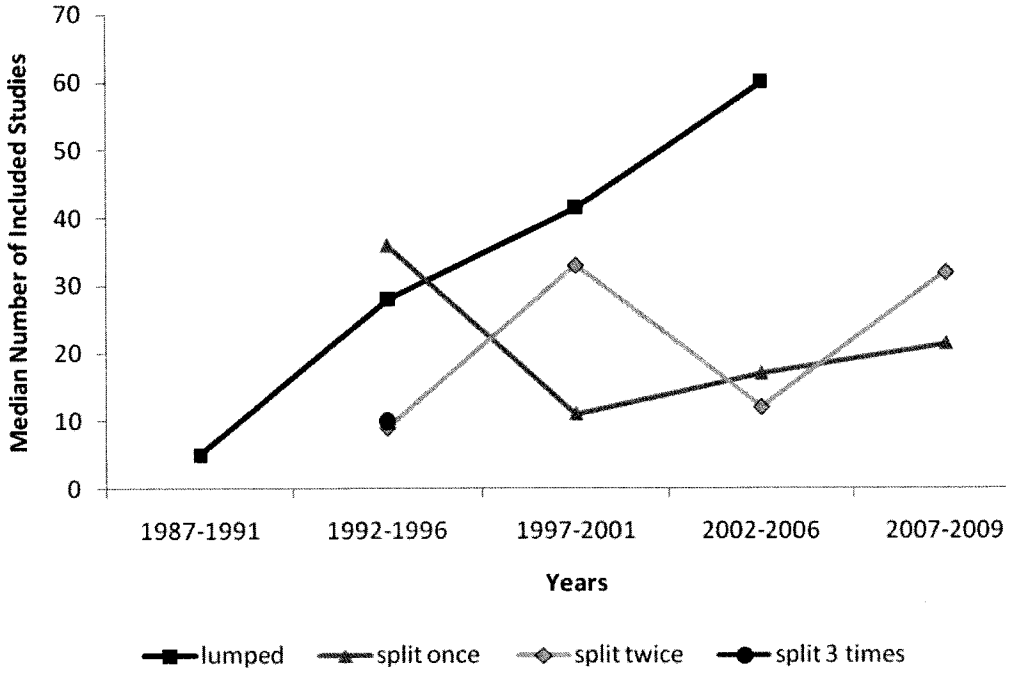
Half of the systematic reviews were split according to condition or targeted behaviour, with preventive care and medication management/prescribing being the most commonly targeted behaviour (Table 4-4). Six systematic reviews limited their reviews to randomized controlled trials (RCTs), and one systematic review limited to 'field evaluation studies'. Three systematic reviews limited to physician-targeted interventions, with one limited to interventions targeting nurses. Only one review split by outcome, which assessed the effect of clinical decision support systems on patient outcomes. (35) Five limited their reviews by setting, including ambulatory care, primary care and outpatient settings.

Table 4-4: Characteristics of splits in systematic reviews of reminder interventions

Level of Split	*Characteristic of split*	*No.*		*%*
Population	Physicians (9;11)	2		
	Physicians - general practitioners only (36)	1		
	Nurses (32)	1		
	Total		**4**	**12.9**
Study Design	Randomized controlled trials (7;9;10;12;17;28)	6		
	Field evaluation studies (16)	1		
	Total		**7**	**22.6**
Outcomes	Patient outcomes (35)	1		
	Total		**1**	**3.2**
Setting	Outpatient care (18;24)	2		
	Ambulatory care (7;13)	2		
	Primary care (29)	1		
	Total		**5**	**16.1**
Condition or targeted behaviour	Preventive care (7;9;11;13;17)	5		
	Medication management or prescribing (12;27;37;38)	4		
	Anticoagulation therapy (14;19)	2		
	Cancer (25)	1		
	Hypertension (30)	1		
	Asthma (33)	1		
	Chest pain (16)	1		
	Pathology services (21)	1		
	Total		**16**	**51.6**

To investigate numbers of included studies in the systematic reviews over time, the type of review (lumped or split) was plotted against the number of studies that were included in the review and grouped according to year of publication (Figure 4-2). The lumped reviews showed increasing numbers of included studies with time, which captures a cumulative increase in systematic reviews on reminder interventions. The reviews that were split one and two times had smaller numbers of included studies than lumped reviews, but did not appear to change over time, and only one review was split three times.

Figure 4-2: Median number of included studies according to year and number of times split



4.4.3 Justification of Reviews

When justifying the conduct of their systematic review, authors often stated that their specific research question had not been investigated, but did not provide evidence that their subset of studies warranted investigation in isolation of all reminder studies. Out of the 24 split reviews, five provided partial justification and 19 reviews provided no justification for their review. Out of the seven lumped reviews, none provided justification for their research question, however, the authors might have thought there was an implicit assumption that the lumped question was appropriate to study.

Of the reviews that provided partial justification, Sintchenko et al. assessed the effect of computerized decision support on patient outcomes and stated that it was more valid to measure patient outcomes than the usually evaluated health professional behaviour outcomes. (35) Eslami et al. stated that the outpatient setting was more disorganized than

other medical settings, and thus reminders in that setting might prove to be more effective in improving patient care. (18)

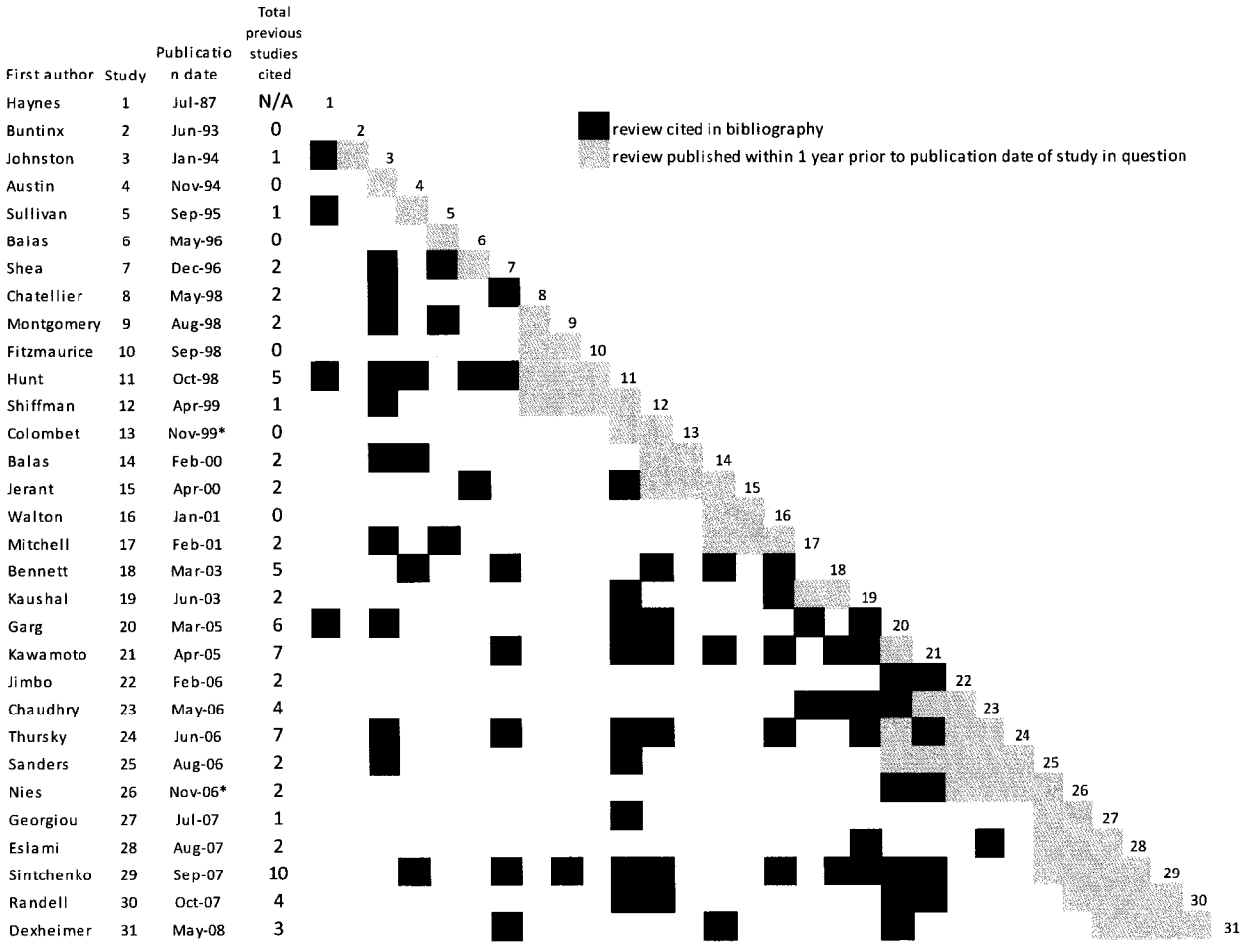
Reviews that provided no clear justification for the conduct of their review included Randell et al., which looked at computerized decision support systems for nurses but did not provide supporting arguments or rationale for why nurses needed to be analyzed separately from the general health professional population. (32) Others assessed the effects of computerized decision support systems (CDSS) for a specific clinical outcome, such as oral anticoagulation management and antibiotic prescribing, but only stated that a review had not been completed in that area without justifying why it might have different results. (19;37) Authors such as Kawamoto et al. and Shea et al. conducted specific analyses that had not been done before such as identifying specific features of CDSS that improved care (28) and conducting a meta-analysis, (7) however given that these reviews did not justify the conduct of a review in their specific topic area, they were still classified as having 'no justification'.

4.4.4 Citations of Previous Reminder Systematic Reviews

Figure 4-3 illustrates citations of previously published reminder systematic reviews for each of the 31 reminder reviews. Allowing for a one-year lag in publication, the median number of prior cited reviews was two and the median percentage of prior cited systematic reviews per publication was 21%. Six systematic reviews did not cite any of the previous reminder reviews, and four cited one previous review. The review that was cited the most was by Johnston et al. published in 1994 (26), which continued to be cited up until 2006, even though it was updated by subsequent publications in 1998 (23) and 2005. (20) Eight of the 31 systematic reviews were related to updates; four in the area of CDSS (20;22;23;26),

two in the area of primary care (29;36), and two in the area of preventive care. (11;17) In some cases, authors cited a review when an updated version existed. Balas et al. and Mitchell cited the Johnston et al. review in their 2000 and 2001 publications when this had been updated by Hunt et al. approximately two years prior and Georgiou et al. cited the Hunt et al. review when it had been updated by Garg et al. two years before.

Figure 4-3: Citations of previous reminder systematic reviews



4.5 Discussion

This descriptive analysis of lumping and splitting demonstrates that for systematic reviews of reminder interventions, splitting is more common than lumping and most split reviews are split by type of reminder or condition. Review authors are poorly justifying the

need for their review and authors are not citing relevant literature in order to put their reviews in the context of the available research. This leads to a poorly organized field of research.

The issue of lumping and splitting of systematic reviews has been discussed in the medical literature but not empirically assessed. This is the first known investigation into the frequency of lumping and splitting in a group of systematic reviews. With the increase in publication of systematic reviews over the years, this study provides a unique examination into the issue of citing previous reviews in the same topic area. Through a careful search of all systematic reviews of reminder interventions, this study shows that although a popular and frequently published topic of research, literature on reminder interventions is not organized in a way that makes it easy to understand.

Limitations of this study exist. As much as the analyses conducted in the study were as objective as possible, they were based on a subjective conception of lumping and splitting categories. As well, it is possible that authors of systematic reviews did not cite other systematic reviews of reminder interventions for reasons other than their own desire to cite them and for reasons out of the control of the authors, such as deletions from the manuscript due to the peer review or the editorial process of publication. This analysis should be repeated in other fields of study to see if this disorganization is consistent across other medical and scientific subject areas.

This study will hopefully lead to the awareness that decisions on lumping or splitting in a systematic review is an important methodological consideration and impacts its usability. Similar to subgroup analyses, review questions based on smaller split groups should be based on an a priori justification that the group in question may differ from the

whole. Given that most systematic reviews do not report working from a protocol, (39) it is difficult for a reader to know whether decisions to split were made post hoc and are a result of inappropriate 'data dredging'. If systematic reviews are conducted on small sub-populations or studies, then reasonable justification should support the authors' decision, not simply the judgement of authors, which seems to be the current practice.

