EDITORIAL

Implementation Science in Pediatric Health Care
Advances and Opportunities

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If you want truly to understand something, try to change it.
Kurt Lewin

This issue of *JAMA Pediatrics* represents a special focus on implementation science in pediatric health care. *Implementation science* refers to the study of methods to promote the systematic uptake of clinical research findings into routine practice.[1] It is described in a multitude of ways around the world (knowledge translation, transfer, mobilization, exchange, dissemination),[2] but ultimately all terms share a similar goal: to close persistent knowledge-to-practice gaps in health care and decision making in an effort to improve outcomes. Real-world uptake of evidence-based practices is essential in pediatric health care to ensure children everywhere benefit from effective treatments, such as the use of glucocorticoids for children with croup that has resulted in a substantial and important decrease in hospitalization for this condition.[3]

Although the field of implementation science has grown exponentially throughout the late 20th and early 21st centuries, examination of the evidence base for health care practices can be traced to the 1800s, when practices such as bloodletting were being called into question as medically sound.[4] Around this time major advances were also being realized in the field of pediatric medicine, spearheaded by individuals such as Abraham Jacobi, MD, who received the first academic appointment in pediatrics in the United States (1860) and was one of the founding members and the first president of the American Pediatric Society (1871).[5,6] Jacobi is well known for advocating that children are not small adults in size or disease as well as for how he used data to advocate for changes in practices such as the institutionalization of children and to support and promote practices such as breastfeeding or the proper preparation of cow's milk when breast milk was not available.[5,6]

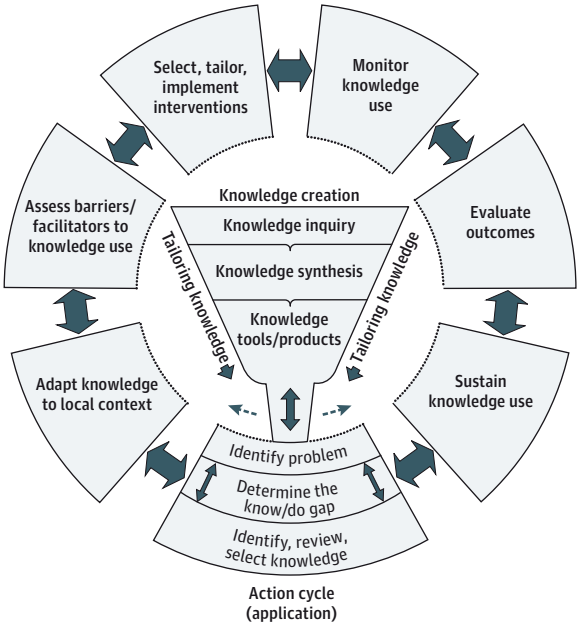
The articles in this issue of *JAMA Pediatrics* bring together the fields of implementation science and pediatrics, representing a wide range of health issues, research designs, and therapeutic interventions. For example, Ardura et al[7] evaluate the effect of implementing new hospital-based protocols for reducing central catheter–associated infections in home settings, illustrating complementary but at times overlapping goals of implementation science and quality improvement. The systematic review and meta-analysis by Manja et al[8] on target oxygen saturation ranges for preterm infants is an excellent example of one of the cornerstones of implementation science and demonstrates that there is not always an evidence-supported best practice on which to inform implementation. These approaches highlight not only the progress that has been made in placing new research within the context of existing evidence but also the active pursuit of tailored messaging and interventions to move evidence into practice. So, where do we go next in implementation science? Where do we go next in pediatric implementation science?

We suggest that to further advance pediatric implementation science, there must be a continued and persistent focus on the following: (1) the use of conceptual frameworks and theories to provide guidance into the relevant factors influencing the implementation process; (2) evaluation of the efficacy of implementation interventions; (3) application and advancement of research designs that are best suited for implementation science; and (4) coordination of efforts to mobilize and scale up widespread change. Implementation research is often complex, and as such our recommendations are in line with the Medical Research Council's guidance on developing and evaluating complex interventions,[9] a valuable resource for implementation researchers.

