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The landscape of knowledge translation interventions in cancer control: What do we know and where to next? A review of systematic reviews

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Abstract

Background: Effective implementation strategies are needed to optimize advancements in the fields of cancer diagnosis, treatment, survivorship, and end-of-life care. We conducted a review of systematic reviews to better understand the evidentiary base of implementation strategies in cancer control.

Methods: Using three databases, we conducted a search and identified English-language systematic reviews published between 2005 and 2010 that targeted consumer, professional, organizational, regulatory, or financial interventions, tested exclusively or partially in a cancer context (primary focus); generic or non-cancer-specific reviews were also considered. Data were extracted, appraised, and analyzed by members of the research team, and research ideas to advance the field were proposed.

Results: Thirty-four systematic reviews providing 41 summaries of evidence on 19 unique interventions comprised the evidence base. AMSTAR quality ratings ranged between 2 and 10. Team members rated most of the interventions as promising and in need of further research, and 64 research ideas were identified.

Conclusions: While many interventions show promise of effectiveness in the cancer-control context, few reviews were able to conclude definitively in favor of or against a specific intervention. We discuss the complexity of implementation research and offer suggestions to advance the science in this area.

Background

Innovations in screening and early detection, development of effective treatment interventions, and strategies to improve quality of life have emerged from primary studies, and systematic reviews of these studies, in cancer control [1-9]. These advancements have the capacity to reduce mortality and morbidity from disease. However, optimizing these advancements requires their appropriate application, a goal that is often difficult to achieve [10,11]. Understanding what are the most effective and promising interventions is warranted to ensure that the appropriate options are chosen and incorporated into implementation plans and prioritized for

future research studies. The analysis of studies examining the effectiveness of implementation interventions is a key component to an overall knowledge translation (KT) research agenda [12].

The purpose of our study was to conduct a review of systematic reviews to better understand the evidentiary foundation regarding what is known about KT interventions. Specifically, we wanted to better understand the strengths and limitations of the field, to identify what interventions are ready for use now, and to identify research priorities and directions for the future. We were interested in studies conducted in the context of cancer control across the care continuum, from diagnoses to survivorship and end-of-life care, and across cancer diagnoses. We chose this scope given that “context” has been identified as an important consideration

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in the design and execution of implementation strategies and is a concept central to several KT models and research paradigms [12-15].

Methods

Overview

This project, *Knowledge Translation to Improve Cancer Control in Canada*, was funded by the Ontario Institute for Cancer Research and the Canadian Partnership Against Cancer. It received ethics approval from the Hamilton Health Sciences/Faculty of Health Sciences Research Ethics Board, McMaster University, Hamilton, Ontario, Canada. The design, execution, analysis, and reporting of the project was editorially independent from the funders.

To avoid duplication of effort, and to complete the study in the required time, we capitalized on available high-quality databases profiling systematic reviews of interventions to systematically search for, appraise, and evaluate the effectiveness of KT interventions that met our inclusion criteria. Aligning with existing categorical schemes (Canadian Agency for Drugs and Technologies in Health [CADTH] and Cochrane Collaboration's Effective Practice and Organisation of Care [EPOC] group), we sought interventions that targeted the groupings of consumers/patients/public (*i.e.*, consumer interventions), clinicians and healthcare providers (*i.e.*, professional interventions), organizational/managers/system leaders (*i.e.*, organizational interventions), regulatory (*i.e.*, new health service delivery regulation), and financial (*i.e.*, incentives).

Search

To identify existing systematic reviews that met our inclusion criteria, we used three databases as our sources:

1. Rx for Change (CADTH-EPOC Group Collaborative Initiative): <http://www.cadth.ca/en/resources/rx-for-change/database>
2. Health Systems Evidence (formerly, Program in Policy Decision-Making), McMaster University: <http://www.healthsystemsevidence.org/>
3. McMaster KT+, McMaster University: <http://plus.mcmaster.ca/kt/Default.aspx>

Eligibility criteria

Inclusion criteria

- Study designs: Systematic reviews published between 2005 and 2010. While the methodology is still evolving, this interval was chosen to align with best evidence suggesting median survival time of a systematic review is approximately five years [16].
- Outcomes: Systematic reviews that included at least one of the following outcomes: measurable clinical

outcomes, observable behavior change, documented intention to behave, documented attitudes, documented knowledge uptake, or reported stakeholder satisfaction.

- KT interventions: Interventions that focused on at least one of the following target groupings: consumer, professional, organization, regulatory, and financial, as outlined in the CADTH-EPOC framework.

- Clinical scenarios:

- Diagnosis: Interventions that were tested in cancer-specific environments (any cancer diagnosis). Reviews that included cancer as part of the clinical context or that were generic/nonspecific to clinical condition were also considered.
- Stage of continuum of care: Diagnosis, treatment, follow-up, survivorship, end-of-life [17]^a.

Exclusion criteria

- Study designs: Any design other than systematic reviews.
- Language: Non-English language due to cost and availability of translations.

Data extraction

Data were extracted from the systematic reviews meeting our eligibility criteria. For all reviews, data extracted included (i) intervention name/label; (ii) intervention definition and purpose; (iii) theories, frameworks, or models used to inform the design or execution of the intervention; (iv) key operational elements underpinning the execution of the intervention; (v) setting; (vi) geography (where the intervention was tested); (vii) stakeholder involvement (who and type of involvement); (viii) evaluation strategy; (ix) measurement instrument(s); (x) quality indicators and outcomes; (xi) recommendations and conclusions; (xii) cost information and/or information regarding sustainability of the intervention; and (xiii) AMSTAR quality appraisal (if available).

