Matern Child Health J (2017) 21:1318–1326
DOI 10.1007/s10995-016-2235-2

Applying Collaborative Learning and Quality Improvement to Public Health: Lessons from the Collaborative Improvement and Innovation Network (CoIIN) to Reduce Infant Mortality

Reem M. Ghandour[1,4] · Katherine Flaherty[2,3] · Ashley Hirai[1] · Vanessa Lee[1] · Deborah Klein Walker[3] · Michael C. Lu[1]

Published online: 18 January 2017

Abstract
Objectives Infant mortality remains a significant public health problem in the U.S. The Collaborative Improvement & Innovation Network (CoIIN) model is an innovative approach, using the science of quality improvement and collaborative learning, which was applied across 13 Southern states in Public Health Regions IV and VI to reduce infant mortality and improve birth outcomes. We provide an in-depth discussion of the history, development, implementation, and adaptation of the model based on the experience of the original CoIIN organizers and participants. In addition to the political genesis and functional components of the initiative, 8 key lessons related to staffing, planning, and implementing future CoIINs are described in detail.
Methods This paper reports the findings from a process evaluation of the model. Data on the states' progress toward reducing infant mortality and improving birth outcomes were collected through a survey in the final months of a 24-month implementation period, as well as through ongoing team communications.
Results The peer-to-peer exchange and platform for collaborative learning, as well as the sharing of data across the states, were major strengths and form the foundation for future CoIIN efforts. A lasting legacy of the initiative is the unique application and sharing of provisional "real time" data to inform "real time" decision-making.
Conclusion The CoIIN model of collaborative learning, QI, and innovation offers a promising approach to strengthening partnerships within and across states, bolstering data systems to inform and track progress more rapidly, and ultimately accelerating improvement toward healthier communities, States, and the Nation as a whole.

Keywords Collaborative learning · Quality improvement · Infant mortality

Significance

What is already known about the subject: Striking and persistent racial/ethnic, socioeconomic, and geographic disparities characterize the ongoing challenge of reducing infant mortality and improving birth outcomes in the U.S. Multi-pronged and innovative approaches are needed to move the needle on this sentinel measure of population health.

What this study adds: The Collaborative Improvement & Innovation Network model is an innovative approach which was applied across 13 Southern states to reduce infant mortality starting in 2012. This paper reports the findings from a process evaluation of the model, and details the development, implementation, and lessons learned from the model based on the unique experience of the original CoIIN organizers and participants.

✉ Reem M. Ghandour
rghandour@hrsa.gov

1 U.S. Department of Health and Human Services, Maternal and Child Health Bureau, Health Resources and Services Administration, Rockville, MD, USA

2 Present Address: Katherine Flaherty Consulting, Franklin, MA, USA

3 Abt Associates, Cambridge, MA, USA

4 Division of Epidemiology, Office of Epidemiology and Research, Maternal and Child Health Bureau, Health Resources and Services Administration, 5600 Fishers Lane, Room 18N122, Rockville, MD 20857, USA

Introduction

Despite improvements, infant mortality remains a significant public health problem in the U.S., particularly among racial and ethnic minority populations (Mathews et al. 2015; Xu et al. 2016; Jacob 2016). Because reducing infant mortality involves addressing complex and multifactorial causes, multi-pronged and innovative approaches are needed to address both proximate and distal influences (Lu and Johnson 2014; Wise 2003). The Collaborative Improvement & Innovation Network (CoIIN) model is an innovative approach that was recently applied to infant mortality. The CoIIN to reduce infant mortality was initiated and sponsored by the Health Resources and Services Administration's Maternal and Child Health Bureau (HRSA MCHB) with public and private partners to assist the 13 Southern states in reducing high rates of infant mortality (https://mchb.hrsa.gov/maternal-child-health-initiatives/collaborative-improvement-innovation-networks-coiins). Using the science of quality improvement (QI) and collaborative learning, the Infant Mortality CoIIN worked to bolster existing policy, clinical and system-level efforts and develop innovative approaches to accelerate improvement in birth outcomes. The success of this CoIIN was recognized with a 2015 U.S. Department of Health and Human Services (HHS) Innovates Award (http://www.hhs.gov/idealab/projects-item/coiin-reduce-infant-mortality/), and has expanded nationally and to other issues.