The CONSORT statement recommends that individuals wishing to conduct RCTs review the existing literature through a formal systematic review or through the identification of a previously conducted systematic review to justify the need for further research in the area. (40) The results of this study show that reminder reviews have been published that address efficacy questions that have previously been evaluated. Journals and journal editors should encourage review authors to put their reviews in the context of the existing literature of systematic reviews in order to justify resource utilization and to prevent redundant publications on the same topic area. Furthermore, it is recommended that journal editors be cautious when they are presented with highly split or overlapping reviews, and should encourage review authors to justify the need for a subspecialized review question that might have been answered through a larger, more generalizable systematic review. Guidelines such as PRISMA could potentially recommend that authors consider other systematic reviews and provide more substantial justification for their reviews. (41) The issue of lumping and splitting is far from clear, but the more that review authors consider how their review will be interpreted, the more useable the reviews will be and the better the overall organization of the field of systematic reviews will be.

Reference List

(1) Smith ML, Glass GV. Meta-analysis of psychotherapy outcome studies. Am Psychol 1977 Sep;32(9):752-60.

(2) Shadish W, Cook T, Campbell D. Experimental & Quasi-Experimental Designs for Generalized Causal Inference. Boston: Houghton-Mifflin; 2002.

(3) Khan KS, Kunz R, Kleijnen J, Antes G. Five steps to conducting a systematic review. J R Soc Med 2003 Mar;96(3):118-21.

(4) Grimshaw J, McAuley LM, Bero LA, Grilli R, Oxman AD, Ramsay C, et al. Systematic reviews of the effectiveness of quality improvement strategies and programmes. Qual Saf Health Care 2003 Aug;12(4):298-303.

(5) Gotzsche PC. Why we need a broad perspective on meta-analysis. It may be crucially important for patients. BMJ 2000 Sep 9;321(7261):585-6.

(6) Grimshaw J, Eccles M, Thomas R, Maclennan G, Ramsay C, Fraser C, et al. Toward evidence-based quality improvement. Evidence (and its limitations) of the effectiveness of guideline dissemination and implementation strategies 1966-1998. J Gen Intern Med 2006 Feb;21 Suppl 2:S14-S20.

(7) Shea S, DuMouchel W, Bahamonde L. A meta-analysis of 16 randomized controlled trials to evaluate computer-based clinical reminder systems for preventive care in the ambulatory setting. J Am Med Inform Assoc 1996 Nov;3(6):399-409.

(8) The Cochrane Collaboration. Cochrane Handbook for Systematic Reviews of Interventions Version 5.0.1. 2008.

(9) Austin SM, Balas EA, Mitchell JA, Ewigman BG. Effect of physician reminders on preventive care: meta-analysis of randomized clinical trials. Proc Annu Symp Comput Appl Med Care 1994;121-4.

(10) Balas EA, Austin SM, Mitchell JA, Ewigman BG, Bopp KD, Brown GD. The clinical value of computerized information services. A review of 98 randomized clinical trials. Arch Fam Med 1996 May;5(5):271-8.

(11) Balas EA, Weingarten S, Garb CT, Blumenthal D, Boren SA, Brown GD. Improving preventive care by prompting physicians. Arch Intern Med 2000 Feb 14;160(3):301-8.

(12) Bennett JW, Glasziou PP. Computerised reminders and feedback in medication management: a systematic review of randomised controlled trials. Med J Aust 2003 Mar 3;178(5):217-22.

(13) Buntinx F, Winkens R, Grol R, Knottnerus JA. Influencing diagnostic and preventive performance in ambulatory care by feedback and reminders. A review. Fam Pract 1993 Jun;10(2):219-28.

(14) Chatellier G, Colombet I, Degoulet P. An overview of the effect of computer-assisted management of anticoagulant therapy on the quality of anticoagulation. Int J Med Inform 1998 May;49(3):311-20.

(15) Chaudhry B, Wang J, Wu S, Maglione M, Mojica W, Roth E, et al. Systematic review: impact of health information technology on quality, efficiency, and costs of medical care. Ann Intern Med 2006 May 16;144(10):742-52.

(16) Colombet I, Chatellier G, Jaulent MC, Degoulet P. Decision aids for triage of patients with chest pain: a systematic review of field evaluation studies. Proc AMIA Symp 1999;721-5.

(17) Dexheimer JW, Talbot TR, Sanders DL, Rosenbloom ST, Aronsky D. Prompting clinicians about preventive care measures: a systematic review of randomized controlled trials. J Am Med Inform Assoc 2008 May;15(3):311-20.

(18) Eslami S, bu-Hanna A, de Keizer NF. Evaluation of outpatient computerized physician medication order entry systems: a systematic review. J Am Med Inform Assoc 2007 Jul;14(4):400-6.

(19) Fitzmaurice DA, Hobbs FD, Delaney BC, Wilson S, McManus R. Review of computerized decision support systems for oral anticoagulation management. Br J Haematol 1998 Sep;102(4):907-9.

(20) Garg AX, Adhikari NK, McDonald H, Rosas-Arellano MP, Devereaux PJ, Beyene J, et al. Effects of computerized clinical decision support systems on practitioner performance and patient outcomes: a systematic review. JAMA 2005 Mar 9;293(10):1223-38.

(21) Georgiou A, Williamson M, Westbrook JI, Ray S. The impact of computerised physician order entry systems on pathology services: a systematic review. Int J Med Inform 2007 Jul;76(7):514-29.

(22) Haynes RB, Walker CJ. Computer-aided quality assurance. A critical appraisal. Arch Intern Med 1987 Jul;147(7):1297-301.

(23) Hunt DL, Haynes RB, Hanna SE, Smith K. Effects of computer-based clinical decision support systems on physician performance and patient outcomes: a systematic review. JAMA 1998 Oct 21;280(15):1339-46.

(24) Jerant AF, Hill DB. Does the use of electronic medical records improve surrogate patient outcomes in outpatient settings? J Fam Pract 2000 Apr;49(4):349-57.

(25) Jimbo M, Nease DE, Jr., Ruffin MT, Rana GK. Information technology and cancer prevention. CA: a Cancer Journal for Clinicians 56(1):26-36; quiz 48-9, 2006 Jan;-Feb.

(26) Johnston ME, Langton KB, Haynes RB, Mathieu A. Effects of computer-based clinical decision support systems on clinician performance and patient outcome. A critical appraisal of research. Ann Intern Med 1994 Jan 15;120(2):135-42.

(27) Kaushal R, Shojania KG, Bates DW. Effects of computerized physician order entry and clinical decision support systems on medication safety: a systematic review. Arch Intern Med 2003 Jun 23;163(12):1409-16.

(28) Kawamoto K, Houlihan CA, Balas EA, Lobach DF. Improving clinical practice using clinical decision support systems: a systematic review of trials to identify features critical to success. BMJ 2005 Apr 2;330(7494):765.

(29) Mitchell E, Sullivan F. A descriptive feast but an evaluative famine: systematic review of published articles on primary care computing during 1980-97. BMJ 2001 Feb 3;322(7281):279-82.

(30) Montgomery AA, Fahey T. A systematic review of the use of computers in the management of hypertension. J Epidemiol Community Health 1998 Aug;52(8):520-5.

(31) Nies J, Colombet I, Degoulet P, Durieux P. Determinants of success for computerized clinical decision support systems integrated in CPOE systems: a systematic review. AMIA Annual Symposium Proceedings/AMIA Symposium :594-8, 2006.

(32) Randell R, Mitchell N, Dowding D, Cullum N, Thompson C. Effects of computerized decision support systems on nursing performance and patient outcomes: a systematic review. J Health Serv Res Policy 2007 Oct;12(4):242-9.

(33) Sanders DL, Aronsky D. Biomedical informatics applications for asthma care: a systematic review. J Am Med Inform Assoc 2006 Jul;13(4):418-27.

(34) Shiffman RN, Liaw Y, Brandt CA, Corb GJ. Computer-based guideline implementation systems: a systematic review of functionality and effectiveness. J Am Med Inform Assoc 1999 Mar;6(2):104-14.

(35) Sintchenko V, Magrabi F, Tipper S. Are we measuring the right end-points? Variables that affect the impact of computerised decision support on patient

outcomes: a systematic review. Medical Informatics & the Internet in Medicine 32(3):225-40, 2007 Sep.

(36) Sullivan F, Mitchell E. Has general practitioner computing made a difference to patient care? A systematic review of published reports. BMJ 1995 Sep 30;311(7009):848-52.

(37) Thursky K. Use of computerized decision support systems to improve antibiotic prescribing. Expert Review of Antiinfective Therapy 4(3):491-507, 2006 Jun.

(38) Walton RT, Harvey E, Dovey S, Freemantle N. Computerised advice on drug dosage to improve prescribing practice. Cochrane Database Syst Rev 2001;(1):CD002894.

(39) Moher D, Tetzlaff J, Tricco AC, Sampson M, Altman DG. Epidemiology and reporting characteristics of systematic reviews. PLoS Med 2007 Mar 27;4(3):e78.

(40) Altman DG, Schulz KF, Moher D, Egger M, Davidoff F, Elbourne D, et al. The revised CONSORT statement for reporting randomized trials: explanation and elaboration. Ann Intern Med 2001 Apr 17;134(8):663-94.

(41) Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. J Clin Epidemiol 2009 Jul 22.

5. Discussion and Conclusions

5.1. Statement of Principal Findings

This thesis examined systematic reviews of professional behaviour change interventions to analyze their epidemiology, quality and methods. Chapter two showed that the number of these reviews have increased substantially over time and are cited widely. As well, there is a wide dispersion of the literature, with 193 reviews published in over 100 different journals and several reviews on overlapping populations, interventions and settings. Unclear and incomplete reporting existed in some reviews, which included the omission of characteristics of included studies and methods of analysis. In addition, a large number of reviews used vote counting or descriptive analysis which is a less preferable method of summarizing results due to the potential introduction of bias. (1)

Chapter three illustrated that the quality of systematic reviews of professional behaviour change is low, as indicated with an average AMSTAR score of 4 out of 11. Certain procedures were rarely reported, such as working from a protocol, searching grey literature sources, providing lists of included and excluded studies, assessing publication bias and disclosing funding and conflict of interest for both the review and individual studies. Cochrane reviews were shown to have significantly higher AMSTAR scores than non-Cochrane reviews.

Chapter four showed that in the area of reminder interventions, many authors are conducting reviews on subsets of professional groups, settings and conditions, which result in a high number of 'split' reviews. Most of these reviews do not justify studying the subgroup that is being investigated, and do not cite their results within the context of other

literature in the field. This leads to a disorganized field of literature and indicates potential inappropriate duplication of effort and inappropriate usage of resources.

5.2. Strengths and Weaknesses of Thesis

To the knowledge of the author, this is the first report of the epidemiology of systematic reviews of professional behaviour change interventions, which is a valuable exercise in indicating gaps in the literature and areas where further research would be beneficial. This is also the first known empirical examination of issues related to lumping and splitting, including the examination of how authors frame their systematic review and justify the conduct of their review. This is an important topic in the area of systematic review methodology and will hopefully fuel further discussion within the systematic review community.

A comprehensive search strategy was created and implemented by an information specialist, which sought to capture all reviews of professional behaviour change interventions. Duplicate and independent screening, quality assessment and extraction of data were conducted for all eligible reviews to minimize potential errors and reduce bias, and quality was assessed using a validated quality assessment tool.

Weaknesses of this study exist. The author and two contributors to the thesis project (JG, AM) are closely involved with the Cochrane EPOC (Effective Practice and Organisation of Care) Group, which was involved in the publication of some of the included reviews. Although assessments were unblinded, precautions were taken to minimize any potential effect of personal bias on this project, such as any bias towards favouring EPOC-related authors or reviews. Firstly, duplicate and independent screening, quality assessment

and data extraction was conducted. As well, explicit and objective decision-rules were created and followed for the quality assessment using AMSTAR. Lastly, any individual that was also an author of a review on professional behaviour change was not involved in its quality assessment or data extraction.

In chapter four, citation frequency was assessed by tabulating cumulative counts of citation, which allows older publications more opportunity to be cited. Utilizing a two-year citation count might have been more robust, however, the most appropriate and available bibliographic measure to compare citations of professional behaviour change systematic reviews to all of the literature were statistics from Eugene Garfield's report, (2) which provided cumulative citation frequency of all life science articles. Therefore, this bibliometric measure was used to approximate relative citation frequency, while acknowledging its limitations.

In chapter four the reference lists of studies were examined to evaluate how authors cite other systematic reviews in the field. This technique is exploratory in nature, as counting the number of systematic reviews in the reference list cannot capture the context that it was referenced in and the appropriateness of the citation. However, this provided information on whether authors were mentioning other pertinent literature in their reviews, as a minimum.