Quality control and critical appraisal

Title, abstract, and full-text screenings were done in duplicate (KG and LD). Disagreements were resolved by consensus or by a third party (JM). Data extraction and critical appraisal (if required) were conducted by one researcher and audited by a second. In circumstances where appraisal was not completed by the original source, the systematic reviews were appraised using AMSTAR [18], an 11-item evaluation tool assessing methodological standards, presentation, and critical appraisal in systematic reviews. AMSTAR ratings can range between 1 and 11, with 11 denoting highest quality.

Interpretation of systematic reviews' results and research priorities/direction

Data tables describing the systematic review study characteristics and results were circulated to subgroups of the research team (see Additional File 1). For each assigned systematic review and using a 7-point scale, members of the subgroups were asked to indicate their "assessment of effectiveness" for each intervention reviewed based on their interpretation of the data. A rubric was designed to guide these assessments and the interpretation of the rating scale. Interventions rated between 1 and 3 were considered ineffective, interventions rated 4 and 5 were considered promising and worth additional investigation, and interventions rated 6 or 7 were considered effective. Average scores of ratings were calculated for each systematic review. Investigators were then asked to identify any specific research priorities or research questions they thought relevant.

Results

Overall

The initial search for systematic reviews yielded 591 reviews for consideration from the three source databases. Of these, a total of 38 reviews were originally considered and 31 retained [19]^b. An additional three reviews were included post hoc, identified by members of the research team (see Additional File 2).

In total, 34 unique systematic review publications providing 41 evidence summaries on 19 unique interventions comprised the evidence base. Table 1 provides the definitions of the interventions considered. Some systematic reviews addressed more than one intervention or provided more than one evidence summary; in addition, more than one systematic review was available for some of the interventions. Additional File 2 provides the references for the included systematic reviews.

The overall quality of the systematic reviews, as measured by the AMSTAR tool [18], was moderate. The systematic reviews were most apt to target the treatment stage of the continuum and least likely to target survivorship (Table 2). Further, despite being a highly prevalent disease site, few systematic reviews targeted patients with lung cancer (Table 3). Some less prevalent diagnoses (head and neck, sarcoma, and melanoma) were rarely or never targeted. A significant number of reviews did not specify cancer diagnosis.

With respect to characteristics of the systematic reviews (Table 4), most did not specify whether a KT theory, model or framework was used to inform the design of the project or the intervention itself. Most of the reviews used a mixture of study designs as their primary evidentiary source, and only four reviews used non-randomized controlled trial (RCT) data exclusively as their primary evidence. Most systematic review

authors reported poorly executed and poorly reported primary studies.

Common outcomes reported in the literature were measures of knowledge, satisfaction, and observed behavior and, to a lesser extent, clinical outcomes. Indeed, 7 of 17 consumer evidence summaries reported clinical outcomes, while 12 reported on knowledge, 10 reported on behavior observed, 9 reported on satisfaction, 8 reported on behavior intention, and 6 reported on attitude. For professional evidence summaries, 11 of 14 reported clinical outcomes, compared to knowledge (2), satisfaction (2), and behavior observed (10). Similarly, the most reported outcome for organizational evidence summaries were clinical outcomes (8), compared to behavior observed (7), satisfaction (7), knowledge (4), attitude (2), and behavior intention (1). However, when considering across the 41 evidence summaries in our sample, only 15 of 41 reported clinical outcomes.

With respect to intervention context (Table 5), clinicians were most often delivering the intervention, and a clinical environment (*e.g.*, clinics, hospitals) was the most common setting for the intervention to take place. Interventions were most often delivered in person, by paper, or by phone. Technology-based modalities were used less often unless they defined the intervention itself (*e.g.*, electronic medical record, clinical decision support systems).

The following sections, including the tables and additional files, provide an overview of the results by cluster of main intervention groupings. For more information on the complete raw data set, readers are asked to contact the corresponding author.

Interventions aimed at consumers (Additional File 3)

Sixteen publications addressing six unique consumer interventions provided 17 evidence summaries. Consumer interventions included education/information provision, decision-making aids, and interventions to support behavior change. Tables 4, 5, and 6 summarize characteristics of the systematic reviews; Table 7 summarizes the quality and efficacy appraisals of the interventions; and Table 8 summarizes the research suggestions made by members of the team.

The overall quality of the systematic reviews targeting consumer interventions was variable, ranging from poor to high. The average AMSTAR score was 7, with scores ranging from 3 to 10. Most of the systematic reviews did not include a meta-analysis or an empirical synthesis of findings. Evidence of effectiveness was most promising for patient education (*e.g.*, improvements in patient knowledge and clinical outcomes); decision aids (*e.g.*, improvements in patient knowledge and satisfaction, reduction in patient decisional conflict, and impact on decisions); and interactive health communication

