Review

Adapting Knowledge Translation Strategies for Rare Rheumatic Diseases

Tania Cellucci, Shirley Lee, and Fiona Webster

ABSTRACT. Rare rheumatic diseases present unique challenges to knowledge translation (KT) researchers. There is often an urgent need to transfer knowledge from research findings into clinical practice to facilitate earlier diagnosis and better outcomes. However, existing KT frameworks have not addressed the specific considerations surrounding rare diseases for which gold standard evidence is not available. Several widely adopted models provide guidance for processes and problems associated with KT. However, they do not address issues surrounding creation or synthesis of knowledge for rare diseases. Additional problems relate to lack of awareness or experience in intended knowledge users, low motivation, and potential barriers to changing practice or policy. Strategies to address the challenges of KT for rare rheumatic diseases include considering different levels of evidence available, linking knowledge creation and transfer directly, incorporating patient and physician advocacy efforts to generate awareness of conditions, and selecting strategies to address barriers to practice or policy change. (J Rheumatol First Release May 1 2016; doi:10.3899/jrheum.151297)

Key Indexing Terms:
TRANSLATIONAL MEDICAL RESEARCH RARE DISEASES
PEDIATRIC RHEUMATIC DISEASES

Children with rare rheumatic diseases may present with life-threatening symptoms, and prognosis often depends on how quickly their underlying condition is recognized. For example, a previously healthy child with central nervous system vasculitis may experience refractory seizures or strokes[1,2]. Late diagnosis leads to poor outcomes, such as brain damage or death, while early recognition and treatment promote full recovery[2]. The effect of delayed diagnosis on morbidity and mortality has been described in other rare rheumatic diseases, ranging from autoimmune encephalitis to systemic sclerosis[3,4,5,6]. Further, novel diseases, such as genetic autoinflammatory syndromes, are being described at a rapid pace, making it challenging to diagnose these conditions[7].

Knowledge gaps about childhood rheumatic diseases present a critical obstacle to diagnosis. Prior international studies have demonstrated that family physicians lack confidence in recognizing and managing autoimmune conditions[8,9,10,11,12,13,14]. These issues are more accentuated for children with rheumatic diseases because of lower prevalence and contribute to observed referral delays to rheumatologists[15,16,17]. Limited awareness and infrequent exposure during clinical training and practice are involved in physicians' discomfort and form barriers to practicing medicine based on evidence[18].

A unique challenge in treating childhood rheumatic diseases relates to an absence of the traditional "pillars" of research evidence — randomized controlled trials — because of small sample sizes[19]. New or modified trial designs and statistical analyses, such as crossover, randomized withdrawal and N-of-1 trials, are increasingly used to augment data available when studying rare diseases[20]. However, access to new research knowledge about rheumatic diseases remains limited mainly to scientific publications and conference presentations.

Studies have demonstrated that traditional methods of research dissemination are too passive to change the behavior of practicing physicians[21,22]. Didactic presentations of new research evidence have consistently been shown to be weak strategies for changing clinician behavior[22,23,24]. For example, journal articles are unlikely to yield behavior change[22,23,25]. Even user-friendly guidelines based on evidence are incorporated slowly and erratically into clinical practice because of multiple factors, such as lack of familiarity, complexity,

From the Division of Pediatric Rheumatology, Department of Pediatrics, McMaster University, Hamilton; Department of Family and Community Medicine, and Institute of Health Policy Management and Evaluation, University of Toronto; Schwartz-Reisman Emergency Medicine Institute, Department of Emergency Medicine, Mount Sinai Hospital, Toronto, Ontario, Canada.

T. Cellucci, MD, MScCH, FRCPC, Assistant Professor, Division of Pediatric Rheumatology, Department of Pediatrics, McMaster University; S. Lee, MD, MHSc (Ed), CCFP(EM), FCFP, Associate Professor, Department of Family and Community Medicine, University of Toronto, and Schwartz-Reisman Emergency Medicine Institute, Department of Emergency Medicine, Mount Sinai Hospital; F. Webster, PhD, Associate Professor, Department of Family and Community Medicine and Institute of Health Policy Management and Evaluation, University of Toronto.