Finally, although the AMSTAR tool has been found to be reliable and valid, it is designed to assess the quality of systematic reviews in any subject area. Its applicability to systematic reviews of professional behaviour change interventions is unclear. Some criteria may be problematic or less relevant for these systematic reviews. For example, publication bias may be more difficult to assess for systematic reviews of professional behaviour

interventions, and omitting its assessment in a review would lower its overall quality score. Nevertheless, key criteria that appeared equally relevant to systematic reviews of professional behaviour change interventions were commonly not reported, for example, working from a protocol.

5.3. Meaning and Implication of Thesis

The high number of reviews dispersed across various sources of literature demonstrates the disorganization of systematic reviews of professional behaviour change interventions. This disorder coupled with reviews on overlapping subject areas demonstrates a potential inappropriate duplication of effort and inefficient use of resources. This signifies that resources could be more appropriately utilized to produce high-quality and relevant systematic reviews. This project challenges authors of professional behaviour change reviews to address the quality and methods of their systematic reviews and suggests that review authors should ensure that they are not duplicating efforts unnecessarily by repeating a systematic review that has already been done. Situations in which a review should be conducted even when one exists on the same topic area is up for discussion, for example, it would be legitimate for an author to conduct a meta-analysis when one has not been done, or to update a review that is out of date.

One strategy that has been proposed to aid in this goal is to create a registry of systematic reviews, similar to that of clinical trials, to increase awareness of ongoing systematic reviews and reduce unnecessary duplication. (3) With the endorsement of the International Committee of Medical Journal Editors (ICMJE) in 2004 that all trials be registered in a publically accessible register as a precondition of publication, there has been

increased acceptance that trial registration is a scientific and ethical responsibility. (4) In the same way that trial registration has the potential to improve medical literature; systematic review registration could enhance transparency and reduce duplication of effort on the part of review authors. (3)

Certain methodological areas scored consistently low on the AMSTAR instrument. In both Cochrane and non-Cochrane reviews, searching of grey literature was only completed in 18% of the reviews. Recent evidence has illustrated the effects of searching grey literature on the results of meta-analyses, suggesting that it should be done in order to minimise bias in reviews. (5) However, given that the applicability of these studies to systematic reviews of professional behaviour change interventions has not been determined, this could be an area of further exploration.

The AMSTAR quality item that assessed disclosure of funding and conflict of interest was not met in any of the systematic reviews, as no reviews reported on disclosures for the included studies of the systematic review. Given the evidence on the impact of industry sponsorship on the quality and conclusions of both primary studies and systematic reviews, disclosing conflict of interest for the review and also for the individual studies more frequently in reviews would ensure transparency. (6-8)

Non-Cochrane reviews scored lower than Cochrane reviews on almost all AMSTAR items, with most having statistically significant differences. Working from a protocol was reported in only 3% of non-Cochrane reviews, which is lower than another study which indicated 11% of a sample of 88 non-Cochrane reviews working from a protocol. (9) Providing a list of included and excluded studies was completed in 5% of non-Cochrane reviews, where most reviews that did not score a point did not include a list of excluded

studies. Listing excluded studies can provide valuable information for readers to understand why studies were not included for analysis. Although this task would require the use of additional space in a publication, many journals are providing additional online material, which allows the hard-copy format to remain the same length, while providing information to readers who wish to access it. Likely factors that contributed to the increased quality of Cochrane reviews include the standard reporting methods and support from review groups. The higher quality of Cochrane reviews is consistent with other findings in the literature. (9-11)

In chapter four it was shown that review authors rarely provide clear justification for conducting a review on their research question within the context of other systematic reviews. Given that chapter two illustrated the high number of overlapping systematic reviews, this justification is important to ensure that resources are put towards producing needed systematic reviews that are based on a sound research question. In addition to conducting a systematic literature search prior to the initiation of a review, authors should assess how their review fits into the context of the literature. If they are conducting a highly 'split' review, an explanation of how the review can be interpreted within the framework of other research should be provided, including rationale for why conducting a 'split' review is justifiable. For example, if one was to study the effects of reminders on rural health care practitioners, the author should present arguments and evidence that factors related to the rural practice would modify the effects of reminders compared to those observed across all practitioners.

Out of the 193 systematic reviews on professional behaviour change interventions, 23 were updates of previously conducted reviews. This lack of updating within a field with so

many publications can create confusion for the end-user when trying to discern which reviews are up-to-date, which have overlapping included studies and how the epidemiology of primary studies has altered over time. For computer-based clinical decision support, Haynes and Walker published a review on its effectiveness in 1987 with 14 included reviews, Johnston et al. updated this in 1994 with 28 included studies, Hunt et al. updated it in 1998 with 68 included studies, and Garg et al. updated it in 2005 with a total of 100 studies. (12-15) With each review clearly identifying itself as update and referencing the original review, this series of reviews clearly demonstrates the increase in studies on the topic of computerized clinical decision support, and allows an end-user to evaluate not only the current state of evidence, but can follow the evolution of a single systematic review question. In the specific investigation of reminder reviews in chapter four, only six out of the 31 systematic reviews were involved in updates, which illustrate the large numbers of unrelated reviews on the single topic of reminders. Given the evidence in other areas that systematic reviews are infrequently updated, (9) reasons that it is not being done should be explored further, such as looking into why research organizations lack formal updating policies or whether journals are reluctant to publish updates that are similar to original reviews.

The high number of reviews combined with the overall low quality creates problems for end-users when trying to interpret systematic reviews. Given the consistent evidence of higher quality in Cochrane reviews, (9-11;16) perhaps end-users should base decisions on a Cochrane review if there are both Cochrane and non-Cochrane reviews available on a similar research question. Other solutions to the high volume of reviews are to utilize databases such as *Rx for Change* (www.rxforchange.ca) and McMaster University's Program in Policy

Decision-Making (PPD; www.researchtopolicy.ca), which aim to help decision makers make sense of research by listing systematic reviews in order of quality, providing structured abstracts, and organizing by specific intervention types. Overviews of systematic reviews have also been produced, which attempt to provide a summary of various types of interventions in a single and usable format, and create a 'friendly-front end' for readers. (17)

In The Cochrane Library (www.thecochranelibrary.org), the process of conducting a systematic review begins with the registering of the title, which requires the author to ensure that a Cochrane review does not already exist on the same topic. The PRISMA Statement, which was recently published on reporting guidelines of systematic reviews and meta-analyses, (18) will hopefully improve the quality and reporting of future systematic reviews, however, guidelines such as these could also include suggestions that review authors conduct a systematic review to identify any previously conducted systematic reviews in the same topic area. As well, PRISMA could discuss the importance of including empirical justification for the conduct of their review, as well as comparing results with other reviews in the field.

5.4. Unanswered Questions and Future Research

The results of this thesis provide a baseline for future research into the epidemiology, quality and methods of systematic reviews. This study of systematic reviews of professional behaviour change interventions shows that review authors rarely conduct meta-analyses or report effect sizes of results, often utilizing vote counting or descriptive methods. As well, the assessment of publication bias was only reported in 5% of the 193 reviews. This could be indicative of a lack of knowledge in methods to combine results or assess publication bias

in this type of systematic review. If so, this could be an area where greater methodological development has the potential to improve methods and provide authors with the ability to conduct more robust and scientifically meaningful analyses. A recent publication discusses the particular challenges that complex interventions in systematic reviews cause and suggests ways in which they might be addressed. (19) Further empirical development of review methods for systematic reviews of professional behaviour change interventions and other complex interventions is warranted.

The issue of duplication of effort raises questions on which circumstances are appropriate for conducting a systematic review, even if one exists on the same topic. Updating out-of-date reviews is important to keep evidence current, although it is still unknown as to which indicators should signify the update of a review. (20) Less frequently discussed are reasons for justification of producing reviews on similar topics, such as whether the utilization of different methodologies to synthesize data might justify the conduct of an additional systematic review.

The subject of lumping and splitting has only been discussed in the literature on a few occasions. (21-23) The assessment in this thesis of the frequency of lumping and splitting should be replicated in other subject areas, including clinical areas that have a high rate of publication. As well, further investigation could be done on understanding the implications of lumping and splitting, such as its impact on the usability of the review, as well as the extent to which the framing of the research question alters the chance of spurious findings. It has been previously noted that policy-makers prefer lumped reviews, while researchers prefer more narrow, split reviews. (23) This opinion could be empirically

studied by investigating the perceived value of lumped or split reviews for end-users by examining decision-makers' opinions and attitudes of reviews that are broadly focused as well as those that are narrowly focused. In addition, the cost-effectiveness of conducting reviews of varying scope could be of interest to funders, including the determination of how much more time it takes to complete larger reviews.

Journal editors, funders, reviewers and readers should be aware of issues related to systematic review quality and methods, and those specifically related to professional behaviour change interventions. Hopefully through increased awareness and interest in quality assessment tools such as AMSTAR, reporting guidelines such as PRISMA, and methodological issues such as lumping and splitting, the quality and organization of systematic reviews will improve.

Reference List

(1) Littell JH, Corcoran J, Pillai V. Systematic Reviews and Meta-Analysis. New York: Oxford University Press; 2008.

(2) Garfield E. The agony and the ecstasy: The history and meaning of the journal impact factor. International Congress on Peer Review and Biomedical Publication. 2005.

(3) Straus S, Moher D. Registering systematic reviews. CMAJ 2009 Jul 20.

(4) Ghersi D, Pang T. From Mexico to Mali: four years in the history of clinical trial registration. Journal of Evidence-Based Medicine 2009 Feb;2(1):1-7.

(5) Hopewell S, McDonald S, Clarke M, Egger M. Grey literature in meta-analyses of randomized trials of health care interventions. Cochrane Database Syst Rev 2007;(2):MR000010.

(6) Yank V, Rennie D, Bero LA. Financial ties and concordance between results and conclusions in meta-analyses: retrospective cohort study. BMJ 2007 Dec 8;335(7631):1202-5.

(7) Lexchin J, Bero LA, Djulbegovic B, Clark O. Pharmaceutical industry sponsorship and research outcome and quality: systematic review. BMJ 2003 May 31;326(7400):1167-70.

(8) Jorgensen AW, Maric KL, Tendal B, Faurschou A, Gotzsche PC. Industry-supported meta-analyses compared with meta-analyses with non-profit or no support: differences in methodological quality and conclusions. BMC Med Res Methodol 2008;8:60.

(9) Moher D, Tetzlaff J, Tricco AC, Sampson M, Altman DG. Epidemiology and reporting characteristics of systematic reviews. PLoS Med 2007 Mar 27;4(3):e78.

(10) Jadad AR, Cook DJ, Jones A, Klassen TP, Tugwell P, Moher M, et al. Methodology and reports of systematic reviews and meta-analyses: a comparison of Cochrane reviews with articles published in paper-based journals. JAMA 1998 Jul 15;280(3):278-80.

(11) Shea B, Moher D, Graham I, Pham B, Tugwell P. A comparison of the quality of Cochrane reviews and systematic reviews published in paper-based journals. Eval Health Prof 2002 Mar;25(1):116-29.

(12) Haynes RB, Walker CJ. Computer-aided quality assurance. A critical appraisal. Arch Intern Med 1987 Jul;147(7):1297-301.

(13) Johnston ME, Langton KB, Haynes RB, Mathieu A. Effects of computer-based clinical decision support systems on clinician performance and patient outcome. A critical appraisal of research. Ann Intern Med 1994 Jan 15;120(2):135-42.

(14) Hunt DL, Haynes RB, Hanna SE, Smith K. Effects of computer-based clinical decision support systems on physician performance and patient outcomes: a systematic review. JAMA 1998 Oct 21;280(15):1339-46.

(15) Garg AX, Adhikari NK, McDonald H, Rosas-Arellano MP, Devereaux PJ, Beyene J, et al. Effects of computerized clinical decision support systems on practitioner performance and patient outcomes: a systematic review. JAMA 2005 Mar 9;293(10):1223-38.

(16) Jadad AR, Moher M, Browman GP, Booker L, Sigouin C, Fuentes M, et al. Systematic reviews and meta-analyses on treatment of asthma: critical evaluation. BMJ 2000 Feb 26;320(7234):537-40.

(17) Becker LA, Oxman AD. Overviews of reviews. In: Higgins JPT, Green S, editors. Cochrane Handbook for Systematic Reviews of Interventions. The Cochrane Collaboration; 2008.

(18) Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. J Clin Epidemiol 2009 Jul 22.

(19) Shepperd S, Lewin S, Straus S, Clarke M, Eccles MP, Fitzpatrick R, et al. Can we systematically review studies that evaluate complex interventions? PLoS Med 2009 Aug;6(8):e1000086.