Table 1 Intervention definitions

Intervention	Definition
<i>Consumer interventions</i>	
Education	interventions informing patients about their treatment and their health (education, information provision, promotion of health)
Decision aids/shared decision-making interventions	interventions designed to assist patients make specific and deliberative choices among options by providing information on the options and outcomes relevant to a person's health status
Interactive health communication application (IHCA) interventions	interventions aimed at enabling interactions between an individual and a communication technology to access or transmit health information, to receive guidance, or to receive support
Contracts	a behavioral strategy aimed at improving patient adherence by setting out a set of rules regarding the behavior of interest and formalizing commitment to adhere to the rules
Reminder packaging	interventions aimed to facilitate safe and appropriate medication use (<i>e.g.</i> , monitored dose symptoms, multi-compartment aids)
Multifaceted interventions	two or more interventions aimed at assisting patients with adherence to treatment/medications and improving the prescription process
<i>Professional interventions</i>	
Educational outreach and audit and feedback	interventions whereby a trained person meets with providers in their practice setting to give information with the goal to change clinical behavior (also referred to as academic detailing) OR any summary of clinical performance (from health records, observation, computer systems) of healthcare over a specified time that may also include recommendations for clinical action
Clinical decision support systems (IT/IM/informatics)	information system interventions that provide the clinician with decision support, including critical clinical data, reminders, advice on drug or care provision, etc.
Computerized physician order entry (IT/IM/informatics)	computer-based systems for ordering medications with automated aspects to the ordering process, such as a list of possible medications for a physician to choose, drug interaction or contraindication prompts, reminders, etc.
Tracker/reminder systems (IT/IM/informatics)	specific interventions that prompt healthcare providers with information specific to the patient or the encounter that would advise on action to do or action to avoid (interventions can be verbal, paper, or electronic)
Local opinion leaders	educational leaders and influentials nominated by their colleagues
Tailored interventions	identify barriers to change and subsequent design of an intervention that addresses identified barriers
Clinical pathways	document-based tools that provide a link between best available evidence and clinical practice by providing recommendations, processes, and time-frames for the management of specific medical conditions or interventions
Guidelines for professions allied to medicine	a systematic statement aimed at assisting in decisions by providers and patients for a specific clinical condition
Discharge planning from hospital to home	interventions aimed at providing individualized plans as a patient is moved from hospital to home
<i>Organizational interventions</i>	
Changing length of consultation	interventions designed to increase consult time between primary care provider and patient
Routine standard assessment interventions	interventions designed to improve the assessment and documentation of patients (akin to pathology checklist concept in Ontario or surgical checklist concept in various provinces)
Chronic care model interventions	interventions aimed at redesigning ambulatory care by modifying elements of the chronic care model (elements include self-management support, decision support, delivery system design, clinical information systems, healthcare organizations, and community resources)
Shared-care interventions	any type of structured system that involves continuing collaborative clinical care between primary care and specialty care in the management of patients
Shared-care tactic interventions	tactics aimed to facilitate information sharing between providers who provide care to a patient; include (i) liaison meetings—meetings between specialists and primary care teams whereby ongoing management of patients within the service is planned and discussed, (ii) shared-care record cards—a formal information-sharing arrangement where a set of data is agreed to, entered onto a record card, and usually carried by the patient, or (iii) computer-assisted shared care/email—a formal information-sharing arrangement whereby a data set is agreed to, entered onto a record card, and shared between two sectors on computer (can also include coordinated computer registration and patient recall)
Health information technology interventions	switching the format or structure of the medical record, such as computerized medical records

IT = information technology; IM = information management.

Table 2 Systematic reviews: Stage in continuum of cancer care and implementation intervention cluster

Cluster	Continuum-of-care stage							
	Prevention	Screening	Diagnosis	Treatment	Survivorship	Follow-up	Supportive care	Palliative end-of-life care
Professional	5	7	7	10	1	2	2	2
Consumer	4	2	8	16	1	3	8	4
Organizational	1	3	6	8	1	3	4	3
Financial	0	0	0	0	0	0	0	0
Regulatory	0	0	0	0	0	0	0	0

applications (e.g., improvements in knowledge, social support, behavior, and clinical outcomes). Most reviews within a given intervention type yielded significant variability with respect to effectiveness, and most authors were unable to provide definitive conclusions to their use.

Assessments by research team members on effectiveness yielded overall mean scores (across evidence summaries of similar interventions) ranging between 3.8 and 6.0 (see “Team Ratings” column of Table 7). Only one, interactive health communication applications, was rated as being effective. The remaining interventions were rated as promising and candidates for more study. Eight research ideas and three systematic review topics were identified by members of the research team (Table 8).

Interventions aimed at professionals (Additional File 4)

Twelve publications addressing seven unique professional interventions provided 14 evidence summaries. Professional interventions included education, audit and feedback, information technology (IT)/information management (IM)/informatics, clinical decision support systems, computerized physician order entry, reminders, local opinion leaders, tailored interventions, clinical pathways, guidelines, and discharge planning. Tables 4, 5, and 9 summarize characteristics of the systematic reviews; Table 10 summarizes the quality and efficacy

appraisals for the interventions; and Table 11 summarizes the research suggestions made by members of the research team.

For these systematic reviews, the average AMSTAR score was 6, with scores ranging from 3 to 8. Trials that comprised the reviews included RCTs, clinical controlled trials, pre-/post studies, cluster RCTs, time series, observational, and trials labeled as “other.” Of the 14 evidence summaries, 4 undertook quantitative pooling (i.e., meta-analysis).

Evidence of effectiveness was most promising for educational outreach and audit and feedback interventions (median improvement in clinical outcomes 5%); clinical decision support (improved clinical performance); computer order entry (reduction in medical errors); clinical pathways (reduction in complication rates); local opinion leaders (reduction in clinician noncompliance); and tailored interventions (improvement in some clinical outcomes). However, these benefits are contrasted against the concerns with the overall quality and lack of consistency across the systematic reviews. Moreover, the primary studies included in the systematic reviews are reported to be of poor quality, heterogeneous, and poorly reported with respect to the interventions, contexts, and measurements of outcomes. Together, this makes definitive conclusions about professional interventions very challenging.