Address correspondence to Dr. T. Cellucci, 1280 Main St. West, HSC 3A74, Hamilton, Ontario L8S 4K1, Canada. E-mail: celluct@mcmaster.ca

Accepted for publication March 31, 2016.

compatibility with current practice, and access to required resources[18,26,27,28]. None of these traditional dissemination methods assist individual practitioners in addressing real barriers to practice change, including financial, organizational, patient, personal, and professional factors[22,23]. For example, research studies may demonstrate that a biologic agent is highly effective in treating a rheumatic disease, but a clinician may not prescribe the medication if insurance companies or government drug programs refuse to fund it.

Knowledge translation (KT) research demonstrates that active strategies, including chart audits and outreach visits, help promote incorporation of research findings into clinical practice[22]. While KT research and practice offer a better approach to addressing clinical knowledge gaps, KT literature has not focused on rare conditions such as childhood rheumatic diseases. As a result, modification of existing KT models is needed to disseminate knowledge surrounding low frequency conditions. We will review the current KT definitions and models, and highlight special considerations for KT involving rare diseases.

METHODS AND LITERATURE SEARCH RESULTS

Our manuscript presents a narrative review of the definition of KT, a number of KT models, and the existing literature on KT strategies in rare diseases. Searches of MEDLINE, CINAHL, EMBASE, and PsycINFO electronic databases were conducted using the key words "knowledge translation," "knowledge transfer," "research dissemination," and "research utilization" to develop a comprehensive list of existing KT models. These search terms were specifically chosen because they have been previously identified as being frequently used to refer to KT in the literature[29]. For our manuscript, the authors excluded all KT models that did not apply specifically to the healthcare field, did not have a robust description in the literature, had never been evaluated or validated in research studies, and were rarely used within KT practice. The remaining KT models were reviewed carefully to answer the research question: "What are the key elements and strategies in KT models that apply to healthcare?"

Then, a search of the MEDLINE, CINAHL, EMBASE, and PsycINFO electronic databases was repeated using the above search terms and adding "rare diseases." The inclusion of the search term "rare diseases" did not yield any relevant articles. In addition, a search through the archives of the journal *Implementation Science* using the search term "rare diseases" identified 32 articles; however, a review of the abstracts of these articles revealed that only 1 article discussed KT for rare disease.

As a result, we performed a search for key papers written by established KT experts that critiqued the existing KT models. A manual search of the references of these relevant articles was also completed. These articles were reviewed in depth to answer the research questions: "What are the specific issues when adapting KT for rare diseases, and what are the potential solutions?" Additional considerations that would affect KT for rare diseases were also recognized by the authors during their review of the KT models and several of the potential solutions were proposed based on the authors' experiences.

DISCUSSION

1. Knowledge translation: Definitions and models

There are several definitions and diverse terminology for KT in the literature, including implementation science, knowledge transfer, and research dissemination or utilization[29]. The Canadian Institutes of Health Research define KT as the "dynamic and iterative process that includes synthesis, dissemination, exchange and ethically-sound application of knowledge to improve the health of Canadians, provide more effective health services and products, and strengthen the health care system"[30].

Currently, there are numerous KT models in the research literature (Table 1). Most suggest that KT should take place through an interactive dynamic process involving many interested parties[31,32]. Several models only focus on 1 aspect of the KT process, for example, the Coordinated Implementation Model and the Practical Robust Implementation and Sustainability Model describe factors that must be considered when implementing existing research in the practice environment[33,34]. Other models focus exclusively on the people involved in the KT process. The Knowledge Exchange and Knowledge Brokering Model depends on the activities of a knowledge broker, while the Interfaces and Receptor Model focuses on the effect of their differing cultures on the interactions between researchers, policymakers, and subsequent decision making[35,36]. The Framework for Adopting an Evidence-Informed Innovation in an Organization, the Framework for Knowledge Transfer, and the Understanding User Context Framework consist of a series of questions to guide researchers but do not actually provide steps for the KT process[37,38,39].

