Accelerating Improvement in Children's Healthcare Through Quality Improvement Collaboratives: a Synthesis of Recent Efforts

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Abbreviations AAP American Academy of Pediatrics · ACR American College of Rheumatology · *Bright STAR* Blood Culture Improvement Guidelines and Diagnostic Stewardship for Antibiotic Reduction in Critically Ill Children · CCBDN Childhood Cancer & Blood Disorders Network · CFF Cystic Fibrosis Foundation · CHA Children's Hospital Association · IPSO Improving Pediatric Sepsis Outcomes · NAPRTCS North American Pediatric Renal Trials and Collaborative Studies · OCHA Ohio Children's Hospital Association · OCHSPS Ohio Children's Hospitals' Solutions for Patient Safety · QIC Quality improvement collaborative · SCDTDP Sickle Cell Disease Treatment Demonstration Program · SCOPE Standardizing Care to Improve Outcomes in Pediatric End Stage Renal Disease · SPS Children's Hospitals' Solutions for Patient Safety · VIP Value in Inpatient Pediatrics

Abstract

Purpose of review Quality improvement collaboratives can accelerate quality improvement and patient safety efforts. We reviewed major pediatric quality improvement collaboratives that have published results in the past 5 years and discussed common success factors and barriers encountered by these collaboratives.

Recent findings Many pediatric quality improvement collaboratives are active in neonatal, cystic fibrosis, congenital heart disease, hematology/oncology, chronic kidney disease, rheumatology, critical care, and general pediatric care.

Summary Factors important to the success of these pediatric quality improvement collaboratives include data sharing and communication, trust among institutions, financial support, support from national organizations, use of a theoretical framework to guide collaboration, patient and family involvement, and incentives for participation at both the individual and institutional levels. Common barriers encountered by these collaboratives include insufficient funding or resources, legal concerns, difficulty coming to consensus on best practices and outcome measures, and overcoming cultural barriers to change. Learning from the successes and challenges encountered by these collaboratives will enable the pediatric healthcare quality improvement community to continue to evolve this approach to maximize benefits to children.

Introduction

Despite significant effort over the last two decades, preventable harm and gaps in quality of care continue to affect children receiving healthcare [1–3]. Implementing best practices to improve the quality of healthcare can be hampered by lack of awareness, familiarity, or agreement; lack of skills or motivation; and external barriers such as insufficient time [4]. Quality improvement collaboratives (QICs) can help to overcome many of these barriers. Involving multiple institutions in a shared improvement effort spreads knowledge and skill, builds social pressure to engage clinicians, and pools resources to overcome barriers to improving the quality of healthcare.

A systematic review of 220 QICs found that 83% of the examined studies reported improvement in one or more study outcomes [5••]. The Michigan Keystone intensive care unit (ICU) project, a well-known QIC, reduced the rate of catheter-related bloodstream infections in ICUs through five relatively simple and low-cost interventions that resulted in preventing approximately

29.9 catheter-related bloodstream infections and saving 3.4 to 7.2 lives per year per hospital [6, 7].

In this review, we focus on the most significant pediatric QIC publications from the last 5 years, including a narrative that provides the history of these QICs (Table 1). Using the definition by Wells et al.: “A QIC is an organised, multifaceted approach that includes teams from multiple healthcare sites coming together to learn, apply and share improvement methods, ideas and data on service performance for a given healthcare topic,” we identified published pediatric QICs that meet this definition by conducting a comprehensive review of literature complemented by the authors’ knowledge [5••]. QICs were included on the basis of size, scope, and impact on care. The review also briefly examines other noteworthy groups, including those that meet the QIC definition but have not yet published their results. Finally, success factors and barriers described in the literature are summarized.

