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Funding change: An environmental scan of research funders' knowledge translation strategic plans and initiatives across 10 high-income countries/regions

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Abstract

Knowledge translation (KT) is the science and practice of dissemination and implementation of evidence. We describe how research funders operationalize and evaluate KT initiatives, identify challenges and opportunities, and suggest strategic considerations for KT support. We conducted an environmental scan, which included a systematic search of published and grey literature and a focus group with Canadian funders. A total of 130 published articles and 2415 grey literature sources were screened; 212 unique data sources were included. Published literature commonly described KT initiatives related to "KT practice and science funding." These initiatives commonly provided funds for infrastructure development (e.g., clinical technologies, database subscriptions) to facilitate translational or applied research to address regional health priorities. Of the articles, 44% outlined an evaluation plan; few provided validated KT metrics. In the grey literature, 364 initiatives were described; the most commonly described initiatives related to "exchange and integrated KT." Focus group participants hoped to see increased resources to support KT, exchange opportunities with policy/decision-makers, and evaluate KT initiatives. Funders completed various KT initiatives, which tended to engage stakeholders to set research priorities, collaborate with a range of stakeholders, build KT capacity, and mandate KT requirements. We provide six considerations for funders to support KT.

Key words: research funding, knowledge translation, integrated knowledge translation, evaluation, barriers, opportunities

Introduction

The Government of Canada invests substantially in Canadian research with the goals of strengthening science and innovation and supporting evidence-based decision-making (Government of Canada 2021). Despite such investments, there remain gaps in the use of researcher-created knowledge by decision-makers (e.g., public policy-makers and healthcare leaders/administration) and other stakeholders (e.g., healthcare providers, non-profit and industry organizations) due to factors including competing demands and lack of mechanisms to package and deliver relevant knowledge to knowledge users in a timely manner (Lavis 2006). In the current COVID-19 pandemic context,

we recognize more than ever the need to rapidly disseminate newly created knowledge and mobilize the implementation of evidence-based recommendations.

The pandemic also disrupted the research ecosystem, through, for example, growth of preprint registries containing non-peer-reviewed research (Bauchner et al. 2020; Palayew et al. 2020; Caulfield et al. 2021), spread of misinformation affecting trust in decision-makers (Saitz and Schwitzer 2020; Caulfield et al. 2021), and increased health inequities with the greatest impact to communities already marginalized in health research (Khazanchi et al. 2020). These challenges, along with current societal contexts, provide opportunity to restructure the ecosystem to meet the needs of stakeholders, including accelerated evidence dissemination and implementation.

This project was conducted in partnership with the Canadian Institutes of Health Research (CIHR). The study team was approached by the CIHR to conduct this environmental scan to support the development of the organization's 2021–2031 strategic plan. As such, for the purpose of this project we define knowledge translation (KT) as the science and practice of dissemination and implementation of evidence into practice and policy (Straus et al. 2009; Straus et al. 2013). This definition reflects the CIHR's comprehensive KT definition, the importance of evaluating KT efforts (Straus et al. 2009), and work of other researchers that broadly categorizes KT into dissemination and implementation activities (Mitchell et al. 2010; Tabak et al. 2012).

Research funders can play a significant role in the future of KT by supporting the funding and translation of evidence into practice and policy. For instance, the CIHR, Canada's primary agency for health research funding, has embedded KT into its mandate to promote translation of new knowledge into improved health and health systems for Canadians (Canadian Institutes of Health Research 2016c). The CIHR embeds KT principles into its research institutes (e.g., Strategy for Patient-Oriented Research, Institute for Health Services and Policy Research) and mandates grant applicants to outline a KT plan for dissemination and (or) implementation of findings. The CIHR has developed several educational modules and frameworks (Canadian Institutes of Health Research 2020) to guide researchers to incorporate KT principles into their research and has dedicated funding streams that prioritize KT initiatives and integrated KT research (Canadian Institutes of Health Research 2013, 2016b). Similar initiatives have been led in other countries. For instance, the United States National Institutes of Health (NIH) support KT research by providing dedicated funding to dissemination and implementation research, building capacity among researchers in using KT frameworks, forming KT-oriented institutes (e.g., National Center for Advancing Translational Sciences (NCATS)), and embedding KT principles/implementation teams into NIH institutes (e.g., National Cancer Institute) (National Institutes of Health n.d.).

To determine the scope of work implemented by such agencies and to assess the impact of these programs, we aimed to conduct an environmental scan to assess the types of KT initiatives currently planned or initiated by high-income countries' research funders, describe how funders evaluate initiatives, identify common challenges and opportunities for funder-led KT initiatives, and provide strategic considerations based on trends observed in the findings for KT science and practice advancement by health research funders. This environmental scan builds upon previous work exploring funding agency support for KT (Tetroe et al. 2008; McLean et al. 2018). It offers insight on current trends of funding agencies to support and evaluate KT, challenges, specific KT initiatives undertaken, future visions for KT, and actionable suggestions for funders.

Materials and methods

As this study was conducted in partnership with the CIHR, the CIHR participated both as project partners (CIHR guided and reviewed methods and end of study products, though was not part of

the data analysis or interpretation) and primary knowledge users, as the study findings supported CIHR strategic planning. As such, this study represents an integrated KT initiative whereby the knowledge user was engaged throughout from research conception to completion (Canadian Institutes of Health Research 2015, 2016a). As part of our integrated KT process, all team members reflect on the biases they bring to projects to ensure transparency and understand how they might impact the research process.

We conducted an environmental scan, which, as outlined by Charlton et al. (2021), can consist of a range of data collection approaches and methods. Our scan consisted of a systematic search of published literature describing planned or implemented KT initiatives by international funding organizations and a document and webpage review of 21 purposefully selected funding organizations in high-income countries using a systematic Google-based search of a comprehensive list of related terms (described further below). This grey literature search was informed by Canadian Agency for Drugs and Technologies in Health's Resource: *Grey Matters: a practical tool for searching health-related grey literature*, which supports a comprehensive search of grey literature and transparent documentation of the process (Canadian Agency for Drugs and Technologies in Health 2021). The scan also involved a focus group where participants representing Canadian research funding organizations provided their perceptions on current and future KT goals and initiatives.

To categorize initiatives, nine "sub-types" of KT were conceptualized and defined a priori with input from the CIHR (Canadian Institutes of Health Research 2021): "within organization KT," "capacity building in KT," "funding of KT practice and science," "KT policies," "evidence-based decision-making," "synthesis," "dissemination and end of grant KT," "exchange and integrated KT," and "implementation" (see **Supplementary Material 1** for definitions and examples). These definitions were conceptualized and defined a priori with input from the CIHR and were informed by Colquhoun et al. (2014) and Rapport et al. (2018). Of note, this study was conducted before the launch of CIHR's new strategic plan, which uses the term knowledge mobilization rather than KT. Knowledge mobilization can be considered synonymous with KT (McKibbon et al. 2010). It is an umbrella term that includes a wide range of activities related to both the production and use of research results (Canadian Institutes of Health Research n.d).

Data sources

In partnership with the CIHR, we selected 10 high-income countries/regions (Canada, Australia, New Zealand (including neighboring islands), the Netherlands, France, the United Kingdom, the United States, Denmark, Norway, and Sweden). These countries were selected because they are comparable to Canada with regard to the structure of funding and granting councils for health-related and KT research as reflected in existing research (McLean et al. 2018). The CIHR reviewed the list to ensure no countries with similar funding and granting councils were omitted. From these countries, we included funding agencies that focus on health and (or) KT research (e.g., we included Social Sciences and Humanities Research Council and Natural Sciences and Engineering Research Council of Canada even though their funded research is not health focused because they include KT as part of their granting processes).

To ensure only recent KT efforts were reflected in the scan, articles were eligible for inclusion if they were published from 2015 to 20 January 2020. There were no restrictions based on study design. Eligible articles described KT initiatives planned or implemented by research funders or challenges or opportunities to implementing KT initiatives by funders. Articles were excluded for the following reasons: published in a language other than English or French; pertained to a country/region other than the aforementioned list (e.g., articles reporting KT initiatives by funding organizations in low- and middle-income countries); published conference proceedings; editorials authored by individuals

not affiliated with a research funding organization in one of the aforementioned countries/regions; did not describe organization-led KT initiatives; or did not map into one of the pre-determined KT sub-types (see **Supplementary Material 1** for sub-types).

A MEDLINE search developed by an expert library technician was conducted on 20 January 2020 (see **Supplementary Material 2** for full search strategy). Informed by the work of McKibbon et al. (2010), a comprehensive taxonomy of KT-related keywords was developed for the search strategy (see **Supplementary Material 3** for keywords). Additionally, a list of research funding organizations in the 10 high-income regions was included with "OR" Boolean terms to facilitate the search.

