Implementation Science and the Pregnancy Risk Assessment Monitoring System

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Abstract

This paper describes the restructuring of the Pregnancy Risk Assessment Monitoring System (PRAMS), a surveillance system of the Centers for Disease Control and Prevention (CDC)'s Division of Reproductive Health conducted for 25 years in collaboration with state and city health departments. With the ultimate goal to better inform health care providers, public health programs, and policy, changes were made to various aspects of PRAMS to enhance its capacity on assessing and monitoring public health interventions and clinical practices in addition to risk behaviors, disease prevalence, comorbidities, and service utilization. Specifically, the three key PRAMS changes identified as necessary and described in this paper are questionnaire revision, launching the web-based centralized PRAMS Integrated Data Collection System, and enhancing the access to PRAMS data through the web query system known as Centers for Disease Control and Prevention's PRAMS Online Data for Epidemiologic Research/PRAMStat. The seven action steps of Knowledge To Action cycle, an illustration of the implementation science process, that reflect the milestones necessary in bridging the knowledge-to-action gap were used as framework for each of these key changes.

Introduction

THE PREGNANCY RISK ASSESSMENT MONITORING SYSTEM (PRAMS) is a surveillance system that the Centers for Disease Control and Prevention's Division of Reproductive Health has conducted for 25 years in collaboration with state and city health departments. As of 2014, the project is conducted in 40 states and New York City. PRAMS is one of the nation's main sources of population-based information on mothers and their offspring. The PRAMS questionnaire collects information on behaviors and attitudes before, during, and shortly after pregnancy among women who had a live birth. Information about PRAMS and its methodology is published elsewhere.^{1,2} To date, PRAMS data have been used to monitor various targets in Healthy People 2020, preconception health and health care indicators and selected performance measures for different programs and initiatives (e.g., Title 5 Maternal and Child Health Program, Collaborative Improvement and Innovation Network to Reduce Infant Mortality).³⁻⁶

Public health systems, surveys included, have to respond to the increasing need for timely information prompted by the enhancing electronic health information exchange in re-

sponse to the national efforts to improve the health care quality, safety, and cost. The increasing use of electronic medical records (EMRs) and electronic health records (EHRs) raised the bar for data collection and transmission at higher standards by using state-of-the-art information technology. The rapid pace at which these changes occur is also an opportunity to expedite the transformation of public health data systems including surveys and align them with the new software technology standards. Through careful planning, public health surveillance systems and surveys should be able to meet these new challenges.

In parallel, the changes in health systems prompted a more rapid translation of science to practice. As a result, "knowledge translation" (KT), also known as research utilization, translational medicine, and implementation science, evolved as a dynamic and iterative process that includes the synthesis, dissemination, exchange, and ethically sound application of knowledge to improve health. The National Institutes of Health (NIH) defined implementation science as "the study of methods to promote the integration of research findings and evidence into healthcare policy and practice. It seeks to understand the behavior of healthcare professionals and other stakeholders as a key variable in the sustainable

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uptake, adoption, and implementation of evidence-based interventions.⁷⁻¹³

To date, these KT efforts have focused more on understanding the barriers and facilitators that influence the successful implementation of effective clinical interventions and much less on developing strategies for continued monitoring of their impact on health outcomes at the population level. Public health surveys and surveillance systems like PRAMS could be key resources for this monitoring, particularly if they are designed to coordinate and harmonize with the changes in health care practices or systems. However, to meet the above-mentioned challenges, surveys like PRAMS must be carefully assessed and upgraded.

We used the knowledge to action (KTA) cycle developed by Graham et al.¹⁴ (Fig. 1) as an effective tool in guiding the adoption of implementation science. KTA cycle conceptualizes the relationship between knowledge creation (knowledge funnel) and action (action cycle), each comprised of different phases. The seven phases of the action cycle that reflect the milestones necessary to bridge the knowledge-to-action gap were used as framework for the three key PRAMS changes described in this paper: (1) questionnaire revision, (2) launching the web-based centralized PRAMS Integrated Data Collection System (PIDS), and (3) enhancing the access to PRAMS data through the web query system known as Centers for Disease Control and Prevention (CDC)'s PRAMS Online Data for Epidemiologic Research (CPONDER)/PRAMStat.