The Ottawa Model of Research Use (OMRU) was designed to guide policymakers through 6 key areas in KT — practice environment, potential adopters, innovation based on evidence, transfer strategies, evidence use, and outcomes — that are dynamically interconnected through assessment, monitoring, and evaluation[40]. Systematic examination of the practice environment, including policies, resources, social context, and patients, and of the intended users according to their knowledge, skills, and motivation for change is recommended to identify barriers to behavior change and to guide selection of KT strategies[40]. The Promoting Action on Research Implementation in Health Services (PARIHS) framework is based on the premise that successful implementation of research into practice depends on high qualities of evidence (including study results, clinical expertise, and patient preferences), practice context (including organizational culture and leadership), and strategies for dissemi-

Table 1. Models of knowledge translation in healthcare.

Models	Brief Description
Canadian Institutes of Health Research Model of Knowledge Translation	Integrates KT at multiple opportunities from knowledge creation to application to assessment of effect; replaced by knowledge-to-action process.
Conduct and Utilization of Research in Nursing	Formal organizational process linking nursing users and researchers when practice problems are identified.
Coordinated Implementation Model	Outlines factors that affect implementation of existing research in practice environment, including coordination of those involved.
Framework for Adopting an Evidence-informed Innovation in an Organization	Describes 5 questions to assess how characteristics of the innovation, organization, and people affect decision making around implementation.
Framework for Knowledge Transfer	Suggests 5 questions to consider regarding research knowledge, people, KT process, and outcomes.
Interfaces and Receptor Model	Focuses on interactions between researchers and policymakers and their effects on decision making.
Iowa Model of Research Use in Practice	Nurses identify questions based on practice problems and work with organizational team to develop, apply, and evaluate practice change.
Knowledge Exchange and Knowledge Brokering Model	Depends on the observations of a knowledge broker to identify a problem and its context, and then design an intervention within a healthcare organization.
Knowledge-to-Action Process	Integrates KT in knowledge creation, adaptation and application, evaluation of outcomes, and maintenance of knowledge use.
Ottawa Model of Research Use	Focuses on selection and tailoring of interventions to practice context to increase use of research knowledge.
Practical Robust Implementation and Sustainability Model (PRISM)	Examines how design, organization and external content, and target population affect the effectiveness of evidence-based interventions.
Promoting Action on Research Implementation in Health Services Framework	Emphasizes facilitating implementation of evidence from various sources (e.g., research, clinical experience, patient experience) into practice.
Stetler Model of Research Utilization	Model for practitioners to evaluate research, decide on application, and evaluate outcomes.
Understanding User Context Framework	Proposes a series of questions to guide researchers' understanding of intended knowledge users.

KT: knowledge translation.

nation[41]. Dissemination is accomplished by deliberate use of interpersonal and group skills to promote change, and success is influenced by effective facilitators' personal characteristics, role within the organization, and communication style[41]. The Knowledge-to-Action (KTA) Process will be reviewed in detail because it is currently the dominant model that addresses multiple aspects of the KT process and its effect is confirmed by research studies[32].

2. The Knowledge-to-Action Process

The KTA Process begins with the identification of a knowledge gap, and then research knowledge is created, synthesized, and developed into a tool to address the problem[21]. Next, the local context is studied to characterize the practice environment and to identify barriers that prevent adoption of knowledge by potential users[21]. This step is critical to ensure effectiveness of the KT intervention. For example, if research knowledge supports the use of a medication that is not available locally, it may be best to direct a first intervention toward increasing access to the medication before encouraging physicians to change their prescribing practice.