To guide the grey literature search, we developed in partnership with the CIHR a list of research funding organizations with similar objectives/mandates to Canadian funding agencies (see **Supplementary Material 4** for organizations).

Webpages and (or) documents were included in the grey literature review if they described one of the target organizations' KT goals and (or) current or planned KT initiatives. Webpages and (or) documents were excluded if the date of publication was prior to January 2015 *and* a more recent version of the document was identified (e.g., an annual report published in 2012 excluded if a more recent version identified); work described took place in a country other than the 10 included countries/regions (e.g., a high-income country supporting KT initiatives in a low- or middle-income country); the webpage/document described a press release, news article, blog, or call for proposals; the webpage/document did not mention KT or the KT mentioned did not map into one of the KT sub-types; or the webpage/document described a subsidiary of the funding agencies or a specific funded project.

A comprehensive list of search terms was developed to identify relevant documents (see **Supplementary Material 5** for search terms). A systematic, Google-based search strategy of these terms was conducted in March 2020 to source these terms on the websites of each target organization (see **Supplementary Material 4** for organizations). A "clean" browser was used for each search (i.e., no cookies or web history were recorded between searches).

Study selection

Two trained researchers (KQL, AC) independently screened 10% of the titles and abstracts of retrieved articles from the database search. Staff met to resolve discrepancies until 75% agreement was reached. The full research team was engaged to support with resolving any discrepancies that could not be resolved by KQL and AC. Once ≥75% agreement was reached, a single researcher screened the remaining articles. Following this, one researcher (KQL) single screened the remaining articles. A similar process was used for screening of full-text articles for inclusion (KQL, RB).

For the grey literature, trained researchers (DK, RB, KQL) reviewed the first page of Google search results (i.e., the first 10 hits) and tracked in a spreadsheet, all webpages that met the inclusion criteria. They assessed page relevance via webpage titles and subtext descriptions on Google. Following this, three research staff (DK, RB, AC) independently screened 10% of the identified webpages to determine eligibility. Staff undertook multiple rounds of screening 10% of the sources followed by discussion until ≥75% agreement on eligibility was reached. Discrepancies were resolved using discussions with the full research team until consensus was reached. The remaining webpages and documents were single screened.

Data abstraction and analysis

Across the published and grey literature, three people (DK, RB, KQL) independently extracted the relevant data from each source into data abstraction templates. Research staff regularly met to ensure consistent interpretation of the abstraction criteria. The following data were abstracted and synthesized: KT goals; KT initiatives and their sub-types (initiatives were categorized into their most relevant sub-types; these sub-types were not mutually exclusive, specifically, a KT initiative could be categorized into and counted in multiple sub-types); organizations' use of an integrated KT approach (defined as an approach to KT that engages stakeholders as partners throughout the research process (Canadian Institutes of Health Research 2016a)) or related concepts such as co-creation (of knowledge through collaboration between researchers and stakeholders (Greenhalgh et al. 2016)) and community-based participatory research (active involvement of community, organizations, and researchers through the research process with a focus on addressing inequalities (Israel et al. 2001)); the use/mention of an evaluation plan or evaluation indicators; and challenges and opportunities for KT initiative planning/implementation or sustainability.

Categorical data were analyzed using descriptive statistics. Open-ended data were analyzed using a thematic analysis approach (Braun and Clarke 2006) whereby three people (DK, RB, KQL) identified common trends across the abstracted data (KT goals, initiatives, evaluation of KT initiatives, and challenges and opportunities). Codebooks were developed for the published and grey literature to organize the common themes among the KT goals, initiatives, evaluation strategies, and challenges and opportunities. Three people (DK, RB, KQL) pilot tested the codebooks to ensure common understanding of the codes. Given this was an environmental scan, a risk of bias assessment was not conducted for identified articles in the published literature search.

Focus group

The scan also involved a focus group with Canadian research funders to explore their current and planned KT initiatives. Focus group participants were asked to describe each of their organizations' KT initiatives and categorize them as organizational KT (KT initiatives that are planned by, or carried out by, the research funder) or KT required of the funded researcher as specified by the funding organization (e.g., end of grant dissemination requirements). Additionally, we provided participants the opportunity to explore as a group "blue sky" ideas (i.e., KT aspirations if budgets and resources were unlimited) they hoped to see implemented to advance organizational KT initiatives. Perspectives and ideas from the individuals were enriched through discussions with others.

The focus group was conducted with Canadian provincial health research and funding organizations in November 2020. Key informant participants were purposefully recruited using email invitations. The focus group was facilitated in English by an experienced KT scientist (SES) via Zoom videoconference, was semi-structured, and lasted 60 minutes (see **Supplementary Material 6** for discussion guide).

Following participant consent, the focus group was audio-recorded and transcribed verbatim. Data were analyzed using a framework rapid analysis approach (Hamilton 2013). The research team developed a coding framework a priori, which organized KT initiatives into participants' organizational KT, KT required of the funded researcher as specified by the funding organization, and participants' "blue sky" ideas. Open-ended data were organized by one researcher (RB) using this framework. Categorical data were analyzed by one researcher (RB) using descriptive statistics. A thematic analysis approach (Braun and Clarke 2006) with two researchers (DK, RB) was used to identify key trends across the organized data (KT initiatives and "blue sky" ideas). A consensus on dominant themes was reached.

From these findings, we developed strategic considerations for funders to support KT and suggestions for how these can be operationalized. These strategic considerations were informed by the common challenges and opportunities identified in the published literature, the KT initiatives identified in the grey literature, and the KT initiatives and "blue sky" ideas identified in the focus group discussion. To develop these considerations, following thematic analysis of the published and grey literature and focus group data, and CIHR review of draft data summaries, two research coordinators (DK, RB) categorized the data into pre-determined areas of interest to the CIHR to ensure relevancy of data. These areas of interest included current trends in organizational KT initiatives, future trends, and inspiring KT efforts. The research staff reviewed the organized data and created draft considerations and suggestions for operationalization by consensus. These were reviewed and refined by two experienced researchers (CF, SES) in relation to the current KT landscape among Canadian funders.

To protect participant anonymity, data are presented in aggregate form. This study received ethics approval from the Unity Health Toronto Research Ethics Board. Focus group participants were sent the terms of consent in advance. If they consented to the terms, they were invited to join the scheduled videoconference. At the start of the videoconference, focus group participants were reminded they received the terms of consent in advance and if they did not consent to participate, they could disconnect from the call; their consent to participate was implied by staying on the line.

Of note, the Institute of Indigenous Peoples' Health of the CIHR undertook similar research, led by the Indigenous community (Canadian Institutes of Health Research 2022).

Results

Published and grey literature

A total of 212 unique data sources (e.g., manuscript, document, or webpage) were identified including 39 published articles and 173 grey literature sources. Across literature types, sources from the United States (30%), Canada (28%), and the United Kingdom (18%) accounted for over 75% (see **Table 1**).

A full list of the published and grey literature sources is available upon request.

Published literature

We identified 130 unique titles and abstracts and subsequently 75 full-text articles were screened. Inter-rater reliability for full-text screening was 100%. A total of 39 articles were included in the review (see **Supplementary Material 7** for PRISMA diagram).

Published literature: Organization and article characteristics

Organization types most commonly represented in the included articles were government (52%), academic (19%), charity or non-profit (12%), and healthcare organizations (11%) (see **Figure 1**). Articles describing KT initiatives in the United States accounted for the majority of published literature (67%) (see **Table 1**).

Published literature: KT initiatives

We identified 52 KT initiatives led by 20 funding organizations (see **Table 2** for overview of initiatives; see **Supplementary Material 8** for organizations identified).

Seven KT sub-types were described in the published articles, with the most common (56% of articles) being the "funding of KT practice and science" (see **Figure 2**). These KT initiatives commonly sought to provide funds for the development of infrastructure (e.g., clinical technologies, database

Table 1. Data sources by country/region (across published and grey literature).

Country/Region	Published		Grey literature		Sources combined	
	N	% of total sources	N	% of total sources	N	% of total sources
United States	26	66.7%	38	22.0%	64	30.2%
Canada	2	5.1%	58	33.5%	60	28.3%
United Kingdom	3	7.7%	34	20.0%	37	17.5%
Australasia *(Australia, New Zealand, and some neighboring Islands)*	2	5.1%	14	8.1%	16	7.5%
Denmark	1	2.6%	15	8.7%	16	7.5%
Norway	0	0%	10	5.8%	10	4.7%
Netherlands	1	2.6%	4	2.3%	5	2.4%
Sweden	2	5.1%	0	0%	2	0.9%
France	1	2.6%	0	0%	1	0.5%
McLean et al. (2018)[a]	1	2.6%	0	0%	1	0.5%
Total number of sources	39	100.0%	173	100.0%	212	100.0%

[a]The study McLean et al. (2018) is separated from other studies as unlike the other studies, which included data from single countries, this study synthesized information from several: Australia, Canada, Netherlands, Denmark, Norway, United Kingdom, United States, France, and Sweden.