The Infant Mortality CoIIN was based on the Collaborative Innovation Network model (COIN) developed by Peter Gloor. A COIN is defined as a "team of self-motivated people with a collective vision, enabled by the Web to collaborate in achieving a common goal by sharing ideas, information, and work" (Gloor 2006). A COIN moves beyond the traditional dissemination of information by engaging participants in the full spectrum of change implementation—from defining the problem, to designing an intervention, to implementation and evaluation, and finally to diffusion and adaptation. Key elements of a COIN include: (1) creating and sustaining a "cyber-team"; (2) fostering innovation through rapid, on-going communication; (3) ensuring work is done in patterns characterized by meritocracy, transparency, and openness to all contributions; and (4) creating innovations that are open and disruptive. (Gloor 2006) In developing the Infant Mortality CoIIN, MCHB adapted the COIN model to emphasize both innovation *and* improvement, creating a Collaborative Improvement & Innovation Network (CoIIN).

Building upon a recent editorial, (McPherson et al. 2015) this paper presents the findings from a process evaluation of the infant mortality CoIIN as well as an overview of the history, development, implementation, and improvement of this model based on the experience of the original CoIIN organizers and participants. Findings from the outcome/impact evaluation are presented in another paper (forthcoming). This paper provides the details and framework for implementing, applying, and adapting this model to the problem of infant mortality, but which may also be applied to other complex public health challenges. The goals of this paper are three-fold: (1) to review the factors which created the political window for the Infant Mortality CoIIN; (2) to describe its key functional components; and (3) to highlight lessons learned and opportunities for innovation and improvement.

A Political Window for Public Health Innovation

The U.S. infant mortality rate (IMR) is among the highest of the 34 Organization for Economic Co-operation and Development nations. In 2011, the U.S. IMR was 6.1 per 1000 live births, ranking 27th among industrialized nations (http://www.cdc.gov/nchs/data/hus/hus14.pdf#listtables). Striking and persistent racial/ethnic, socioeconomic, and geographic disparities contribute to this poor international ranking. In 2011, the year before the CoIIN launched, the rate of infant mortality was over two times higher among non-Hispanic black mothers compared to non-Hispanic white mothers (Murphy et al. 2012). Similarly, the infant mortality rate for mothers with less than a high school degree was more than twice that of mothers with a bachelor's degree or higher. These and other factors have historically collided in the U.S. South where infant mortality rates are among the highest in the country. In fact, the top quartile of infant mortality rates in the U.S. is found almost entirely in HHS Regions IV (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina and Tennessee) and VI (Arkansas, Louisiana, New Mexico, Oklahoma and Texas; Hirai et al. 2014). In recognition of limited state-specific success in addressing this challenge, in November of 2010 the State Health Officials (SHOs) in Public Health Regions IV and VI requested assistance from HHS to support a collaborative, multi-state approach. This request built upon a prior history of regional action to address infant mortality, (Hallman 2005) and specifically called for organizational and logistical support for a regional collaborative that would leverage existing investments to coordinate and maximize the use of evidence-based, best, and/or promising practices to reduce infant mortality. In response, HRSA\MCHB supported a Regional Infant Mortality Summit in January 2012 that convened SHOs, MCH Directors, and Medicaid Medical Directors, as well as public and private partners, to share experiences and ideas for improving birth outcomes (Hallman 2005; http://www.shepscenter.unc.edu/data/rndmu/). The Summit highlighted challenges and opportunities facing

participating states and resulted in the broader demand for *shared collaborative learning and action* along common priorities.