KT strategies are then selected and tailored to target knowledge users and their practice context, with potential barriers to knowledge uptake identified[21]. This is followed by the implementation of the KT strategies[21]. After this action phase, it is necessary to evaluate the use or application of knowledge by the target audience[21]. The desired effects of an intervention may vary from an increase in knowledge to a change in clinical practice. Improved patient outcomes are often seen later and may therefore be difficult to attribute to the KT intervention. Further strategies to maintain the use of knowledge in the target audience may be developed by restarting the KTA cycle[21].

Strengths of the KTA Process include its flexibility to adapt to different contexts within and beyond the healthcare system[21]. This model promotes a logical, stepwise approach that addresses many important elements in the KT process, beginning with the definition of a knowledge-related problem. It also emphasizes the importance of understanding the context in which the knowledge is to be used, including the intended users and their environment, to increase the probability that the KT intervention will achieve the desired outcomes[21,42].

A potential gap in the KTA Process relates to the model's focus on problems and processes associated with transferring rather than producing knowledge[43]. The model also provides limited guidance regarding certain key decisions, such as what knowledge should be transferred, who should be disseminating the knowledge, and how to select interventions appropriately[42].

3. Special considerations for KT surrounding rare diseases

Issue 1. Traditional definitions of evidence quality are poorly applied to rare diseases[19]. Randomized controlled studies are difficult to perform with childhood rheumatic diseases given their low incidence and prevalence. Research evidence may also be very limited if the conditions have only recently been identified, such as new genetic autoinflammatory conditions, or if a medication has only recently been developed, such as a new biologic agent[7]. Therefore, developing KT interventions based on a systematic review research methodology is not an effective strategy for rare rheumatic diseases[23].

Potential solutions. Recommendations for diagnostic investigations and management within a KT intervention may need to rely on an expanded definition of valid evidence, including case series, and cohort studies[19]. Fortunately, all 3 of the KT models discussed previously would allow for evidence from multiple sources, although they favor scientifically robust research. Increased use of trial designs and statistical analyses that are specifically adapted to rare diseases will also yield higher-quality evidence in pediatric rheumatology[20]. Another option is to directly link KT strategies with multicenter, national, and international efforts to collect data on diagnosis and treatment of rare rheumatic diseases. For example, combined translational research networks and patient registries for autoinflammatory diseases are currently being used to collect larger datasets, but could incorporate KT strategies to raise awareness of these conditions and their management among patients, their families, healthcare providers, and policymakers[44]. Linking with patient advocacy groups and using social media forums, such as Twitter and Facebook, may also be effective strategies for recruiting patients for KT and/or research.

Issue 2. Engagement of stakeholders is more challenging when a KT intervention focuses on a rare disease. Typical examples of KT focus on health promotion activities that target large populations, such as immunizations or smoking cessation[31]. The potential for these activities to affect the health of many individuals encourages engagement by audiences ranging from primary care physicians to government agencies. In contrast, incentive to change practice or policy may be limited for rare childhood rheumatic diseases because of the lack of exposure or awareness by primary care providers or politicians.

Potential solutions. This lack of familiarity with rare conditions by groups such as funding agencies and primary care physicians must be specifically identified as a barrier to KT within any chosen model. Therefore, any KT process for rare rheumatic diseases needs to incorporate strategies to generate awareness before attempting to change practice[21,40]. The task of increasing awareness of a rare rheumatic disease could be assigned to a skilled facilitator if using the PARIHS framework or a knowledge broker within an organization[35,41]. Also, the use of patient narratives to demonstrate the features of a condition and the danger of delayed diagnosis (such as the risk of brain damage and death in children with inflammatory brain diseases) may be a powerful tool to raise awareness, possibly through traditional and social media[45]. Many charitable disease-centered organizations successfully use this strategy in education and fundraising campaigns. However, use of patient narratives to raise awareness of a condition must be strengthened by incorporation of evidence[46].