Table 1. Significant pediatric quality improvement collaboratives

Name	Year founded	Patient population	Clinical outcome(s) targeted	Active in 2018?
California Perinatal Quality of Care Collaborative [8, 9, 10●●, 11, 12, 13, 14●, 15]	1997	Neonatal intensive care units in California	Delivery room management, breast milk feeding, length of stay, bronchopulmonary dysplasia	Yes
Cystic Fibrosis Foundation [16–19]	2002	Cystic fibrosis	Being seen by respiratory therapist/dietician, survival, pulmonary function tests	Yes
National Pediatric Cardiology Quality Improvement Collaborative [20, 21●●, 22●●, 23, 24, 25●, 26]	2005	Hypoplastic left heart	Reduce mortality and improve quality of life during interstage period between Norwood and Glenn procedures	Yes
ImproveCareNow [27, 28, 29●●, 30, 31●, 32]	2007	Inflammatory bowel disease	Inactive disease, patients not requiring steroid treatment, complete disease classification, pharmacologic genotypes before starting thiopurines	Yes
Value in Inpatient Pediatrics [33–36]	2007	Pediatric inpatients	Bronchiolitis, pneumonia	Yes
Children's Hospitals' Solutions for Patient Safety [37, 38●●, 39, 40●, 41●, 42●●, 43]	2009	Pediatric inpatients and employees/staff	Adverse drug events; antimicrobial stewardship; catheter-associated urinary tract infections; central line-associated bloodstream infections; central line-associated bloodstream infections hematology/oncology; central venous catheter venous thromboembolism; employee/staff safety: overexertion; employee/staff safety: patient behavioral events; employee/staff safety: slips, trips and falls; serious falls (falls with injury); nephrotoxic acute kidney injury; non-central venous catheter venous thromboembolism; peripheral intravenous infiltration and extravasations; pressure injuries; readmissions; respiratory device-related pressure injuries; serious safety events; surgical site infections; unplanned extubations; ventilator-associated events	Yes
Childhood Cancer & Blood Disorders Network [44–46]	2009	Pediatric	hematology/oncology (Hem/Onc) inpatients	Central
line-associated bloodstream infections	*No			
Sickle Cell Disease Treatment Demonstration Program [47, 48]	2010	Sickle cell disease	Emergency department care, coordinating care between primary care and specialty providers, improving follow-up care for newborns with sickle cell disease, improving the transition of care from pediatric to adult providers, optimizing the use of hydroxyurea	Yes

Table 1. (Continued)

Name	Year founded	Patient population	Clinical outcome(s) targeted	Active in 2018?
Improving Patient Handoffs Quality Improvement Collaborative [49]	2010	Pediatric inpatients	Handoff-related errors	No
Standardizing Care to Improve Outcomes in Pediatric End Stage Renal Disease [50–53]	2011	Peritoneal dialysis	Peritonitis	Yes
Pediatric Rheumatology Care and Outcomes Improvement Network [54, 55•, 56–60]	2011	Juvenile idiopathic arthritis	Remission rate, disease monitoring, medication counseling	Yes
Improving Pediatric Sepsis Outcomes [61, 62]	2015	Pediatric inpatients and outpatients Pediatric intensive care unit	Sepsis mortality, sepsis onset	Yes
Blood Culture Improvement Guidelines and Diagnostic Stewardship for Antibiotic Reduction in Critically Ill Children [63]	2018		Diagnostic stewardship of blood cultures	Yes
*Work continues through the SPS CLABSI Hem/Onc Workgroup

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Fig. 1. The Breakthrough Series collaborative model adapted from Kilo 1998 [64].

A framework for collaborative quality improvement

Breakthrough Series collaborative model

A framework extensively used by QICs is the Breakthrough Series collaborative model from the Institute for Healthcare Improvement [5••, 64]. This model targets a specific clinical topic for improvement and then uses learning sessions and Plan-Do-Study-Act (PDSA) cycles to accelerate improvement by drawing upon the shared successes and failures of each member (Fig. 1) [64]. Learning sessions function as important waypoints to determine the changes needed to improve in the clinical area (learning session 1), assess the progress made and share findings from involved organizations (learning session 2), and summarize what has been learned from this improvement process (learning session 3). During action periods, PDSA cycles occur and organizations share their knowledge and experiences through site visits, conference calls, or other forms of communication. Many QICs also share features of the Learning Healthcare System model [65].