Together with public and private partners, HRSA/MCHB formally launched the Infant Mortality CoIIN in July 2012. Through the CoIIN, the science of QI and collaborative learning was used to address poor birth outcomes through a focus on five shared priority areas identified by participating states: (1) reduction of elective deliveries <39 weeks gestation; (2) increased access to interconception care among women with a prior adverse birth outcome who were enrolled in Medicaid; (3) the promotion of safe sleep behaviors; (4) increased smoking cessation among pregnant women; and (5) increased access to risk-appropriate perinatal care for all mothers and newborns.

Through both *improvement* and *innovation*, the Infant Mortality CoIIN sought to concurrently drive the improvement of existing investments and implement new strategies. In the development and implementation of the CoIIN, we drew heavily from the Collaborative Innovation Network model (Gloor 2006) described above, as well as the Breakthrough Series Model for Improvement (Institute for Healthcare Improvement 2003) developed by the Institute for Healthcare Improvement; the application of these approaches is described below.

THE COIIN in Practice: Implementing A New Way of "Doing Business"

As noted above, existing public and private investments targeting improvements in birth outcomes provided a critical foundation for the Infant Mortality CoIIN. However, a philosophical shift in our expectations for Federal efforts was also needed. Rather than providing financial assistance tied to pre-defined outcomes of interest, the CoIIN offered participating states an organizational structure and technical assistance to both refine and maximize existing investments and develop new strategies by working together to exchange best practices and lessons learned within similar geopolitical contexts. Further, by engaging in collaborative learning and utilizing tools and techniques from QI and innovation science, the timeframe for both the implementation and the observed impact of these efforts was expected to be accelerated.

Core elements of this new model were: (1) the formation and maintenance of multi-state "cyberteams" focused on each of the five shared priority areas (common aims); (2) research and identification of evidence-based and promising practices to improve birth outcomes (coordinated strategies) in the five areas; (3) access to, collection and use of "real time" data; (4) development of a set of shared measures to track progress towards aims; and (5) leveraging of local, state, and national will and resources. The organizational structure and processes which supported the work of the original CoIIN is illustrated in Fig. 1; key features, functions and processes are discussed below.

Timeline

While many QI initiatives can be achieved in a 12–18 month timeframe, the application of QI to public health problems can require more time. Originally planned for 18 months, the timeline for the Regions IV and IV CoIIN was extended to 24 months in order to achieve stated aims. This was due to: (1) the systemic nature of the public health challenge; (2) the multitude of stakeholders engaged; and (3) the numbers and types of strategies necessary to achieve change. Additionally, public health QI efforts may be challenged by the availability and timeliness of data or may not lend themselves to tracking through traditional data sources at all.

Priority Areas

Multiple factors were considered when identifying the CoIIN priority areas in Regions IV and VI. First, the *evidence base* supporting the efficacy of strategies to reduce infant mortality was considered and evaluated against what was known about the ability to improve birth outcomes over 18–24 months, the availability of existing data systems to track progress, and the expected population-level impact. Second, while participating states had multiple shared areas of interest, not all were at the same stage with respect to planning and/or implementation. Some already had initiatives in place, and therefore did not need the CoIIN to plan and implement strategies. The five CoIIN priority areas ultimately selected reflected areas of *common interest* as well as *shared challenges*.

Team Formation

One of the key features of the CoIIN was working as a multi-state "cyberteam". The CoIIN teams in Regions IV and VI were comprised of two to three leads or topical experts, one data or methods expert, two support staff from MCHB and partner organizations, self-selected representatives from all participating states, and representatives from key stakeholder groups and partner organizations. The responsibilities of these individuals varied by focus area, group dynamics and needs, however, common characteristics of successful team members are noted in Fig. 2. The formation and maintenance of a successful team may be a dynamic process, particularly given the duration, pace and intensity of the CoIIN process. While