Issue 3. Accessing and involving individual healthcare providers in KT interventions may be difficult, especially for those who work in a community setting. For rare childhood rheumatic diseases, appropriate knowledge users within a community may include primary care physicians who need to recognize the illness and refer to the appropriate specialist, rheumatologists who diagnose and treat the condition, and allied health professionals who provide education and medical care to patients and families. These health professionals typically do not work in the same community setting and require different KT strategies to change the behavior in each group.

Potential solutions. A specific strategy that may facilitate KT is to develop a community network between local community physicians, allied health professionals, and rheumatologists to share knowledge about rare rheumatic diseases and facilitate care[47]. It would also be helpful to target opinion leaders within communities or organizations (e.g., a local hospital or home care program) because of the research evidence that trusted colleagues strongly influence the adoption of new behaviors or knowledge within their social and work networks[45,47]. This approach would create "champions" who could support further KT efforts around rare rheumatic diseases[37,47].

Issue 4. Policymakers may be unwilling to make changes for rare diseases that affect a small portion of the population. Changing legislation or policy generally involves a significant investment of time and money, but this may not be considered a valuable use of those resources if only a small group of children will benefit from the change. For example, genetic testing for rare autoinflammatory diseases is currently performed by a small number of commercial and research laboratories internationally. It is unlikely that this testing will be made available at most hospitals because of limitations in institutional healthcare funding.

Potential solutions. Involving patient advocacy groups may be critical when a KT strategy focuses on health policymakers because these groups have successfully advocated for changes in the past, including the development of the Rare Diseases Clinical Research Network at the US National Institutes of Health[48]. Patient advocacy groups have been established for very rare rheumatic conditions, such as the Autoinflammatory Alliance and the Autoimmune Encephalitis Alliance, in addition to more familiar advocacy groups

for arthritis, systemic lupus erythematosus, vasculitis, myositis, and systemic sclerosis. Linking to motivated patients and families who advocate and raise awareness of their condition through social media may also be an effective strategy for reaching target audiences.

The KT team should consider collaborating with other specialists who are involved in managing the condition when the target audience includes health policymakers. For example, if the goal of a KT project were to improve access to biologic agents for children with rheumatic diseases, then physicians and allied health professionals in rheumatology could join with other specialties (e.g., gastroenterology) who use biologic medications to have more influence on the government.

Issue 5. Many early KT interventions to promote practice based on evidence failed because they did not adequately address the professional and system barriers to behavior change[26]. Low motivation, less self-efficacy, and perceived or real external barriers may harm KT and practice or policy change for rare diseases[18]. For instance, a pediatrician may not be motivated to learn more about microscopic polyangiitis because the low incidence in children means they are unlikely to see a child with this diagnosis[6]. External barriers may prevent a clinician from changing their behavior, even if they are familiar with new research evidence. Hence, a rheumatologist may not prescribe triamcinolone hexacetonide or a new effective biologic agent if extensive documentation is required to access the medication or if it is unavailable locally.

Potential solutions. Careful assessment and exploration of potential barriers for the target audience is a critical component of any KT project involving rare diseases. Patients and their families may also provide valuable input here because they may be able to identify the barriers encountered and resources used during the process of diagnosing the child's illness. Children with rheumatic diseases often see multiple health professionals before their diagnosis is determined[15,16,17].

It is appropriate to assess the intended knowledge users' motivational state, or readiness for change, during the KT process[49]. This is already built into the OMRU model and may be part of assessing potential barriers in the KTA process and analyzing context in the PARIHS framework. Then, strategies may be tailored according to the individual's or organization's stage of readiness, and this increases the likelihood of success in achieving and sustaining behavioral change[49,50]. For example, motivation often depends on each professional's experience with a rare rheumatic disease — reflection surrounding a critical incident of misdiagnosis will often prompt an individual to change their practice[51]. Chart audits have been shown to be an effective tool for KT, perhaps because they prompt a practitioner to reflect on their practice and increase motivation to change practice behavior[22,45].