(20) Moher D, Tsertsvadze A, Tricco AC, Eccles M, Grimshaw J, Sampson M, et al. When and how to update systematic reviews. Cochrane Database Syst Rev 2008;(1):MR000023.

(21) Grimshaw J, McAuley LM, Bero LA, Grilli R, Oxman AD, Ramsay C, et al. Systematic reviews of the effectiveness of quality improvement strategies and programmes. Qual Saf Health Care 2003 Aug;12(4):298-303.

(22) Gotzsche PC. Why we need a broad perspective on meta-analysis. It may be crucially important for patients. BMJ 2000 Sep 9;321(7261):585-6.

(23) Pope C, Mays N, Popay J. Synthesizing Qualitative and Quantitative Health Research. Open University Press; 2007.

Appendix A: Databases Searched

Rx for Change (2006):

- MEDLINE (1966 - December 2005)
- Cochrane EPOC review database (searched March 11, 2004)
- DARE (2004, Issue 3)
- NHS Economic Evaluation Database (2004, Issue 3)
- EMBASE (1980 through 2005)
- Econlit (1969 through August 2006)
- ABI/Inform (1985 through August 2006)
- Proquest Digital Dissertations and Theses (formerly known as Dissertation Abstracts; 1990 through to last search in August 2006)
- PsycINFO (1806 through April Week 4, 2006)
- CINAHL (1982 through April Week 3, 2006)
- ERIC (1966 to current; searched May 2006)
- IPA (1970 through April 2006)

Rx for Change (2008 update)

- MEDLINE
- EMBASE
- Cochrane Library
- DARE

Appendix B: Individuals Involved in Searching, Screening and Quality Assessment

Searching:
Doug Salzwedel (information specialist)
Jessie McGowan (information specialist)

Screening:
Michelle Weir
Julia Worswick
Alain Mayhew
Signe Flottorp
Lillebeth Larun
Joanna Sarnecka
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Helene Laberge
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Quality Assessment:
Michelle Weir
Julia Worswick
Alain Mayhew
Adrienne Stevens
Joanna Sarnecka
Changhua Yu
Avtar Lal
Tom Oliver
Michelle Kho
Tomas Pantoja
Alison Jennings
Lucieni Conterno
Arash Rashidian
Alison Jennings
Julie Makarski

Appendix C: Data Collection Information

Intervention: *From EPOC Taxonomy - Professional interventions*

a) Distribution of educational materials (Distribution of published or printed recommendations for clinical care, including clinical practice guidelines, audio-visual materials and electronic publications. The materials may have been delivered personally or through mass mailings.)

b) Educational meetings (Health care providers who have participated in conferences, lectures, workshops or traineeships.)

c) Local consensus processes (Inclusion of participating providers in discussion to ensure that they agreed that the chosen clinical problem was important and the approach to managing the problem was appropriate.)

d) Educational outreach visits (Use of a trained person who met with providers in their practice settings to give information with the intent of changing the provider's practice. The information given may have included feedback on the performance of the provider(s). This can also be called academic detailing.)

e) Local opinion leaders (Use of providers nominated by their colleagues as 'educationally influential'. The investigators must have explicitly stated that their colleagues identified the opinion leaders.)

f) Patient mediated interventions (New clinical information (not previously available) collected directly from patients and given to the provider e.g. depression scores from an instrument.)

g) Audit and feedback (Any summary of clinical performance of health care over a specified period of time. The summary may also have included recommendations for clinical action. The information may have been obtained from medical records, computerised databases, or observations from patients.)

The following interventions are excluded:

- Provision of new clinical information not directly reflecting provider performance which was collected from patients e.g. scores on a depression instrument, abnormal test results. These interventions should be described as patient mediated.
- Feedback of individual patients' health record information in an alternate format (e.g. computerised). These interventions should be described as organisational.

h) Reminders (Patient or encounter specific information, provided verbally, on paper or on a computer screen, which is designed or intended to prompt a health professional to recall information. This would usually be encountered through their general education; in the medical records or through interactions with peers, and so remind them to perform or avoid some action to aid individual patient care. Computer aided decision support (CDSS) and computer physician order entry (CPOE) are included.)

i) Tailored [Formerly called Marketing] (Use of personal interviewing, group discussion ('focus groups'), or a survey of targeted providers to identify barriers to change and subsequent design of an intervention that addresses identified barriers.)

j) Mass media (varied use of communication that reached great numbers of people including television, radio, newspapers, posters, leaflets, and booklets, alone or in conjunction with other interventions; targeted at the population level.)

k) Other (Other categories to be agreed in consultation with the EPOC editorial team.)

Note: Multifaceted designs were those that evaluated the effectiveness of the combination of two or more interventions.

Study Design:

a) RCT (randomised controlled trial)
b) CT or CCT (controlled trial – including quasi-randomised controlled trials)
c) CBA (controlled before and after study),
d) ITS (interrupted time series analysis – control may or may not be present)
e) BA (before and after study)
f) Other – (observational, repeated measures)
g) Unclear/unspecified

Authors' Analysis of Data:

a) Meta-analysis
b) Meta-regression
c) Effect sizes without pooling (no meta-analysis conducted)
d) Vote counting
e) Descriptive

Outcomes:

a) Process (behaviour of health professionals e.g. referrals, test ordering, procedures, compliance with guidelines, screening, immunizations, prescribing)
b) Outcome (patient health outcomes e.g. blood pressure, glucose testing)
c) Cost (health care costs)
d) Patient/Provider satisfaction (satisfaction with evaluated intervention)

Appendix D: Included Systematic Reviews

(1) Implementing clinical guidelines. Can guidelines be used to improve clinical practice? Effective Health Care 1[8]. 1994.

(2) Aboelela SW, Stone PW, Larson EL. Effectiveness of bundled behavioural interventions to control healthcare-associated infections: a systematic review of the literature. [Review] [21 refs]. Journal of Hospital Infection 66(2):101-8, 2007 Jun.

(3) Allard P, Maunsell E, Labbe J, Dorval M. Educational interventions to improve cancer pain control: a systematic review. J Palliat Med 2001;4(2):191-203.

(4) Alvarez MP, Agra Y. Systematic review of educational interventions in palliative care for primary care physicians. [Review] [72 refs]. Palliative Medicine 2006;(7):673-83.

(5) Anderson GM, Lexchin J. Strategies for improving prescribing practice. CMAJ 1996 Apr 1;154(7):1013-7.

(6) Anderson LA, Janes GR, Jenkins C. Implementing preventive services: to what extent can we change provider performance in ambulatory care? A review of the screening, immunization, and counseling literature. Ann Behav Med 1998;20(3):161-7.

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

(8) Austin SM, Balas EA, Mitchell JA, Ewigman BG. Effect of physician reminders on preventive care: meta-analysis of randomized clinical trials. Proc Annu Symp Comput Appl Med Care 1994;121-4.

(9) Awad AI, Ball DE, Eltayeb IB. Improving rational drug use in Africa: the example of Sudan. [Review] [37 refs]. Eastern Mediterranean Health Journal 13(5):1202-11, 2007 Sep;-Oct.

(10) Axt-Adam P, van der Wouden JC, van der Does E. Influencing behavior of physicians ordering laboratory tests: a literature study. Med Care 1993 Sep;31(9):784-94.

(11) Balas EA, Boren SA, Brown GD, Ewigman BG, Mitchell JA, Perkoff GT. Effect of physician profiling on utilization. Meta-analysis of randomized clinical trials. J Gen Intern Med 1996 Oct;11(10):584-90.

(12) Balas EA, Austin SM, Mitchell JA, Ewigman BG, Bopp KD, Brown GD. The clinical value of computerized information services. A review of 98 randomized clinical trials. Arch Fam Med 1996 May;5(5):271-8.

(13) Balas EA, Weingarten S, Garb CT, Blumenthal D, Boren SA, Brown GD. Improving preventive care by prompting physicians. Arch Intern Med 2000 Feb 14;160(3):301-8.

(14) Beach MC, Gary TL, Price EG, Robinson K, Gozu A, Palacio A, et al. Improving health care quality for racial/ethnic minorities: a systematic review of the best evidence regarding provider and organization interventions. [Review] [39 refs]. BMC Public Health 6:104, 2006.

(15) Beaudry JS. The Effectiveness of Continuing Medical Education: A Quantitative Synthesis. The Journal of Continuing Education in the Health Professions 1989;9(4):285-307.

(16) Beilby JJ, Silagy CA. Trials of providing costing information to general practitioners: a systematic review. Med J Aust 1997 Jul 21;167(2):89-92.

(17) Beney J, Bero LA, Bond C. Expanding the roles of outpatient pharmacists: effects on health services utilisation, costs, and patient outcomes. Cochrane Database Syst Rev 2000;(3):CD000336.

(18) Bennett JW, Glasziou PP. Computerised reminders and feedback in medication management: a systematic review of randomised controlled trials. Med J Aust 2003 Mar 3;178(5):217-22.

(19) Bertram DA, Brooks-Bertram PA. The evaluation of continuing medical education: a literature review. Health Educ Monogr 1977;5(4):330-62.

(20) Boonyasai RT, Windish DM, Chakraborti C, Feldman LS, Rubin HR, Bass EB. Effectiveness of teaching quality improvement to clinicians: a systematic review.[see comment]. [Review] [68 refs]. JAMA 298(9):1023-37, 2007 Sep 5.

(21) Bordley WC, Chelminski A, Margolis PA, Kraus R, Szilagyi PG, Vann JJ. The effect of audit and feedback on immunization delivery: a systematic review. Am J Prev Med 2000 May;18(4):343-50.

(22) Bosch-Capblanch X, Garner P. Primary health care supervision in developing countries. [Review] [94 refs]. Tropical Medicine & International Health 13(3):369-83, 2008 Mar.

(23) Brouwer HJ, Bindels PJ, Weert HC. Data quality improvement in general practice. [Review] [29 refs]. Family Practice 23(5):529-36, 2006 Oct.

(24) Buntinx F, Winkens R, Grol R, Knottnerus JA. Influencing diagnostic and preventive performance in ambulatory care by feedback and reminders. A review. Fam Pract 1993 Jun;10(2):219-28.

(25) Carroll NV. Do community pharmacists influence prescribing? J Am Pharm Assoc (2003) 2003 Sep;43(5):612-21.

(26) Carter YH, Bannon MJ, Limbert C, Docherty A, Barlow J. Improving child protection: a systematic review of training and procedural interventions. Arch Dis Child 2006 Sep;91(9):740-3.

(27) Chaillet N, Dube E, Dugas M, Audibert F, Tourigny C, Fraser WD, et al. Evidence-based strategies for implementing guidelines in obstetrics: a systematic review. [Review] [71 refs]. Obstetrics & Gynecology 108(5):1234-45, 2006 Nov.

(28) Chaillet N, Dumont A. Evidence-based strategies for reducing cesarean section rates: a meta-analysis. [Review] [72 refs]. Birth 34(1):53-64, 2007 Mar.

(29) Chaix-Couturier C, Durand-Zaleski I, Jolly D, Durieux P. Effects of financial incentives on medical practice: results from a systematic review of the literature and methodological issues. Int J Qual Health Care 2000 Apr;12(2):133-42.

(30) Chatellier G, Colombet I, Degoulet P. An overview of the effect of computer-assisted management of anticoagulant therapy on the quality of anticoagulation. Int J Med Inform 1998 May;49(3):311-20.

(31) Chaudhry B, Wang J, Wu S, Maglione M, Mojica W, Roth E, et al. Systematic review: impact of health information technology on quality, efficiency, and costs of medical care. Ann Intern Med 2006 May 16;144(10):742-52.

(32) Christensen H, Griffiths KM, Gulliver A, Clack D, Kljakovic M, Wells L. Models in the delivery of depression care: a systematic review of randomised and controlled intervention trials. BMC Fam Pract 2008;9:25.

(33) Colombet I, Chatellier G, Jaulent MC, Degoulet P. Decision aids for triage of patients with chest pain: a systematic review of field evaluation studies. Proc AMIA Symp 1999;721-5.

(34) Coomarasamy A, Khan KS. What is the evidence that postgraduate teaching in evidence based medicine changes anything? A systematic review. BMJ 2004 Oct 30;329(7473):1017.

(35) Cortoos PJ, Simoens S, Peetermans W, Willems L, Laekeman G. Implementing a hospital guideline on pneumonia: a semi-quantitative review. [Review] [44 refs]. International Journal for Quality in Health Care 2007;(6):358-67.

(36) Costello I, Wong IC, Nunn AJ. A literature review to identify interventions to improve the use of medicines in children. Child Care Health Dev 2004 Nov;30(6):647-65.