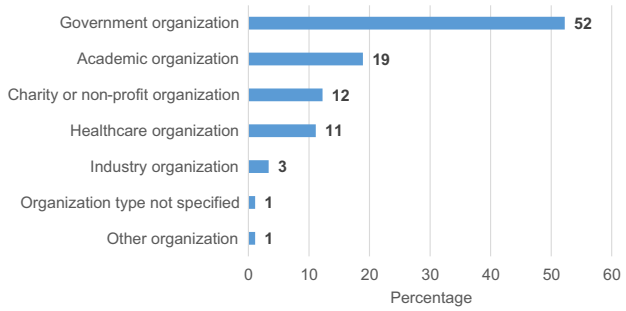

Fig. 1. Organization types represented in the published literature[a,b]

subscriptions, software licenses) to facilitate translational or applied research to address regional health priorities. For example, the Infrastructure Development Award for Clinical Translational Research program (NIH) funds infrastructure for clinical and translational research programs in regions in the United States and Puerto Rico that have historically received less support from the NIH (Dao et al. 2015; Willey et al. 2018). "Capacity building in KT" initiatives were also common (38% of articles); these tended to dedicate resources to support KT and community engagement training for researchers and stakeholders. For example, the NIH Mentored Clinical Scientist Research

[a]The "other organization" refers to the UK Clinical Research Collaboration.
[b]Healthcare organizations that may be academic centers or otherwise involved in research were only additionally categorized under "academic organization" if the hospital's research arm or institute was explicitly mentioned in the article.

Table 2. Overview of KT initiatives identified in the published literature.

KT sub-type	Country/Region	Themes	Example
Funding of KT practice and science	United States	Programs to support the translation of basic science to clinical application	The National Institutes of Health (NIH) have invested over $4 billion in nanotechnology research to move human disease conditions (most commonly cancer) from discovery to clinical application
		Research grants to support dissemination and implementation research	NIH Research Project Grant dissemination and implementation and translational research awards
	United Kingdom; Australasia	Funding to facilitate collaborative applied research between academics and health practitioners	The National Institute for Health Research (NIHR) funds regional partnerships between National Health Service organizations and academic institutes to conduct research that addresses local needs, translates findings to practice, and builds organizational capacity for research
Capacity building in KT	United States	Funding and mentorship programs for underrepresented groups and early career researchers	The NIH Mentored Clinical Scientist Research Career Development includes awards for patient-facing research. These awards aim to support early career researchers to transition to independent researcher awards
Exchange and integrated KT	United States	Dedicated funding and guidance to support community engagement in research	Patient-Centered Outcomes Research Institute's (PCORI) Pipeline to proposal supports patient and stakeholder partnerships in conducting research and supports new stakeholders to develop such partnerships
	United Kingdom	Mechanisms to support practitioner-driven research inquires	The UK Clinical Research Collaboration (UKCRC)-funded Centre for Translational Research in Public Health's "AskFuse" service allows individuals in the health system to submit their questions to be paired with relevant researchers, to promote community-driven research
Implementation	United States	Establishment of multidisciplinary networks to accelerate the implementation of medical technology	Consortia for Improving Medicine with Innovation and Technology (CIMIT) is a network of academic medical centers and universities that have developed a model to accelerate implementation of research into devices, procedures, and technologies. The group collaborates with diverse stakeholders to implement such technologies
	Canada	Funding to build practitioner and institutional capacity for implementing research in patient care	Council of Academic Hospitals of Ontario's (CAHO) Advancing Research to Improve Care (ARTIC) program supports academic hospitals in Ontario to implement research evidence to improve patient outcomes
Dissemination and end of grant KT	United States	Collaborations to identify challenges to, and opportunities for, conducting D&I research	The University of Southern California in partnership with the NIH and Kaiser Permanente held a symposium on conducting successful dissemination and implementation research
Evidence-based decision-making	France	Development of data and clinical networks to iteratively evaluate and improve clinical care	The France Ministry of Higher Education, Research and Innovation and Ministry of Health supported the development of a national network of schizophrenia expert centers that use an iterative data-driven approach to develop personalized care programs for patients
KT policies	United States	Mandating transparent and publically available dissemination as a requirement for funded teams	Various US-funding bodies (e.g., Agency for Healthcare Research and Quality (AHRQ), Centers for Disease Control and Prevention (CDC), Food and Drug Administration (FDA), NIH) mandate that manuscripts be stored in PubMed central while others require all trials to be registered on clinicaltrials.gov. PCORI has policies to target dissemination of findings to academic, lay and research audiences

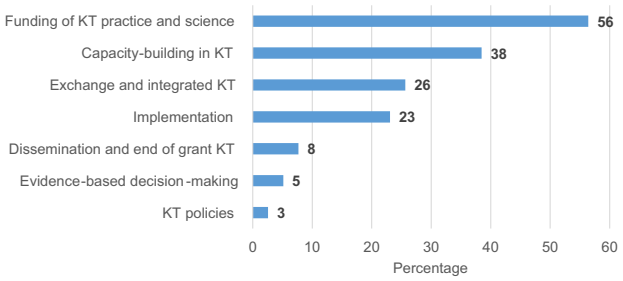

Fig. 2. KT sub-types represented in published articles (n = 173).

Career Development program supports training of early career researchers in translational and patient-facing research (Schneider et al. 2015; Yin et al. 2015; Good et al. 2018). "Exchange and integrated KT" initiatives were another common sub-type (26% of articles), which provided funding and guidance for community engagement in research. For example, NIH's NCATS Clinical and Translational Science Awards-funded institutes are required to have a Community Engagement Core focused on pursuing community engagement through the center's research (Holzer and Kass 2015).

Published literature: KT initiative evaluation

Of the included articles, 44% described an evaluation plan for the KT initiative; 88% of these articles included indicators in their evaluation plan. Examples of indicators included quality of interactions with stakeholders, number of funded translational projects that resulted in a clinical trial, degree to which funding contributed to relationships between researchers and policy-makers, and self-reported understanding of KT concepts (see **Table 3** for list of all identified plans and indicators by KT sub-type).

Published literature: KT initiative challenges and opportunities

A lack of dedicated financial and personnel resources to support KT, particularly as needed to meaningfully engage target stakeholders (e.g., patients, public, organizations), and lack of minimum standards for project KT were common challenges to implementing KT initiatives across KT sub-types (see **Table 4** for further details on challenges). Additionally, misalignments in priorities, processes, and timelines between research organizations and relevant stakeholders challenged the uptake of research evidence. Common opportunities for research funders included: dedicating funding to meet resource needs to support KT, resources and mentorship of early career researchers to support their career development in KT-related skills (e.g., in relationship building), knowledge user (e.g., policy-makers and patients) engagement in research, outlining minimum dissemination requirements for funded research projects, making research publicly available to stakeholders and researchers, and building capacity among research organizations as leaders in KT so they can support funded researchers in KT activities and promote KT throughout projects (see **Table 4** for further details on opportunities).

Grey literature

The grey literature search strategy identified 2415 webpages and documents; 912 were excluded during initial screening and 1503 webpages and documents underwent full-text screening. Inter-rater reliability for full-text screening was 92%. A total of 173 sources representing 21 funding organizations were included in the analysis (see **Supplementary Material 9** for PRISMA).

Table 3. Evaluation plans or indicators identified in the published literature.

KT sub-type	Evaluation plans and (or) indicators described in published literature[a]
Funding of KT practice and science	**United States** • **National Institutes of Health (NIH)'s National Heart, Lung, and Blood Institute (NHLBI) Science Moving towArds Research Translation and Therapy program (SMARTT) program indicators (Ebert et al. 2016):** ○ Number of Investigational New Drug (IND) applications supported by the program ○ Quality of interactions with the Food and Drug Administration (FDA) ○ Number of pre-IND meetings conducted ○ Number of Orphan Drug Applications submitted ○ Number of investigators supported through the planning process (even if they did not reach the stage of IND application) • The **NIH nanotechnology** portfolio indicators (Henderson and Shankar 2017): ○ Number of funded translational projects that resulted in a clinical trial • **NIH's National Center for Advancing Translational Sciences (NCATS) Clinical and Translational Science Awards (CTSA)** program indicators (Hogle and Moberg 2014): ○ Success case studies (i.e., project-specific descriptions and researchers' perceptions of program impact on researchers' scientific achievement and career advancement) • **NIH's NCATS CTSA** indicators of Emergency Department involvement (Meurer et al. 2016): ○ National survey to assess the degree of involvement of Emergency Care programs in CTSA institutions across the United States, as well as the programs' use of CTSA resources and their degree of academic collaboration with the CTSA. • **Conference on sustainability in KT** activity indicators (Proctor et al. 2015): ○ Conference satisfaction survey at the end of the meeting **United Kingdom** • **NIHR's Collaboration for Leadership in Applied Health Research and Care, South West Peninsula (PenCLAHRC)** indicators (Heaton et al. 2016): ○ Monitored the progress of the PenCLAHRC projects and used theory and observations to identify consistent characteristics that led to PenCLAHRC project success **Australasia** • **New South Wales (NSW) Ministry of Health's Population Health and Health Services Research Support (PHHSRS)** indicators (Thackway, Campbell and Loppacher 2017): ○ The degree to which the funding contributed to relationships between researchers and policy-makers ○ The degree to which the funding increased researchers' use of an "embedded approach" to research (i.e., building relationships in local settings and developing a deeper understanding of health system issues) ○ Policy stakeholders' intended use of NSW Ministry of Health reviews