Table 3 Systematic reviews: Cancer diagnosis and implementation intervention cluster

	Cluster				
	Professional	Consumer	Organizational	Financial	Regulatory
Breast	4	9	4	0	0
Gastrointestinal	2	2	2	0	0
Genitourinary	2	4	2	0	0
Gynecological	1	1	1	0	0
Head and neck	0	2	0	0	0
Diagnosis Hematologic	1	2	1	0	0
Lung	0	3	0	0	0
Melanoma	1	1	1	0	0
Neuro-oncology	0	0	0	0	0
Sarcoma	1	0	1	0	0
Not specified	5	6	5	0	0

Table 4 Characteristics of systematic reviews

Type of intervention (number of evidence summaries)	Theory/framework			Study designs included			Outcomes included					
	Y	N	NS	RCT only	Non-RCT only	Mixed	C	BO	BI	K	A	S
<i>Consumer interventions</i>												
Patient education/patient information (n = 8)	2	0	6	2	0	6	4	3	6	6	4	5
Decision aids/shared decision making (n = 5)	2	2	1	0	0	5	1	3	2	4	1	3
Interactive health communication applications (n = 1)	0	0	1	1	0	0	1	1	0	1	0	0
Contracts (n = 1)	1	0	0	1	0	0	0	1	0	1	0	1
Reminder packaging (n = 1)	0	0	1	1	0	0	0	1	0	0	1	0
Multifaceted (n = 1)	0	0	1	1	0	0	1	1	0	0	0	0
Overall	5	2	10	6	0	11	7	10	8	12	6	9
<i>Professional interventions</i>												
Educational outreach visits & audit and feedback (n = 4)	1	2	1	2	1	1	4	2	0	2	0	1
IT/IM/informatic interventions (n = 5)	0	1	4	0	1	4	4	5	0	0	0	0
Local opinion leaders (n = 1)	0	0	1	1	0	0	0	1	0	0	0	0
Tailored interventions (n = 1)	1	0	0	1	0	0	1	0	0	0	0	0
Clinical pathway interventions (n = 1)	-	-	-	0	0	1	1	1	0	0	0	0
Guidelines for professions allied to medicine (n = 1)	-	-	-	0	0	1	0	1	0	0	0	0
Discharge planning from hospital to home (n = 1)	-	-	-	1	0	0	1	0	0	0	0	1
Overall	2	3	6	5	2	7	11	10	0	2	0	2
<i>Organizational interventions</i>												
Changing length of consultation (n = 1)	0	0	1	0	0	1	1	1	0	0	0	1
Routine standardized assessment (n = 1)	0	0	1	0	0	1	1	1	0	1	1	1
Chronic care model interventions (n = 1)	1	0	0	0	0	1	0	1	0	0	0	0
Models-of-care/integrated care-related interventions (n = 5)	0	2	3	0	2	3	4	2	1	3	1	3
Shared-care tactic interventions (n = 1)	0	1	0	0	0	1	1	1	0	0	0	1
Health information technology (n = 1)	1	0	0	0	0	1	1	1	0	0	0	1
Overall	2	3	5	0	2	8	8	7	1	4	2	7

Y = yes; N = no; NS = not specified; RCT = randomized controlled trial; C = clinical; BO = behaviour observed; BI = behaviour intention; K = knowledge; A = attitudes; S = satisfaction; IT = information technology; IM = information management.

Note: The reviews added post-hoc (Rotter, 2010; Shepperd, 2010; Thomas, 2009) did not have full data extraction completed; this is indicated by cells with “-”.

Research team ratings of the interventions were assessed, and the overall mean scores (across evidence summaries of the same intervention) ranged between 4.3 and 5.0 all were within the “promising” category (see “Team Ratings” column in Table 10). Twenty-eight research ideas were recommended by members of the research team (see Table 11).

Interventions aimed at organizations (Additional File 5)

Nine reports addressing six unique organizational interventions provided 10 evidence summaries. The interventions included organizational/structural specific, continuity-of-care related, shared-care tactics, revisions of professional roles, and health information technology. Tables 4, 5, and 12 summarize characteristics of the systematic reviews; Table 13 summarizes the quality and efficacy appraisals of the interventions; and Table 14

summarizes the research suggestions made by members of the team.

Organizational interventions are those aimed at encouraging use and uptake of knowledge at the organizational level. The average AMSTAR score was 5, with scores ranging from 2 to 8, which indicates the range of very poor methodological quality to moderately high methodological quality. Overall, the reviews were not able to provide definite conclusions (e.g., statistically significant findings) to support the use of any of the specific interventions reviewed.

Two of the interventions, changing length of consultation time and shared-care tactic interventions, were rated by members of the research team as not effective (ratings of 3 and under). The remaining interventions fell between 4 and 5 on the scale, indicating promise and are candidates for further study (see Table 13).

