A randomized controlled trial evaluating the impact of knowledge translation and exchange strategies

Submitted by:
Maureen Dobbins, RN, PhD[1], Associate Professor*
dobbinsm@mcmaster.ca
Steven E. Hanna, PhD[1], Associate Professor
hannas@mcmaster.ca
Donna Ciliska, RN, PhD[1], Professor
ciliska@mcmaster.ca
Steve Manske, Ed.D. [2]
manske@healthy.uwaterloo.ca
Roy Cameron, MA, PhD[2], Professor
cameron@healthy.uwaterloo.ca
Shawna L. Mercer, MSc, PhD[3], Director
Zhi5@CDC.GOV
Linda O'Mara, RN, PhD[1], Associate Professor
omara@mcmaster.ca
Kara DeCorby, MSc[1], Research Coordinator
kdecorby@health-evidence.ca
Paula Robeson, RN, MScN[1], Knowledge Broker
probeson@health-evidence.ca
[1]McMaster University, [2]University of Waterloo, [3]The Guide to Community Preventive Services, National Center for Health Marketing, Centers for Disease Control and Prevention, Atlanta, GA, USA

***Corresponding Author**

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Authors' contributions

MD conceived of the study, participated in the analysis and drafted the manuscript. PR provided the intervention and assisted in draft of the manuscript. DC, SH, RC, LO, KD, SM, and SH consulted on the intervention as it was designed and provided, and participated in review of the manuscript. All authors read and approved the final manuscript.

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CONTEXT: Significant resources and time are invested in the production of research knowledge. The primary objective of this randomized controlled trial was to evaluate the effectiveness of three knowledge translation and exchange strategies in the incorporation of research evidence into public health policies and programs. **METHODS:** This trial was conducted with a national sample of public health departments in Canada. The three interventions, implemented over one year, included access to an online registry of research evidence; tailored messaging; and a knowledge broker. The primary outcome assessed the extent to which research evidence was used in a recent program decision and the secondary outcome measured the change in the sum of evidence-informed healthy body weight promotion policies or programs being delivered at health departments. Mixed-effects models were used to test the hypotheses. **FINDINGS:** 108 of 141 (77%) health departments participated in this study. No significant effect of the intervention was observed for primary outcome ($p < .45$). However, for health policies and programs (HPPs), a significant effect of the intervention was observed for tailored messaging only ($p < .01$). The treatment effect was moderated by perceived organizational research culture. **CONCLUSIONS:** The results of this study suggest that tailored messaging is more effective, under certain conditions, than knowledge brokering and access to an online registry of research evidence. Tailored messages were effective when organizations perceived themselves as having high research culture but not for low research culture. Greater emphasis on the identification of research culture attributes are needed in order to implement strategies that meet the needs of individual organizations.

INTRODUCTION

Currently there is substantial political and societal pressure to demonstrate the integration of the best available research evidence with local contextual factors, so as to provide the most effective health services in optimizing health outcomes [1]. The purpose of this randomized controlled trial (RCT) was to evaluate the impact of three knowledge translation and exchange (KTE) strategies in promoting the incorporation of research evidence by public health decision makers into policies and programs related to healthy body weight promotion in children.

BACKGROUND

Knowledge Translation and Exchange: What We Know

The integration of research evidence into policy and program decision making is commonly referred to as evidence-informed decision making (EIDM) [2], and strategies to promote it as KTE. However, it is well known that the decision making process is complex and that multiple forms of knowledge impact both the process as well as the decision. Important factors contributing to decisions include past experiences, beliefs, values, skills, resources, legislation, protocols, patient preferences, societal norms and research results [3-6]. The intent of EIDM is not to suggest that policy and program decisions be determined solely by research evidence, but rather research evidence be considered alongside other forms of evidence in the decision making process.

Barriers consistently identified to EIDM include: lack of time; limited access to research evidence; limited capacity to appraise and translate research evidence; and resistance to change [7-13]. System-level changes needed to support EIDM include:

researchers gaining a better appreciation of the context in which decision makers function; and building more collaborative relationships with decision makers [14-16].

Three KTE strategies are currently being widely used to promote EIDM. These include a) freely accessible web-based resources that summarize research evidence; b) tailored messaging which connects relevant research evidence to specific decision-makers [17]; and c) knowledge brokers, who work one-on-one with decision makers to facilitate EIDM [18]. The Internet is established as an essential component of KTE [19] and significant resources have been and continue to be allocated to Internet-based KTE strategies. Several web-based resources have been developed with the intent of compiling the best available research evidence by topic area or health care discipline (e.g., Medline Plus, More EBN, health-evidence.ca). Some have gone one step further to synthesize the results of the evidence to answer specific practice-based questions [20]. However, there is a scarcity of literature evaluating the effectiveness of web-based resources in achieving EIDM.