(*continued*)

Table 3. (*continued*)

KT sub-type	Evaluation plans and (or) indicators described in published literature[a]
Capacity building in KT	**United States** • **NIH's National Institute on Drug Abuse (NIDA)** "Graduate Certificate in Translational Research in Adolescent Behavioral Health Program" indicators (Baldwin et al. 2017): ○ Translational Research Impact Scale (TRIS) was used to evaluate. The scale includes three domains of potential impact: ■ Research-related impact (e.g., increases in number of grant submissions and publications by translational researchers) ■ Translational impacts (e.g., incorporation of clinical trial results into clinical guidelines) ■ Societal impacts (e.g., strengthening and refining health-related policies, improvements in community health) • **NIH's NIDA, National Institute on Minority Health and Health Disparities (NIMHD), and National Cancer Institute (NCI)'s Clinical Research Education and Career Development (CRECD)**-funded university program indicators (Estape et al. 2018): ○ Multidisciplinary career development, including: ■ Programs' achievement of diversity outcomes (i.e., composition of annual enrollment of students and diversity of disciplines represented in the composition of the students' research committees) ■ Amount of research being conducted on health disparities ○ Degree of multi-institutional participation (e.g., having partner schools' faculty participate in the program's admission committee) ○ Researcher career development metrics, including number of: ■ Scientific presentations ■ Peer-reviewed and public publications, honors, and awards ■ Grant submissions ■ Externally funded research projects ■ Research and (or) academic appointments • **NIH's Translational Science Training Program (TSTP)** indicators (Gilliland et al. 2017): ○ Participant self-reported questionnaire on knowledge and understanding of translational science, career development, exploration, and networking • Indicators of success rates of pediatric **NIH** career development awardees (i.e., **K08 or K23** awards) transitioning to independent research (**R01**) awards (Good et al. 2018): ○ Number of researchers who accessed NIH RePORTER, an electronic repository of NIH-funded projects ○ Characteristics of successful career-development awardees • Indicators for **NIH's NCATS CTSA** Mentored to Independent Investigator Working Group assessment of the "K2R" transition (Yin et al. 2015): ○ Number of **K08** or **K23** award winners that apply to, versus receive an **R01** award ○ K2R acceptance timelines • **NIH's NCATS CTSA KL2** career development program indicators (Schneider et al. 2015): ○ Survey to CTSA education core program administrators on the institutional environment where each KL2 program was implemented (e.g., KL2 program funding, number of KL2 positions available, required coursework) ○ Application and progress reports as well as institutional data were used to assess KL2 awardees' early career outcomes (e.g., demographic information, department, professional status, number of grants and publications before and after KL2, career outcomes after KL2 program)
Exchange and integrated KT	**United States** • **PCORI's National Patient-Centered Clinical Research Network (PCORnet)** evaluation approach (Terry 2017): ○ Three committees (data, engagement, and research) iteratively assess if the program is achieving "authentic engagement" ○ Program is committed to being transparent about their lessons learned

(*continued*)

Table 3. (*concluded*)

KT sub-type	Evaluation plans and (or) indicators described in published literature[a]
Implementation	**United States** • **Consortia for Improving Medicine with Innovation and Technology (CIMIT)** indicators (Parrish et al. 2015): ○ Evaluated clinical, academic, and commercial outcomes to assess the success of their program (e.g., return on investment) **Canada** • **Council of Academic Hospitals of Ontario (CAHO)'s Adopting Research to Improve Care (ARTIC)** program conducted both a project-level and program-level evaluation (Moore et al. 2016). No specific indicators were listed for the project-level evaluation. Program-level indicators: ○ Reach of the ARTIC program ○ Sustainability of the ARTIC program ○ Spread of the ARTIC program ○ Data collection measures: interviews with program stakeholders and local teams, surveys with all participating sites, document review from the project team leads and the ARTIC program office (each team was required to submit a monitoring and evaluation component)
Dissemination and end of grant KT	N/A
Evidence-based decision-making	N/A
KT policies	N/A

[a]This column summarizes the evaluation plans and (or) indicators that were described in the published article(s) included in the review and may not be a comprehensive list of the programs' evaluation plans and (or) indicators.

Grey literature: organization and source characteristics

The majority of organizations were government organizations (76%); the remaining organizations were charity or non-profit organizations (see Table 5). The data sources consisted of webpages/documents describing a program or initiative (44%), "about us" webpages (17%), strategic and operational plans (15%), annual reports/reviews (8%), "mission, vision and values" webpages (5%), evaluation reports (3%), financial statements/reports (1%), and other types of webpages/documents (8%). Aligned with the purposeful selection of Canadian and international funding organizations, 34% of the sources were from Canada, 22% from the United States, and 20% from the United Kingdom. The remaining sources were from Denmark (9%), Australasia (8%), Norway (6%), and the Netherlands (2%) (Table 1).

Grey literature: KT goals and initiatives

All organizations described KT goals and initiatives; the majority of organizations outlined evaluations for at least one KT goal (62% of organizations) or initiative (71% of organizations) yet only approximately one half (52%) of organizations provided evaluation indicators for the goals and one-third (33%) for the initiatives (see Supplementary Material 10 for a summary of organizations' KT goals, initiatives, sub-types, use of integrated KT, and stakeholders). Only one organization, the Saskatchewan Health Research Foundation (SHRF) (Canada), provided a cost analysis of a KT initiative (Saskatchewan Health Research Foundation 2019).

More than 90% of organizations described all KT sub-types in their KT goals and (or) KT initiatives, apart from "KT policies" (76% of organizations) and "synthesis" (62% of organizations) (see Supplementary Material 10 for details). Most organizations (95%) mentioned carrying out integrated KT and related concepts; however, only 76% of organizations provided actionable details/

Table 4. Description of common challenges and opportunities for funder-led KT initiatives.

KT sub-type	Audience	Key challenges to KT initiative implementation/sustainability	Key facilitators/opportunities for KT initiative implementation/sustainability by research funders
Funding of KT practice and science	For funders	Limited available funding for KT research	Fund research on sustainability and capacity building
		With increased focus on translation science, there are fears about the impact on basic science research	Use "dispersed" leaderships models to increase buy-in and success of funded teams (e.g., involve multiple stakeholders, develop shared accountability for project success)
			Make continued funding contingent on meeting benchmarks (e.g., Science Moving towArds Research Translation and Therapy program (SMARTT) program)
Capacity building in KT	For funders		Invest in resources to support career development for early career researchers (particularly as related to translational research and relationship building)
Exchange and integrated KT	For funders	Communities (e.g., patients, public) are often not meaningfully engaged in research processes	Allocate dedicated funds to support community engagement and the use of integrated KT
		Budgets to support community-partnered research are not adequate for meaningful, continued engagement	Provide resources and mentorship to funded research teams to promote uptake of meaningful integrated KT (e.g., Patient-Centered Outcomes Research Institute (PCORI)'s Pipeline to Proposal mechanism)
		Research and public health processes may not be compatible (e.g., public stakeholders require answers on a short timeline)	Ongoing forums and conferences can promote community partnership in dissemination and implementation
Implementation	For funders	Lack of implementation knowledge/capacity among funding organizations	Build capacity among research funders so they perceive success of implementation as part of their role
			Provide appropriate resources to research teams to facilitate successful implementation
	For research teams	Lack of appropriate funding/clear funding requirements can limit number/impact of implementation activities	Aim to secure resources needed to execute KT work (e.g., personnel with required skills, dedicated research time, funds)
		Evaluation of implementation efforts can be resource intensive	Use multidisciplinary teams with strong facilitators and a focus on end-users to increase success of KT projects
Dissemination and end of grant KT	For funders and research teams	Research priorities, processes, and outcomes do not always fit the needs of the healthcare system. Methods to combine effectiveness and improvement science may address these challenges	The use of multidisciplinary teams can promote dissemination of research findings
Evidence-based decision-making	For funders and research teams		Leadership (at the funding or health system level) can promote uptake of evidence-based decision-making
	For research teams	Resource limitations (including time, personnel, and funds) and negative attitudes can restrict evidence-based decision-making	
KT policies	For funders	There is a general lack of dissemination requirements for funded research projects; few organizations have policies to promote dissemination and uptake of funded research	Consider outlining minimum dissemination requirements for funded research projects. Dissemination should ideally be accessible to the public and provide capacity building tools to improve research uptake

Table 5. Characteristics of organizations included in grey literature review.