Table 5 Characteristics of interventions studied

Type of intervention (number of evidence summaries)	Context: Who delivered						Context: Where delivered				Context: How delivered					
	Pt	Fam	Clin	Ad	PH	O	Home	Comm	CIE	O	Per	Paper	Phone	TI	TS	NS
<i>Consumer interventions</i>																
Patient education/patient information (n = 8)	0	0	5	0	0	3	4	3	7	4	4	7	4	2	2	0
Decision aids/shared decision making (n = 5)	0	0	5	0	0	0	2	0	3	2	2	5	1	4	2	0
Interactive health communication applications (n = 1)	0	0	0	0	0	1	1	1	1	0	1	1	0	1	1	0
Contracts (n = 1)	0	0	1	0	0	0	1	0	1	0	1	1	0	0	0	0
Reminder packaging (n = 1)	1	1	1	0	0	1	1	1	1	1	1	0	0	0	1	0
Multifaceted (n = 1)	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	0
Overall	2	2	13	0	0	6	10	6	14	8	10	15	6	8	7	0
<i>Professional interventions</i>																
Educational outreach visits & audit and feedback (n = 4)	0	0	3	1	0	2	0	1	4	1	4	4	3	2	1	0
IT/IM/informatic interventions (n = 5)	0	0	2	1	0	4	0	2	5	1	0	0	0	4	1	0
Local opinion leaders (n = 1)	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0
Tailored interventions (n = 1)	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	1
Clinical pathway interventions (n = 1)	0	0	1	0	0	0	-	-	-	-	-	-	-	-	-	-
Guidelines for professions allied to medicine (n = 1)	0	0	1	0	0	0	-	-	-	-	-	-	-	-	-	-
Discharge planning from hospital to home (n = 1)	0	0	1	0	0	0	-	-	-	-	-	-	-	-	-	-
Overall	0	0	9	2	0	7	0	4	11	2	5	4	3	6	2	1
<i>Organizational interventions</i>																
Changing length of consultation (n = 1)	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0
Routine standardized assessment (n = 1)	0	0	1	0	0	1	0	0	1	0	1	1	0	0	0	0
Chronic care model interventions (n = 1)	0	0	1	0	0	1	0	1	1	0	1	0	0	0	0	1
Models-of-care/integrated care-related interventions (n = 5)	0	0	5	0	0	0	1	2	5	1	5	4	2	2	0	0
Shared-care tactic interventions (n = 1)	0	0	1	0	0	0	1	1	1	1	1	1	1	1	0	0
Health information technology (n = 1)	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0
Overall	0	0	10	1	0	2	2	4	10	2	9	6	3	4	0	1

Pt = patients; Fam = family; Clin = clinicians; Ad = administrator/manager; PH = public health; O = other; Comm = community; CIE = clinical environment; Per = person; TI = technology–interactive; TS = technology–static; NS = not specified; IT = information technology; IM = information management.

Note: The reviews added post-hoc (Rotter, 2010; Shepperd, 2010; Thomas, 2009) did not have full data extraction completed; this is indicated by cells with “-”.

Table 6 Consumer-focused interventions: Number of systematic reviews for each cluster

Type of intervention	Total number of SRs	Number of SRs–cancer only	Number of SRs–mixed	Number of SRs–no cancer
Patient education and patient information	8	4	4	0
Patient decision aids	5	3	2	0
Interactive health communication applications	1	0	1	0
Contracts	1	0	0	1
Reminder packaging	1	0	0	1
Multifaceted	1	0	1	0

SR = systematic review.

Table 7 Consumer interventions: Appraisal of systematic review (AMSTAR) scores and intervention effectiveness ratings by research team

Intervention cluster and systematic review first author (year)	Scores and ratings		
	AMSTAR (1 to 11)	Research team ratings Mean	SD
Patient education/patient information			
Bennett (2009) [26]	8	5.7	0.67
Gaston (2005a) [35]	5	4.7	0.45
Gysels (2007) [37]	5	3.0	1.00
Goldberg (2007a) [36]	3	3.8	0.45
Wofford (2005) [56]	7	4.3	0.84
Santo (2005) [47]	7	4.6	0.89
Conn (2008) [30]	10	4.3	1.79
Raynor (2007) [45]	8	4.0	0.71
Overall mean score	7		4.3
Patient decision aids			
Evans (2005) [33]	7	4.4	1.14
Gaston (2005b) [35]	5	4.3	0.97
Waljee (2007) [54]	8	6.1	0.22
Edwards (2008) [32]	5	3.8	0.45
Joosten (2008) [41]	5	5.1	0.22
Overall mean score	6		4.7
Interactive health communication applications			
Murray (2005) [43]	11	6	1
Contracts			
Bosch-Capblanch (2007) [27]	9	3.8	0.84
Reminder packaging			
Heneghan (2006) [39]	10	5.1	0.74
Multifaceted			
Haynes (2008) [38]	10	4.6	0.89

Table 8 Consumer interventions: Nominated research ideas

Type of intervention	Research ideas
Patient education/patient information	Randomized studies directly comparing different intervention formats/modalities/techniques on satisfaction, adherence, and clinical outcomes (prioritize those interventions from which individual studies have shown greatest promise on clinical outcomes) (<i>i.e.</i> , how to do it)
Decision aids	Development, testing, and evaluation of cancer decision aids in understudied areas (<i>e.g.</i> , role within personalized medicine, molecular-genetics) • Development, testing, and evaluation of cancer decision aids in understudied populations
Interactive health communication applications (IHCA)	What are the implications for IHCA on privacy policies and legislations?
Contract interventions	Outside of cancer prevention, no role
Reminder packaging	Research to identify if adherence to medication protocols is a problem for cancer patients (<i>e.g.</i> , for which drugs, cancer diagnoses, complexity of drug regimen) • Generalize to other aspects of cancer care—What are effective strategies to remind cancer survivors of follow-up and monitoring regimens? (linked to discharge plan priorities)
Multifaceted intervention	Design and evaluate multifaceted consumer interventions for specific cancer control problems using Haynes <i>et al.</i> review as foundation (<i>i.e.</i> , deconstruct systematic review to identify most promising intervention clusters for specific contexts)
Systematic review priorities	Acquiring skills and competencies • Consumer system participation • Minimizing risks or harms