Issue 6. Monitoring outcomes of KT interventions is more challenging for rare diseases. The ultimate goal of many KT interventions for rare diseases is to improve survival and quality of life. However, this type of outcome is challenging to evaluate. Changes in morbidity and mortality for children with most rheumatic diseases may not be evident until years after a new intervention (such as a new medication) is implemented and may be difficult to attribute specifically to a single intervention.

Potential solutions. More feasible evaluation outcomes would involve monitoring for changes in the behavior of the target audience[49,50]. For example, audits of health records could be used to identify whether an increased number of patients were recognized to have a specific disease, underwent the appropriate diagnostic investigations, and were treated appropriately[22,45]. A reasonable indicator that a KT intervention successfully increased awareness of genetic fever syndromes among primary care physicians may be a subsequent increased number of referrals for these conditions.

Our review indicates that current models of KT require modifications to address the unique challenges of changing practice related to rare rheumatic diseases in children. Suggested modifications include incorporating advocacy efforts to generate awareness of these conditions prior to implementing a KT intervention. It is clear that specific information about the target audience, their context, and the potential barriers to knowledge use is needed to maximize dissemination goals and effects. KT interventions should be selected carefully and tailored to address a lack of familiarity or low motivation within the target audience and to accommodate for the different levels of evidence available for rare childhood rheumatic diseases. Further research on the adaptation of KT frameworks in the context of rare diseases is needed.

REFERENCES

1. Benseler SM, Silverman E, Aviv RI, Schneider R, Armstrong D, Tyrrell PN, et al. Primary central nervous system vasculitis in children. Arthritis Rheum 2006;54:1291-7.
2. Cellucci T, Benseler SM. Central nervous system vasculitis in children. Curr Opin Rheumatol 2010;22:590-7.
3. Hacohen Y, Wright S, Waters P, Agrawal S, Carr L, Cross H, et al. Paediatric autoimmune encephalopathies: clinical features, laboratory investigations and outcomes in patients with or without antibodies to known central nervous system autoantigens. J Neurol Neurosurg Psychiatry 2013;84:748-55.
4. Hawley DP, Baildam EM, Amin TS, Cruikshank MK, Davidson JE, Dixon J, et al. Access to care for children and young people diagnosed with localized scleroderma or juvenile SSc in the UK. Rheumatol 2012;51:1235-9.
5. Kramer M, Amer R, Mukamel M, Snir M, Jaouni T, Friling R. Uveitis in juvenile Behçet's disease: clinical course and visual outcome compared with adult patients. Eye 2009;23:2034-41.
6. Peco-Antic A, Bonaci-Nikolic B, Basta-Jovanovic G, Kostic M, Markovic-Lipkovski J, Nikolic M, et al. Childhood microscopic polyangiitis associated with MPO-ANCA. Pediatr Nephrol 2006;21:46-53.