Knowledge Translation/Implementation Science

For almost 20 years, attention has focused on reducing the barriers to translating evidence into practice and policy. In response to the increasing need to address the gap between scientific findings regarding effective interventions and what was actually implemented in practice or programs, the new field of research known as implementation science evolved. Seeking to more thoroughly disseminate and integrate evidence-based strategies, implementation science attempts to address what, how, and why underlying inefficiencies and gaps exist in health service delivery.¹⁴⁻¹⁶ It also enhances the extent to which intervention research is generalizable, representative, and comprehensive in order to increase public health impact.¹⁰

Over the last decade, knowledge translation (KT) gained attention in Canada, with most recent preferred terms being knowledge to action (KTA) and knowledge exchange. The terms often used in the United States is implementation science. Agencies such as the National Institutes of Health (NIH), Agency for Healthcare Research and Quality, and Centers for Disease Control and Prevention (CDC) promote, support, and/or conduct implementation science. Subsequently, these agencies have been expanding their implementation science portfolios.¹⁷

The KTA cycle that illustrates the implementation science process is divided into two concepts, (1) knowledge creation and (2) action, with each concept comprised of ideal phases

FIG. 1. Knowledge to action (KTA) cycle (Source: Graham et al., 2006).

or categories (Fig. 1). The knowledge creation (knowledge funnel) consists of the major types of knowledge generation or research. The action cycle is a process by which the knowledge created is implemented and consists of seven phases: (1) identify a problem that needs to be addressed and identify, review, and select the knowledge or research relevant to the problem; (2) adapt the identified knowledge or research to the local context; (3) assess barriers to using the knowledge; (4) select, tailor, and implement interventions to promote the use of knowledge (i.e., implement the change); (5) monitor knowledge use; (6) evaluate the outcomes of using the knowledge, and (7) sustain ongoing knowledge use. These phases are dynamic, can influence each other, and can be influenced by the knowledge creation phases. As described by Graham and his colleagues, “the process is complex and dynamic, and the boundaries between these two concepts and their ideal phases are fluid and permeable.”¹⁴

Key PRAMS Changes

The three key PRAMS changes identified as necessary in order to meet the new challenges and standards were: questionnaire revision, launching the web-based centralized database PIDS, and enhancing the access to PRAMS data through CPONDER/PRAMStat. KTA cycle was used for each of these key changes in order to identify problems and select relevant knowledge (KTA step 1), make adaptations to the local context through assessment of barriers and tailored interventions to enhance PRAMS (KTA step 2 through 4), and to make plans for monitoring the changes and evaluate and sustain them (KTA steps 5 through 7).

PRAMS questionnaire revision

The PRAMS questionnaire has two parts: “core” required questions that are asked by all participating states and “standard” (optional) questions that states can use in whatever combination they choose, resulting in each state having a unique PRAMS questionnaire. A response rate at or above 65% is required for inclusion in multisite/multistate analyses. Using state-based sampling and having high response rates are characteristics that may also increase the validity and reliability of information collected by this survey.

The current PRAMS process requires revision of the questionnaire every 4 years to allow for modifications of existing questions or addition of new questions as necessary. In 2012, at the beginning of another new phase (phase 8) questionnaire revision process, several items were identified for modification and enhancement to ensure that PRAMS data could have maximum utility in the context of implementation science. These items were (a) reducing the core questionnaire, (b) prioritizing the core questions and modifying the process for accepting new questions, and (c) setting more specific criteria for the selection of standard questions.

Efforts to make the information gathered by the PRAMS questionnaire most relevant included reduction of the length of the core questionnaire to allow ample space for questions on state priority issues. Being a state-based system, a major strength of PRAMS is the ability to provide state-based estimates, in particular on state priorities for which data is needed in order to implement relevant programs and policies, as well as to monitor state-specific performance measures (identify problem and select knowledge—KTA step 1). As

we worked to reduce the number of core questions, we employed flow diagrams to ensure that priority was given to topics supporting national or state health initiatives, such as Healthy People 2020 and access to and receipt of health care services with a focus on prevention and known modifiable behaviors, and within the context of new regulations set forth by the transformations of health system (adapt knowledge to local context—KTA step 2).

Further, we modified our process for soliciting new questions for the new phase of the survey. For the first time, we instituted a process that includes the option of sponsoring the addition of new questions to the core and standard lists, which is in contrast to earlier revisions where questions were added based on a voting process that often resulted in low uptake or minimal use of the data from the new questions. Instituting this new process may prompt the identification of high priority issues for which data are needed to understand the emerging trends, also leading to an increase in the uptake of new questions (assess and address barriers—KTA step 3).