Pediatric quality improvement collaboratives

CPQCC

Founded in 1997 by the California Association of Neonatologists with foundation and state funds, the California Perinatal Quality of Care Collaborative (CPQCC) includes 128 neonatal intensive care units (NICUs) caring for more than 90% of NICU patients in California [8, 9]. The CPQCC uses the Breakthrough Series collaborative model [10••, 64]. The CPQCC has implemented a delivery room checklist that reached 80% compliance [8]. This collaborative decreased the rate of bronchopulmonary dysplasia (odds ratio 0.8), decreased hypothermia and intubation in the delivery room, decreased postmenstrual age at discharge from 37.8 to 37.5 weeks ($P=0.02$), decreased length of stay and treatment for patients with neonatal abstinence syndrome, and increased breast milk feeding rates from 54.6 to 61.7% with necrotizing enterocolitis rates decreasing from 7 to 4.3% [10••, 11, 12, 13, 14•]. The CPQCC also showed that NICUs participating in QICs had greater improvement than did NICUs working alone [10••, 12, 13].

CFF

Aided by the Cystic Fibrosis Foundation (CFF) patient registry created in 1966, the CFF launched a quality improvement (QI) initiative in 2002 by “assembling national experts to develop a strategic plan to disseminate QI training and processes” [16]. This registry and the Foundation facilitated the rapid identification of improvement opportunities [16]. From 2002 to 2013, 90% of all cystic fibrosis centers in the United States (US) participated in 11 QIC projects [17]. The collaborative used the Dartmouth Clinical Microsystem applied theory and curriculum, which focuses on improving small clinical units using various quality improvement methods [66, 67]. Collaborative members communicated frequently through monthly webinars and routine coaching calls [17].

CFF was successful in increasing the percentage of patients seen by a respiratory therapist from 69% in 2006 to 86.7% in 2012, increasing the percentage of patients seen by a dietitian from 70.2% in 2003 to 87.5% in 2012, increasing the median predicted survival of patients from 31.3 years in 2002 to 41.1 years in 2012, and significantly improving patients’ forced expiratory volume in 1 s values (FEV1) from 2002 to 2012 [17, 18].

NPC-QIC

In 2005, the Joint Council on Congenital Heart Disease developed the National Pediatric Cardiology Quality Improvement Collaborative (NPC-QIC), which works to improve interstage survival for children with a hypoplastic left heart and to decrease interstage growth failure and hospital readmissions [20, 21••]. The NPC-QIC uses the Breakthrough Series collaborative model; activities include monthly data submission with routine reports, monthly webinars, an active listserv, and semi-annual learning session workshops involving health-care providers and parents [21••, 64]. The NPC-QIC worked to improve transparency by sharing aggregate outcome data with the public and member institutions [22••]. The NPC-QIC began with fewer than ten sites and now includes more than 50 sites [21••].

The NPC-QIC decreased interstage mortality by 44% from 9.5 to 5.3%, improved growth after implementing a nutritional care bundle, and improved care processes, such as identifying the post-care coordinator and updating the preventive care plan/written medication list/red flag action plan [21••, 23]. Analysis from a single center found a reduction in interstage mortality correlating to one less patient death per 23 total patients [24]. Annual administrative costs for participating in the collaborative were \$38,271, and the median revenue provided by caring for a patient for 12 months of life was \$488,944 [24]. The NPC-QIC also developed a patient data registry that has been used for research purposes [25•].

ICN

ImproveCareNow (ICN) is a pediatric QIC that improves care for children with inflammatory bowel disease [27]. This network originated from the Pediatric Inflammatory Bowel Disease Network Trailblazer Improvement Collaborative formed in 2007 and sponsored by the North American Society for Pediatric Gastroenterology, Hepatology, and Nutrition and the American Board of Pediatrics (ABP) [27]. This network then developed into the ICN Network, with

more than 100 sites in the US and Europe [27, 28]. In addition to using the Breakthrough Series collaborative model, ICN uses "theories from leadership of social movements to motivate and build cross-stakeholder collaboration" [29••, 30, 64]. In the planning phase, ICN took input from many stakeholders such as patients, families, pediatric gastroenterologists, nurses, researchers, social scientists, technologists, community organizers, and designers [29••]. ICN also facilitated data submission by enabling relevant patient data to be sent to the ICN central data repository from participants' electronic health record [31•]. ICN generates data reports for each patient that provide decision support and pre-visit planning [68].