Tailored messaging has gained momentum as a popular KTE strategy [21-24]. Evidence indicates that computer-tailored messaging is associated with increased uptake compared to standardized messages [25], and that electronic targeted messaging to sub groups with common interests is effective in promoting EIDM [26]. While tailored messaging has been shown to improve uptake of systematic reviews [27], questions remain as to what content is most wanted and required for different audiences, what the most effective communication channels are [25]; and which organizations will benefit most from tailored messaging.

Knowledge brokers have been implemented widely in private industry [28-30], and more recently in healthcare settings [18,31,32]. In fact, a great many organizations in Canada have quickly moved to adopt knowledge broker roles with little more than anecdotal evidence supporting its effectiveness. A knowledge broker acts as a catalyst for systems change [33], establishing and nurturing connections between researchers and end users [34], and facilitating learning and exchange of knowledge [35]. The anecdotal evidence suggests that knowledge brokers improve the quality and usefulness of evidence that is employed in decision making [36] while promoting a decision-making culture that values the use of evidence [37,38]. Furthermore, the heightened degree of interaction with decision makers through knowledge brokering is assumed by many to be the optimal KTE strategy in comparison to less interactive strategies; however, this has yet to be proven [39]. Given the lack of evaluation of each of these KTE strategies individually or in comparison to one another the timing was right for the conduct of this study.

METHODS

Design

This RCT funded in 2003 by the Canadian Institutes of Health Research, was the first in Canada to evaluate the effectiveness of a knowledge broker in comparison to other KTE interventions on promoting EIDM in public health departments. Following ethics approval (McMaster University Faculty of Health Sciences Research Ethics Board) and recruitment, 108 health departments were stratified according to size of population served

and randomly allocated to groups within population size strata using computer-generated random numbers. The health department was the unit of analysis.

The framework proposed by Dobbins et al, [40] is one of many frameworks [41-46] that have been developed to illustrate the process of knowledge translation and evidence-based decision-making. Dobbins' framework has been used to guide the development of the proposed knowledge translation strategy and identify relevant outcomes for this study. The framework demonstrates the complex inter-relationships that exist between the five stages of innovation identified by Rogers,[47] (knowledge, persuasion, decision, implementation and confirmation), and four types of characteristics, organizational, environmental, individual and the innovation [48], as the knowledge translation process occurs. (Figure 1). The framework also identifies the variety of possible outcomes that can be observed including: a) knowledge and attitudes; b) decision-making; c) implementation (ie. putting research knowledge into policy and practice, guideline development); and d) outcomes (i.e. changes in policy and practice). This study focused on the measurement of outcomes related to evidence-informed decision-making.

The hypotheses were: 1) public health departments exposed to tailored messaging and the knowledge broker would report greater EIDM than those exposed to a repository of quality assessed systematic reviews evaluating public health interventions (health-evidence.ca); 2) knowledge brokering would lead to greater EIDM than tailored messaging; and 3) characteristics of the organization, environment, and individual would moderate EIDM.

Sample and Recruitment

The sample was comprised of regional and local public health departments in Canada. Eligible participants from participating health departments were directly responsible for making program decisions related to healthy body weight promotion in children. This included program managers and/or coordinators in Ontario, and program directors in the rest of Canada. All 141 health departments in Canada were invited to participate.

Intervention

The three interventions were implemented over 12 months. The least interactive KTE intervention was access to www.health-evidence.ca (HE group). Health-evidence.ca is a repository of all systematic reviews published since 1985 evaluating any public health intervention. All participants in the study received electronic communication about the availability of this site. Upon searching this site, those exposed to the HE group received the title, citation, and assessment of the methodological quality of eight systematic reviews evaluating the effectiveness of interventions to promote healthy body weight in children. Participants also had access to the published abstract, and the full text article (copyright purchased for this study). Finally, a short summary for each of the eight systematic reviews, written by the research team, identified the key findings and recommendations for policy and practice. Such summaries are written for all of the systematic reviews appearing in health-evidence.ca and are available to all users.

The moderately interactive KTE intervention included tailored messaging plus access to health-evidence.ca (TM group). The TM intervention included emailing participants in a staged process, first the title and abstract of the eight systematic reviews followed by the short summaries and finally the full text of each review.