Table 9 Professional-focused interventions: Number of systematic reviews for each cluster

Type of intervention	Total number of SRs	Number of SRs–cancer only	Number of SRs–mixed	Number of SRs– no cancer
Educational outreach visits & audit and feedback	4	2	2	0
IT/IM/informatics	5	1	4	0
Local opinion leaders	1	0	1	0
Tailored interventions	1	0	0	1
Clinical pathways	1	0	1	0
Guidelines for professions allied to medicine	1	0	1	0
Discharge planning from hospital to home	1	0	1	0

SR = systematic review; IT = information technology; IM = information management.

Twenty-eight research ideas were recommended by members of the research team (see Table 14).

Conclusion

We considered 34 unique systematic reviews providing 41 evidence summaries for 19 KT interventions. The quality of the execution of the systematic reviews varied significantly,

with AMSTAR ratings ranging between 2 and 10. Primary evidence serving as the foundation for the systematic reviews included RCTs and nonrandomized trials. Systematic review authors describe the primary evidence as uneven with respect to quality, reporting, and outcomes.

While many interventions suggested promise of effectiveness, few reviews were able to conclude definitively

Table 10 Professional interventions: Appraisal of systematic review (AMSTAR) scores and intervention effectiveness ratings by research team

Intervention cluster and systematic review first author (year)	Scores and ratings		
	AMSTAR (1 to 11)	Research team ratings Mean	SD
Educational outreach visit & audit and feedback interventions			
Goldberg (2007b) [36]	3	4.6	0.89
O'Brien (2007) [44]	8	4.8	1.17
Goldberg (2007c) [36]	3	3.8	0.98
Jamtvedt (2006) [40]	8	4.7	0.82
Overall mean score	5.5	4.5	
IT/IM/informatic interventions			
Goldberg (2007d) [36]	3	3.7	0.52
Garg (2005) [34]	5	5.3	0.52
Ammenwerth (2008) [23]	6	5.7	0.52
Beach (2006a) [25]	5	5.7	1.03
Shojania (2009) [50]	8	4.7	0.52
Overall mean score	5.4	5.0	
Local opinion leader interventions			
Doumit (2007) [31]	7	4.3	0.82
Tailored interventions			
Baker (2010) [24]	7	4.8	1.47
Clinical pathway interventions			
Rotter (2010) ^a [46]	–	NA	NA
Guidelines for professions allied to medicine			
Thomas (2009) ^a [53]	–	NA	NA
Discharge planning from hospital to home			
Shepperd (2010) ^a [49]	–	NA	NA

^aThese reviews were included *post hoc*, identified by members of the research team.

IT = information technology; IM = information management.

Table 11 Professional interventions: Nominated research ideas

Type of intervention	Research ideas
Educational outreach visits (EOV)/audit and feedback (AF)	Better quality trials directly evaluating specific modalities and methods of EOV (proper randomization, baseline data, variety of outcomes—including patient outcomes and costing) Better quality trials directly evaluating specific modalities and methods of methods of AF (as above) For which clinicians, clinical conditions, and stage in the continuum is EOV most impactful? For which clinicians, clinical conditions, and stage in the continuum is AF most impactful? What is the impact of regional AF versus individual AF on changing patterns of practice?
IT/IM/informatic interventions	Better quality trials directly evaluating specific modalities and methods of informatic interventions (proper randomization) For which clinicians, clinical conditions, and stage in the continuum are informatics interventions most impactful? Develop methods to enable practice guidelines to be directly integrated into informatic interventions What is the cost effectiveness of different informatic interventions? Are informatic interventions effective in non-drug-prescribing aspects of cancer care?
Local opinion leader interventions	Methodological development in choosing local opinion leaders in a reliable manner Methodological development in understanding factors that increase and decrease sustainability of local opinion leader designation Research to better understand for which provider groups and under what clinical contexts (cancer diagnosis, practice setting, stage of the cancer trajectory) local opinion leaders are most effective
Tailored interventions	Methodological analysis of the operational techniques of tailoring in existing high-quality primary studies Methodological development to determine when tailoring has or has not addressed identified barriers Identification of defining factors of effective tailoring Direct comparisons of different tailoring interventions (tactic and modality, etc.) on uptake of evidence, processes of care, and clinical outcomes
Clinical pathway interventions	Testing of clinical pathway interventions on different stages of continuum of cancer care Testing of clinical pathway interventions with different healthcare providers involved in cancer control Methodological development to determine for which clinical problem (<i>e.g.</i> , cancer diagnosis, complexity of care) clinical pathways are most effective Direct comparisons of different clinical pathway strategies (methods and modality, etc.) on uptake of evidence, processes of care, and clinical outcomes Is the introduction of clinical pathways cost effective in Ontario/Canada?
Guidelines	Compare and contrast use of and impact of guidelines on processes of care and clinical outcome as a function of cancer care provider Testing innovative strategies to disseminate guideline messages to different providers Testing of innovative strategies to disseminate guideline messages to administrators Testing of innovate strategies to disseminate guideline messages to policy makers
Discharge planning	What are the defining features/components to a discharge plan that are linked to patient satisfaction, provider satisfaction, process outcomes, and clinical outcomes? Determining the specific clinical components for discharge plans for different cancer diagnoses

IT = information technology; IM = information management.

