

Collective quality improvement in the paediatric cardiology acute care unit: establishment of the Pediatric Acute Care Cardiology Collaborative (PAC³)

Original Article

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Abstract

Collaborative quality improvement and learning networks have amended healthcare quality and value across specialties. Motivated by these successes, the Pediatric Acute Care Cardiology Collaborative (PAC³) was founded in late 2014 with an emphasis on improving outcomes of paediatric cardiology patients within cardiac acute care units; acute care encompasses all hospital-based inpatient non-intensive care. PAC³ aims to deliver higher quality and greater value care by facilitating the sharing of ideas and building alignment among its member institutions. These aims are intentionally aligned with the work of other national clinical collaborations, registries, and parent advocacy organisations. The mission and early work of PAC³ is exemplified by the formal partnership with the Pediatric Cardiac Critical Care Consortium (PC⁴), as well as the creation of a clinical registry, which links with the PC⁴ registry to track practices and outcomes across the entire inpatient encounter from admission to discharge. Capturing the full inpatient experience allows detection of outcome differences related to variation in care delivered outside the cardiac ICU and development of benchmarks for cardiac acute care. We aspire to improve patient outcomes such as morbidity, hospital length of stay, and re-admission rates, while working to advance patient and family satisfaction. We will use quality improvement methodologies consistent with the Model for Improvement to achieve these aims. Membership currently includes 36 centres across North America, out of which 26 are also members of PC⁴. In this report, we describe the development of PAC³, including the philosophical, organisational, and infrastructural elements that will enable a paediatric acute care cardiology learning network.

Inpatient cardiology care in paediatric hospitals includes treatment for a broad range of clinical conditions and patient types, including those with CHD or acquired heart disease, and involves the full spectrum of ages from newborn to adult. Given the complexity and acuity of this patient population, many paediatric hospital centres have committed to formalising their care structure for these patients, commonly including the creation of a cardiac acute care unit. For patients initially admitted to the cardiovascular ICU, the cardiac acute care unit is a place of transition for patients well enough to be cared for outside of the cardiac ICU, but not yet ready to be discharged home. In addition, many cardiac patients are admitted and discharged directly from the cardiac acute care unit. The clinicians of the cardiac acute care unit, with varied subspecialty expertise including cardiologists, cardiothoracic surgeons, nurse practitioners, physician assistants, as well as the nursing staff, focus to facilitate the safe, efficient, and successful discharge of patients to their home environment in the context of monitoring all patients to prevent and treat clinical deterioration. The cardiac acute care unit population is medically diverse: pre-surgical/post-surgical and pre-procedural/post-procedural patients, including those with single-ventricle physiology; patients with heart failure including those

awaiting transplant or post transplant; and patients undergoing treatment for various heart disease types, including electrophysiological conditions and pulmonary hypertension.

This diverse patient population, having the potential for a broad range of acuity, has historically led medical centres to develop variable clinical care models. Unfortunately, most care models have been built in the absence of any evidence to guide decision-making. Standardisation of care within institutions has also been hampered by the traditional attending physician service model wherein most of the centre’s cardiologists attend in the cardiac acute care unit on occasion rather than with a frequency great enough to develop specialisation of practice. Currently, at many centres, there is a shift to enlist a smaller core group of acute care cardiologists working alongside cardiac acute care unit staff as a strategy to reliably deliver high-quality, safe, cost-effective care to cardiac patients with increasingly complex medical needs. There is a great opportunity and desire for a more purposeful approach to the care of these patients, enhanced by a collaborative learning network and supported by the science of quality improvement.

The Pediatric Acute Care Cardiology Collaborative (PAC³) is the result of this shared vision to unite clinicians across the dedicated field of acute care cardiology. We believe that leveraging our combined experiences and enthusiastically working towards common aims will drive improved outcomes. Founded in November 2014 by Drs A.K. and N.M., PAC³ is an organisation developed to meet the needs of the cardiac acute care unit patients, families, and clinical staff. Our mission is to improve the quality, value, and experience of cardiac acute care in partnership with other national clinical collaborations, registries, and parent advocacy organisations. We describe here the development of PAC³, including the philosophical, organisational, and infrastructural elements that will enable collaborative quality improvement across paediatric cardiac acute care units. In creating this improvement initiative, we created a driver diagram to focus and define key leverage points (Fig 1).