Conceptual frameworks are systems of concepts, assumptions, and theories organized graphically or narratively,[10] and theories are defined as a coherent and noncontradictory set of statements, concepts, or ideas that organizes, predicts, and explains phenomena, events, and behavior.[11] They are promoted in implementation science to guide the systematic adoption of evidence in practice and are postulated to provide generalizable components for developing research questions and interventions, allowing for an incremental accumulation of knowledge.[1] Several conceptual frameworks for implementation and knowledge translation have been published,[12] and as none have been demonstrated to be superior to another, users can currently choose which best meet their needs. One commonly used framework developed in Canada and adopted internationally is the Knowledge-to-Action Framework.[13,14] It provides step-by-step guidance for implementation and has been used in a number of health contexts.[15] It identifies 2 key phases to move from knowledge production to implementation: the knowledge creation phase and the action cycle (**Figure**).

Applying the Knowledge-to-Action Framework to the articles in the current issue (**Table**) places each of the studies presented here in the context of the full implementation process. Doing this highlights the absence of studies rigorously addressing barriers and facilitators to knowledge use and sustaining knowledge use in the current issue. The lack of studies examining the sustainment of evidence-based practice is perhaps unsurprising, as incorporating mechanisms for sustained implementation and long-term tracking often falls outside the traditional research realm and funding periods, and this lack is a common criticism in the

Figure. Knowledge-to-Action Framework



The Knowledge-to-Action Framework.[13,14] Reprinted with permission from John Wiley and Sons.

Table. Knowledge-to-Action Framework and Current Articles Addressing Its Components

Knowledge-to-Action Framework Component	*JAMA Pediatrics* Theme Issue Article
Knowledge inquiry	Mikolajczyk et al[16]
Knowledge synthesis	Manja et al,[8] Douglas-Escobar and Weiss[17]
Knowledge tools and products	Bender et al[18]
Identify problem, determine the know/do gap, and identify, review, and select knowledge	Ardura et al,[7] Manja et al,[8] Mikolajczyk et al,[16] Douglas-Escobar and Weiss,[17] Bender et al,[18] Zickafoose et al[19]
Adapt knowledge to local context	Zickafoose et al[19]
Assess barriers and facilitators to knowledge use	
Select, tailor, and implement interventions	Ardura et al[7]
Monitor knowledge use	Ardura et al[7]
Evaluate outcomes	Ardura et al[7]
Sustain knowledge use	

field of implementation science.[20] However, it is important to ensure that the lack of consideration for barriers and facilitators to implementation does not become a gap in pediatric implementation science in and of itself, as understanding and targeting barriers and facilitators are a key component of addressing the knowledge-to-practice gap.[21]

Moving forward in pediatric implementation science, adoption and evaluation of evidence-based implementation interventions will be critical. The body of evidence in this area is growing, and groups such as the Cochrane Effective Practice and Organisation of Care Group are continually synthesizing it with systematic reviews, effectiveness summaries, and user-friendly websites[22] to guide users in the selection of practice change (ie, implementation) interventions. While the optimal implementation intervention for a particular issue will likely be content and context driven, pediatric researchers should be aware of the existing evidence base regarding what does and does not work at changing behavior.[23] The Cochrane Effective Practice and Organisation of Care Group has identified more than 300 systematic reviews of professional behavior change interventions. Interventions with overall positive median effect sizes include printed educational materials, educational meetings, educational outreach, local opinion leaders, audit and feedback, computerized reminders, and tailored interventions, although individual study effect sizes range significantly from negative to positive.[21] Emerging areas of interest in implementation interventions whose effects have yet to be supported in systematic reviews include arts-based interventions, social media strategies, and networks or communities of practice.