The ICN Collaborative increased the percentage of patients with inactive disease from 55 to 68% for Crohn's disease and from 61 to 72% for ulcerative colitis [30]. It also increased the percentage of patients with Crohn's disease not taking prednisone from 86 to 90% and increased the number of patients in whom complete disease classification and thiopurine methyltransferase genotype was established before initiating a thiopurine medication [30].

VIP

The Value in Inpatient Pediatrics (VIP) Network conducted multiple collaborative QI projects for children with bronchiolitis and pneumonia [33–35]. The first bronchiolitis project involved 17 centers from 2007 to 2010, including members volunteering from the American Academy of Pediatrics (AAP) Section on Hospital Medicine [33]. Members adopted national guidelines at their own pace and did not have to follow the guidelines to remain in the collaborative. Most centers performed PDSA cycles. The collaborative generated a yearly report showing each hospital's rates of unnecessary care for bronchiolitis against the network's average. High performers were honored at an annual meeting and encouraged to share successful tools online [33].

The VIP Network conducted a second collaborative targeting bronchiolitis patients from 2013 to 2014 that involved 21 hospitals [34]. The bronchiolitis initiative was sponsored by the Quality Improvement Innovation Network of the AAP [34]. This collaborative was more programmatic, with the implementation of a standardized change package with evidence-based pathways, order sets, and educational materials along with scheduled webinars, a listserv, and individual site coaching [34]. The AAP maintained a website that included performance data and webinar recordings [34].

Running from 2014 to 15 and including 48 hospitals, the VIP Network also worked to improve evidence-based care for patients with pneumonia [35]. Members implemented a standardized change package that included evidence-based pathways and order sets and had regularly scheduled webinars, a project listserv, and individual site coaching [35]. Each site also received a pre-assigned expert to help guide improvement based on their unique needs. The AAP maintained an online workspace for data collection and access to educational materials [35].

The VIP collaboratives demonstrated improvement in multiple areas. The first bronchiolitis collaborative demonstrated a 46% reduction in the use of bronchodilators and a significant decrease in the use of chest physiotherapy [33]. The second bronchiolitis collaborative demonstrated a 29% decrease in the number of patients receiving any bronchodilator, a 68% decrease in the

amount of corticosteroid use, and a decrease in the length of stay for bronchiolitis patients by 5 h [34]. The pneumonia collaborative increased the use of narrow-spectrum antibiotics from 36 to 63% and decreased the use of macrolide antibiotics from 30.3 to 18.6% [35].

SPS

Children's Hospitals' Solutions for Patient Safety (SPS) originated from the Ohio Children's Hospital Association (OCHA), six hospitals that worked together in the 1980s to advocate for pediatric healthcare in Ohio, emerging in 2009 with eight hospitals as Ohio Children's Hospitals' Solutions for Patient Safety (OCHSPS) [37]. Initially, OCHSPS worked to decrease codes outside the ICU, surgical site infections, and adverse drug events through the use of PDSA cycles and data submission to a central registry with real-time data access to facilitate rapid learning across all hospitals [37]. In 2012, OCHSPS expanded to become the nationwide SPS collaborative that initially included 33 children's hospitals [37]. SPS used semi-annual in-person learning sessions, monthly webinars, online discussions, and data submission and to promote an "all teach, all learn" philosophy [38••].