(37) Craven MA, Bland R. Better practices in collaborative mental health care: an analysis of the evidence base. Can J Psychiatry 2006 May;51(6 Suppl 1):7S-72S.

(38) Davey P, Brown E, Fenelon L, Finch R, Gould I, Hartman G, et al. Interventions to improve antibiotic prescribing practices for hospital inpatients. Cochrane Database Syst Rev 2005;(4):CD003543.

(39) Davey P, Brown E, Fenelon L, Finch R, Gould I, Holmes A, et al. Systematic review of antimicrobial drug prescribing in hospitals. [Review] [37 refs]. Emerging Infectious Diseases 12(2):211-6, 2006 Feb.

(40) Davis D, O'Brien MA, Freemantle N, Wolf FM, Mazmanian P, Taylor-Vaisey A. Impact of formal continuing medical education: do conferences, workshops, rounds, and other traditional continuing education activities change physician behavior or health care outcomes? JAMA 1999 Sep 1;282(9):867-74.

(41) Davis DA, Thomson MA, Oxman AD, Haynes RB. Evidence for the effectiveness of CME. A review of 50 randomized controlled trials. JAMA 1992 Sep 2;268(9):1111-7.

(42) Davis DA, Thomson MA, Oxman AD, Haynes RB. Changing physician performance. A systematic review of the effect of continuing medical education strategies. JAMA 1995 Sep 6;274(9):700-5.

(43) Davis DA, Taylor-Vaisey A. Translating guidelines into practice. A systematic review of theoretic concepts, practical experience and research evidence in the adoption of clinical practice guidelines. CMAJ 1997 Aug 15;157(4):408-16.

(44) De Smet PA, Dautzenberg M. Repeat prescribing: scale, problems and quality management in ambulatory care patients. Drugs 2004;64(16):1779-800.

(45) Dexheimer JW, Talbot TR, Sanders DL, Rosenbloom ST, Aronsky D. Prompting clinicians about preventive care measures: a systematic review of randomized controlled trials. J Am Med Inform Assoc 2008 May;15(3):311-20.

(46) Dijkstra R, Wensing M, Thomas R, Akkermans R, Braspenning J, Grimshaw J, et al. The relationship between organisational characteristics and the effects of clinical guidelines on medical performance in hospitals, a meta-analysis. BMC Health Serv Res 2006;6:53.

(47) Doumit G, Gattellari M, Grimshaw J, O'Brien MA. Local opinion leaders: effects on professional practice and health care outcomes.[update of Cochrane Database Syst Rev. 2000;(2):CD000125; PMID: 10796491]. [Review] [54 refs]. Cochrane Database of Systematic Reviews (1):CD000125, 2007.

(48) Dulko D. Audit and feedback as a clinical practice guideline implementation strategy: a model for acute care nurse practitioners. [Review] [34 refs]. Worldviews on Evidence-Based Nursing 4(4):200-9, 2007.

(49) Edwards G. The training and education of nurses working in stroke care. [Review] [19 refs]. British Journal of Nursing 15(21):1180-4, 2006 Nov 23;-Dec.

(50) Eslami S, bu-Hanna A, de Keizer NF. Evaluation of outpatient computerized physician medication order entry systems: a systematic review. J Am Med Inform Assoc 2007 Jul;14(4):400-6.

(51) Espallargues M, Valderas JM, Alonso J. Provision of feedback on perceived health status to health care professionals: a systematic review of its impact. Med Care 2000 Feb;38(2):175-86.

(52) Fahey T, Schroeder K, Ebrahim S. Interventions used to improve control of blood pressure in patients with hypertension. Cochrane Database Syst Rev 2006;(4):CD005182.

(53) Faulkner A, Mills N, Bainton D, Baxter K, Kinnersley P, Peters TJ, et al. A systematic review of the effect of primary care-based service innovations on quality and patterns of referral to specialist secondary care. Br J Gen Pract 2003 Nov;53(496):878-84.

(54) 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 May;7(2):223-41.

(55) Finley PR, Crismon ML, Rush AJ. Evaluating the impact of pharmacists in mental health: a systematic review. Pharmacotherapy 2003 Dec;23(12):1634-44.

(56) Fish A, Watson MC, Bond CM. Practice-based pharmaceutical services: a systematic review. Int J Pharm Pract 10[4], 225-233. 2002.
Ref Type: Generic

(57) Fitzmaurice DA, Hobbs FD, Delaney BC, Wilson S, McManus R. Review of computerized decision support systems for oral anticoagulation management. Br J Haematol 1998 Sep;102(4):907-9.

(58) Flores-Mateo G, Argimon JM. Evidence based practice in postgraduate healthcare education: a systematic review. [Review] [47 refs]. BMC Health Services Research 7:119, 2007.

(59) Freemantle N, Harvey EL, Wolf F, Grimshaw JM, Grilli R, Bero LA. Printed educational materials: effects on professional practice and health care outcomes. Cochrane Database Syst Rev 1997;(2):CD000172.

(60) Freudenstein U, Howe A. Recommendations for future studies: a systematic review of educational interventions in primary care settings. Br J Gen Pract 1999 Dec;49(449):995-1001.

(61) Garcia RM. Five ways you can reduce inappropriate prescribing in the elderly: a systematic review. [Review] [32 refs]. Journal of Family Practice 55(4):305-12, 2006 Apr.

(62) Garg AX, Adhikari NK, McDonald H, Rosas-Arellano MP, Devereaux PJ, Beyene J, et al. Effects of computerized clinical decision support systems on practitioner performance and patient outcomes: a systematic review. JAMA 2005 Mar 9;293(10):1223-38.

(63) Gastmeier P, Geffers C. Prevention of catheter-related bloodstream infections: analysis of studies published between 2002 and 2005. J Hosp Infect 2006 Dec;64(4):326-35.

(64) Georgiou A, Williamson M, Westbrook JI, Ray S. The impact of computerised physician order entry systems on pathology services: a systematic review. Int J Med Inform 2007 Jul;76(7):514-29.

(65) Gilbody S, Whitty P, Grimshaw J, Thomas R. Educational and organizational interventions to improve the management of depression in primary care: a systematic review. JAMA 2003 Jun 18;289(23):3145-51.

(66) Gilbody SM, Whitty PM, Grimshaw JM, Thomas RE. Improving the detection and management of depression in primary care. Qual Saf Health Care 2003 Apr;12(2):149-55.

(67) Gill PS, Makela M, Vermeulen KM, Freemantle N, Ryan G, Bond C, et al. Changing doctor prescribing behaviour. Pharm World Sci 1999 Aug;21(4):158-67.

(68) Ginige S, Fairley CK, Hocking JS, Bowden FJ, Chen MY. Interventions for increasing chlamydia screening in primary care: a review. [Review] [18 refs]. BMC Public Health 7:95, 2007.

(69) Gould DJ, Chudleigh JH, Moralejo D, Drey N. Interventions to improve hand hygiene compliance in patient care. Cochrane Database Syst Rev 2007;(2):CD005186.

(70) Gould DJ, Drey NS, Moralejo D, Grimshaw J, Chudleigh J. Interventions to improve hand hygiene compliance in patient care. J Hosp Infect 2008 Mar;68(3):193-202.

(71) Grilli R, Lomas J. Evaluating the message: the relationship between compliance rate and the subject of a practice guideline. Med Care 1994 Mar;32(3):202-13.

(72) Grilli R, Freemantle N, Minozzi S, Domenighetti G, Finer D. [Impact of mass media on the use of health services. A systematic review of the literature]. Epidemiol Prev 1998 Apr;22(2):103-10.

(73) Grilli R, Freemantle N, Minozzi S, Domenighetti G, Finer D. Mass media interventions: effects on health services utilisation. Cochrane Database Syst Rev 2000;(2):CD000389.

(74) Grilli R, Ramsay C, Minozzi S. Mass media interventions: effects on health services utilisation. Cochrane Database Syst Rev 2002;(1):CD000389.

(75) Grimshaw J, Eccles M, Thomas R, Maclennan G, Ramsay C, Fraser C, et al. Toward evidence-based quality improvement. Evidence (and its limitations) of the effectiveness of guideline dissemination and implementation strategies 1966-1998. J Gen Intern Med 2006 Feb;21 Suppl 2:S14-S20.

(76) Grimshaw JM, Russell IT. Effect of clinical guidelines on medical practice: a systematic review of rigorous evaluations. Lancet 1993 Nov 27;342(8883):1317-22.

(77) Grimshaw JM, Thomas RE, Maclennan G, Fraser C, Ramsay CR, Vale L, et al. Effectiveness and efficiency of guideline dissemination and implementation strategies. Health Technol Assess 2004 Feb;8(6):iii-72.

(78) Gross PA, Pujat D. Implementing practice guidelines for appropriate antimicrobial usage: a systematic review. Med Care 2001 Aug;39(8 Suppl 2):II55-II69.

(79) Groves KE, Sketris I, Tett SE. Prescription drug samples--does this marketing strategy counteract policies for quality use of medicines? J Clin Pharm Ther 2003 Aug;28(4):259-71.

(80) Guo J-L, Gottlieb NH, Huang C-M. Effects of office system and education interventions in increasing the delivery of preventive health services: a Meta-analysis. Meta-Analytic Preventive Health Services 2002;2(1):36-51.

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

(82) Gyorkos TW, Tannenbaum TN, Abrahamowicz M, Bedard L, Carsley J, Franco ED, et al. Evaluation of the effectiveness of immunization delivery methods. Can J Public Health 1994 Jul;85 Suppl 1:S14-S30.

(83) Hajjar ER, Cafiero AC, Hanlon JT. Polypharmacy in elderly patients.[see comment]. [Review] [59 refs]. American Journal Geriatric Pharmacotherapy 5(4):345-51, 2007 Dec.

(84) Hanson LC, Tulsky JA, Danis M. Can clinical interventions change care at the end of life? Ann Intern Med 1997 Mar 1;126(5):381-8.

(85) Harvey EL, Glenny AM, Kirk SF, Summerbell CD. A systematic review of interventions to improve health professionals' management of obesity. Int J Obes Relat Metab Disord 1999 Dec;23(12):1213-22.

(86) Harvey EL, Glenny A, Kirk SF, Summerbell CD. Improving health professionals' management and the organisation of care for overweight and obese people. Cochrane Database Syst Rev 2000;(2):CD000984.

(87) Harvey EL, Glenny A, Kirk SF, Summerbell CD. Improving health professionals' management and the organisation of care for overweight and obese people. Cochrane Database Syst Rev 2001;(2):CD000984.

(88) Harvey EL, Glenny AM, Kirk SF, Summerbell CD. An updated systematic review of interventions to improve health professionals' management of obesity. Obes Rev 2002 Feb;3(1):45-55.

(89) Haynes RB, Davis DA, McKibbon A, Tugwell P. A critical appraisal of the efficacy of continuing medical education. JAMA 1984 Jan 6;251(1):61-4.

(90) Haynes RB, Walker CJ. Computer-aided quality assurance. A critical appraisal. Arch Intern Med 1987 Jul;147(7):1297-301.

(91) Haywood K, Marshall S, Fitzpatrick R. Patient participation in the consultation process: a structured review of intervention strategies. [Review] [59 refs]. Patient Education & Counseling 63(1-2):12-23, 2006 Oct.

(92) Hulscher ME, Wensing M, Grol RP, van der WT, van WC. Interventions to improve the delivery of preventive services in primary care. Am J Public Health 1999 May;89(5):737-46.

(93) Hulscher ME, Wensing M, van der WT, Grol R. Interventions to implement prevention in primary care. Cochrane Database Syst Rev 2001;(1):CD000362.

(94) Hunt DL, Haynes RB, Hanna SE, Smith K. Effects of computer-based clinical decision support systems on physician performance and patient outcomes: a systematic review. JAMA 1998 Oct 21;280(15):1339-46.

(95) Ioannidis JP, Lau J. Evidence on interventions to reduce medical errors: an overview and recommendations for future research. J Gen Intern Med 2001 May;16(5):325-34.

(96) Irajpour A, Norman I, Griffiths P. Interprofessional education to improve pain management. [Review] [25 refs]. British Journal of Community Nursing 11(1):29-32, 2006 Jan.

(97) Jamtvedt G, Young JM, Kristoffersen DT, Thomson O'Brien MA, Oxman AD. Audit and feedback: effects on professional practice and health care outcomes. Cochrane Database Syst Rev 2003;(3):CD000259.

(98) Jamtvedt G, Young JM, Kristoffersen DT, O'Brien MA, Oxman AD. Audit and feedback: effects on professional practice and health care outcomes.[update of

Cochrane Database Syst Rev. 2003;(3):CD000259; PMID: 12917891]. [Review] [214 refs]. Cochrane Database of Systematic Reviews (2):CD000259, 2006.