PAC³ quality improvement

A commitment to collaborative learning and quality improvement is central to the mission of PAC³, which aims to become a Learning Network.¹ The quality improvement collaborative model is rooted in shared learning and exchange of insights among different healthcare organisations;² however, in its purest form it is a time-limited interaction, whereas a Learning Network has no end date. There is evidence that quality improvement collaboratives have advanced the quality and value of healthcare across many specialties,³ including paediatric cardiology.⁴ For PAC³, we sought to unite multidisciplinary teams to share an ongoing commitment to collaborative learning and quality improvement methodology to produce innovative results across participating centres.

Much of the care delivered to paediatric cardiology patients does not have well-defined, evidenced-based best practices. To address this opportunity, several registries and organisations seek to discover and implement best practices. Although cardiothoracic surgical knowledge and expertise has improved by way of the Society of Thoracic Surgeons (STS), and paediatric critical care has been enhanced by the effort of the Pediatric Cardiac Critical Care Consortium (PC⁴) and virtual PICU systems, acute care cardiology has thus far lacked the benefit of a data infrastructure and collaboration between specialists. In addition, patient population-specific organisations, including the National Pediatric Cardiology Quality Improvement Collaborative, have improved outcomes and reduced knowledge gaps regarding certain groups of patients. However, the complete breadth of care for acute care cardiology patients has not been explored until now.

Given PAC³’s aim to enhance the safety and quality of outcomes, including the effective transition to outpatient care, it is instructive to examine some of the present-day knowledge gaps. Consider a standard-risk post-operative patient, such as one undergoing a ventricular septal defect closure or right ventricle to pulmonary artery conduit replacement. Currently, data from the Operating Room (OR) and cardiac ICU course are captured as

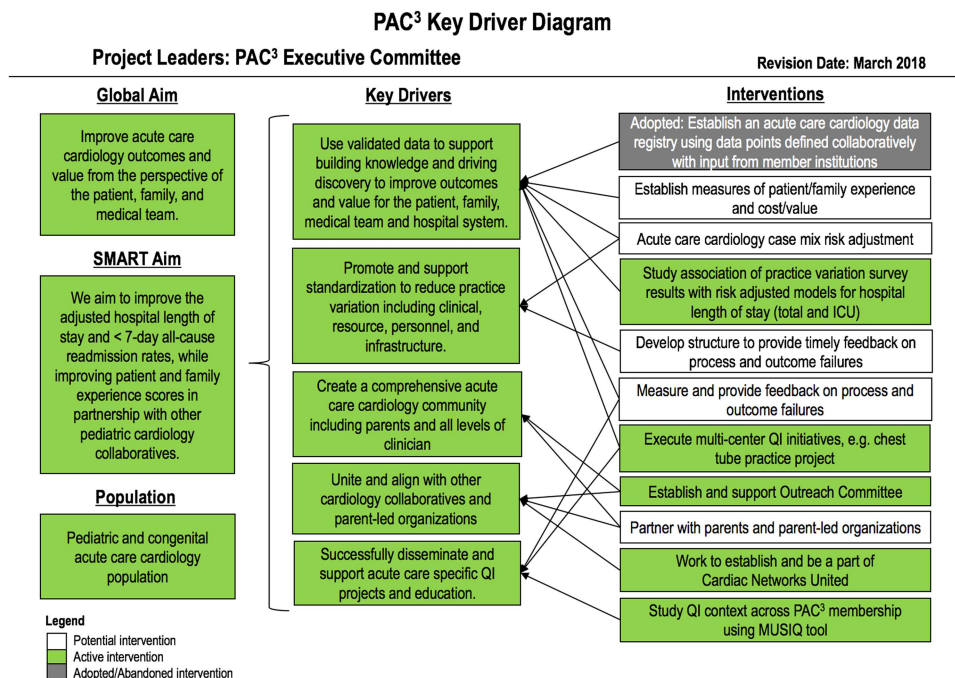


Figure 1. Pediatric Acute Care Cardiology (PAC³) key driver diagram. MUSIQ = Model for Understanding Success in Quality¹³; QI = quality improvement.

part of the Society of Thoracic Surgeons and PC⁴ registries, respectively. However, once transferred to the cardiac acute care unit, no information apart from discharge date is captured. There is no available centralised repository to track vascular access or chest tube management. There are no data on feeding challenges, which is such a core aspect of the acute care experience for patients and families. In addition, beyond what is included in Society of Thoracic Surgeons, there is no mechanism to fully capture rates of complications diagnosed outside of the cardiac ICU. Similarly, consider a more complex post-operative patient, such as an infant with palliated single-ventricle physiology. The clinical course may include a transfer back to the cardiac ICU owing to clinical decline, struggles with aspiration, or chylothorax that may determine outpatient feeding regimens, and/or sedative medication weans, which may affect long-term neurological outcomes. In addition, there are the medical admissions to acute care cardiology that never appear within any current registries to consider. PAC³ would provide a mechanism to capture the missing data needed to guide improvement, and provide an opportunity to document the functional status of these standard or complex patients at the time of hospital discharge.