The OCHSPS reduced surgical site infections by 58% and adverse drug events by 50% [37, 39]. Over a 34-month period, the OCHSPS reduced its serious safety event rate by 55%, which is an estimated 70 fewer children harmed per year [37]. SPS reduced surgical site infections by 21% from January 2011 to December 2013 and decreased the rate of stage 4 pressure injuries from 0.01 to 0.004 per 1000 patient days ($P=0.02$) from 2011 to 2013 [40•, 41•]. SPS significantly decreased harm in eight out of nine hospital-acquired conditions and decreased the mean monthly serious safety event rate by 32% [38••]. As of the latest published results, this work spared an estimated 9000 children from serious harm and saved \$148.5 million through June 2017 [42••]. SPS has grown to now include more than 130 member hospitals in the US and Canada. The focus of SPS has expanded to now include numerous additional hospital-acquired harms and employee safety.

SCDTDP

Coordinated by the National Institute for Children's Health Quality (NICHQ) using federal funding, the Sickle Cell Disease Treatment Demonstration Program (SCDTDP) ran from 2010 to 2014, with the goal of improving care for patients with sickle cell disease and has another initiative ongoing from 2018 to 2021 [47, 48]. This collaborative consisted of nine grantees across the US working to improve various quality measures involving acute care, care coordination, follow-up, and hydroxyurea use. The SCDTDP was modeled after the Breakthrough Series Learning Collaborative [47, 64]. Parents and patients were involved to incorporate the parent and family perspective [47]. NICHQ performed site visits to provide technical assistance to members [47].

The SCDTDP improved the wait time for pain assessment in the acute care setting by 69% and improved the time between triage and the first dose of pain medication by 29% [47]. This collaborative improved care coordination with 135% more patients seen by a hematologist in the previous year [47].

SCOPE

The Standardizing Care to Improve Outcomes in Pediatric End Stage Renal Disease (SCOPE) Collaborative reduced the rate of peritoneal dialysis catheter-related infections by implementing best practices for peritoneal dialysis care [50]. SCOPE was started in 2011 with assistance from quality improvement experts at the Children's Hospital Association (CHA) and by partnering with the North American Pediatric Renal Trials and Collaborative Studies (NAPRTCS) registry [51]. The NAPRTCS registry contains data on patients with pediatric chronic kidney disease from over 100 sites [50]. The NAPRTCS provided Web-based data collection and analysis services for SCOPE [50]. Currently, this collaborative includes 44 sites that implement standardized best-care bundles for catheter insertion, provide training to patients and caregivers for catheter care, and conduct follow-up procedures [50, 52]. To encourage group learning, the collaborative has two face-to-face learning sessions per year, monthly webinars/conference calls, one-on-one coaching of members, and monthly data sharing [50]. The individual institutions provide financial support for this collaborative [50].

The SCOPE Collaborative decreased peritonitis from 0.63 per patient year to 0.42 per patient year and found that increasing compliance with standardized follow-up practices was associated with decreased peritonitis [51, 53].

PR-COIN

Pediatric Rheumatology Care and Outcomes Improvement Network (PR-COIN) was founded in 2011 to improve outcomes for patients with juvenile idiopathic arthritis and includes 18 member hospitals [54, 55]. PR-COIN receives funding from the Patient-Centered Outcomes Research Institute, American College of Rheumatology (ACR), participating member hospitals, and pharmaceutical companies [54, 56]. This collaborative uses the Break-through Series collaborative model with monthly webinars, "learning labs," and semi-annual learning sessions, and sites contribute data to a central registry maintained by the ACR [57, 64]. Patients and families are part of this improvement process and help to set priorities, with one parent on the governing body [58].

The PR-COIN Collaborative has increased remission rates from 37.2 to 48.4% and has seen improvements in various quality measures such as measurement of functional ability and improved uveitis screening [57, 59, 60].

Other pediatric quality improvement collaboratives and data collection groups

The Childhood Cancer & Blood Disorders Network (CCBDN) was organized by the CHA in 2009 to reduce central line-associated bloodstream infections (CLABSIs) in pediatric hematology/oncology inpatients [44]. The CCBDN reduced the rate of CLABSIs from 2.85 to 2.04 CLABSIs per 1000 central-line days, thereby preventing an estimated 290 CLABSIs with a likely cost savings of approximately \$11 million [45]. The Improving Patient Handoffs Quality Improvement Collaborative started in 2010 and was coordinated by the Child Health Corporation of America (CHCA), which then became part of the CHA

[49]. This collaborative decreased handoff-related failures from 25.8 to 7.9%, and overall satisfaction with the handoff improved from 55 to 70% [49].