(99) Jamtvedt G, Young JM, Kristoffersen DT, O'Brien MA, Oxman AD. Does telling people what they have been doing change what they do? A systematic review of the effects of audit and feedback. Qual Saf Health Care 2006 Dec;15(6):433-6.

(100) Jerant AF, Hill DB. Does the use of electronic medical records improve surrogate patient outcomes in outpatient settings? J Fam Pract 2000 Apr;49(4):349-57.

(101) Jimbo M, Nease DE, Jr., Ruffin MT, Rana GK. Information technology and cancer prevention. [Review] [62 refs]. CA: a Cancer Journal for Clinicians 56(1):26-36; quiz 48-9, 2006 Jan;-Feb.

(102) Johnston ME, Langton KB, Haynes RB, Mathieu A. Effects of computer-based clinical decision support systems on clinician performance and patient outcome. A critical appraisal of research. Ann Intern Med 1994 Jan 15;120(2):135-42.

(103) Kaushal R, Shojania KG, Bates DW. Effects of computerized physician order entry and clinical decision support systems on medication safety: a systematic review. Arch Intern Med 2003 Jun 23;163(12):1409-16.

(104) Kawamoto K, Houlihan CA, Balas EA, Lobach DF. Improving clinical practice using clinical decision support systems: a systematic review of trials to identify features critical to success. BMJ 2005 Apr 2;330(7494):765.

(105) Kroenke K, Taylor-Vaisey A, Dietrich AJ, Oxman TE. Interventions to improve provider diagnosis and treatment of mental disorders in primary care. A critical review of the literature. Psychosomatics 2000 Jan;41(1):39-52.

(106) Lancaster T, Silagy C, Fowler G. Training health professionals in smoking cessation. Cochrane Database Syst Rev 2000;(3):CD000214.

(107) Lewin SA, Skea ZC, Entwistle V, Zwarenstein M, Dick J. Interventions for providers to promote a patient-centred approach in clinical consultations. Cochrane Database Syst Rev 2001;(4):CD003267.

(108) Lloyd JS, Abrahamson S. Effectiveness of continuing medical education: a review of the evidence. Eval Health Prof 1979 Sep;2(3):251-80.

(109) Lomas J, Haynes RB. A taxonomy and critical review of tested strategies for the application of clinical practice recommendations: from "official" to "individual" clinical policy. Am J Prev Med 1988;4(4 Suppl):77-94.

(110) Lomas J. Words without action? The production, dissemination, and impact of consensus recommendations. Annu Rev Public Health 1991;12:41-65.

(111) Lu CY, Ross-Degnan D, Soumerai SB, Pearson SA. Interventions designed to improve the quality and efficiency of medication use in managed care: a critical review of the literature - 2001-2007. BMC Health Services Research 8(1):75, 2008.

(112) Mandelblatt J, Kanetsky PA. Effectiveness of interventions to enhance physician screening for breast cancer. J Fam Pract 1995 Feb;40(2):162-71.

(113) Mandelblatt JS, Yabroff KR. Effectiveness of interventions designed to increase mammography use: a meta-analysis of provider-targeted strategies. Cancer Epidemiol Biomarkers Prev 1999 Sep;8(9):759-67.

(114) Mansouri M, Lockyer J. A meta-analysis of continuing medical education effectiveness. Journal of Continuing Education in the Health Professions 27(1):6-15, 2007.

(115) Marcus AC, Crane LA. A review of cervical cancer screening intervention research: implications for public health programs and future research. Prev Med 1998 Jan;27(1):13-31.

(116) Marinopoulos SS, Dorman T, Ratanawongsa N, Wilson LM, Ashar BH, Magaziner JL, et al. Effectiveness of continuing medical education. [Review] [165 refs]. Evidence Report/Technology Assessment (149):1-69, 2007 Jan.

(117) Marshall S, Haywood K, Fitzpatrick R. Impact of patient-reported outcome measures on routine practice: a structured review. [Review] [46 refs]. Journal of Evaluation in Clinical Practice 12(5):559-68, 2006 Oct.

(118) Maskerine C, Loeb M. Improving adherence to hand hygiene among health care workers. [Review] [38 refs]. Journal of Continuing Education in the Health Professions 26(3):244-51, 2006.

(119) McKinstry B, Ashcroft RE, Car J, Freeman GK, Sheikh A. Interventions for improving patients' trust in doctors and groups of doctors. Cochrane Database Syst Rev 2006;3:CD004134.

(120) Michota FA. Bridging the gap between evidence and practice in venous thromboembolism prophylaxis: the quality improvement process. [Review] [40 refs]. Journal of General Internal Medicine 22(12):1762-70, 2007 Dec.

(121) Milne D, James I. A systematic review of effective cognitive-behavioural supervision. Br J Clin Psychol 2000 Jun;39 (Pt 2):111-27.

(122) Milton JC, Hill-Smith I, Jackson SH. Prescribing for older people. [Review] [38 refs]. BMJ 336(7644):606-9, 2008 Mar 15.

(123) Mitchell E, Sullivan F. A descriptive feast but an evaluative famine: systematic review of published articles on primary care computing during 1980-97. BMJ 2001 Feb 3;322(7281):279-82.

(124) Montgomery AA, Fahey T. A systematic review of the use of computers in the management of hypertension. J Epidemiol Community Health 1998 Aug;52(8):520-5.

(125) Mugford M, Banfield P, O'Hanlon M. Effects of feedback of information on clinical practice: a review. BMJ 1991 Aug 17;303(6799):398-402.

(126) Naikoba S, Hayward A. The effectiveness of interventions aimed at increasing handwashing in healthcare workers - a systematic review. J Hosp Infect 2001 Mar;47(3):173-80.

(127) Nies J, Colombet I, Degoulet P, Durieux P. Determinants of success for computerized clinical decision support systems integrated in CPOE systems: a systematic review. [Review] [14 refs]. AMIA Annual Symposium Proceedings/AMIA Symposium :594-8, 2006.

(128) Nilsen P, Aalto M, Bendtsen P, Seppa K. Effectiveness of strategies to implement brief alcohol intervention in primary healthcare. A systematic review. Scand J Prim Health Care 2006 Mar;24(1):5-15.

(129) O'Brien MA, Rogers S, Jamtvedt G, Oxman AD, Odgaard-Jensen J, Kristoffersen DT, et al. Educational outreach visits: effects on professional practice and health care outcomes.[update of Cochrane Database Syst Rev. 2000;(2):CD000409; PMID: 10796542]. [Review] [111 refs]. Cochrane Database of Systematic Reviews (4):CD000409, 2007.

(130) Oxman AD, Thomson MA, Davis DA, Haynes RB. No magic bullets: a systematic review of 102 trials of interventions to improve professional practice. CMAJ 1995 Nov 15;153(10):1423-31.

(131) Parkes J, Hyde C, Deeks J, Milne R. Teaching critical appraisal skills in health care settings. Cochrane Database Syst Rev 2001;(3):CD001270.

(132) Parrino TA. Controlled trials to improve antibiotic utilization: a systematic review of experience, 1984-2004. Pharmacotherapy 2005 Feb;25(2):289-98.

(133) Patouillard E, Goodman CA, Hanson KG, Mills AJ. Can working with the private for-profit sector improve utilization of quality health services by the poor? A systematic review of the literature. Int J Equity Health 2007;6:17.

(134) 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 Nov;9(11):715-31.

(135) Peek ME, Cargill A, Huang ES. Diabetes health disparities: a systematic review of health care interventions. [Review] [152 refs]. Medical Care Research & Review 64(5 Suppl):101S-56S, 2007 Oct.

(136) Pirkis JE, Jolley D, Dunt DR. Recruitment of women by GPs for pap tests: a meta-analysis. Br J Gen Pract 1998 Sep;48(434):1603-7.

(137) Qureshi N, Allen J, Hapgood R. A systematic review of educational outreach visits for non-prescribing interventions in general practice. European Journal of General Practice 2002 Mar 1;8:31-6.

(138) Randell R, Mitchell N, Dowding D, Cullum N, Thompson C. Effects of computerized decision support systems on nursing performance and patient outcomes: a systematic review. J Health Serv Res Policy 2007 Oct;12(4):242-9.

(139) Rao JK, Anderson LA, Inui TS, Frankel RM. Communication interventions make a difference in conversations between physicians and patients: a systematic review of the evidence. [Review] [65 refs]. Medical Care 45(4):340-9, 2007 Apr.

(140) Redfern J, McKevitt C, Wolfe CD. Development of complex interventions in stroke care: a systematic review. [Review] [100 refs]. Stroke 37(9):2410-9, 2006 Sep.

(141) Reeves S. A systematic review of the effects of interprofessional education on staff involved in the care of adults with mental health problems. J Psychiatr Ment Health Nurs 2001 Dec;8(6):533-42.

(142) Reeves S, Zwarenstein M, Goldman J, Barr H, Freeth D, Hammick M, et al. Interprofessional education: effects on professional practice and health care outcomes.[update of Cochrane Database Syst Rev. 2001;(1):CD002213; PMID: 11279759]. [Review] [83 refs]. Cochrane Database of Systematic Reviews (1):CD002213, 2008.

(143) Renders CM, Valk GD, Griffin S, Wagner EH, Eijk JT, Assendelft WJ. Interventions to improve the management of diabetes mellitus in primary care, outpatient and community settings. Cochrane Database Syst Rev 2001;(1):CD001481.

(144) Renders CM, Valk GD, Griffin SJ, Wagner EH, Eijk Van JT, Assendelft WJ. Interventions to improve the management of diabetes in primary care, outpatient, and community settings: a systematic review. Diabetes Care 2001 Oct;24(10):1821-33.

(145) Rollason V, Vogt N. Reduction of polypharmacy in the elderly: a systematic review of the role of the pharmacist. Drugs Aging 2003;20(11):817-32.

(146) Rowe RE, Garcia J, Macfarlane AJ, Davidson LL. Improving communication between health professionals and women in maternity care: a structured review. Health Expect 2002 Mar;5(1):63-83.

(147) Safdar N, Abad C. Educational interventions for prevention of healthcare-associated infection: a systematic review. [Review] [50 refs]. Critical Care Medicine 36(3):933-40, 2008 Mar.

(148) Sanders DL, Aronsky D. Biomedical informatics applications for asthma care: a systematic review. J Am Med Inform Assoc 2006 Jul;13(4):418-27.

(149) Sarnoff R, Rundall T. Meta-analysis of effectiveness of interventions to increase influenza immunization rates among high-risk population groups. Med Care Res Rev 1998 Dec;55(4):432-56.

(150) Saxena S, Misra T, Car J, Netuveli G, Smith R, Majeed A. Systematic review of primary healthcare interventions to improve diabetes outcomes in minority ethnic groups. [Review] [36 refs]. Journal of Ambulatory Care Management 30(3):218-30, 2007 Jul;-Sep.

(151) Shaw B, Cheater F, Baker R, Gillies C, Hearnshaw H, Flottorp S, et al. Tailored interventions to overcome identified barriers to change: effects on professional practice and health care outcomes. Cochrane Database Syst Rev 2005;(3):CD005470.

(152) Shea S, DuMouchel W, Bahamonde L. A meta-analysis of 16 randomized controlled trials to evaluate computer-based clinical reminder systems for preventive care in the ambulatory setting. J Am Med Inform Assoc 1996 Nov;3(6):399-409.

(153) Shiffman RN, Liaw Y, Brandt CA, Corb GJ. Computer-based guideline implementation systems: a systematic review of functionality and effectiveness. J Am Med Inform Assoc 1999 Mar;6(2):104-14.

(154) Shojania KG, Duncan BW, McDonald KM, Wachter RM, Markowitz AJ. Making health care safer: a critical analysis of patient safety practices. Evid Rep Technol Assess (Summ) 2001;(43):i-668.

(155) Silagy C, Lancaster T, Gray S, Fowler G. Effectiveness of training health professionals to provide smoking cessation interventions: systematic review of randomised controlled trials. Qual Health Care 1994 Dec;3(4):193-8.

(156) Sintchenko V, Magrabi F, Tipper S. Are we measuring the right end-points? Variables that affect the impact of computerised decision support on patient outcomes: a systematic review. [Review] [68 refs]. Medical Informatics & the Internet in Medicine 32(3):225-40, 2007 Sep.

(157) Smith F, Singleton A, Hilton S. General practitioners' continuing education: a review of policies, strategies and effectiveness, and their implications for the future. Br J Gen Pract 1998 Oct;48(435):1689-95.