The most interactive KTE intervention included both the HE and TM components and a knowledge broker who worked one on one with decision makers in the public health departments to develop capacity to incorporate research evidence into decision making and to develop skills to translate research evidence within the local context (KB group). KB activities were classified into the following categories: a) initial and ongoing needs assessments; b) scanning the horizon; c) knowledge management; d) knowledge translation and exchange; e) network development, maintenance, and facilitation; f) facilitation of individual capacity development in EIDM; and g) facilitation of and support for organizational change. These activities were carried out through regular electronic and telephone communication, and one site visit to each health department. As well each health department was invited to attend a one day workshop held regionally (4 cities) across Canada. A more complete description of the KB intervention is published elsewhere [49].

Data collection

The data were collected using a telephone-administered survey (Knowledge Transfer and Exchange Data Collection Tool) at baseline and immediately post the year long intervention. Items in the questionnaire were chosen from questionnaires previously tested and used in diffusion of innovation and research utilization studies [7,47,50-56]. We tested the modified questionnaire for reliability and validity among public health decision makers, and have a reported Cronbach alpha of .65 for reliability [7,57,58]. The questionnaire is available from the primary author upon request. The questionnaire was administered twice to participants at baseline, one month apart.

Independent Variables

Data were collected on organizational, environmental and individual characteristics shown previously to be related to EIDM [59] and measured using 7-point Likert scales. Organizational characteristics included: organizational culture (e.g. value placed on using research evidence in decision making, expectation to demonstrate use of research evidence in decision making) staff training in research methods and critical appraisal, and decision-making style. The environmental characteristic included collaboration with other community organizations. Individual characteristics included age, education, position, perceived influence over the decision-making process, and perception of the barriers to using research evidence in public health decision making. All variables were measured in the same direction.

Dependent Variables

Two dependent variables were evaluated: Global EIDM and Health Policies and Programs (HPPs). For Global EIDM participants were asked to report on the extent to which research evidence was considered in a recent program planning decision (previous 12 months) related to healthy body weight promotion. This is a common way of measuring research use in the KTE field. Participants were asked to quantify their response ranging from 1-Not at all to 7-Completely. However, given many have suggested that this is not an optimal way of measuring EIDM, we developed a second outcome variable, labeled, Health Policies and Programs. HPPs are the sum of actual strategies, policies and or interventions for healthy body weight in children being implemented by the health department. Eleven policies/programs with known effectiveness were identified from seven rigorous systematic reviews [60-66] (Table 1). Participants were asked whether the HPPs were being implemented by their health

department (yes/no). The total number of HPPs was summed and compared across groups from baseline to post intervention.

Analysis

Mixed-effects models were used to conduct tests of the two hypotheses related to the treatment effects, which is a standard approach to the analysis of designs with repeated measurements [67]. Repeated measurements over time were modeled as nested within participants, and time of observation was coded to estimate the differences between groups in scores at the average of the two baseline observations, and then the change from baseline to the post-intervention follow-up. The interaction of this change with the randomized treatment assignment is the appropriate estimate of the treatment effect, such that we tested whether change following the intervention differs among the intervention groups. These mixed-effects models provide for appropriate adjustment for the repeated measurements with participants when testing treatment effects, and they also allow for flexible handling of missing data. The moderating roles of selected predictor characteristics (hypothesis three) were also tested by evaluating their 3-way interactions with time and treatment.

Results

Of the 141 public health departments 108 (77%) agreed to participate. Stated reasons for not participating included undergoing restructuring, involved in too many research studies, or the topic was not a priority. Thirty-six public health departments were assigned to each intervention group. No statistically significant differences were observed between groups at baseline.

Follow-up Data

Participation by province and territory ranged from 29% to 100% with the sample consisting primarily of health departments serving both urban and rural populations (46%). Table 2 presents a description of the study sample. Follow-up data were collected from 88/108 (81.5%) participating public health departments. Reasons for not participating in the follow-up survey were lack of time and not having anyone working in healthy body weight promotion. Among the HE, TM and KB groups similar drop-out rates were observed; 7, 6, 7 health departments respectively. The study process is shown in Figure 1.

Intervention Integrity

It is unknown to what extent the HE group accessed www.health-evidence.ca. To our knowledge all those exposed to the TM intervention received 100% of the intervention. For those exposed to the KB intervention, approximately 70% received the full intervention (e.g. frequency, intensity) with approximately 15% respectively, not engaging at all, or to a limited extent. Organizations were analyzed according to their assigned group.