More recently formed collaboratives focus on diagnostic stewardship and sepsis. The Blood Culture Improvement Guidelines and Diagnostic Stewardship for Antibiotic Reduction in Critically Ill Children (Bright STAR Collaborative) was founded by Johns Hopkins Children's Center in January 2018. The Bright STAR Collaborative is implementing a clinical practice strategy for diagnostic stewardship of blood cultures in the critical care setting but has not yet published outcome data [63]. The Improving Pediatric Sepsis Outcomes (IPSO) was created by the CHA in 2015, with the goal of reducing sepsis-related mortality by 75% and hospital-onset severe sepsis by 75% by 2020, but has not yet published outcome data [61, 62]. Other collaborative improvement efforts are embedded within federal funding mechanisms. For example, centers funded by the federal Ryan White program, which provides care for a substantial portion of pediatric HIV patients, must participate in the HIVQUAL program which guides care improvement through clinical guidelines, measurement, and improvement methods [69–71].

The National Surgical Quality Improvement Program-Pediatric (NSQIP-Pediatric) and Pediatric Cardiac Critical Care Consortium (PC4) are two organizations that collect large amounts of data on pediatric patients but do not fully meet the QIC definition used in this review based on their level of focus and organized communication of a QIC outlined in this article [72, 73, 74•, 75•, 76–78]. Several other multi-institutional QI efforts focused on pediatric patients also do not meet the QIC definition outlined in this article: birth certificate data, NICU CLABSI prevention, primary care screening, standardized medication concentrations, handoff improvements, intubation safety, and venous thromboembolism [79–81, 82•, 83•, 84, 85].

Discussion

We have reviewed features and outcomes of major pediatric QICs, but other impactful QICs have not been covered due to a lack of published data or the authors not being aware of QICs in every pediatric specialty. There are multiple factors that are associated with successful collaboratives. Outlined below are those success-related factors, barriers for success, and potential solutions that can mitigate the challenges associated with conducting a successful collaborative.

Factors leading to the success of pediatric quality improvement collaboratives

Collaborative data sharing and communication

Free flow of data and communication among members are likely the most important aspects of a successful QIC. SPS used the “all teach, all learn” philosophy to ensure free flow of information among members, with semi-annual in-person learning sessions, monthly webinars on various topics, discussions on a password-protected website, and frequent data reporting, so that top-performing hospitals could be identified and share their successful methods with others [38••]. The NPC-QIC used similar methods [21••]. The CFF

went beyond electronic communication and performed benchmarked site visits wherein QI teams visit high-performing sites to see in person what made these sites successful [17].

Data sharing and identifying high-performing hospitals can inspire improvement through public and peer pressure. Public availability of data on the CFF registry may have motivated lower-performing hospitals to improve [16]. In the VIP Network, top performers were honored at a yearly meeting thus potentially creating peer pressure to improve [33].

Data sharing and identifying high-performing hospitals can also motivate improvement work. A hospital working in isolation might accept poor patient safety outcomes because this has always been the accepted norm. However, after joining a QIC and seeing the possibility of better outcomes, it can be motivated to improve. The CFF collaborative reported that data transparency motivated members to learn how to achieve the high-performance measures found at other institutions [17]. We believe a successful QIC can induce a shift in institutional culture and a change from the mindset that some preventable patient harm events are acceptable to the attitude that preventable harm can be reduced or eliminated.

Previous working relationship and trust

The founding SPS members had already worked with each other for many years as part of the OCHA [37]. The VIP members had previous relationships because they participated in the AAP Section on Hospital Medicine and the AAP Hospital Medicine Listserv [33, 35].

Inter-institutional and interpersonal trust is important for the success of many collaboratives. The sharing of sensitive and parochial data requires the trust that the purpose of the data sharing is to learn from each other, to identify best practices and best outcomes which can be used to drive better patient outcomes. Should such data be used to gain a competitive advantage in the marketplace, the success of learning from each other would likely jeopardize collaborative success. For example, SPS collaborative leadership understood the importance of making sure that sensitive data would be shared without fear of competition by explicitly stating that "We will not compete on safety" [42••].