Organization (n = 21)	Country	Type of organization	Number of sources included in analysis
Social Sciences and Humanities Research Council (SSHRC)	Canada	Government organization	6
Natural Sciences and Engineering Research Council of Canada (NSERC)	Canada	Government organization	7
Canadian Institute for Advanced Research (CIFAR)	Canada	Charity or non-profit organization	4
Health Quality Ontario (HQO)	Canada	Government organization	8
Council of Academic Hospitals of Ontario (CAHO)	Canada	Government organization	5
Saskatchewan Health Research Foundation (SHRF)	Canada	Government organization	4
Michael Smith Foundation for Health Research (MSFHR)	Canada	Government organization	13
Research Nova Scotia (RNS)[a]	Canada	Charity or non-profit organization	3
Alberta Innovates (AI)	Canada	Government organization	8
U.S. Department of Veterans Affairs (VA)	United States	Government organization	10
Patient-Centered Outcomes Research Institute (PCORI)	United States	Charity or non-profit organization	15
National Institutes of Health (NIH)	United States	Government organization	13
Medical Research Council (MRC)[b]	United Kingdom	Government organization	11
Wellcome Trust (WT)	United Kingdom	Charity or non-profit organization	4
National Institute for Health Research (NIHR)	United Kingdom	Government organization	15
Health Foundation (HF)	United Kingdom	Charity or non-profit organization	4
National Health and Medical Research Council (NHMRC)	Australia	Government organization	7
Health Research Council of New Zealand (HRC)	New Zealand	Government organization	7
Norwegian Medical Research Council (NMRC)	Norway	Government organization	4
Danish Agency for Science, Technology and Innovation (DASHE)	Denmark	Government organization	10
Netherlands Organization for Health Research and Development (ZonMw)	The Netherlands	Government organization	15
Total number of URLs reviewed			173

[a]Nova Scotia Health Research Foundation (NSHRF) was replaced by Research Nova Scotia (RNS) in 2019.
[b]MRC URLs include URLs related to ResearchFish, which began as an MRC project assisting MRC with data gathering, research tracking, and measurement of grant impacts.

examples on these concepts, which could allow activities to be replicated by other organizations (see Supplementary Material 10 for details).

A total of 364 KT initiatives were described across the 21 organizations (see Supplementary Material 11 for key examples of initiatives, arranged by KT sub-type). "Exchange and integrated KT" were the most common KT initiatives (61% of initiatives), followed by "dissemination and end of grant KT" (57%) and "implementation" (39%). "Exchange and integrated KT" initiatives commonly sought to provide opportunities to include stakeholders in strategic planning and priority setting, forums for collaboration with end-users (e.g., communities, patients and the public, clinicians, decision-makers) including structured co-creation activities, and capacity-building initiatives for researchers and stakeholders in "exchange and integrated KT." "Dissemination and end of grant KT" initiatives commonly supported open-access policies, disseminated project findings via dedicated events and media or communications strategies, often with dedicated communications teams and programs, and specified minimum dissemination requirements for researchers. "Implementation"

initiatives commonly sought to develop or leverage existing networks or partnerships to support implementation, assist researchers with implementation activities, and study implementation efforts.

Grey literature: stakeholder groups

Stakeholders were groups that could have been mentioned in the context of any KT initiative, such as co-creation activities or community-based participatory research activities. Commonly mentioned stakeholder groups included public and patients (100% of organizations), policy-makers (95%), and researchers (95%); 48% specified early career researchers, and 29% specified later stage career researchers. Healthcare professionals (81%) and healthcare leaders (62%) were also commonly mentioned stakeholders (**Supplementary Material 10**). Organizations commonly reported involving stakeholders across their organizational activities including project co-creation and results dissemination (particularly public and patients), research priority setting (particularly policy-makers), and results implementation (particularly healthcare professionals).

Focus group

Focus group: Participant characteristics

Nine individuals representing eight Canadian provincial funding organizations participated in the focus group. Of these, four represented a government organization, three represented a charity or non-profit organization, and one was an academic organization. To ensure anonymity, their organizations are not specified.

Focus group: KT initiatives

Focus group participants cited 28 current KT initiatives led by their organizations, the majority of which focused on "dissemination and end of grant KT" (75%), "exchange and integrated KT" (75%), followed by "funding of KT practice and science" (63%), and "KT policies" (50%). The majority of initiatives (82%) represented organizational KT, whereby organizations connected researchers and research users (particularly government and healthcare policy-makers) through in-person and virtual events to build relationships, disseminated research findings via reports and webinars, and provided opportunity for research users to communicate their priorities and guide research design. The remaining initiatives (18%) represented KT required of the funded researcher as specified by the funding organization. These initiatives often aligned with organizations' "KT policies" and outlined their requirements for funded researchers' proposals to include KT or impact plans and organizations' minimum standards for reporting KT (e.g., in researchers' final reports or publications).

Focus group: KT "blue sky" ideas

Focus group participants were asked to identify "blue sky" ideas. Through discussion, six themes emerged: participants suggested the research funding system be re-engineered to emphasize "pull innovation," meaning research users should help prioritize which research projects should proceed and research users should be properly resourced with time, funds, and knowledge to be involved in research and KT. Participants recommended that funders appoint a team within the funding organization to support KT and communications. Some participants recommended this group may act as a "KT lab" to synthesize findings across related funded research projects and disseminate these to research users. Participants also suggested that funders create a mechanism for research results to flow into a relevant database, increase engagement of community organizations to enable evidence implementation, embed KT experts within decision-making bodies, and evaluate the quality and impact of KT initiatives conducted by funders and funded teams (see **Table 6** for participant quotations elaborating on these themes).

Table 6. Participant quotes elaborating on the "blue sky" idea themes.

"Blue sky" idea themes	Illustrative quotation
Research funding system be re-engineered to emphasize "pull innovation"	*"Go upstream and identify what the problems are… the way research has been funded, it seems to be designed for the scholarly circuit of the research and the goal of the circuit is to get another trip around the circuit, and it's not to actually influence practice or actually change the design on the backend. So I think I would do a methodological reengineering of the system to make sure we had all those things, and I think pull innovation is really important." – Participant 15*
Funders appoint a team within the funding organization to support KT and communications	*"I would create a dedicated team inside my organization completely dedicated to KT being able to promote some different actions in terms of funding, but also in terms of I don't like to say communication because it's KT is more than communication but that is the point." – Participant 85*
Funders create a mechanism for research results to flow into a relevant database	*"It'll be really good to have an ability to go in there and then utilize the funding that we do with our researchers and have that key aspect at the end of the research that the data that's generated can actually flow into, can be put in a certain manner that can flow into this large database. So it could be utilized, so connectivity." – Participant 67*
Funders increase engagement of community organizations to enable evidence implementation	*"I would also try to find a way to engage more strongly municipalities and community organizations. Part of evidence should be translated in interventions led by them." – Participant 85*
Funders embed KT experts within decision-making bodies	*"I'd love to be able to embed both senior level in the health authorities with someone who understands knowledge translation. I know the people that we work with who are at the mid-level are really striking their heads against a wall, trying to get senior management to understand the benefits around knowledge translation and what needs to be done." – Participant 43*
Funders evaluate the quality and impact of KT initiatives conducted by funders and funded teams	*"Co-determine who needs to be at the table and they would have the time and money to be there. You co-design solutions with them at the table and then you would co-implement those solutions and evaluate at the back end." – Participant 15*

Discussion

Our findings show that Canadian and international research funders have made investments in advancing KT of funded research. Initiatives included developing infrastructure to facilitate KT, allocating resources to build KT capacity among researchers and stakeholders, supporting collaboration with communities, the public, and other stakeholders for co-creation of projects and results implementation, supporting collaboration with decision-makers to set priorities, and mandating minimum requirements for KT use and reporting.

We classified KT initiatives using KT sub-types that were conceptualized and defined a priori. This approach allowed for comparisons in initiative type, including insight on KT trends across organizations and regions. The most common sub-type identified in the published articles' KT initiatives was "funding of KT practice and science." In contrast, the most common sub-type identified in the grey literature's KT initiatives was "exchange and integrated KT." As the grey literature search focused on public-facing websites, organizations may have chosen to showcase their exchange and integrated KT activities as a means for advertising public involvement.