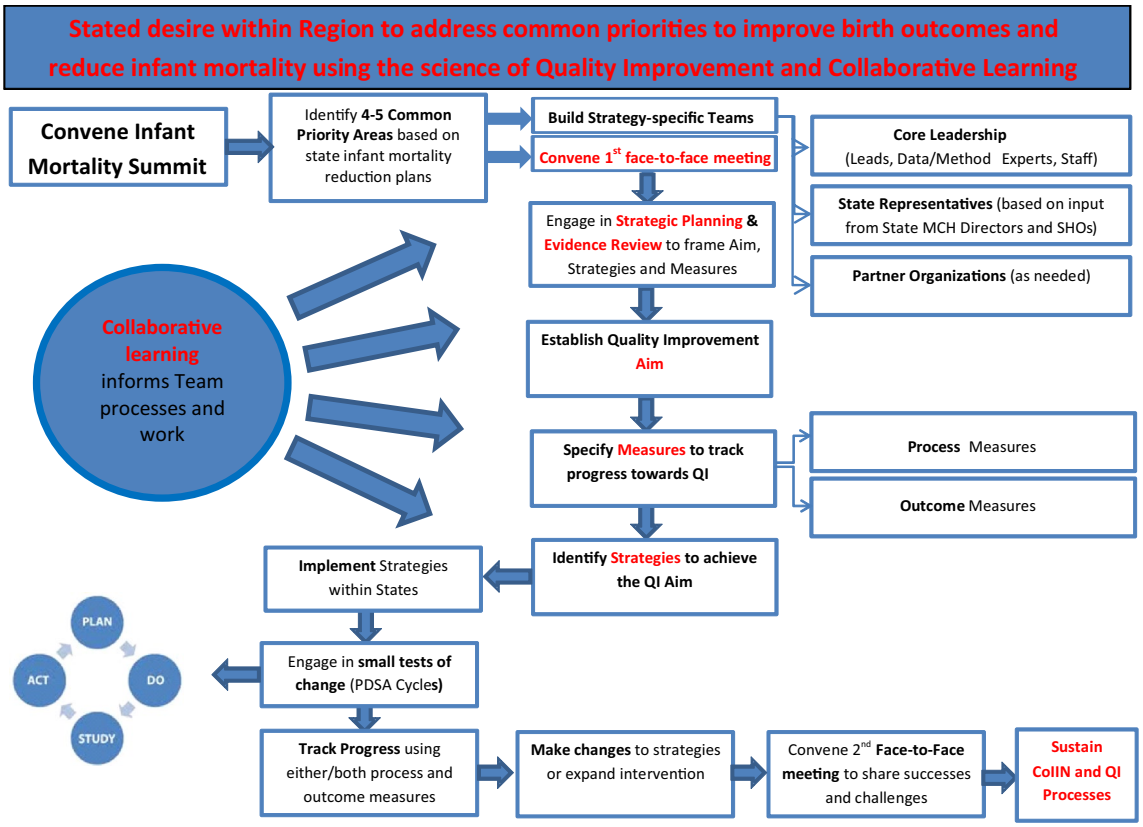

Fig. 1 Key steps in development and implementation of the Region IV and VI Infant Mortality CoIIN

a shift in team membership can be disruptive, it can also be adaptive if it brings new expertise or leverage.

"Cyberteams"

Another key feature of the CoIIN model is reliance on distance-based technology. In the current climate of budgetary restraint, reliance on face-to-face interaction to build trust, set agendas, and implement change is rarely feasible. As such, the Infant Mortality CoIIN in Regions IV and VI supported only two face-to-face meetings—one to launch the initiative and one near the mid-point. Team members primarily communicated and collaborated through monthly virtual meetings and conference calls, and an online collaborative workspace. The web space served as a secure portal for CoIIN team members to upload and share products, information and best practices; a monthly digest was also disseminated. Importantly, although we polled state members about IT system requirements before the selection of the web platform, access issues remained. Finally, variability in experience and/or comfort levels with distance communication technology remained an ongoing challenge.