Financial support

Participating in a QIC can require significant financial resources to pay for clinician time, QI experts, data collection and analysis, and implementing QI changes. Private sources can provide this funding. The OCHSPS received support from the private industry through the Ohio Business Roundtable and from corporations [37]. The PR-COIN received funding from pharmaceutical companies [56].

Some QICs receive funding through member contributions. SPS members pay an annual fee, and PR-COIN receives financial support from its members [38••, 56]. However, funding the collaborative through member contributions can make it difficult for smaller hospitals to participate.

National organizations and government entities are common sources of funding. The CPQCC received financial support from the California Association of Neonatologists, the David and Lucile Packard Foundation, and the

California Department of Public Health [9]. The SCDTDP was funded by the NICHQ and the Maternal and Child Health Bureau of the Health Resources and Services Administration [47]. The CCBDN was supported by the Agency for Healthcare Research and Quality and the CHA [45]. PR-COIN received financial support from the ACR [56]. Funding from a national organization allows smaller hospitals with less resources to more easily participate.

Participating in a QIC can be financially beneficial. Analysis from a single center participating in the NPC-QIC found a reduction in interstage mortality correlating to one less patient death per 23 total patients [24]. Annual administrative costs for participating in the collaborative were \$38,271, and the median revenue provided by caring for a patient for 12 months of life was \$488,944 [24]. Thus, if this single center has at least 23 hypoplastic left heart patients per year, the hospital will save \$450,673 compared to not participating in the NPC-QIC. The Michigan Keystone ICU project was also financially beneficial with the average cost of preventing a central line–associated infection at \$3375 while the healthcare costs associated with a central line–associated infection ranging from \$12,208 to \$56,167 [6]. The Children’s Hospital Association Quality Transformation Network saved \$129,737,916 through the prevention of central line–associated bloodstream infections from 2006 to 2011 [86]. Hospitals interested in participating in SPS can calculate the financial benefit from participating in the collaborative through the use of a value calculator that incorporates data regarding cost savings from decreasing hospital-acquired conditions [42••].

Support from established organizations

Established organizations provide legitimacy and credibility to a newly formed collaborative, access to patient data, and logistical support for data collection and analysis. Examples include support for ICN by the North American Society for Pediatric Gastroenterology, Hepatology, and Nutrition and the ABP, for the CFF collaborative by the Cystic Fibrosis Foundation, for the VIP Network by the AAP, and for the NPC-QIC by the Joint Council on Congenital Heart Disease [16, 17, 21••, 27, 35].

Theoretical framework

Starting a pediatric QIC can be daunting because it requires extensive logistical coordination. Most successful QICs used an already existing theoretical framework to guide this collaboration. Many pediatric QICs have used some form of the Breakthrough Series collaborative model because it has a proven track record of success [10, 21••, 30, 47, 49, 57, 64]. Interestingly, the ICN Network also used “theories from leadership of social movements to motivate and build cross-stakeholder collaboration,” which shows the importance of social engineering [29••]. Using an existing, proven theoretical framework to launch a QIC increases the feasibility for smaller institutions without QI expertise to participate.

Patient and family involvement

Involving patients and families in the collaborative can help identify areas for improvement. Multiple collaboratives have made a conscious effort to involve

patients and families [17, 21••, 29••, 47, 58]. The NPC-QIC had trouble getting parents involved but solved this problem by reaching out to Sisters by Heart, a parent organization for families affected by hypoplastic left heart syndrome [21••]. PR-COIN took parental involvement a step further by appointing a parent on its governing body [58].

Incentives for participation

Many collaboratives give incentives to individuals and institutions to increase participation. Several collaboratives encouraged individual participation by providing American Board of Pediatrics Maintenance of Certification Part 4 Credit [21••, 34, 86]. The NPC-QIC encouraged institutional support with NPC-QIC participation, resulting in points for the US News and World Report's rankings of best pediatric cardiology programs [21••]. However, although concrete incentives can increase participation at both the individual and institutional levels, there is the risk of participants becoming overly focused on obtaining these concrete incentives by meeting metrics rather than concentrating on actual improvement.