The next phase of pediatric implementation science will also involve the adoption and advancement of innovative research designs. As reviewed elsewhere,[24-26] the ideal design for implementation research likely exists somewhere between before-and-after designs, with their known limitations, and the randomized clinical trial, touted for its rigor but criticized for its limited ability to inform about mechanisms and contexts, especially in complex interventions and implementation environments.[26] To advance implementation science, we need to consider quasi-experimental designs (eg, interrupted time series),[27,28] mixed methods research to capitalize on the richness of qualitative data, and alternative randomized designs (eg, adaptive trials, randomized encouragement trials, and sequential multiple assignment randomized trials)[24,25] that emulate the rigor of the classic randomized clinical trial while addressing some of the associated constraints. The call to examine alternative trial designs extends beyond health research methods and encourages researchers to continue to learn from fields such as quality engineering, marketing, anthropology, and ethnography.[25,26] Indeed, in both the science and practice of implementation, we may stand to benefit greatly from building expert teams that include not only clinicians, researchers, and patients but also experts in communication fields outside health care such as marketing and journalism, educators, artists, and evaluators. This expertise has been brought together to form the knowledge translation platform within the Centre for Healthcare Innovation at the University of Manitoba, Winnipeg, Manitoba, Canada (http://chimb.ca/) and will be evaluated in ongoing efforts to understand what works in implementation.

Finally, coordinated initiatives will be key for mobilizing and scaling up widespread practice change. Pediatric research demands collaboration, as sample sizes are often small and cooperation is needed across institutions and organizations. Fortunately, national networks often exist for pediatric subspecialties, and researchers can capitalize on these relationships to translate best practices on a large scale. This is the model that Translating Emergency Knowledge for Kids (http://trekk.ca/), part of the Canadian Networks of Centres of Excellence Knowledge Mobilization Initiative, has successfully

implemented. Building on the strengths of the national Pediatric Emergency Research Canada network,[29] researchers have been able to connect pediatric and general emergency departments across Canada to assess knowledge gaps and share evidence and best practices. Moreover, pediatric researchers and clinicians work with both youths and their families, a broad and diverse target audience that presents unique challenges and opportunities for effecting change. In a time when there is ever-increasing focus on integrating the voice of the patient and family member into the research process, pediatric researchers and clinicians have a unique opportunity to engage with patients and their families to learn how they would like to receive information (such as social media, the arts, or technology) or promote change in the health care system that will continue to inform the methods we use and study.

This issue of *JAMA Pediatrics* represents an important step in the development of implementation science in child health. It encourages us to reflect on the need to explicitly evaluate how to use research to improve care by adopting new effective approaches and stopping ineffective or harmful treatments, and it also encourages us to consider how we may contribute to improving the science of implementation. Ultimately, efforts toward reducing the knowledge-to-practice gap are efforts toward improving the health outcomes of children and their families. Continued and coordinated use and development of appropriate implementation frameworks, interventions, and designs will launch pediatric implementation science to the next level—informing both practice change and the science (and art) of knowledge translation.

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REFERENCES

1. Eccles MP, Armstrong D, Baker R, et al. An implementation research agenda. *Implement Sci*. 2009;4:18.

2. McKibbon KA, Lokker C, Wilczynski NL, 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.

3. Segal AO, Crighton EJ, Moineddin R, Mamdani M, Upshur RE. Croup hospitalizations in Ontario: a 14-year time-series analysis. *Pediatrics*. 2005;116(1):51-55.

4. Greenstone G. The history of bloodletting. *B C Med J*. 2010;52(1):12-14.

5. Ligon-Borden BL. Abraham Jacobi, MD: father of American pediatrics and advocate for children's health. *Semin Pediatr Infect Dis*. 2003;14(3):245-249.

6. Haggerty RJ. Abraham Jacobi, MD, respectable rebel. *Pediatrics*. 1997;99(3):462-466.

7. Ardura MI, Lewis J, Tansmore JL, Harp PL, Dienhart MC, Balint JP. Central catheter–associated bloodstream infection reduction with ethanol lock prophylaxis in pediatric intestinal failure: broadening quality improvement initiatives from hospital to home [published online February 2, 2015]. *JAMA Pediatr*. doi:10.1001/jamapediatrics.2014.3291.

8. Manja V, Lakshminrusimha S, Cook DJ. Oxygen saturation target range for extremely preterm infants: a systematic review and meta-analysis [published online February 9, 2015]. *JAMA Pediatr*. doi:10.1001/jamapediatrics.2014.3307.

9. Craig P, Dieppe P, Macintyre S, Michie S, Nazareth I, Petticrew M; Medical Research Council Guidance. Developing and evaluating complex interventions: the new Medical Research Council guidance. *BMJ*. 2008;337:a1655.