Finally, in an effort to make the use of core and standard questions most effective in addressing key issues across states and being able to answer implementation science questions (*what, how and why*), we specified criteria to be met when selecting PRAMS standard questions to add to each states’ core PRAMS survey for phase 8. The purpose of this activity was to ensure adequacy in the number and content of questions on priority topics so that sufficient information is collected for monitoring both women’s knowledge and behaviors in conjunction with the implementation of corresponding evidence based health services (select, tailor, implement—KTA step 4). More deliberate placement of relevant standard questions could help better differentiate between the influences on health outcomes of personal knowledge and behaviors versus clinical interventions. This process may become more effective as population-based indicators mirror the clinical performance measures developed for assessing the implementation of evidence based clinical interventions and practices endorsed by expert groups/task force.

As the revised questionnaire (phase 8) will be implemented, the survey response rate and the use of information obtained from PRAMS will continue to be assessed (monitor knowledge use, evaluate outcomes, and sustain the knowledge use—KTA steps 5, 6, and 7). These efforts may also be topic specific (e.g., health care access, contraception use, safe sleep) and dependent on the system changes, and therefore, subjects for future reports and papers.

PIDS implementation

In this fast changing and technology-driven health care transformation, public health systems like PRAMS must also increase data timeliness, accuracy and flexibility in order to be compatible for the harmonization between public health indicators and clinical performance measures monitored through electronic medical records (identify problem and select knowledge—KTA step 1).

To meet these emerging needs and priorities, PRAMS implemented the web-based centralized PIDS. This real-time data collection will allow more effective day-to-day PRAMS operations and data processing with the goal of expediting data availability and use. More efficient data collection and

processing, along with the latest software technology can, in turn, lead to reducing the questionnaire phases from a 4-year cycle down to a 2- to 3-year cycle. Therefore, PIDS will also improve the ability to review the PRAMS questionnaire more frequently. This capability of modifying the questionnaire in a shorter timeframe will also increase PRAMS flexibility and use for timely information related to public health programs strategies and policies as well as in emergency preparedness efforts, such as pandemic related questions (adapt knowledge to local context—KTA step 2).

PIDS was designed and developed by implementing industry standard software products that are constantly being enhanced by the vendor. These enhancements are passed on to PIDS at little or no cost. Overall, the time and effort invested to design and implement the new solution that consolidates multiple systems into one system (PIDS) with a single point of entry along with the benefit of reusable architecture mean also cost savings (assess and address barriers—KTA step 3).

Until now, PRAMS has collected data through mail and phone survey modes only. The software products used for PIDS already have the web survey functionality built in, which allows us to bridge the technology gap in providing a web survey mode for data collection. This enhancement will assist PRAMS in the efforts to increase the survey response rates by expanding the outreach and maybe adding to surveillance other population segments including hard-to-reach. Furthermore, PIDS web platform may provide great potential for interoperability with other web based systems (select, tailor, implement—KTA step 4).

As PIDS is being implemented in all PRAMS sites, measures for continued assessment of its functionality and cost associated with the maintenance of this web data collection system are being developed (monitor knowledge use, evaluate outcomes and sustain the knowledge use—KTA steps 5, 6, and 7).

PRAMS CPONDER/PRAMStat access enhancement

CPONDER is an online data system that allows web-based public access to anyone interested in accessing data collected through PRAMS.² Users have the ability to design their own analysis by choosing from an indexed list of available categorical variables. Descriptive statistics in the form of proportions are included in the resulting reports and corresponding graphs.

This platform has been in existence for many years and in 2013 was upgraded with the release of CPONDER, version 2.0. With this release, the number of available indicators increased from 54 to 195 including the addition of influenza vaccination (flu) and preconception health indicators where PRAMS is the primary data source. In addition, there are 16 variables for use in stratifying the key indicators of interest. Analyses may be for a single state and year, for a single state and all available years, or for all available states and a single year. Table 1 is an example of CPONDER output.