PAC³ also aims to drive efforts to improve healthcare value by sharing effective cost containment strategies and tactics to achieve the same or better outcomes with less resource utilisation. Previous models have shown that quality improvement initiatives at the individual centre level are effective in improving value by reducing preventable harm,⁵ reducing resource utilisation,⁶ or decreasing length of stay.⁷ Collaborative learning has decreased hospital costs primarily through reductions in complications, across a group of surgical centres.⁸ In the paediatric cardiac surgical domain, institutions with the highest quality care have been shown to deliver care at the lowest cost,⁹ related to fewer major complications including observed-to-predicted mortality and shortened length of stay. As acute care of cardiology patients plays a critical role in time to discharge and patient exposure to preventable harm, PAC³ collaborative efforts could play a pivotal role in cost containment and thereby value.

Last, since the inception of PAC³, there has been small but intentional spread of patient care practices across member centres based on informal learning. Although most of these projects

have not been implemented using formal collaborative quality improvement methodology, the expansion has been influential. Examples include: utilising blended oxygen delivery and initiation of milrinone in the cardiac acute care unit at Lucille Packard Children’s Hospital at Stanford, informed by work at Children’s Hospital of Atlanta and Morgan Stanley Children’s Hospital at Columbia; initiation and titration of intravenous pulmonary hypertension medications in the cardiac acute care unit at Cincinnati Children’s Hospital, informed by experience at Lucille Packard Children’s Hospital at Stanford and Boston Children’s Hospital; titration of vasoactive infusions in the cardiac acute care unit at Children’s National Health System as informed by the experience across many member cardiac acute care units; and ICU to cardiac acute care unit handoff work at Nationwide Children’s, Children’s Hospital of Philadelphia, and UCSF Benioff Children’s Hospital adapting a model achieved at Lucille Packard Children’s Hospital at Stanford.¹⁰

PAC³ registry and partnership with PC⁴

The variability among paediatric heart centres in the care intensity and support offered to patients during their acute care hospitalisation influences the timing of transfer to and from the cardiac ICU and thereby complicates comparisons of the entire inpatient encounter across sites. In other words, the care required at the time of transfer to the cardiac acute care unit – i.e., the end of PC⁴ registry data collection – for a patient in one centre may be quite different from a similar patient at another heart centre. Consequentially, there is no current mechanism to determine how acute care processes and intermediate outcomes influence key inpatient episodes of care outcome measures such as hospital length of stay and re-admission rates.

To remedy these knowledge gaps, PAC³ has entered a formal partnership with PC⁴. While maintaining the unique vision and mission within each organisation, the organisations have built a shared organisational data structure, crafted a statement of partnership, developed joint committees, and invited members of each organisation’s leadership to join the other’s executive committee (Fig 2). In alignment with PC⁴ philosophy, PAC³ has