Barriers to the success of pediatric quality improvement collaboratives

Insufficient funding or resources as a barrier to participation in network

Multiple QICs reported that institutions that are small or have less resources had limited participation [8, 30, 37]. ICN reported that some centers had lower levels of improvement, likely reflecting the lack of resources at these centers [30]. This illustrates the limited ability of QICs to help smaller resource-poor institutions. This is unfortunate because these institutions need QI the most to maximize patient outcomes in resource-limited settings. A possible solution is to fund the QICs through various government entities, private organizations, national physician organizations, or national disease-based organizations rather than depending on member contributions [9, 37, 45, 47, 56].

Legal concerns regarding sharing patient data

Legal concerns can arise when sharing sensitive patient safety data, especially when data indicate preventable patient harm are shared across state lines. The NPC-QIC made efforts to make their data sharing more transparent but met with concerns from hospital legal departments [22••]. Obtaining legal protection for data sharing can prove difficult, especially since hospitals often focus on state protections and QICs include institutions in different states with different state laws and governments. Although the OCHSPS had legal protection for sharing patient data, members raised concerns [37]. The legal protection provided by Ohio's peer review statute applies to SPS data and outcomes through the creation of an SPS Peer Review Committee, and over time legal concerns have not limited growth in SPS. As healthcare safety and quality data become more transparent, these concerns may diminish, but

additional federal legal protections may facilitate data sharing at a national level.

Consensus on best practices and outcome measures

In the case of rare pediatric diseases for which many guidelines for clinical management are not available, it can be difficult to reach a consensus on best practices and most important outcome measures. This problem was especially apparent in the NPC-QIC and ICN collaboratives because of their focus on relatively rare diagnoses [21••, 30]. A potential solution is to involve nationally recognized experts in the field to develop expert consensus opinion for unifying the collaborative [21••, 45, 51]. QICs can also help reach consensus by providing “large, representative study samples with high-quality data that can be used to generate evidence and inform clinical decision-making” [87].

Existing institutional practices, inertia, and culture

QI efforts involve changing an existing institutional practice. Although a change in practice can be supported by evidence, the institutional culture still needs to be changed to implement this evidence. The VIP Network found that the strongest association with failure to decrease unnecessary bronchiolitis treatments was having a bronchiolitis protocol before joining the network [33]. The CFF collaborative found that some members were initially hesitant to participate because they had trouble believing they were not delivering the best possible care and doubted the accuracy of registry data [16].

The OCHSPS used various task forces to create an error prevention safety culture at both the employee and leadership levels [37]. The CPQCC asked members for direct input on the design of interventions to improve institutional buy in [8].

Members of the collaborative also need to be assured that the culture of the collaborative is one of learning and not shaming or punishing for lower performance. Members of the CFF collaborative initially had concerns about being punished for not performing at optimal levels and had to be reassured that the culture of the collaborative was one of learning [16]. SPS made efforts to make clear that the culture of the collaborative is not one of competition but of focus on patient safety by stating that “We will not compete on safety” and utilizing the “all teach, all learn” philosophy [38••, 42••].

Conclusion

The diversity and scale of QICs in pediatrics is impressive. We observed commonalities in the improvement methods used as well as barriers and success factors reported. As the number of QICs continues to grow, and the rapid cycle improvement approach evolves toward long-term continuous improvement efforts, competition for scarce resources will necessitate continued innovation to optimize efficiency and sustainability. For example, opportunities may exist to combine efforts across QICs or share common data management infrastructure. It will be important for collaboratives to share not only outcomes but

also details of how successes are achieved in the literature to foster further growth and maturation of the QIC approach.

Compliance with Ethical Standards

Conflict of Interest

Richard J. Brill declares no conflict of interest.

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Human and Animal Rights and Informed Consent

This article does not contain any studies with human or animal subjects performed by any of the authors.

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