Outcomes

The estimates from the mixed-effects models are presented in Table 3. The table gives estimated pair-wise differences for the TM and KB groups, relative to control (HE group), as well as overall tests of group differences at baseline and for the change from baseline to follow-up. In addition, the standard deviation in outcome between and within health departments over time is provided. This gives an indication of the degree of variation in the outcomes that remains unexplained after accounting for the intervention. For both outcomes, most of the remaining variation appears as unexplained changes over

time within health departments. Table 3 shows that baseline scores do not differ significantly between groups for either outcome, although the TM group possibly had fewer HPPs at baseline compared to the HE group ($p < .06$).

As shown in Table 3, the intervention had no significant effect on Global EIDM ($p < .45$), although all groups improved to some extent. For HPPs, a significant effect of the intervention was observed ($p < .01$), as illustrated in Figure 2. For this outcome the TM group improved significantly by 1.67 policies, while both HE and KB groups showed no significant change. With respect to hypothesis three, only certain organizational characteristics, and not environmental or individual ones, were shown to moderate the intervention effect. When organizational research culture was added to the mixed-effects models as a predictor, the group x time x culture interaction was significant ($p < 0.03$). This 3-way interaction is illustrated in Figure 3, with the predictions for each group shown at relatively low (4/7) and high (6/7) values of research culture.

For health departments with low organizational research culture, the intervention effect was as we hypothesized – the control group was unchanged, the TM group improved somewhat, and the KB group improved most. However, when organizational research culture was high (6 on a 7 point scale), the HE group remained unchanged, the KB group worsened (fewer HPPs) and the TM group improved greatly. Similar trends were observed for organizational characteristics such as expectation to use research evidence and frequency of hearing the term research evidence.

DISCUSSION

Generally the results of this RCT show the need to match the organizational research culture to intervention type, and in particular support the hypothesis that tailored

messaging plus website can be an effective strategy for facilitating EIDM. The results indicate that the 'right' evidence, 'pushed' out to the right decision maker working in an organization supportive of EIDM, results in greater EIDM. In addition, simply having access to an online registry of research evidence appears to have no impact on EIDM. Finally, knowledge brokering does not appear to be effective in promoting EIDM overall, although there appears to be a trend toward a positive effect when organizational culture is perceived as low.

These findings are supported by published studies showing that simple KTE interventions are more effective than complex, multi-faceted ones [68-70]. A recent meta-analysis evaluating the effectiveness of KTE strategies found that reminders resulted in improved uptake of research evidence compared to more complex-multi-faceted KTE strategies [71]. It might be that complex, multi-faceted interventions dilute the key messages of the intervention making it difficult for decision makers to know what they should do.

It may be that TM provides decision makers with just the 'right amount' of information that has direct relevance to their practice, thereby making it easier to incorporate the evidence into program planning decisions. These results are supported by Hawkins et al, who found that TM employs strategies of personalization, feedback, and content matching and that these factors work together to facilitate research use [72]. In our study, the TM intervention employed personalization and content matching given each decision maker received individualized messages directly matched to their area of decision making authority.

The results also suggest that TM is most effective for certain organizations: Those with perceived high research culture. It may be that those health departments reporting a high research culture are already motivated to use research evidence and what they require most is facilitated access to rigorous, summarized, relevant research evidence personalized to their decision making needs in order to achieve EIDM. McGregor et al [73] reported similar findings that policy-makers were more likely to use the results of technology assessments when they requested information, and when they received the information while still engaged in making a decision on that topic. Furthermore, the results suggest that TM is not sufficient for public health departments with perceived low research culture. One might question why organizations that value research culture highly require tailored messages. One explanation might be that decision makers face incredible barriers to EIDM, most notably time to find, retrieve and translate research evidence. Therefore, KTE strategies that minimize the time barrier, and that assist the process of translation by tailoring findings to decision maker needs intuitively make sense.

The inability to demonstrate a positive effect of the KB intervention counters widely held assumptions that a customized, highly interactive KTE strategy results in greater EIDM [74]. Some have suggested that knowledge brokering is a long and involved process [75-77]. It is likely that the duration and intensity of our KB intervention was too short to facilitate significant changes in EIDM and that greater face to face interaction was needed. It is also possible, as suggested recently [78,79], that facilitation of a community of practice was an important element missing from our KB intervention. Our KB also did not have access to a network of KBs for guidance and

support, which has been shown to be crucial for optimal implementation of similar roles [80-82].