QI Training and Processes

All of the CoIIN participants were provided with basic QI training through four webinars on the following topics: (1) QI theory and its application to the Infant Mortality CoIIN priority areas; (2) team building; (3) the Plan-Do-Study-Act (PDSA) Cycle; and (4) a mid-point review of the fundamentals of QI and strategies to support implementation efforts. Additional QI technical assistance was available on demand. All five CoIIN teams engaged in structured QI processes and developed driver diagrams that specified an aim statement, drivers of and strategies for change, and measures to determine if the aim was achieved. Aims are illustrated in Fig. 3.

Although all teams developed driver diagrams (or logic models) and used general QI processes, the specific application of QI processes varied by team. Two factors contributed to this variability: some priority areas lent themselves to QI processes more easily than others and the degree of both knowledge and comfort with QI processes and practices varied among team members. As noted previously, the Region IV and VI CoIIN was based, in part, on the Breakthrough Series Model for Improvement which utilizes PDSA cycles and small tests of change. The teams that

Leads	Data/Methods Experts	Support Staff	Members
2-3 per Team	1-2 per Team	2 per Team	Unlimited
Drawn from State infant mortality reduction teams and state/national experts.	Drawn from (mostly) state-level epidemiology programs and CDC staff.	Drawn from MCHB and partner organizations.	Drawn from State infant mortality reduction teams and other partners/stakeholders in the state.
Role: Provide content expertise, intellectual leadership and strategic direction and oversight of the team, as well as the CoIIN initiative overall.	Role: Provide data and methods expertise and direction related to the identification of both process and outcome measures for the team.	Role: Provide logistical, procedural and organizational support to the team; contribute to team agenda-setting and deliberation; coordination of activities with other teams.	Role: Contribute to team agenda-setting and deliberations; lead and/or support implementation of team strategies at the state level; coordinate COIIN strategies with related State efforts; participate in QI training and collaborative learning.
Characteristics of successful Leads: • Experience engaging and leading large groups of diverse individuals with a track record for successfully managing multiple perspectives, meeting deadlines, and fostering broad engagement among members; • Availability to consistently attend and lead Team calls/meetings or establish a proxy with decision-making authority;	**Characteristics of successful Experts:** • Knowledge of strategy-related data systems; • Ability to frame both process and outcome measures; • Clear understanding and belief in QI processes, including monitoring tests of change; • Willingness and skills to "think outside the box" to obtain needed data from multiple sources.	**Characteristics of successful Staff:** • Availability to consistently attend and support Team calls/meetings; • Knowledge of and comfort with distance-based technology; • Experience convening and facilitating large groups of diverse individuals; • Ability to "lead" from behind the scenes if needed; • Clear understanding and belief in QI and Collaborative	**Characteristics of successful Members:** • Availability to consistently attend and support team calls/meetings; • Knowledge of and comfort with distance-based technology; • Availability to participate in QI training and methods; • Ability to link CoIIN strategies with related State work.
• Clear understanding of and commitment to QI and collaborative learning processes; • Expertise in the area of the team's focus.		Learning processes; • Ability to successfully negotiate needed support from supervisors and co-staff.	

Fig. 2 Team roles, responsibilities, and key characteristics

Fig. 3 CoIIN team aims

Elective Delivery: Reduce the proportion of non-medically indicated deliveries before 39 weeks gestation by 33% in Region IV and VI States by December 2013.

Interconception Care (ICC): Modify Medicaid policies and procedures in 5-8 Southern States by December 2013 in order to improve access to and financing of postpartum visits and interconception care case management for women who have experienced a Medicaid financed birth that resulted in an adverse pregnancy outcome.

Perinatal Regionalization: Increase to 90% or by 20% above baseline, mothers delivering infants less than 32 weeks gestation and/or less than 1500 grams in Level III/IV facilities.

Safe Sleep: Increase infant safe sleep practices by 5% by December, 2013 in Region IV and VI States. The baseline date for the safe sleep outcome measures examining the percent of infants placed on their back to sleep and the percent of infants not sharing a sleep surface was 2010.