The underlying software technology for the current CPONDER system is outdated and requires a technology refresh to be in compliance with the agency's software standards (identify problem and select knowledge—KTA step 1). Work is in progress to transform it into a cost-effective open data platform solution that will allow the users to develop dashboards by selecting indicators/measures of interest, conduct

TABLE 1. PRECONCEPTION HEALTH: INDICATOR OF PREPREGNANCY BLOOD PRESSURE CHECK, 2011, FOR PRAMS SITES WITH $\geq 65\%$ RESPONSE RATE

State		No	Yes
Arkansas	%	89.4	10.6
	CI	86.5–91.8	8.2–13.5
	n	1131	193
Colorado	%	93.0	7.0
	CI	91.3–94.5	5.5–8.7
	n	1695	138
Georgia	%	90.8	9.2
	CI	87.9–93.1	6.9–12.1
	n	1378	192
Hawaii	%	90.9	9.1
	CI	88.9–92.6	7.4–11.1
	n	1401	148
Maine	%	92.6	7.4
	CI	90.4–94.3	5.7–9.6
	n	948	79
Maryland	%	86.9	13.1
	CI	83.8–89.4	10.6–16.2
	n	1246	204
Michigan	%	89.8	10.2
	CI	88.0–91.3	8.7–12.0
	n	1434	202
Minnesota	%	92.7	7.3
	CI	91.0–94.1	5.9–9.0
	n	1261	115
Missouri	%	90.3	9.7
	CI	88.2–92.1	7.9–11.8
	n	1106	131
Nebraska	%	90.9	9.1
	CI	89.2–92.3	7.7–10.8
	n	1513	195
New Jersey	%	89.5	10.5
	CI	87.6–91.1	8.9–12.4
	n	1233	158
New Mexico	%	89.8	10.2
	CI	88.1–91.2	8.8–11.9
	n	1270	138
New York (excluding NYC)	%	92.1	7.9
	CI	89.7–94.0	6.0–10.3
	n	940	104
New York City	%	89.4	10.6
	CI	87.3–91.3	8.7–12.7
	n	1245	157
Oklahoma	%	91.9	8.1
	CI	89.2–94.0	6.0–10.8
	n	1716	227
Oregon	%	93.3	6.7
	CI	91.7–94.6	5.4–8.3
	n	1558	185
Pennsylvania	%	91.6	8.4
	CI	89.5–93.3	6.7–10.5
	n	979	92
Rhode Island	%	89.5	10.5
	CI	87.3–91.3	8.7–12.7
	n	1099	143

(continued)

TABLE 1. (CONTINUED)

State		No	Yes
Utah	%	95.8	4.2
	CI	94.5–96.8	3.2–5.5
	n	1351	74
Vermont	%	94.8	5.2
	CI	93.3–96.0	4.0–6.7
	n	1014	63
Washington	%	91.8	8.2
	CI	89.8–93.4	6.6–10.2
	n	1039	136
West Virginia	%	87.2	12.8
	CI	85.0–89.1	10.9–15.0
	n	1377	207
Wisconsin	%	91.7	8.3
	CI	89.7–93.3	6.7–10.3
	n	1321	243
Wyoming	%	94.3	5.7
	CI	92.0–96.0	4.0–8.0
	n	632	51

Table created on CDC's PRAMS Online Data for Epidemiologic Research (CPONDER) platform.

Cell size percentages are weighted to population characteristics. %, percent; CI, 95% confidence interval for percent; n, sample size.

different analyses including trends, draw maps, and develop presentations online. CPONDER will become PRAMStat.

The open data platform will also allow more sophisticated users to download the PRAMS data as necessary. They could then manipulate the data to best suit their own needs, customize graphs and tables, and incorporate this information into presentations and reports. Finally, this platform will allow for comparisons across states and comparison of PRAMS state data with PRAMS aggregate data at the health and human services regional and near-national levels. An open data platform may also serve as the clearinghouse for data from many CDC program areas (adapt knowledge to local context—KTA step 2; assess and address barriers—KTA step 3; select, tailor, implement—KTA step 4).

The functionality of the open data platform will be constantly assessed. In addition to the existing metrics that assess the functionality of similar web-based systems and how they meet the evolving informatics standards, other specific measures are being developed and will be implemented as soon as the PRAMS open data platform will be launched (monitor knowledge use, evaluate outcomes, and sustain the knowledge use—KTA step 5, 6, and 7).

Conclusions

Using the KTA cycle as implementation science tool, we identified and addressed existing problems within PRAMS infrastructure to meet current needs. Specifically, this process helped us make a clear determination of the next steps in order to implement changes in three key identified areas: refining the questionnaire as appropriate, implementing a web platform to increase the data collection timeliness, and making data accessible to researchers and other professionals interested in using surveys like PRAMS for program strategies and policies.