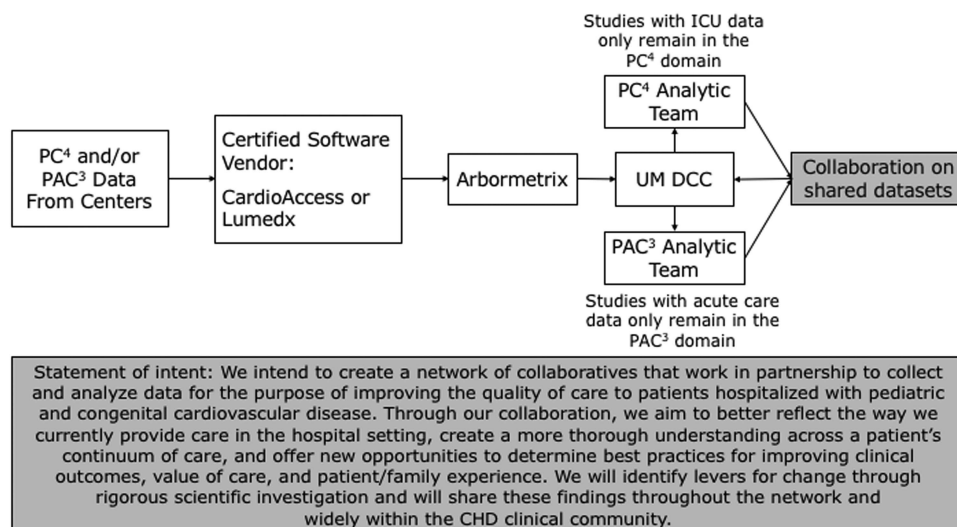


Figure 2. Pediatric Acute Care Cardiology Collaborative (PAC³) and Pediatric Cardiac Critical Care Consortium (PC⁴) Shared Platform Data Flow Diagram and Partnership Intent Statement. UM DCC= University of Michigan Data Coordinating Center.

created a detailed and relevant clinical registry that will link seamlessly with PC⁴ to track practices and outcomes and help drive quality improvement efforts across hospital-based paediatric cardiology care.

A PAC³ encounter is defined by the time the cardiology acute care service team assumes care of the patient, regardless of the physical location of the patient. We intend to include all the medical diverse populations these teams treat; it is not limited to patients before or after cardiothoracic surgery. Recognising the significant investment in clinical registries most centres have already made, the PAC³ registry was built to integrate and pull data from existing registries including Society of Thoracic Surgeons, IMPACT, and PC⁴ to harmonise data capture and improve efficiency while minimising additional resource burden. Collaboration with electronic health record vendors to build extractable discrete fields into the comprehensive reports our acute care teams already produce – e.g. discharge summaries – is ongoing. This may further streamline registry participation and help make PAC³ membership more sustainable. In addition, we believe that close and accurate examination of the clinical data from the entire hospitalisation across multiple institutions will help hospitals fulfil the promise of coordinated and integrated improvement efforts to their patients and parent communities.

Consistent with the integration and partnership with PC⁴, all data collected for PAC³ will be directed to the data coordination centre in Ann Arbor, Michigan, and presented on the Arbor-Matrix, Inc. web-based platform (Fig 2). This allows centres participating in both registries to view outcomes across the inpatient care continuum and avoids the complexities of linking patient data at the time of analysis. Centres may use the same data vendor used for other data submissions. However, it should be mentioned that while participating in both PC⁴ and PAC³ provides many of the highlighted advantages, it is not a requirement to be a member of both organisations. Once each PAC³ centre has participated in the registry for >1 year and has demonstrated their data validity along the same guidelines as detailed in PC⁴,¹¹ the centre's self-determined clinical champion will receive access to unblinded hospital-level data, allowing for both timely performance feedback to clinicians and administrators, as well as transparent data sharing to facilitate collaborative learning.

PAC³ structure and metrics

The PAC³ membership currently includes 36 centres across North America, 26 of which are also members of PC⁴ (Table 1). In addition, all 35 U.S. centres submit data to Society of Thoracic Surgeons. Our membership includes freestanding children's hospitals, as well as those integrated into larger medical centres. Although PAC³ includes most large-volume centres in North America, membership is not contingent on surgical volume or clinical practice structure. In fact, PAC³ aims to better understand the variation in practice among centres across the full clinical spectrum to learn from those centres with the best outcomes regardless of size or centre organisation.

The PAC³ organisation is committed to several operational philosophies: shared governance and leadership; the highest standards of data integrity and scientific methods; seamless integration of data collection, management, and storage with equal access and transparency about shared data; and collaboration on scientific and quality improvement endeavors. The PAC³ organisational structure consists of an executive committee, four

Table 1. Paediatric Acute Care Cardiology Collaborative (PAC³) member institutions in alphabetical order.

Boston Children's Hospital	Lucile Packard Children's Hospital at Stanford
Children's Healthcare of Atlanta	Lurie Children's Hospital
Children's of Alabama	Medical University of South Carolina Children's
Children's Hospital of Colorado	Mercy Kansas City
Children's Hospital of Los Angeles	Monroe Carell Jr Children's Hospital at Vanderbilt
Children's Hospital of Pittsburgh	Morgan Stanley Children's Hospital
Children's Hospital of Philadelphia	Nationwide Children's Hospital
Children's Hospital of Wisconsin	Nemours/Alfred I. DuPont Children's Hospital
Children's Hospital of the Kings Daughters	Nicklaus Children's Hospital
Children's Mercy Kansas City	Primary Children's Hospital
Children's Minnesota	Rainbow Babies and Children's Hospital
Children's National Health System	Seattle Children's Hospital
Cincinnati Children's Hospital	St. Louis Children's Hospital
Cohen Children's Medical Center	The Hospital for Sick Children
C.S. Mott Children's Hospital, University of Michigan	Texas Children's Hospital
Joe DiMaggio Children's Hospital	UCSF Benioff Children's Hospital
Le Bonheur Children's Hospital	University of Florida Children's Hospital
Levine Children Hospital	University of Texas, Southwestern