10. Maxwell JA. *Qualitative Research Design: An Interactive Approach*. 3rd ed. Thousand Oaks, CA: Sage; 2013.

11. Eccles M, Grimshaw J, Walker A, Johnston M, Pitts N. Changing the behavior of healthcare professionals: the use of theory in promoting the uptake of research findings. *J Clin Epidemiol*. 2005;58(2):107-112.

12. World Health Organization. *Knowledge Translation Framework for Ageing and Health*. Geneva, Switzerland: World Health Organization; 2012.

13. Graham ID, Logan J, Harrison MB, et al. Lost in knowledge translation: time for a map? *J Contin Educ Health Prof*. 2006;26(1):13-24.

14. Straus SE, Tetroe J, Graham ID, eds. *Knowledge Translation in Health Care: Moving From Evidence to Practice*. 2nd ed. Hoboken, NJ: John Wiley & Sons; 2013.

15. Field B, Booth A, Ilott I, Gerrish K. Using the Knowledge to Action Framework in practice: a citation analysis and systematic review. *Implement Sci*. 2014;9(1):172-186.

16. Mikolajczyk R, Horn J, Schmedt N, Langner I, Lindemann C, Garbe E. Injury prevention by medication among children with attention-deficit/hyperactivity disorder: a case-only study [published online February 16, 2015]. *JAMA Pediatr*. doi:10.1001/jamapediatrics.2014.3275.

17. Douglas-Escobar M, Weiss MD. Hypoxic-ischemic encephalopathy: a review for the clinician [published online February 16, 2015]. *JAMA Pediatr*. doi:10.1001/jamapediatrics.2014.3269.

18. Bender BG, Cvietusa PJ, Goodrich GK, et al. Pragmatic trial of health care technologies to improve adherence to pediatric asthma treatment: a randomized clinical trial [published online February 9, 2015]. *JAMA Pediatr*. doi:10.1001/jamapediatrics.2014.3280.

19. Zickafoose JS, DeCamp LR, Prosser LA. Parents' preferences for enhanced access in the pediatric medical home: a discrete choice experiment [published online February 2, 2015]. *JAMA Pediatr*. doi:10.1001/jamapediatrics.2014.3534.

20. Kastner M, Straus SE. Application of the Knowledge-to-Action and Medical Research Council frameworks in the development of an osteoporosis clinical decision support tool. *J Clin Epidemiol*. 2012;65(11):1163-1170.

21. Grimshaw JM, Eccles MP, Lavis JN, Hill SJ, Squires JE. Knowledge translation of research findings. *Implement Sci*. 2012;7:50.

22. Canadian Agency for Drugs and Technologies in Health. Rx for Change. http://www.cadth.ca/en/resources/rx-for-change. Accessed December 30, 2014.

23. Wensing M, Bosch M, Grol R. Developing and selecting knowledge translation interventions. In: Straus SE, Tetroe J, Graham ID, eds. *Knowledge Translation in Health Care: Moving From Evidence to Practice*. 2nd ed. Hoboken, NJ: John Wiley & Sons; 2013:150-162.

24. Brown CH, Ten Have TR, Jo B, et al. Adaptive designs for randomized trials in public health. *Annu Rev Public Health*. 2009;30:1-25.

25. Landsverk J, Brown CH, Rolls Reutz J, Palinkas L, Horwitz SM. Design elements in implementation research: a structured review of child welfare and child mental health studies. *Adm Policy Ment Health*. 2011;38(1):54-63.

26. Berwick DM. The science of improvement. *JAMA*. 2008;299(10):1182-1184.

27. Ramsay CR, Matowe L, Grilli R, Grimshaw JM, Thomas RE. Interrupted time series designs in health technology assessment: lessons from two systematic reviews of behavior change strategies. *Int J Technol Assess Health Care*. 2003;19(4):613-623.

28. Penfold RB, Zhang F. Use of interrupted time series analysis in evaluating health care quality improvements. *Acad Pediatr*. 2013;13(6)(suppl):S38-S44.

29. Hartling L, Scott-Findlay S, Johnson D, et al; Canadian Institutes for Health Research Team in Pediatric Emergency Medicine. Bridging the gap between clinical research and knowledge translation in pediatric emergency medicine. *Acad Emerg Med*. 2007;14(11):968-977.