Table 12 Organizational-focused interventions: Number of systematic reviews for each cluster

Type of intervention	Total number of SRs	Number of SRs–cancer only	Number of SRs– cancer included	Number of SRs– no cancer
Changing length of consultation	1	0	0	1
Routine standard assessment	1	1	0	0
Chronic care model	1	0	1	0
Models of care/integrated care	5	2	3	0
Shared-care tactic	1	0	1	0
Health information technology	1	0	1	0

SR = systematic review.

Table 13 Organizational-focused interventions: Appraisal of systematic review (AMSTAR) scores and intervention effectiveness ratings by research team

Intervention cluster and relevant systematic review first author (year)	Scores and ratings		
	AMSTAR (1 to 11)	Research team ratings	
		Mean	SD
Changing length of consultation interventions			
Wilson (2006) [55]	7	3	0.71
Routine standard assessment interventions			
Goldberg (2007e) [36]	3	3.8	1.30
Chronic care model interventions			
Coleman (2009) [29]	2	4.4	0.55
Models-of-care/integrated care-related interventions			
Lewis (2009) [42]	7	3.8	1.10
Smith (2008) [52]	8	3.2	1.30
Beach (2006b) [25]	5	4.6	0.89
Goldberg (2007f) [36]	3	3.6	0.89
Scheuner (2008) [48]	4	2.6	0.55
Overall mean score	5.4	3.6	
Shared-care tactic interventions			
Smith (2007) [51]	8	3	1.22
Health information technology interventions			
Chaudhry (2006) [28]	4	4.6	0.89

in favor of or against a specific intervention. The interpretation of the evidence by members of the research team aligned with this analysis. The majority of the interventions were rated by the research team members as promising, but in need of additional study.

In considering KT in cancer control, one is struck by the complexity of the enterprise. While there are many studies being conducted, the quality is decidedly uneven and the impact on patient care or system performance is questionable. To that end, some key observations are noted and conclusions for the research enterprise can be drawn.

Overall, the approach to KT in cancer control appears patchy and unsystematic. While this may be due, in part, to the breadth, size, and scope of the research area, it is likely to be a major contributor to the hodgepodge of studies being conducted, the failure of the research community to consistently embrace high-quality research paradigms and standards, and the inability to create a common language and taxonomy in the field. Indeed, common across the systematic reviews considered here is that the studies that underpin them often fail to adequately describe all aspects of the KT intervention under investigation and (where relevant) the control group. This makes it very difficult to synthesize data, to improve the overall research enterprise, and to build from one study to another. Here, work by Cochrane's EPOC group and researchers such as Michie and others may assist in designing a common language,

a common set of operational definitions, and common labels to facilitate the advancement of the KT field [20-22].

The complexity of the cancer field and the impact of that complexity to the KT research agenda cannot be underestimated. The numerous but unique diagnoses, the variety of providers involved in cancer care and control (*i.e.*, public health, primary care, medical specialists, allied health providers, lay and peer providers), the various organizational settings in which care is offered, the risks associated with some care options, and the variability in decision-making styles by individuals affected by cancer are examples of this complexity. As it relates to the KT research enterprise, the role of context and individual differences must be stressed.

The design and execution of the primary studies fall below acceptable levels of quality. For example, we found that the systematic reviews often fail to measure meaningful end points because these data are not available in the primary literature that comprise the evidentiary base for synthesis. While measures of knowledge, satisfaction, and intention are important—and in fact, better studied—measures of intervention fidelity (or adherence to intervention), relevant clinical end points, and valid patient-centered outcomes are often lacking.

In addition, the design and execution of the systematic reviews in the KT field are uneven. For example, use of factorial designs, multilevel modeling techniques, and regression strategies could improve the precision by