Smoking Cessation: Decrease the tobacco smoking rate by 3% among pregnant women in the States of Regions IV and VI by December 31, 2013.

focused on broad policy and system-level changes, e.g., expansion of interconception care, did not use PDSA cycles but tracked progress through process measures where feasible.

Implementation of QI Strategies at the State Level

One of the most challenging transitions in the CoIIN process was transitioning from strategy development in collaborative, multistate teams to implementation at the State level. Participating states found that retaining a connection to state-specific infant mortality reduction efforts provided a critical launch point for the implementation of CoIIN strategies. Further, identifying a "menu" of various strategies tied to the team's aim facilitated broader uptake of CoIIN activities at the State level. State team members could tailor implementation activities to fit their state environments. Thus, not all 13 states implemented the same strategies/actions to address each aim. Furthermore, in selecting and implementing CoIIN strategies, states were encouraged to fortify and expand existing efforts rather than summarily beginning new initiatives.

Monitoring Change through a Data Dashboard

To track progress toward their aims, the teams selected a common set of measures and the states reported data on the measures for display on a shared Dashboard. The dashboard provided a visual display of the measures across the states, and facilitated the monitoring of progress "in real time" and at a glance. The availability of real-time data was essential to provide timely feedback on state efforts so that effective strategies could be identified and spread to other states and states could engage in "healthy" competition. Data plateaus and lack of progress also challenged states to think creatively and drill deeper to identify and target drivers within their states (e.g. hospital outliers, racial/ethnic disparities). A key challenge to this critical component of the CoIIN was obtaining permission from the states to share data. The development of data sharing and use agreements ultimately provided the needed protections to address this challenge.

What Worked and What Didn't?

Data on the states' progress toward reducing infant mortality and improving birth outcomes were collected through a survey in the final months of the 24-month period, as well as through standing team calls. States cited the following impact of participation in CoIIN: (1) the initiative convened key leaders and stakeholders and created or enhanced partnerships that resulted in the development of state-wide strategic plans and other initiatives to reduce infant mortality; (2) existing state efforts to reduce infant mortality were refined and/or reinvigorated; (3) the platform facilitated collaborative learning and the sharing of best practices

across states; and (4) the Data Dashboard and use of real-time data stimulated efforts to effectively measure, report, and use vital statistics data on a provisional basis, a development which may support data timeliness for other public health initiatives.

Lessons Learned and Considerations for Broader Application

Lessons learned for the future application of the CoIIN model include:

1. Providing clarity about the CoIIN model and engaging and/or educating leaders who understand QI as applied to public health must occur at the onset. CoIIN is a different model for supporting states through the provision of technical assistance and a platform for state-to-state collaborative learning, rather than funding to accomplish a specific activity or achieve a predetermined goal. The model relies on self-motivated individuals and builds upon participants' desire to see better outcomes in their states/localities and their belief in opportunities for improvement in current efforts and investments.
2. Team formation, training and support are critical to success. The selection of team leads, experts, staff and state members is a process which should be thoughtful, deliberative, and strategic. In addition to the characteristics illustrated in Fig. 2, our experience yielded the following insights: (a) roles and responsibilities of team members should be clear at the onset, especially the time commitment; (b) data/methods experts should be engaged as early as possible in the process of defining the problem, identifying and evaluating strategies, related measures and the availability of data; (c) consumer representatives should be engaged as early as possible so that their input can inform the development and implementation of strategies; and (d) strategies should be implemented to minimize the impact of turnover, i.e., new member orientations, identification of back-up/shared team memberships to prevent fatigue.
3. Because CoIIN is fundamentally a QI initiative, all participants should have a basic understanding of QI principles and practices. An assessment of the levels of QI knowledge and experience at the beginning of the initiative would be helpful in developing the QI training sessions and technical assistance. Because QI has traditionally been more common in clinical settings, training of participants in the application of QI principles and practices to public health, in particular, is necessary.
4. The inherent tension between collaboration and timeliness in the CoIIN model should be acknowledged and addressed. This tension may arise at multiple points. First, early adoption of common aims, strategies, and metrics is critical to capitalizing on early momentum and driving change. This requires striking a delicate balance between allowing adequate time for deliberation and disagreement without succumbing to "paralysis by analysis". It may also necessitate a degree of flexibility wherein CoIIN participants are free to opt out of engagement in selected activities if a particular aim or strategy cannot be reconciled with existing political or other pressures. Second, the CoIIN timeline of 18–24 months requires teams and states to define, implement and monitor tests of change rapidly over a relatively short period of time. Individuals and teams may be tempted to rely on traditional partnerships without taking the time to build new relationships that could foster even deeper collaboration. A two-fold strategy of working within known networks and collectively identifying and pursing new partnerships is recommended for the long term success of CoIIN. Throughout the CoIIN process, strategic use of varied communication strategies coupled with strong leadership and administrative support are needed to move effectively and efficiently through collaborative deliberations.
5. CoIIN is not one-size fits all. Although QI principles generally require a degree of uniformity in the implementation and tracking of "tests of change", engagement in CoIIN and the specific strategies tested will vary from State to State depending on political constraints and current, emergent and competing priorities. Focusing teams on *small tests of change* may allow more States to implement similar strategies despite differences in buy-in. Definitions of "success" may also vary by strategy: while somewhat more difficult to measure using traditional metrics, policy changes may be just as critical to achieving a selected aim as clinical practice or behavioral changes.
6. Early formulation of a data plan/measurement strategy is an essential component of CoIIN. The importance of engaging in this process as early as possible cannot be overstated. One of the key challenges faced by the Regions IV and VI CoIIN was the lack of timely data with which to track progress on outcome measures. In fact, data sources commonly used for public health surveillance are generally not publicly available on a schedule that supports traditional QI efforts. As such, promoting access and analysis of provisional data at the state level, as was done successfully with vital records, will most likely need to be pursued for other data sources. The engagement of epidemiologists and provision of technical assistance to support data submission are critical to promote timely and consistent

tracking. In addition to outcome measures, state strategies, interventions, and policy changes also need to be consistently and uniformly tracked in order to identify which strategies led to successful improvement.

7. Linkages to related state infant mortality efforts should be encouraged, established and maintained. The transition from state-based teams to cross-state teams formed around priority areas is a key characteristic of the CoIIN model which enables participating states to engage in collaborative learning and problem solving around shared priorities. However, the implementation of strategies identified through that shared, multi-state process may require team members to resume/reinvigorate work with state partners which has been suspended during the early adoption of CoIIN. States in the Region IV and VI CoIIN experienced greater success in this stage of the process when: (a) a state CoIIN coordinator was designated to oversee and coordinate all CoIIN-related activities as well as other ongoing related activities; and (b) the same individuals were engaged in both CoIIN activities and other related infant mortality reduction activities to facilitate cross-pollination and coordination.
8. A central, convening entity is critical to proving overall project management and logistical support. Even the most committed groups benefit from skilled facilitation of deliberative processes to define aims, identify measures, and develop strategies, as well as the development of tailored strategies to enable effective communication and use of real-time data. Convening organizations should be skilled in project management, data collection and management, group dynamics and communications.

Conclusions

In this paper we provide an overview of the structure, design, process, successes and lessons learned from the original Infant Mortality CoIIN. The peer-to-peer exchange and platform for collaborative learning, as well as the sharing of data across the states, are major strengths and the foundation for CoIIN. The CoIIN depended upon and was strengthened by both vertical partnerships at the federal, state, and local levels as well as partnerships across federal agencies and private organizations. A lasting legacy of the initiative is the emphasis on "real time" data for "real time" decision-making.

The lessons learned in the early CoIIN experience in Regions IV and VI have been applied in the national scale-up of the Infant Mortality CoIIN and can be used in other CoIIN initiatives. The CoIIN model of collaborative learning, QI, and innovation offers a promising approach to strengthening partnerships within and across states, bolstering data systems to inform and track progress more rapidly, and ultimately accelerating improvement toward healthier communities, States, and the Nation as a whole.