Most (95%) organizations included in the grey literature review mentioned carrying out integrated KT or related concepts; 76% of organizations provided actionable details on these concepts. Organizations reported engaging a variety of relevant stakeholder groups across activities such as project co-creation, results dissemination, research priority setting, and results implementation.

Our findings are consistent with similar studies published in the past decade, which suggest funding agencies have increasingly recognized their critical role in supporting all phases of KT from knowledge creation to implementation (Tetroe et al. 2008; McLean et al. 2018). Notably, types of

KT initiatives may have evolved over time. For instance, McLean et al. (2018) demonstrated an increased prevalence of integrated KT (or exchange) initiatives by funders in the past decade, noting a shift away from traditional funding approaches that prioritize researcher over research user.

The grey literature review revealed trends by region. "Exchange and integrated KT" was the most common KT sub-type reflected across KT initiatives from Canadian and UK organizations; in contrast "dissemination and end of grant KT" was most commonly cited by US organizations and "implementation" was most prevalent in Australasia, Norway, Denmark, and the Netherlands. Some organizations highlighted specific groups for engagement (e.g., Indigenous communities in Canada, Australia, and New Zealand). Across different countries, research assessment exercises and policy landscapes are conducted differently and this could influence KT activities, in particular by underscoring the need to focus on research dissemination and uptake. For example, institutions that sign on to Declaration on Research Assessment (DORA) are committed to improving the way researchers and scholarly outputs of research are evaluated, moving beyond considering journal impact factors to assessing research impact, which implies KT (DORA n.d.; Science Europe 2022).

Few sources included in our study provided specific evaluation tools to track indicator metrics. One exception is the Translational Research Impact Scale (Dembe et al. 2014) used by the National Institute of Health Research. This scale provides a systematic approach to assessing return on research investment and impact of research on practice and health, using 72 indicators (Dembe et al. 2014). It was found to have a high degree of reliability (ranging from .75 to .94) when it underwent a validation process with an expert panel (Dembe et al. 2014). Only one identified source provided a cost analysis of a KT initiative (Saskatchewan Health Research Foundation 2019).

This evaluation challenge facing funders was previously reported by Tetroe et al. (2008) who after conducting semi-structured interviews with international health funding agencies reported in 2008 that funding agencies were not prepared to conduct comprehensive evaluations of impact due to issues in designing robust studies and selecting appropriate indicators. Ten years later, using website and document reviews and a focus group, the research team arrived at a similar conclusion, demonstrating that funders were unable to provide empirical evidence to evaluate the impact of their KT initiatives (McLean et al. 2018). Additional work to develop and encourage uptake of evaluation frameworks or metrics to assess impacts and returns on investments is needed.

Summarizing the findings of our environmental scan, we find that Canadian and international research funders are carrying out several KT initiatives. These tend to engage stakeholders to set research priorities, collaborate and co-create with a range of stakeholders, particularly patients and the public, build researcher and stakeholder capacity in KT, and mandate KT requirements. To "keep current" with the KT trends described in this paper, research funders could consider incorporating similar initiatives into processes and policies. For funders in the planning stages of KT initiatives, the common challenges and opportunities to implementing KT initiatives from the published literature and "blue sky" ideas from the focus group offer important considerations. These highlight the importance of ensuring sufficient resources and policies to support KT activities (including KT capacity building) and their evaluation and of aligning funders' and stakeholders' priorities, processes, and timelines around research and subsequent knowledge uptake.

Considering this, we provide six strategic considerations for funders to support dissemination and implementation initiatives. These considerations include (1) collaborating with and supporting uptake of evidence by policy/decision-makers; (2) engaging in and supporting collaboration and co-creation with patients and the public; (3) incorporating KT mandates into organizational policies and processes; (4) investing in KT capacity building and mentorship (for both internal and external stakeholders); (5) leading dissemination and implementation activities; and (6) developing metrics

to assess impact and sustainability of KT initiatives. We provide suggestions of how these considerations can be operationalized in **Box 1** along with some examples of organizations' KT initiatives to further illustrate how these could be operationalized.

Box 1. Strategic Considerations.

1. **Collaborate with and support uptake of evidence by policy/decision-makers**
   - Identify decision-makers' knowledge requirements to set funding priorities (e.g, ZonMw's role as a Knowledge Programmer) through, for example, holding events to co-develop research goals and teaching decision-makers to develop researchable questions
   - Coordinate grant deadlines to align with decision-makers' timelines (e.g., government fiscal year)
   - (for certain research calls), require researchers to meaningfully partner with decision-makers to support project co-design or policy-level dissemination or uptake of findings (e.g., MSFHR's Research Operating Grants Program)
   - Encourage researchers to tailor dissemination of project findings to decision-makers' needs and contextualize the data for local environments
2. **Engage in and support collaboration and co-creation with patients and the public**
   - Establish patient or public advisory groups to provide input on calls for proposals, funding priorities, strategic plans, and to support dissemination (e.g., PCORI's Ambassador Program)
   - Engage patients and the public in the peer review of grant proposals (e.g., PCORI's Peer Reviewer initiative)
   - Involve groups that are often marginalized or under-represented in research processes (e.g., SSHRC's Strategic Plan for Research with Indigenous Communities)
   - Require funded researchers to engage meaningfully with patients/members of the public including providing plans to feedback findings to project partners and participants
3. **Incorporate KT mandates into organizational policies and processes**
   - Outline minimum dissemination and implementation requirements for funded researchers; where appropriate, include requirements for tailoring dissemination products to relevant audiences (e.g., patients and caregivers)
   - Require a detailed integrated and (or) end of grant KT plan in all funding applications including a detailed budget
   - Ensure budgets for funded projects are adequately sized to support KT initiatives including meaningful engagement with relevant stakeholders and to ensure adequate monitoring and evaluation of KT activities
4. **Invest in KT capacity building and mentorship (for both internal and external stakeholders)**
   - Provide training opportunities for researchers on KT or disseminating their research findings to target audiences, including dedicating resources to such training (e.g., CIFAR's Roadmaps; MSFHR's KT Pathways)

Box 1. (*continued*)

- Support knowledge users (e.g., healthcare providers) to apply for funding or develop researchable questions
- Invest in KT training for staff to build capacity within the organization to support dissemination and implementation of research findings, including training staff who assess funding applications
- Invest in funding opportunities to advance the science and practice of dissemination and implementation

5. **Lead dissemination and implementation activities**
   - Host dissemination events to disseminate project findings to decision-makers (e.g., CAHO's Health Research Showcase at Queen's Park)
   - Connect with publishers and libraries to support dissemination and accessibility of open-access research (e.g., WT's Support for Public Libraries)
   - Support the development of innovative and digital formats for dissemination that increase accessibility of the knowledge to audiences with varying access needs
   - Co-create and disseminate narratives on the patient journey within health systems to improve researcher and knowledge user understanding of patient experiences (e.g., VA's Veteran Journey Maps)
   - Support funding recipients to disseminate and implement their research findings, including through facilitating connections between researchers and the "right people" (i.e., those who will use and can help support dissemination of the knowledge)
6. **Develop metrics to assess impact and sustainability of KT initiatives**
   - Define key evaluation, impact, and sustainability indicators at funding call onset; select relevant indicators in partnership with decision-makers, patients, and public stakeholders that can inform concrete community and health-system impact statements
   - Define metrics to quantify returns on KT investments (e.g., impacts of funded grants)
   - Evaluate impacts of organizational-led KT activities

Limitations

There were some limitations to this study. First, the published search was conducted only in a single database due to resource limitations and restricted to a 5-year period, and it is possible that relevant articles housed in other databases were missed. Second, we used liberal interpretations of KT concept definitions to ensure a comprehensive search; however, this may have led to the inclusion of certain initiatives that may not be considered KT to all stakeholders (e.g., translational science). Third, we coded KT initiatives using a set of pre-defined KT sub-types based on the primary focus on the KT initiative. We note that these categories were not mutually exclusive, meaning a KT initiative may have been representative of multiple subcategories and thereby initiatives were double counted within each subcategory. Additionally, the use of pre-defined KT sub-types may have limited the KT initiatives yielded in the literature search and focus group; however, this was likely mitigated by our liberal interpretations of KT concept definitions. Fourth, despite the comprehensive published literature search, for studies involving funders across the 10 high-income regions, a high proportion of these studies are from the United States, suggesting greater research in this area in the United States

compared to other countries. As such, the published literature data summaries are more reflective of US contexts relative to the other countries. Fifth, organizations included in the grey literature search were purposefully selected as they have similar objectives and mandates to Canada's federal health funding system. Related, we only included countries comparable to Canada with regard to structure of funding and granting councils. Accordingly, this scan does not represent a comprehensive overview of all organizations in these, and other, regions that conduct KT work; however, this environmental scan provides a snapshot of the common types of KT goals and initiatives emphasized by such organizations (as well as common challenges to and opportunities for implementation) and lays a groundwork for strategic planning by research funding organizations. Sixth, it is possible that organizational websites contained KT information in webpages or documents not captured by the search terms; however, the likelihood of this is low, as we used a comprehensive list of keywords (identified by the literature and refined iteratively) and an exhaustive search strategy. Seventh, we did not disaggregate the data on KT initiatives by current versus planned initiatives as the literature did not always make this distinction. As a result, funders' actual investments in KT activities (beyond planning) are not clear. Eighth, focus group participants were purposefully selected to present KT activity trends in Canadian organizations, as such, they were restricted to Canadian funders; further, their perceptions may not reflect those of all Canadian funders. Notably, federal funders such as the CIHR were not among the organizations included in the literature search or as focus group participants since they were team members. Additionally, only 1–2 participants represented each organization in the focus group; therefore, the data included are limited to the perceptions and knowledge of these individuals.