Understanding why health outcomes may or may not improve within the continuously changing health systems environment is a joint task for the clinical and public health sectors. There is obvious need for collaboration among health care researchers; public health professionals including epidemiologists, economists, information scientists, biostatisticians; and key stakeholders (citizens and practitioners included).⁸ Such collaboration requires also concomitant increase in the knowledge on implementation science through training sessions offered to all despite the background and responsibilities. In parallel, comprehensive studies (e.g., mixed methods designs that include quantitative and qualitative approaches) must be jointly conducted to monitor and assess the implementation of clinical guidelines in conjunction with public health education strategies.

In conclusion, the process of PRAMS transformation suggests that implementation science tools like KTA cycle can be used to identify the problems and determine next steps towards improving the structure of similar systems in this changing health system environment. Furthermore, this process supports the vision that surveillance systems and surveys may be used as instruments that complement the information collected through EHRs and EMRs, while also serving as feedback loops from “population to bedside and bench.” It also mirrors and complements the American College of Epidemiology's new vision for epidemiologists as “the conductors” (“bench to bedside” and “bench and bedside to population”) in clinical and translational research.¹⁸

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References

- Centers for Disease Control and Prevention (CDC). PRAMS. Available at: www.cdc.gov/PRAMS Accessed September 9, 2014.
- CDC's PRAMS online data for epidemiologic research (CPONDER) V2.0. Available at: www.cdc.gov/PRAMS/CPONDER.htm Accessed September 9, 2014.
- Robbins CL, Zapata LB, Farr SL, et al. Core state pre-conception health indicators—pregnancy risk assessment monitoring system and behavioral risk factor surveillance system, 2009. *MMWR Surveill Summ* 2014;63:1–62.
- CDC. PRAMS and smoking. www.cdc.gov/prams/TobaccoandPrams.htm Accessed September 9, 2014.
- Health Resources and Services Administration (HRSA). Maternal and child health. Available at: <http://mchb.hrsa.gov> Accessed September 9, 2014.
- HRSA. Maternal and Child Health Collaborative Improvement and Innovation Network to Reduce Infant Mortality. Available at: <http://mchb.hrsa.gov/infantmortality/coiin> Accessed September 9, 2014.
- NIH Fogarty International Center, Advancing Science for Global Health. Available at: <http://www.fic.nih.gov/News/Events/implementation-science/Pages/faqs.aspx> Accessed July 6, 2014.

8. NIH US National Library of Medicine, Health Services Research Information Central. Available at: http://www.nlm.nih.gov/hsrinfo/implementation_science.html Accessed July 6, 2014.
9. Glied S. Opening Plenary presentation, National Institutes of Health, Fifth Annual Conference on Science of Dissemination and Implementation, March 19, 2012. Available at: http://obssr.od.nih.gov/scientific_areas/translation/dissemination_and_implementation/DI2012/resources/Plenary_Glied.pdf
10. Glasgow RE, Vinson C, Chambers D, Khoury MJ, Kaplan RM, Hunter C. National Institutes of Health approaches to dissemination and implementation science: Current and future directions. *Am J Public Health* 2012;102:1274–1281.
11. Sudsawad P. Knowledge translation: Introduction to models, strategies, and measures. Austin, TX: Southwest Educational Development Laboratory, National Center for the Dissemination of Disability Research, 2007. Available at: www.ktdrr.org/ktlibrary/articles_pubs/ktmodels/ktintro.pdf Accessed March 25, 2012.
12. Logan J, Graham I D. Toward a comprehensive interdisciplinary model of health care research use. *Sci Commun* 1998;20:227–246.
13. Lane JP, Flagg JL. Translating three states of knowledge—Discovery, invention, and innovation. *Implement Sci* 2010; 5:1–14.
14. Graham ID, Logan J, Harrison MB. Lost in knowledge translation: Time for a map? *J Contin Educ Health Prof* 2006;26:13–24.
15. Sung NS, Crowley WF, Genel M, et al. Central challenges facing national clinical research enterprise. *JAMA* 2003; 289:1278–1287.
16. Eccles MP, Mittman BS. Welcome to implementation science. *Implement Sci* 2006;1:1.
17. National Institutes of Health. NIH launches training institute on dissemination and implementation research. U.S. Department of Health and Human Services, 2011. Available at: www.nih.gov/news/health/apr2011/od-04.htm Accessed March 31, 2012.
18. Hiatt R, Samet J, Ness RB; American College of Epidemiology Policy Committee. The role of the epidemiologist in clinical and translational science. *Ann Epidemiol* 2006; 16:409–410.

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