(158) Smith SM, Allwright S, O'Dowd T. Effectiveness of shared care across the interface between primary and specialty care in chronic disease management. Cochrane Database Syst Rev 2007;(3):CD004910.

(159) Smits PB, Verbeek JH, de Buisonje CD. Problem based learning in continuing medical education: a review of controlled evaluation studies. BMJ 2002 Jan 19;324(7330):153-6.

(160) Snell JL, Buck EL. Increasing cancer screening: a meta-analysis. Prev Med 1996 Nov;25(6):702-7.

(161) Solomon DH, Hashimoto H, Daltroy L, Liang MH. Techniques to improve physicians' use of diagnostic tests: a new conceptual framework. JAMA 1998 Dec 16;280(23):2020-7.

(162) Sood R, Sood A, Ghosh AK. Non-evidence-based variables affecting physicians' test-ordering tendencies: a systematic review. [Review] [65 refs]. Netherlands Journal of Medicine 65(5):167-77, 2007 May.

(163) 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.

(164) Spinewine A, Schmader KE, Barber N, Hughes C, Lapane KL, Swine C, et al. Appropriate prescribing in elderly people: how well can it be measured and optimised?[see comment]. [Review] [154 refs]. Lancet 370(9582):173-84, 2007 Jul 14.

(165) Steinman MA, Ranji SR, Shojania KG, Gonzales R. Improving antibiotic selection: a systematic review and quantitative analysis of quality improvement strategies. [Review] [50 refs]. Medical Care 44(7):617-28, 2006 Jul.

(166) Stone EG, Morton SC, Hulscher ME, Maglione MA, Roth EA, Grimshaw JM, et al. Interventions that increase use of adult immunization and cancer screening services: a meta-analysis. Ann Intern Med 2002 May 7;136(9):641-51.

(167) Sullivan F, Mitchell E. Has general practitioner computing made a difference to patient care? A systematic review of published reports. BMJ 1995 Sep 30;311(7009):848-52.

(168) Thomas DC, Johnston B, Dunn K, Sullivan GM, Brett B, Matzko M, et al. Continuing medical education, continuing professional development, and knowledge translation: improving care of older patients by practicing physicians.

[Review] [20 refs]. Journal of the American Geriatrics Society 54(10):1610-8, 2006 Oct.

(169) Thomas L, Cullum N, McColl E, Rousseau N, Soutter J, Steen N. Guidelines in professions allied to medicine. Cochrane Database Syst Rev 2000;(2):CD000349.

(170) Thomson O'Brien MA, Oxman AD, Davis DA, Haynes RB, Freemantle N, Harvey EL. Educational outreach visits: effects on professional practice and health care outcomes. Cochrane Database Syst Rev 2000;(2):CD000409.

(171) Thomson O'Brien MA, Oxman AD, Haynes RB, Davis DA, Freemantle N, Harvey EL. Local opinion leaders: effects on professional practice and health care outcomes. Cochrane Database Syst Rev 2000;(2):CD000125.

(172) Thomson O'Brien MA, Oxman AD, Davis DA, Haynes RB, Freemantle N, Harvey EL. Audit and feedback versus alternative strategies: effects on professional practice and health care outcomes. Cochrane Database Syst Rev 2000;(2):CD000260.

(173) Thomson O'Brien MA, Oxman AD, Davis DA, Haynes RB, Freemantle N, Harvey EL. Audit and feedback: effects on professional practice and health care outcomes. Cochrane Database Syst Rev 2000;(2):CD000259.

(174) Thomson O'Brien MA, Freemantle N, Oxman AD, Wolf F, Davis DA, Herrin J. Continuing education meetings and workshops: effects on professional practice and health care outcomes. Cochrane Database Syst Rev 2001;(2):CD003030.

(175) Thursky K. Use of computerized decision support systems to improve antibiotic prescribing. [Review] [103 refs]. Expert Review of Antiinfective Therapy 4(3):491-507, 2006 Jun.

(176) Tian J, Atkinson NL, Portnoy B, Gold RS. A systematic review of evaluation in formal continuing medical education. [Review] [48 refs]. Journal of Continuing Education in the Health Professions 27(1):16-27, 2007.

(177) Tooher R, Middleton P, Pham C, Fitridge R, Rowe S, Babidge W, et al. A systematic review of strategies to improve prophylaxis for venous thromboembolism in hospitals. Ann Surg 2005 Mar;241(3):397-415.

(178) Valderas JM, Kotzeva A, Espallargues M, Guyatt G, Ferrans CE, Halyard MY, et al. The impact of measuring patient-reported outcomes in clinical practice: a systematic review of the literature. Qual Life Res 2008 Mar;17(2):179-93.

(179) Veloski J, Boex JR, Grasberger MJ, Evans A, Wolfson DB. Systematic review of the literature on assessment, feedback and physicians' clinical performance: BEME Guide No. 7. [Review] [32 refs]. Medical Teacher 28(2):117-28, 2006 Mar.

(180) von G, V, Reymond JP, Beney J. Clinical and economic outcomes of pharmaceutical services related to antibiotic use: a literature review. [Review] [62 refs]. Pharmacy World & Science 29(3):146-63, 2007 Jun.

(181) Waddell DL. The effects of continuing education on nursing practice: a meta-analysis. J Contin Educ Nurs 1991 May;22(3):113-8.

(182) Walsh JM, McDonald KM, Shojania KG, Sundaram V, Nayak S, Lewis R, et al. Quality improvement strategies for hypertension management: a systematic review. [Review] [73 refs]. Medical Care 44(7):646-57, 2006 Jul.

(183) Walton RT, Harvey E, Dovey S, Freemantle N. Computerised advice on drug dosage to improve prescribing practice. Cochrane Database Syst Rev 2001;(1):CD002894.

(184) Weinmann S, Koesters M, Becker T. Effects of implementation of psychiatric guidelines on provider performance and patient outcome: systematic review.[see comment]. [Review] [35 refs]. Acta Psychiatrica Scandinavica 115(6):420-33, 2007 Jun.

(185) Wensing M, Grol R. Single and combined strategies for implementing changes in primary care: a literature review. Int J Qual Health Care 1994 Jun;6(2):115-32.

(186) Wensing M, van der WT, Grol R. Implementing guidelines and innovations in general practice: which interventions are effective? Br J Gen Pract 1998 Feb;48(427):991-7.

(187) Wilson DL, Beyth RJ, Linn P, Berger P. Systematic review of public education and policy for stroke prevention. [Review] [44 refs]. Current Drug Targets 8(7):874-9, 2007 Jul.

(188) Wilson K, Macdougall L, Fergusson D, Graham I, Tinmouth A, Hebert PC. The effectiveness of interventions to reduce physician's levels of inappropriate transfusion: what can be learned from a systematic review of the literature. Transfusion 2002 Sep;42(9):1224-9.

(189) Worrall G, Chaulk P, Freake D. The effects of clinical practice guidelines on patient outcomes in primary care: a systematic review. CMAJ 1997 Jun 15;156(12):1705-12.

(190) Yabroff KR, Mangan P, Mandelblatt J. Effectiveness of interventions to increase Papanicolaou smear use. J Am Board Fam Pract 2003 May;16(3):188-203.

(191) Yano EM, Fink A, Hirsch SH, Robbins AS, Rubenstein LV. Helping practices reach primary care goals. Lessons from the literature. Arch Intern Med 1995 Jun 12;155(11):1146-56.

(192) Zwarenstein M, Bryant W. Interventions to promote collaboration between nurses and doctors. Cochrane Database Syst Rev 2000;(2):CD000072.

(193) Zwarenstein M, Reeves S, Barr H, Hammick M, Koppel I, Atkins J. Interprofessional education: effects on professional practice and health care outcomes. Cochrane Database Syst Rev 2001;(1):CD002213.

Appendix E: Duplicate Publications

1 *Davey P, Brown E, Fenelon L et al. Interventions to improve antibiotic prescribing practices for hospital inpatients. Cochrane Database Syst Rev 2005;(4):CD003543.

Davey P, Brown E, Fenelon L et al. Systematic review of antimicrobial drug prescribing in hospitals. Emerging Infectious Diseases 12(2):211-6, 2006.

2 *Gould DJ, Chudleigh JH, Moralejo D, Drey N. Interventions to improve hand hygiene compliance in patient care. Cochrane Database Syst Rev 2007;(2):CD005186.

Gould DJ, Drey NS, Moralejo D, Grimshaw J, Chudleigh J. Interventions to improve hand hygiene compliance in patient care. J Hosp Infect 2008; 68(3):193-202.

3 *Grilli R, Freemantle N, Minozzi S, Domenighetti G, Finer D. Mass media interventions: effects on health services utilisation. Cochrane Database Syst Rev. 2000;(2):CD000389.

Grilli R, Freemantle N, Minozzi S, Domenighetti G, Finer D. (75) [Italian] Epidemiol Prev. 1998 Apr-Jun;22(2):103-10.

4 *Grimshaw JM, Thomas RE, Maclennan G et al. Effectiveness and efficiency of guideline dissemination and implementation strategies. Health Technol Assess 2004; 8(6):iii-72.

Grimshaw J, Eccles M, Thomas R et al. Toward evidence-based quality improvement. Evidence (and its limitations) of the effectiveness of guideline dissemination and implementation strategies 1966-1998. J Gen Intern Med 2006; 21 Suppl 2:S14-S20.

5 Harvey EL, Glenny AM, Kirk SF, Summerbell CD. A systematic review of interventions to improve health professionals' management of obesity. Int J Obes Relat Metab Disord 1999; 23(12):1213-1222

*Harvey EL, Glenny A, Kirk SF, Summerbell CD. Improving health professionals' management and the organisation of care for overweight and obese people. Cochrane Database Syst Rev 2000;(2):CD000984.

6 *Harvey EL, Glenny A, Kirk SF, Summerbell CD. Improving health professionals' management and the organisation of care for overweight and obese people. Cochrane Database Syst Rev. 2001;(2):CD000984

Harvey EL, Glenny AM, Kirk SF, Summerbell CD. An updated systematic review of interventions to improve health professionals' management of obesity. Obes Rev 2002; 3(1):45-55.

7 Hulscher ME, Wensing M, Grol RP, van der WT, van WC. Interventions to improve the delivery of preventive services in primary care. Am J Public Health 1999; 89(5):737-746.

*Hulscher ME, Wensing M, van Der Weijden T, Grol R. Interventions to implement prevention in primary care. Cochrane Database Syst Rev. 2001;(1):CD000362.

8 *Jamtvedt G, Young JM, Kristoffersen DT, O'Brien MA, Oxman AD. Audit and feedback: effects on professional practice and health care outcomes. Cochrane Database of Systematic Reviews (2):CD000259, 2006.

Jamtvedt G, Young JM, Kristoffersen DT, O'Brien MA, Oxman AD. Does telling people what they have been doing change what they do? A systematic review of the effects of audit and feedback. Qual Saf Health Care 2006; 15(6):433-436.

9 *Renders CM, Valk GD, Griffin S, Wagner EH, Eijk JT, Assendelft WJ. Interventions to improve the management of diabetes mellitus in primary care, outpatient and community settings. Cochrane Database Syst Rev 2001;(1):CD001481.

Renders CM, Valk GD, Griffin SJ, Wagner EH, Eijk Van JT, Assendelft WJ. Interventions to improve the management of diabetes in primary care, outpatient, and community settings: a systematic review. Diabetes Care 2001; 24(10):1821-1833.

10 * Thomson O'Brien MA, Freemantle N, Oxman AD, Wolf F, Davis DA, Herrin J. Continuing education meetings and workshops: effects on professional practice and health care outcomes. Cochrane Database Syst Rev 2001;(2):CD003030.

Davis

*Indicates review that data was abstracted from. Only publication information was abstracted from non-asteriked reviews.

Appendix F: Excluded Reviews

Review	Reason for Exclusion
Aspinall 2007	No professional intervention
Baer 2007	No professional intervention
Brettle 2003	Inappropriate outcomes
Brown 1995	No professional intervention
Brown 2002	Inappropriate outcomes
Carroll 2002	No professional intervention
Ebbert 2001	Inappropriate outcomes
Edmonson 2007	No outcome data
Greenhalgh 2003	No outcome data
Griscti 2006	No outcome data
Hoomans 2007	No outcome data
Pulver 2006	No outcome data
Rogers 2001	No professional intervention
Rosenburg 2003	Inappropriate population
Thijs 2007	Not professional intervention
Wright 2007	No outcome data
Yen 2006	No explicit methods
Zuckerbrot 2006	No professional intervention

Appendix G: Updated Reviews

By Intervention:

Audit and Feedback

Thomson O'Brien MA, Oxman AD, Davis DA, Haynes RB, Freemantle N, Harvey EL. Audit and feedback versus alternative strategies: effects on professional practice and health care outcomes. Cochrane Database Syst Rev 2000;(2):CD000260. Thomson O'Brien MA, Oxman AD, Davis DA, Haynes RB, Freemantle N, Harvey EL. Audit and feedback: effects on professional practice and health care outcomes. Cochrane Database Syst Rev 2000;(2):CD000259.