Table 14 Organizational interventions: Nominated research ideas

Type of intervention	Research ideas
Changing length of consultation	<p>Does length of consultation influence patient satisfaction, clinician satisfaction, or patient outcomes in a clinical context?</p> <p>Modeling the clinical encounter to predict patient satisfaction, clinician satisfaction, and patient outcomes. Use length of consult time as one of the predictors (examples of others: types of information shared, type of clinician, diagnosis).</p> <p>In what stages of the cancer continuum does the length of consultation impact patient satisfaction, clinician satisfaction, and patient outcomes?</p> <p>What is the cost effectiveness of longer consultation times?</p>
Routine assessment interventions	<p>Conduct a high-quality systematic review examining the impact of routine standard assessment (across cancer care continuum) on delivery of cancer care, satisfaction (patient and clinician), and clinical outcomes</p> <p>What is the impact of routine standard assessment on other aspects of cancer care other than pain?</p> <p>Conduct a well-designed randomized trial to evaluate the impact of routine standard assessments on delivery of care (fidelity), satisfaction of care (patient and clinician), and clinical outcomes</p> <p>Compare and contrast methods used to determine and create tools to support implementation of routine standard assessments to ensure they are based on evidence and acceptable to clinicians and patients</p> <p>Research examining how to implement routine standard assessments into an oncology practice setting (ambulatory or in-patient) so that it is acceptable (to management, clinicians, patients), effective, and cost effective</p>
Chronic care model (CMM) interventions	<p>Conduct a high-quality systematic review examining the impact of CMM on delivery of cancer control, satisfaction (patient, clinician, policy), and clinical outcomes</p> <p>Research (qualitative and/or scoping review) to assess whether CCM applies well to the cancer control context. Which components of the CCM (if any) are most relevant to cancer control? Which aspect of cancer control (<i>e.g.</i>, diagnosis) lends itself to the CCM model?</p> <p>Design, evaluate, and refine tools to support each of the six CCM components using high-quality methods</p>
Models of care/integrated care interventions 1	<p>Research to better understand for what cancer diagnoses, cancer care options, stages in the continuum, and contexts (<i>e.g.</i>, geography) are different models of care and integration of services most appropriate (<i>e.g.</i>, systematic review, case study intervention)</p> <p>High-quality economic analysis comparing different models of care</p> <p>Research aimed to analyze (and perhaps statistically model) existing models of care to better understand the mechanisms underlying the processes and the outcomes of different approaches</p> <p>Deconstruction of existing systematic reviews to better understand the mechanisms underlying different models of care</p> <p>Develop methods to better measure the concepts of shared care and integrated care</p>
Models of care/integrated care interventions 2	<p>Development/identification, implementation, and evaluation (process, satisfaction, patient outcomes) of various models (care and service) aimed at the diagnostic stage of continuum and transition to treatment (<i>e.g.</i>, systemic review, scoping review, or randomized trial)</p> <p>As above but focused on treatment only (<i>e.g.</i>, systematic review or scoping review)</p> <p>As above but aimed at the treatment stage of the continuum and transition to survivorship or palliative care</p> <p>How to best introduce new models of care or new clinical roles into the care system</p> <p>Research aimed to test effectiveness, safety, satisfaction (patient, providers, and system) and cost effectiveness of new clinical roles in cancer control by non-medical clinical professionals</p>
Shared-care implementation tactic interventions	<p>Using high-quality randomized methods, compare and contrast different existing tactics aimed to facilitate communication between healthcare providers</p> <p>Develop, test, and refine new tactics aimed at facilitating communication between different practitioners</p>
Health information technology (HIT) interventions	<p>What are the most effective and efficient strategies to implement an HIT solution?</p> <p>For what cancer-control contexts (<i>e.g.</i>, continuum of care, diagnosis, practice setting) is an HIT solution most appropriate?</p> <p>Does embedding evidence-based recommendations into the HIT solutions improve quality of care over HIT solutions alone?</p> <p>Are HIT solutions cost effective?</p>

which we understand KT interventions. The application of these techniques is warranted. While this has been undertaken in some of the systematic reviews, it is not consistent, nor is it being done in the primary studies underpinning the existing reviews.

Thus, common principles of good scholarship and methodological rigor are required in systematic reviews of KT research and in the primary studies that underpin them. Namely, well-defined research questions, appropriate research design, patient-centered outcomes, analytic strategies to better understand the mechanisms associated with change, and completeness of reporting are necessary.

There are, however, limitations to our study. First, to manage scope and resource constraints of the project, we considered only systematic reviews available in databases of systematic reviews. While trying to avoid duplication, we acknowledge there may be other reviews that would have met our inclusion criteria that were not included in any of the three databases. Further, one review by Grimshaw (2006) [19] was found to be eligible during our search but was erroneously deleted and not included in our review. In addition, we acknowledge that there are likely primary studies not yet included in any of the systematic reviews we considered that would have been relevant to our question.

Second, this study was Canadian in focus with respect to members of the research team. While this conformed to the *request for proposals* criteria of the project's funders, it may be that a different composition of individuals would have yielded different conclusions. To advance the field, gathering a more international perspective may be warranted.

In summary, this project provides an overview of the evidence related to KT in cancer control. Given the current state of the evidence and the need for additional research in so many areas, we were not able to offer a definitive blueprint outlining a small manageable set of research priorities in this context. The field is open and considerable work is required. To ensure world-class research and research that will have a positive impact on people with cancer and on cancer system performance requires clarity and transparency of research scope and goals coupled with high expectations for the research community to achieve excellence in study design, execution, and reporting.

Endnotes

^aInterventions to influence uptake of cancer screening were explored in a separate project and were not considered here [17]. Cancer prevention was out of scope for this project and the aforementioned project.

^bOne eligible systematic review by Grimshaw *et al.* (2006) was inadvertently deleted from the systematic

review sample [19]. It focused on guidance dissemination and implementation strategies. They found absolute improvement in performance of 14.1% for reminders, 8.1% for dissemination, 7.0% for audit and feedback, and 6% for multifaceted interventions. This review is not included in the summary statistics presented.

Additional material

Additional file 1: Research Team. List of the Research Team members and their affiliations

Additional file 2: Eligible Systematic Reviews. List of full citations of systematic reviews and the corresponding intervention cluster(s) [23-56]

Additional file 3: Interventions aimed at consumers. Table of data on each intervention aimed at consumers

Additional file 4: Interventions aimed at professionals. Table of data on each intervention aimed at professionals

Additional file 5: Interventions aimed at organizations. Table of data on each intervention aimed at organizations

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Authors' contributions

MCB conceived of the study and participated in its design and execution. JM participated in the study's design and coordination. MCB, JM, and KG were directly involved in the preparation of this manuscript. KG and LD were responsible for data collection and data synthesis. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

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