7. Omenetti A, Federici S, Gattorno M. Inherited autoinflammatory diseases: a critical digest of the recent literature. Clin Exp Rheumatol 2013;31 Suppl 77:118-26.
8. Cabrera Pivaral CE, Gutiérrez González TY, Gámez Nava JI, Nava A, Villa Manzano AI, Luce González E. Clinical competence for autoimmune and non-autoimmune rheumatic disorders in primary care. Rev Alerg Mex 2009;56:18-22.
9. Pacheco RD, Gatica RH, Kaliski KS. [Self assessment of strengths, weaknesses and self confidence of primary care physicians taking care of rheumatic diseases]. [Article in Spanish] Rev Med Chil 2006;134:813-20.
10. Petrella RJ, Davis P. Improving management of musculoskeletal disorders in primary care: The Joint Adventures program. Clin Rheumatol 2007;26:1061-6.
11. Freed GL, Jee S, Stein L, Spera L, Clark SJ. Comparing the self-reported referral and management preferences of pediatricians and family physicians for children with juvenile rheumatoid arthritis. J Rheumatol 2003;30:2700-4.
12. Gamez-Nava JI, Gonzalez-Lopez L, Davis P, Suarez-Almazor ME. Referral and diagnosis of common rheumatic diseases by primary care physicians. Br J Rheumatol 1998;37:1215-9.
13. Suarez-Almazor ME, Gonzalez-Lopez L, Gamez-Nava JI, Belseck E, Kendall CJ, Davis P. Utilization and predictive value of laboratory tests in patients referred to rheumatologists by primary care physicians. J Rheumatol 1998;25:1980-5.
14. Glazier RH, Dalby DM, Badley EM, Hawker GA, Bell MJ, Buchbinder R. Determinants of physician confidence in the primary care management of musculoskeletal disorders. J Rheumatol 1996;2:351-6.
15. Tzaribachev N, Benseler SM, Tyrrell PN, Meyer A, Kuemmerle-Deschner JB. Predictors of delayed referral to a pediatric rheumatology center. Arthritis Rheum 2009;61:1367-72.
16. Shiff NJ, Abdwani R, Cabral DA, Houghton KM, Malleson PN, Petty RE, et al. Access to pediatric rheumatology subspecialty care in British Columbia, Canada. J Rheumatol 2009;36:410-5.
17. Foster HE, Eltringham MS, Kay LJ, Friswell M, Abinun M, Myers A. Delay in access to appropriate care for children presenting with musculoskeletal symptoms and ultimately diagnosed with juvenile idiopathic arthritis. Arthritis Rheum 2007;57:921-7.
18. Cabana MD, Rand CS, Powe NR, Wu AW, Wilson MH, Abboud PA, et al. Why don't physicians follow clinical practice guidelines? A framework for improvement. JAMA 1999;282:1458-65.
19. Lambert H. Accounting for EBM: notions of evidence in medicine. Soc Sci Med 2006;62:2633-45.
20. Tudur Smith C, Williamson PR, Beresford MW. Methodology of clinical trials for rare diseases. Best Pract Res Clin Rheumatol 2014;28:247-62.
21. Graham ID, Logan J, Harrison MB, Straus SE, Tetroe J, Caswell W, et al. Lost in knowledge translation: time for a map? J Contin Educ Health Prof 2006;26:13-24.
22. Grol R, Grimshaw J. From best evidence to best practice: effective implementation of change in patients' care. Lancet 2003; 362:1225-30.
23. Grimshaw JM, Eccles MP, Lavis JN, Hill SJ, Squires JE. Knowledge translation of research findings. Implement Sci 2012;7:50.
24. Davis D, O'Brien MA, Freemantle N, Wolf FM, Mazmanian P, Taylor-Vaisey A. Impact of formal continuing medical education: do conferences, workshops, rounds, and other traditional continuing education activities change physician behavior or health care outcomes? JAMA 1999;282:867-74.
25. Grimshaw JM, Eccles MP, Walker AE, Thomas RE. Changing physicians' behavior: What works and thoughts on getting more things to work. J Contin Educ Health Prof 2002;22:237-43.
26. Ellen ME, Léon G, Bouchard G, Ouimet M, Grimshaw JM, Lavis JN. Barriers, facilitators and views about next steps to implementing supports for evidence-informed decision-making in health systems: a qualitative study. Implement Sci 2014;9:179.
27. Solberg LI, Brekke ML, Fazio CJ, Fowles J, Jacobsen DN, Kottke TE, et al. Lessons from experienced guideline implementers: Attend to many factors and use multiple strategies. Jt Comm J Qual Improv 2000;26:171-88.