Conclusion

We summarize findings from over 210 unique data sources describing KT initiatives by Canadian and high-income country research funders. Published articles and grey literature resources most commonly described initiatives related to "funding of KT practice and science" and "exchange and integrated KT," respectively. We found that Canadian and international research funders are carrying out several KT initiatives. These engage stakeholders to set research priorities, collaborate and co-create with a range of stakeholders, particularly patients and the public, build researcher and stakeholder capacity in KT, and mandate KT requirements. Informed by the findings of this scan, we provide six strategic considerations for consideration by health research funders to support KT integration and strategic planning. As this scan was limited to 10 countries/regions, reviewing funder-supported KT activities in other countries and regions would be a helpful area for future research.

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[c]The initials "AC" indicate Arthana Chandraraj; the initials "A-C" indicate Amanda Crupi.

Authors' contributions

CF, SES, and A-C designed the study. CF, DK, RB, KQL, AC, and ST collected and analyzed literature review and focus group data. A-C supported with collection of focus group data. CF, DK, RB, and KQL interpreted the data. CF wrote the manuscript with support from DK, RB, KQL, ST, and SES. All authors read and approved the final manuscript.

Competing interests

The authors have declared that no competing interests exist.

Availability of data and materials

The datasets used and (or) analyzed during the current study are available from the corresponding author on reasonable request.

Abbreviations

AHRQ	Agency for Healthcare Research and Quality
AI	Alberta Innovates
ARTIC	Adopting Research to Improve Care
CAHO	Council of Academic Hospitals of Ontario
CDC	Centers for Disease Control and Prevention
CHeReL	Centre for Health Record Linkage
CIFAR	Canadian Institute for Advanced Research
CIHR	Canadian Institutes of Health Research
CIMIT	Consortia for Improving Medicine with Innovation and Technology
CMS	Centers for Medicare and Medicaid Services
CRECD	Clinical Research Education and Career Development
CTSA	Clinical and Translational Science Awards
DASHE	Danish Agency for Science, Technology and Innovation
DOD	US Department of Defense
FDA	Food and Drug Administration
HF	Health Foundation
HQO	Health Quality Ontario
HRC	Health Research Council of New Zealand
HRSA	Health Resources and Services Administration
IND	Investigational New Drug
KT	Knowledge Translation
MRC	Medical Research Council
MSFHR	Michael Smith Foundation for Health Research
NCATS	National Center for Advancing Translational Sciences
NCI	National Cancer Institute
NHLBI	National Heart, Lung, and Blood Institute
NHMRC	National Health and Medical Research Council
NIDA	National Institute on Drug Abuse
NIGMS	National Institute of General Medical Sciences
NIH	National Institutes of Health
NIHR	National Institute for Health Research
NIHR SPHR	NIHR School for Public Health Research
NIMH	National Institute of Mental Health

NIMHD	National Institute on Minority Health and Health Disparities
NINDS	National Institute of Neurological Disorders and Stroke
NMRC	Norwegian Medical Research Council
NSERC	Natural Sciences and Engineering Research Council of Canada
NSF	National Science Foundation
NSHRF	Nova Scotia Health Research Foundation
NSW	New South Wales
ORA	Outcome Reporting Accelerator
PenCLAHRC	Collaboration for Leadership in Applied Health Research and Care, South West Peninsula
PCORI	Patient-Centered Outcomes Research Institute
PCORnet	Patient-Centered Clinical Research Network
PHHSRS	Population Health and Health Services Research Support
RF	ResearchFish
RNS	Research Nova Scotia
SMARTT	Science Moving towArds Research Translation and Therapy program
SHRF	Saskatchewan Health Research Foundation
SSHRC	Social Sciences and Humanities Research Council
TRIS	Translational Research Impact Scale
TSTP	Translational Science Training Program
UKCRC	UK Clinical Research Collaboration
USDA	U.S. Department of Agriculture
VA	U.S. Department of Veterans Affairs
WT	Wellcome Trust
ZonMw	Netherlands Organization for Health Research and Development

Supplementary material

The following Supplementary Material is available with the article through the journal website at doi:10.1139/facets-2022-0124.

Supplementary Material

References

Baldwin JA, Williamson HJ, Reaves ER, Levin BL, Burton DL, and Massey OT. 2017. Broadening measures of success: Results of a behavioral health translational research training program. Implementation Science, 12(1): 1–11. DOI: 10.1186/s13012-017-0621-9

Bauchner H, Fontanarosa PB, and Golub RM. 2020. Editorial evaluation and peer review during a pandemic: How journals maintain standards. JAMA - Journal of the American Medical Association, 324(5): 453–454. DOI: 10.1001/JAMA.2020.11764

Braun V, and Clarke V. 2006. Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2): 77–101. DOI: 10.1191/1478088706qp063oa

Canadian Agency for Drugs and Technologies in Health. 2021. Grey matters: A practical tool for searching health-related grey literature. [online]: Available from cadth.ca/grey-matters-practical-tool-searching-health-related-grey-literature-0.

Canadian Institutes of Health Research. 2013. Evaluation of CIHR's knowledge translation funding program. [online]: Available from cihr-irsc.gc.ca/e/47332.html.

Canadian Institutes of Health Research. 2015. Guide to knowledge translation planning at CIHR: Integrated and end-of-grant approaches. [online]: Available from cihr-irsc.gc.ca/e/45321.html.

Canadian Institutes of Health Research. 2016a. About us. [online]: Available from cihr-irsc.gc.ca/e/29418.html.

Canadian Institutes of Health Research. 2016b. IHSPR Knowledge translation. [online]: Available from cihr-irsc.gc.ca/e/27293.html.

Canadian Institutes of Health Research. 2016c. Two approaches to knowledge translation at CIHR. [online]: Available from cihr-irsc.gc.ca/e/29418.html#7

Canadian Institutes of Health Research. 2020. Learning. [online]: Available from cihr-irsc.gc.ca/e/49443.html

Canadian Institutes of Health Research. 2021. Home. [online]: Available from cihr-irsc.gc.ca/e/193.html.

Canadian Institutes of Health Research. 2022. Indigenous peoples and covid-19 knowledge mobilization forum – final report. [online]: Available from cihr-irsc.gc.ca/e/53001.html

Canadian Institutes of Health Research. n.d. Canadian institutes of health research strategic plan 2021–2031. [online]: Available from cihr-irsc.gc.ca/e/documents/cihr-strategic-plan-2021-2031-en.pdf

Caulfield T, Bubela T, Kimmelman J, and Ravitsky V. 2021. Let's do better: Public representations of COVID-19 science. Facets, 6(1): 403–423. DOI: 10.1139/FACETS-2021-0018/ASSET/IMAGES/MEDIUM/FACETS-2021-0018F1.GIF

Charlton P, Kean T, Liu RH, Nagel DA, Amzar R, Doucet S, et al. 2021. Use of environmental scans in health services delivery research: A scoping review. BMJ Open, 11(11): e050284. DOI: 10.1136/BMJOPEN-2021-050284

Colquhoun H, Leeman J, Michie S, Lokker C, Bragge P, Hempel S, et al. 2014. Towards a common terminology: A simplified framework of interventions to promote and integrate evidence into health practices, systems, and policies. Implementation Science, 9(1). DOI: 10.1186/1748-5908-9-51

Dao HD, Kota P, James JA, Stoner JA, and Akins DR. 2015. Assessment of translational and interdisciplinary clinical research at an Oklahoma health sciences center. The Journal of the Oklahoma State Medical Association, 108(3): 93. [online]: Available from pmc/articles/PMC4686264/

Dembe AE, Lynch MS, Gugiu PC, and Jackson RD. 2014. The translational research impact scale: Development, construct validity, and reliability testing. Evaluation and the Health Professions, 37(1): 50–70. DOI: 10.1177/0163278713506112

DORA. n.d. San Francisco declaration on research assessment. [online]: Available from sfdora.org/read/