An interesting finding was the moderating effect research culture had on the KB impact for the HPPs. Health departments with perceived low research culture exposed to the KB intervention experienced a significant and positive improvement in HPPs. However, no benefit and possibly a decline in HPPs was observed when research culture was high, suggesting that a KB may be effective for certain health departments and not others. It is possible that KBs facilitate the development of capacity and support for EIDM in health departments with low research culture, which may be an important precursor to EIDM. Cillo [83] reported similar results suggesting a KB had greater success when the role was matched well to both organizational context and the complexity of market knowledge. The findings demonstrate the importance of assessing characteristics of each organization (e.g. research culture), and then using this information to tailor KTE strategies to meet the needs of each organization.

Outcome Measurement

Our primary outcome, Global EIDM, may not be optimal for measuring KTE effectiveness despite its consistent use in the KTE literature. It is likely that this measure is too vague to elicit reliable and valid responses. One conclusion is that concrete outcome measures, such as HPPs, that are tied to specific behaviors and/or programs provide a more concrete measure of EIDM. However, challenges still exist with this measure since the existence of organizational policies does not necessarily translate into actual services being provided, and it is unclear what the optimal data source is for identifying HPPs. Priorities for future research include: 1) Development and testing of

data collection tools for measuring more objectively EIDM outcomes ; and 2) continued exploration of subjective measures (as obtained through the qualitative component of this study) so as to better understand EIDM and KB processes, as well as what could be measured as indicators of KB success.

Limitations

The limitations in this study include: The source of data, participant turnover and exposure to the intervention, and self-reported outcome measures. A decision to have just one participant from each organization provide data was made following an assessment that suggested services for healthy body weight promotion in children were coordinated across health departments. In reality these programs span multiple divisions (e.g. healthy lifestyles, family health) and multiple teams within divisions (e.g. nutrition, physical activity, schools), resulting in many public health professionals working simultaneously on different interventions, usually with limited knowledge of what others are doing. It is possible that the participants in our study had inadequate knowledge to accurately report on all HPPs provided by their organization. This may have led to both under and over-reporting of the HPPs. One strategy to overcome this issue would be to have multiple participants from each health department participate in data collection. Furthermore, while the knowledge broker encouraged multiple decision makers from each public health department to participate in the KB intervention, for many health departments only one decision maker was exposed to the intervention. This likely resulted in insufficient exposure to the intervention to facilitate change at the organizational level.

A significant limitation of this study was high participant turnover. While the majority of health departments (81.5%) completed the study, different decision makers

completed the baseline and follow-up surveys in 30% of health departments. This reflects the transient nature of public health in Canada and in the United States, and is not something that could have been avoided. This high turnover rate may have resulted in substantial error in outcome measurement and may explain some of the huge variation in the number of HPPs observed from baseline to follow-up in some health departments. This continues to represent a significant issue and one that we are unable to quantify in terms of its impact and in which direction on the data. Furthermore, given up to 30% of participants either did not engage with the KB at all or to a limited extent, it is possible that the results of this study are generalizable only to those health departments that would have engaged with the KB.

This brings into question the feasibility of conducting empirical studies for evaluating the effectiveness of KTE strategies in public health specifically, and health care systems more generally. Factors such as high turnover are problematic for quantitative studies such as RCTs. Furthermore, it is impossible through randomization to eliminate all differences (particularly organizational ones) within and between groups, making interpretation of results challenging at best. Future research must look beyond traditional quantitative designs to obtain better ways of 'knowing' and understanding in which circumstances KTE strategies work, for whom, and why [84]. Other designs likely to be useful include case studies including nested case studies, interrupted time series, and qualitative methods such as grounded theory. Designs such as these will allow the effect of organizational factors and context to be more fully recognized and accounted for. Finally, additional research is required to develop and test a tool for assessing

organizational factors associated with EIDM. While some assessment tools exist, no one tool currently stands out as being optimal.

CONCLUSIONS

The results of this study suggest that tailored messaging is more effective than knowledge brokering or access to www.health-evidence.ca, particularly in organizations in which the culture highly values research. Lessons learned suggest a greater emphasis on the identification of research culture attributes so as to identify and implement an optimal array of KTE strategies; that more attention to appropriate outcome measures is needed, and that alternative research designs are necessary in understanding KTE impact.

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Figure 1

Figure 1: Framework for Research Dissemination and Utilization