Jamtvedt G, Young JM, Kristoffersen DT, Thomson O'Brien MA, Oxman AD. Audit and feedback: effects on professional practice and health care outcomes. Cochrane Database Syst Rev 2003;(3):CD000259.

Jamtvedt G, Young JM, Kristoffersen DT, O'Brien MA, Oxman AD. Audit and feedback: effects on professional practice and health care outcomes. Cochrane Database of Systematic Reviews (2):CD000259, 2006.

Continuing Medical Education

Haynes RB, Davis DA, McKibbon A, Tugwell P. A critical appraisal of the efficacy of continuing medical education. JAMA 1984 Jan 6;251(1):61-4.

Davis D, O'Brien MA, Freemantle N, Wolf FM, Mazmanian P, Taylor-Vaisey A. Impact of formal continuing medical education: do conferences, workshops, rounds, and other traditional continuing education activities change physician behavior or health care outcomes? JAMA 1999 Sep 1;282(9):867-74.

Davis DA, Thomson MA, Oxman AD, Haynes RB. Changing physician performance. A systematic review of the effect of continuing medical education strategies. JAMA 1995 Sep 6;274(9):700-5.

Davis DA, Thomson MA, Oxman AD, Haynes RB. Evidence for the effectiveness of CME. A review of 50 randomized controlled trials. JAMA 1992 Sep 2;268(9):1111-7.

Tian J, Atkinson NL, Portnoy B, Gold RS. A systematic review of evaluation in formal continuing medical education. Journal of Continuing Education in the Health Professions 27(1):16-27, 2007.

Educational Outreach

Thomson O'Brien MA, Oxman AD, Davis DA, Haynes RB, Freemantle N, Harvey EL. Educational outreach visits: effects on professional practice and health care outcomes. Cochrane Database Syst Rev 2000;(2):CD000409.

O'Brien MA, Rogers S, Jamtvedt G, Oxman AD, Odgaard-Jensen J, Kristoffersen DT, et al. Educational outreach visits: effects on professional practice and health care outcomes. Cochrane Database of Systematic Reviews (4):CD000409, 2007.

Guidelines

Grimshaw JM, Russell IT. Effect of clinical guidelines on medical practice: a systematic review of rigorous evaluations. Lancet 1993 Nov 27;342(8883):1317-22.

Implementing clinical guidelines. Can guidelines be used to improve clinical practice? Effective Health Care 1(8). 1994.

Interprofessional education

Reeves S, Zwarenstein M, Goldman J, Barr H, Freeth D, Hammick M, et al. Interprofessional education: effects on professional practice and health care outcomes. Cochrane Database of Systematic Reviews (1):CD002213, 2008.

Zwarenstein M, Reeves S, Barr H, Hammick M, Koppel I, Atkins J. Interprofessional education: effects on professional practice and health care outcomes. Cochrane Database Syst Rev 2001;(1):CD002213.

Mass Media

Grilli R, Freemantle N, Minozzi S, Domenighetti G, Finer D. Mass media interventions: effects on health services utilisation. Cochrane Database Syst Rev 2000;(2):CD000389.

Grilli R, Ramsay C, Minozzi S. Mass media interventions: effects on health services utilisation. Cochrane Database Syst Rev 2002;(1):CD000389.

Local Opinion Leaders

Thomson O'Brien MA, Oxman AD, Haynes RB, Davis DA, Freemantle N, Harvey EL. Local opinion leaders: effects on professional practice and health care outcomes. Cochrane Database Syst Rev 2000;(2):CD000125.

Doumit G, Gattellari M, Grimshaw J, O'Brien MA. Local opinion leaders: effects on professional practice and health care outcomes. Cochrane Database of Systematic Reviews (1):CD000125, 2007.

Patient Mediated

Espallargues M, Valderas JM, Alonso J. Provision of feedback on perceived health status to health care professionals: a systematic review of its impact. Med Care 2000 Feb;38(2):175-86.

Valderas JM, Kotzeva A, Espallargues M, Guyatt G, Ferrans CE, Halyard MY, et al. The impact of measuring patient-reported outcomes in clinical practice: a systematic review of the literature. Qual Life Res 2008 Mar;17(2):179-93.

Reminders – Computerized Decision Support Systems

Haynes RB, Walker CJ. Computer-aided quality assurance. A critical appraisal. Arch Intern Med 1987 Jul;147(7):1297-301.

Johnston ME, Langton KB, Haynes RB, Mathieu A. Effects of computer-based clinical decision support systems on clinician performance and patient outcome. A critical appraisal of research. Ann Intern Med 1994 Jan 15;120(2):135-42.

Hunt DL, Haynes RB, Hanna SE, Smith K. Effects of computer-based clinical decision support systems on physician performance and patient outcomes: a systematic review. JAMA 1998 Oct 21;280(15):1339-46.

Garg AX, Adhikari NK, McDonald H, Rosas-Arellano MP, Devereaux PJ, Beyene J, et al. Effects of computerized clinical decision support systems on practitioner performance and patient outcomes: a systematic review. JAMA 2005 Mar 9;293(10):1223-38.

Reminders

Mitchell E, Sullivan F. A descriptive feast but an evaluative famine: systematic review of published articles on primary care computing during 1980-97. BMJ 2001 Feb 3;322(7281):279-82.

Sullivan F, Mitchell E. Has general practitioner computing made a difference to patient care? A systematic review of published reports. BMJ 1995 Sep 30;311(7009):848-52.

By Behaviours:

Medication Use

Lu CY, Ross-Degnan D, Soumerai SB, Pearson SA. Interventions designed to improve the quality and efficiency of medication use in managed care: a critical review of the literature - 2001-2007. BMC Health Services Research 8(1):75, 2008.

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 Nov;9(11):715-31.

Prescribing

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.

Anderson GM, Lexchin J. Strategies for improving prescribing practice. CMAJ 1996 Apr 1;154(7):1013-7.

Reminders for Preventive Care

Balas EA, Weingarten S, Garb CT, Blumenthal D, Boren SA, Brown GD. Improving preventive care by prompting physicians. Arch Intern Med 2000 Feb 14;160(3):301-8.

Dexheimer JW, Talbot TR, Sanders DL, Rosenbloom ST, Aronsky D. Prompting clinicians about preventive care measures: a systematic review of randomized controlled trials. J Am Med Inform Assoc 2008 May;15(3):311-20.

By Condition:

Breast cancer

Mandelblatt J, Kanetsky PA. Effectiveness of interventions to enhance physician screening for breast cancer. J Fam Pract 1995 Feb;40(2):162-71.

Mandelblatt JS, Yabroff KR. Effectiveness of interventions designed to increase mammography use: a meta-analysis of provider-targeted strategies. Cancer Epidemiol Biomarkers Prev 1999 Sep;8(9):759-67.

Overweight & Obesity

Harvey EL, Glenny A, Kirk SF, Summerbell CD. Improving health professionals' management and the organisation of care for overweight and obese people. Cochrane Database Syst Rev 2000;(2):CD000984.

Harvey EL, Glenny A, Kirk SF, Summerbell CD. Improving health professionals' management and the organisation of care for overweight and obese people. Cochrane Database Syst Rev 2001;(2):CD000984.

Venous Thromboembolism Prophylaxis

Michota FA. Bridging the gap between evidence and practice in venous thromboembolism prophylaxis: the quality improvement process. Journal of General Internal Medicine 22(12):1762-70, 2007 Dec.

Tooher R, Middleton P, Pham C, Fitridge R, Rowe S, Babidge W, et al. A systematic review of strategies to improve prophylaxis for venous thromboembolism in hospitals. Ann Surg 2005 Mar;241(3):397-415.

Primary Care

Wensing M, Grol R. Single and combined strategies for implementing changes in primary care: a literature review. Int J Qual Health Care 1994 Jun;6(2):115-32.

Wensing M, van der WT, Grol R. Implementing guidelines and innovations in general practice: which interventions are effective? Br J Gen Pract 1998 Feb;48(427):991-7.

Appendix H: AMSTAR Tool

1. Was an 'a priori' design provided?
The research question and inclusion criteria should be established before the conduct of the review.
_ Yes
_ No
_ Can't answer
_ Not applicable

2. Was there duplicate study selection and data extraction?
There should be at least two independent data extractors and a consensus procedure for disagreements should be in place.
_ Yes
_ No
_ Can't answer
_ Not applicable

3. Was a comprehensive literature search performed?
At least two electronic sources should be searched. The report must include years and databases used (e.g. Central, EMBASE, and MEDLINE). Key words and/or MESH terms must be stated and where feasible the search strategy should be provided. All searches should be supplemented by consulting current contents, reviews, textbooks, specialized registers, or experts in the particular field of study, and by reviewing the references in the studies found.
_ Yes
_ No
_ Can't answer
_ Not applicable

4. Was the status of publication (i.e. grey literature) used as an inclusion criterion?
The authors should state that they searched for reports regardless of their publication type. The authors should state whether or not they excluded any reports (from the systematic review), based on their publication status, language etc.
_ Yes
_ No
_ Can't answer
_ Not applicable

5. Was a list of studies (included and excluded) provided?
A list of included and excluded studies should be provided.
_ Yes
_ No
_ Can't answer
_ Not applicable

6. Were the characteristics of the included studies provided?
In an aggregated form such as a table, data from the original studies should be provided on the participants, interventions and outcomes. The ranges of characteristics in all the studies analyzed e.g. age, race, sex, relevant socioeconomic data, disease status, duration, severity, or other diseases should be reported.
_ Yes
_ No
_ Can't answer
_ Not applicable

7. Was the scientific quality of the included studies assessed and documented?
'A priori' methods of assessment should be provided (e.g., for effectiveness studies if the author(s) chose to include only randomized, double-blind, placebo controlled studies, or allocation concealment as inclusion criteria); for other types of studies alternative items will be relevant.
_ Yes
_ No
_ Can't answer
_ Not applicable

8. Was the scientific quality of the included studies used appropriately in formulating conclusions?
The results of the methodological rigor and scientific quality should be considered in the analysis and the conclusions of the review, and explicitly stated in formulating recommendations.
_ Yes
_ No
_ Can't answer
_ Not applicable

9. Were the methods used to combine the findings of studies appropriate?
For the pooled results, a test should be done to ensure the studies were combinable, to assess their homogeneity (i.e. Chisquared test for homogeneity, I2). If heterogeneity exists a random effects model should be used and/or the clinical appropriateness of combining should be taken into consideration (i.e. is it sensible to combine?).
_ Yes
_ No
_ Can't answer
_ Not applicable

10. Was the likelihood of publication bias assessed?
An assessment of publication bias should include a combination of graphical aids (e.g., funnel plot, other available tests) and/or statistical tests (e.g., Egger regression test).
_ Yes
_ No
_ Can't answer
_ Not applicable

11. Was the conflict of interest stated?
Potential sources of support should be clearly acknowledged in both the systematic review and the included studies.
_ Yes
_ No
_ Can't answer
_ Not applicable

Appendix I: AMSTAR Decision-Rules

AMSTAR Item	**'Yes' Decision-Rule**
1. Was an 'a priori' design provided?	Reference to a protocol in the text.
2. Was there duplicate study selection and data extraction?	Both duplicate study selection and data extraction.
3. Was a comprehensive literature search performed?	A search of at least 2 electronic sources.
4. Was the status of publication (i.e. grey literature) used as an inclusion criterion?	Searches of the SIGLE database or dissertation databases were included.
5. Was a list of studies (included and excluded) provided?	Lists of both included and excluded studies.
6. Were the characteristics of the included studies provided?	Characteristics could be in a table or non-table format as long as characteristics were suitably described.
7. Was the scientific quality of the included studies assessed and documented?	Needed to use some sort of quality criterion or checklist.
8. Was the scientific quality of the included studies used appropriately in formulating conclusions?	Could not score yes for 8 if scored no for 7.
9. Were the methods used to combine the findings of studies appropriate?	If discussed heterogeneity as reason for lack of pooling, scored yes.
10. Was the likelihood of publication bias assessed?	Using funnel plot or statistical test.
11. Was the conflict of interest stated?	Statement of funding for both the review and each of the included studies.

Note: Decision-rules were created by the *Rx for Change* team in discussions with AMSTAR co-developers Beverly Shea and Jeremy Grimshaw.