Ebert RF, Danthi NS, Charette MF, Hanspal M, Mondoro TH, Noel PJ, et al. 2016. The NHLBI SMARTT Program: A novel approach to facilitate translational research for heart, lung and blood diseases. Circulation Research, 118(12): 1867–1871. DOI: 10.1161/CIRCRESAHA.116.308550

Estape ES, Quarshie A, Segarra B, San Martin M, Rios R, Martinez K, et al. 2018. Promoting diversity in the clinical and translational research workforce. Journal of the National Medical Association, 110(6): 598–605. DOI: 10.1016/j.jnma.2018.03.010

Gilliland CT, Sittampalam GS, Wang PY, and Ryan PE. 2017. The translational science training program at NIH: Introducing early career researchers to the science and operation of translation of basic research to medical interventions. Biochemistry and Molecular Biology Education, 45(1): 13–24. DOI: 10.1002/bmb.20978

Good M, McElroy SJ, Berger JN, Moore DJ, and Wynn JL. 2018. Limited achievement of NIH research independence by pediatric K award recipients. Pediatric Research 2018 84:4, 84(4): 479–480. DOI: 10.1038/s41390-018-0056-2

Government of Canada. 2021. Canada's science vision. [online]: Available from ic.gc.ca/eic/site/131.nsf/eng/h_00000.html

Greenhalgh T, Jackson C, Shaw S, and Janamian T. 2016. Achieving research impact through co-creation incommunity-based health services: Literature review and case study. The Milbank Quarterly, 94(2): 392. DOI: 10.1111/1468-0009.12197

Hamilton A. 2013. Qualitative methods in rapid turn-around health services research. [online]: Available from hsrd.research.va.gov/for_researchers/cyber_seminars/archives/video_archive.cfm?SessionID=780.

Heaton J, Day J, and Britten N. 2016. Collaborative research and the co-production of knowledge for practice: An illustrative case study. Implementation Science, 11(1): 1–10. DOI: 10.1186/s13012-016-0383-9

Henderson LA, and Shankar LK. 2017. Clinical translation of the national institutes of health's investments in nanodrug products and devices. AAPS Journal, 19(2): 343–359. DOI: 10.1208/s12248-016-9995-x

Hogle JA, and Moberg DP. 2014. Success case studies contribute to evaluation of complex research infrastructure. Evaluation and the Health Professions, 37(1): 98–113. DOI: 10.1177/0163278713500140

Holzer J, and Kass N. 2015. Understanding the supports of and challenges to community engagement in the CTSAs. Clinical and Translational Science, 8(2): 116–122. DOI: 10.1111/CTS.12205

Israel B, Schulz AJ, Parker EA, Becker AB, and Community-Campus Partnerships for Health. 2001. Community-based participatory research: Policy recommendations for promoting a partnership approach in health Research. Education for health, 14(2): 182–197. DOI: 10.1080/13576280110051055

Khazanchi R, Evans CT, and Marcelin JR. 2020. Racism, not race, drives inequity across the COVID-19 continuum. JAMA Network Open, 3(9): e2019933–e2019933. DOI: 10.1001/JAMANETWORKOPEN.2020.19933

Lavis JN. 2006. Research, public policymaking, and knowledge-translation processes: Canadian efforts to build bridges. The Journal of continuing education in the health professions, 26(1): 37–45. DOI: 10.1002/CHP.49

McKibbon KA, Lokker C, Wilczynski NL, Ciliska D, Dobbins M, Davis DA, et al. 2010. A cross-sectional study of the number and frequency of terms used to refer to knowledge translation in a body of health literature in 2006: A Tower of Babel? Implementation Science, 5(1). DOI: 10.1186/1748-5908-5-16

McLean RKD, Graham ID, Tetroe JM, and Volmink JA. 2018. Translating research into action: An international study of the role of research funders. Health Research Policy and Systems, 16(1): 1–15. DOI: 10.1186/s12961-018-0316-y

Meurer WJ, Quinn J, Lindsell C, Schneider S, and Newgard CD. 2016. Emergency medicine resources within the clinical translational science institutes: A cross-sectional study. Academic Emergency Medicine, 23(6): 740–743. DOI: 10.1111/acem.12926

Mitchell SA, Fisher CA, Hastings CE, Silverman LB, and Wallen GR. 2010. A thematic analysis of theoretical models for translational science in nursing: Mapping the field. Nursing Outlook, 58(6): 287–300. DOI: 10.1016/J.OUTLOOK.2010.07.001

Moore JE, Grouchy M, Graham ID, Shandling M, Doyle W, and Straus SE. 2016. The council of academic hospitals of Ontario (CAHO) adopting research to improve care (ARTIC) program: Reach, sustainability, spread and lessons learned from an implementation funding model. Healthcare Policy, 11(4): 27–39. DOI: 10.12927/hcpol.2016.24629

National Institutes of Health. n.d. Research priorities. [online]: Available from prevention.nih.gov/research-priorities/dissemination-implementation.

Palayew A, Norgaard O, Safreed-Harmon K, Anderson TH, Rasmussen LN, and Lazarus JV. 2020. Pandemic publishing poses a new COVID-19 challenge. Nature Human Behaviour 2020 4:7, 4(7): 666–669. DOI: 10.1038/s41562-020-0911-0

Parrish J, Schachter S, Dempsy M, and Collins J. 2015. Facilitating translational research. Journal of Investigative Dermatology, 135(6): 1463–1465. DOI: 10.1038/jid.2015.5

Proctor E, Luke D, Calhoun A, McMillen C, Brownson R, McCrary S, and Padek M. 2015. 'Sustainability of evidence-based healthcare: Research agenda, methodological advances, and infrastructure support', Implementation Science, 10(1): 1–13. DOI: 10.1186/s13012-015-0274-5

Rapport F, Clay-Williams R, Churruca K, Shih P, Hogden A, and Braithwaite J. 2018. The struggle of translating science into action: Foundational concepts of implementation science. Wiley Online Library, 24(1): 117–126. DOI: 10.1111/jep.12741

Saitz R, and Schwitzer G. 2020. Communicating science in the time of a pandemic. JAMA, 324(5): 443–444. DOI: 10.1001/JAMA.2020.12535

Saskatchewan Health Research Foundation. 2019. Annual report 2018–19. [online]: Available from 680fabdc-55b5-42ce-8581-30fcb6258e30.filesusr.com/ugd/008f91_8bd2bd3fa0cf4e32b59c7bbc7b9b4ef1.pdf.

Schneider M, Guerrero L, Jones LB, Tong G, Ireland C, Dumbauld J, and Rainwater J. 2015. Developing the translational research workforce: A pilot study of common metrics for evaluating

the clinical and translational award KL2 program. Clinical and Translational Science, 8(6): 662–667. DOI: 10.1111/CTS.12353

Science Europe. 2022. The agreement on reforming research assessment is now final. [online]: Available from scienceeurope.org/news/rra-agreement-final/

Straus SE, Tetro J, and Graham I. 2009. Defining knowledge translation. CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne, 181(3–4): 165–168. [online]: Available from cmaj.ca/content/181/3-4/165.short

Straus S, Tetroe J, and Graham ID. 2013. Knowledge translation in health care: Moving from evidence to practice. 2nd edn. BMJ Books, London

Tabak RG, Khoong EC, Chambers DA, and Brownson RC. 2012. Bridging research and practice: Models for dissemination and implementation research. American Journal of Preventive Medicine, 43(3): 337–350. DOI: 10.1016/J.AMEPRE.2012.05.024

Terry SF. 2017. The study is open: Participants are now recruiting investigators. Science Translational Medicine, 9(371): 1–4. DOI: 10.1126/scitranslmed.aaf1001

Tetroe JM, Graham ID, Foy R, Robinson N, Eccles MP, Wensing M, et al. 2008. Health research funding agencies' support and promotion of knowledge translation: An international study. Milbank Quarterly, 86(1): 125–155. DOI: 10.1111/J.1468-0009.2007.00515.X

Thackway S, Campbell D, and Loppacher T. 2017. A long-term, strategic approach to evidence generation and knowledge translation in NSW, Australia. Public Health Research and Practice, 27(1): 1–4. DOI: 10.17061/phrp2711702

Willey C, Fede J, Stevenson J, Hayward A, Kogut S, Fournier H, and Padbury J. 2018. Clinical and translational research in Rhode Island: Results of a needs assessment survey: A study performed by the tracking and evaluation key component activity (KCA) for advance-CTR. Rhode Island medical journal (2013), 101(1): 21. [online]: Available from /pmc/articles/PMC6053046/

Yin HL, Gabrilove J, Jackson R, Sweeney C, Fair AM, and Toto R, Clinical and Translational Science Award "Mentored to Independent Investigator Working Group Committee". 2015. Sustaining the clinical and translational research workforce: Training and empowering the next generation of investigators. Academic Medicine, 90(7): 861–865. DOI: 10.1097/ACM.0000000000000758