28. Grimshaw JM, Thomas RE, MacLennan G, Fraser C, Ramsay CR, Vale L, et al. Effectiveness and efficiency of guideline dissemination and implementation strategies. Health Technol Assess 2004;8:iii-iv, 1-72.
29. McKibbon KA, Lokker C, Wilczynski NL, Ciliska D, Dobbins M, Davis DA, et al. 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? Implement Sci 2010;5:16.
30. Canadian Institutes of Health Research. Knowledge translation. [Internet. Accessed April 4, 2016.] Available from: www.cihr-irsc.gc.ca/e/29418.html
31. Estabrooks CA, Thompson DS, Lovely JJ, Hofmeyer A. A guide to knowledge translation theory. J Contin Educ Health Prof 2006;26:25-36.
32. Sudsawad P. Knowledge translation: introduction to models, strategies, and measures. [Internet. Accessed April 4, 2016.] Available from: ktdrr.org/ktlibrary/articles_pubs/ktmodels/#fig2
33. Lomas J. Retailing research: Increasing the role of evidence in clinical services for childbirth. Milbank Q 1993;71:439-75.
34. Feldstein AC, Glasgow RE. A practical, robust implementation and sustainability model (PRISM) for integrating research findings into practice. Jt Comm J Qual Patient Saf 2008;34:228-43.
35. Ward V, Smith S, Carruthers S, Hamer S, House A. Knowledge brokering: exploring the process of transferring knowledge into action. Leeds: University of Leeds; 2010.
36. Hanney S. Personal interaction with researchers or detached synthesis of the evidence: modelling the health policy paradox. Eval Res Educ 2004;18:72-82.
37. Dobbins M, Robeson P, Ciliska D, Hanna S, Cameron R, O'Mara L, et al. A description of a knowledge broker role implemented as part of a randomized controlled trial evaluating three knowledge translation strategies. Implement Sci 2009;4:23.
38. Lavis JN, Robertson D, Woodside JM, McLeod CB, Abelson J; Knowledge Transfer Study Group. How can research organizations more effectively transfer research knowledge to decision makers? Milbank Q 2003;81:221-48, 171-2.
39. Jacobson N, Butterill D, Goering P. Development of a framework for knowledge translation: understanding user context. J Health Serv Res Policy 2003;8:94-9.
40. Logan J, Graham ID. Toward a comprehensive interdisciplinary model of health care research use. Sci Commun 1998;20:227-46.
41. Rycroft-Malone J, Seers K, Chandler J, Hawkes CA, Crichton N, Allen C, et al. The role of evidence, context, and facilitation in an implementation trial: implications for the development of the PARIHS framework. Implement Sci 2013;8:28.
42. Graham ID, Tetroe J; KT Theories Research Group. Some theoretical underpinnings of knowledge translation. Acad Emerg Med 2007;14:936-41.
43. Webster F. The social organization of best practice for acute stroke: an institutional ethnography [dissertation]. Toronto: University of Toronto; 2009.
44. Toplak N, Frenkel J, Ozen S, Lachmann HJ, Woo P, Koné-Paut I, et al; Paediatric Rheumatology International Trials Organisation (PRINTO), Eurotraps and Eurofever Projects. An international registry on autoinflammatory diseases: the Eurofever experience. Ann Rheum Dis 2012;71:1177-82.
45. Goldner EM, Jenkins EK, Fischer B. A narrative review of recent developments in knowledge translation and implications for

mental health care providers. Can J Psychiatry 2014;59:160-9.
46. Kothari A, Armstrong R. Community-based knowledge translation: unexplored opportunities. Implement Sci 2011;6:59.
47. Palinkas LA, Holloway IW, Rice E, Fuentes D, Wu Q, Chamberlain P. Social networks and implementation of evidence-based practices in public youth-serving systems: A mixed-methods study. Implement Sci 2011;6:113.
48. Batshaw ML, Groft SC, Krischer JP. Research into rare diseases of childhood. JAMA 2014;311:1729-30.
49. Prochaska JO, DiClemente CC. Stages of change in the modification of problem behaviors. Prog Behav Modif 1992;28:183-218.
50. Weiner BJ, Amick H, Lee SY. Conceptualization and measurement of organizational readiness for change: a review of the literature in health services research and other fields. Med Care Res Rev 2008;65:379-436.
51. Vachon B, LeBlanc J. Effectiveness of past and current critical incident analysis on reflective learning and practice change. Med Educ 2011;45:894-904.