Acknowledgements We would like to extend our deepest gratitude to the individuals and teams that made this work possible. Specifically, we would like to acknowledge the Strategy Team leads who provided invaluable leadership and expertise to the Regions IV and VI Infant Mortality CoIIN (alpha): Michelle Alletto, Wanda Barfield, Al Brann, Stephen Cha, Lekisha Daniel-Robinson, Suzanna Dooley, Rebekah Gee, Paul Halverson, David Lakey, Kate Menard, Carrie Shapiro-Mendoza, Ruth Ann Shepherd, Cathy Taylor, and Kim Wyche Etheridge. We would also like to acknowledge the Strategy Team Data and Methods Experts (alpha): Kay Johnson, Dabo Brantley, David Goodman, Lyn Kieltyka, Laurin Kasehagen, Cheryl Robbins, Bill Sappenfield.

References

Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina and Tennessee.

Arkansas, Louisiana, New Mexico, Oklahoma and Texas.

Gloor, P. A. (2006). *Swarm Creativity: Competitive Advantage through Collaborative Innovation Networks*. New York: Oxford University Press.

Hallman, Y. N. (2005) The Southern Regional Project on Infant Mortality: a 20-year retrospective. Atlanta: Southern Legislative Conference. http://www.slcatlanta.org/Publications/HSPS/infant_mortality/mortality_web/infant_mortality_web.pdf.

Heisler, E. J. (2012). *The U.S. Infant Mortality Rate: International Comparisons, Underlying Factors, and Federal Programs*. Washington: Congressional Research Service. http://www.cdc.gov/nchs/data/hus/hus14.pdf#listtables

Hirai, A. H., Sappenfield, W. M., Kogan, M. D., et al. (2014). Contributors to excess infant mortality in the U.S. South. *American Journal of Preventive Medicine, 46*(3), 219–227.

Institute for Healthcare Improvement. (2003). *The Breakthrough Series: IHI's Collaborative Model for Achieving Breakthrough Improvement*. Boston: Institute for Healthcare Improvement.

Jacob, J. A. (2016). US Infant Mortality Rate Declines but Still Exceeds Other Developed Countries. JAMA, *315*(5):451–452.

Lu, M. C., & Johnson, K. A. (2014). Toward a national strategy on infant mortality. *American Journal of Public Health, 104*(Suppl 1), S13–S16.

Maternal and Child Health Bureau. Collaborative Improvement and Innovation Network to Reduce Infant Mortality. http://www.mchb.hrsa.gov/infantmortality/coiin/index.html.

Mathews, T. J., MacDorman, M. F., & Thoma, M. E. (2015). *Infant mortality statistics from the 2013 period linked birth/infant death data set. National vital statistics reports*; vol 64 no 9. Hyattsville: National Center for Health Statistics.

McPherson ME, Gloor PA, Smith LA. (2015). Using Collaborative Improvement and Innovation Networks to Tackle Complex Population Health Problems. *JAMA Pediatrics, 169*(8):709–710.

Murphy, S., Xu, J., & Kochanek, K. (2012). *Deaths: Preliminary Data for 2010*. Hyattsville: National Center for Health Statistics.

U.S. Department of Health and Human Services. A "CoIIN" to Reduce Infant Mortality. http://www.hhs.gov/idealab/projects-item/coiin-reduce-infant-mortality/.

University of North Carolina. Region IV Network for Data Management and Utilization: project overview. http://www.shepscenter.unc.edu/data/rndmu/. Accessed 28 Sept 2015.

Wise, P. H. (2003). The anatomy of a disparity in infant mortality. *Annual review of public health, 24*, 341–362.

Xu, J. Q., Murphy, S. L., Kochanek, K. D., & Bastian, B. A. (2016). *Deaths: Final data for 2013. National vital statistics reports*; vol 64 no 2. Hyattsville: National Center for Health Statistics.