Bold type = Pediatric Cardiac Critical Care Consortium (PC⁴) member

separate sub-committees (Database, Scientific Review, Quality improvement, and Outreach), and the data-coordinating centre. From our earliest meetings, there has been a strong commitment from all members to foster transparent data sharing to speed improvement.

The metrics of PAC³ will be focused on outcomes of care and will be generated by the data registry. Emphasis will be on those related to complications/morbidity, hospital length of stay, re-admission, cost, and patient/family satisfaction as described by the organisational Key Driver Diagram. However, additional efforts have also been initiated to capture process metrics potentially influencing these outcome metrics of interest. Specifically, in 2017, a 400-question survey was distributed across the PAC³ membership to determine the degree of practice variation across five domains: hospital/staffing/patient demographics, resource/therapy allocation, standard care practices, transitions of care including discharge, and quality improvement practices. The results of this survey will be submitted for publication in 2018. Once the outcome metrics of the registry are available, it is a goal of PAC³ to associate the results of practice variation surveys to determine whether best practices can be determined.

PAC³ organisational goals

There are three PAC³ organisational goals for 2018–2019: begin acute care cardiology data registry collection as per the data variables developed in 2017; continue data integration and collaborative efforts with the PC⁴ registry; and execute our initial organisational quality improvement projects. For the first two organisational goals, the PAC³ registry data dictionary has been completed and the data registry will be in production by spring 2018 for testing. After testing, the target is to initiate phase 1 data collection by July 2018.

Our first quality improvement project goal is to decrease chest tube duration with a global aim to shorten total hospital length of stay. This quality improvement project is a joint effort with PC⁴ because post-operative chest tube management is shared between the cardiac ICU and acute care cardiology, and thus improvement will require coordinated efforts across the inpatient care continuum. We have designed this project to include a control period of baseline measurement followed by an intervention period. The quality improvement components will be nominated by comparing centre performances during the control period.¹² Each centre will elect to follow one or more of these components and the effect on chest tube duration and process adherence will be studied. We aim to demonstrate the value of an interdisciplinary collaborative learning approach in critical and acute care environments with both medical and surgical teams.

The second quality improvement project aims to define and improve quality improvement context across PAC³ member centres. Using a validated quality improvement questionnaire, the Model for Understanding Success in Quality,¹⁵ we aim first to define quality improvement context at each participating institution. This tool has previously been shown to improve and develop the quality improvement environment of collaborative organisations.¹⁴ After defining the quality improvement framework variability across participating sites, members at each centre will identify an element of local quality improvement context to focus on with assistance from PAC³. The long-term ambition is to measure the Model for Understanding Success in Quality score annually across PAC³ member centres to define the degree to which these centres improve over time.

Summary

There are many aspects to providing high-quality care for increasingly complex paediatric cardiology patients in the acute care environment. PAC³ is a new organisation built to assist our understanding of this increasingly complex patient population and facilitate sharing of ideas to examine these variables with the goal of improving outcomes and value. We aspire to work together to lower morbidity, decrease hospital length of stay, reduce re-admissions, increase value, and improve patient and family satisfaction. Through the creation of a learning network leveraging quality improvement methodologies bolstered by transparent data sharing, we believe this collaborative can accomplish these goals.

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Conflicts of Interest. None.

References

1. Britto MT, Fuller SC, Kaplan HC, et al. Using a network organisational architecture to support the development of learning healthcare systems. *BMJ Qual Saf* 2018, February 27. [Epub ahead of print].
2. Kilo CM. Improving care through collaboration. *Pediatrics* 1999; 103 (1 Suppl E): 384–393.
3. Wells S, Tamir O, Gray J, et al. Are quality improvement collaboratives effective? A systematic review. *BMJ Qual Saf* 2017, October 21. [Epub ahead of print] <https://doi.org/10.1136/bmjqs-2017-006926>.
4. Anderson JB, Beekman RH, Kugler MD, et al. Improvement in interstage survival in a national pediatric cardiology learning network. *Circ Cardiovasc Qual Outcomes* 2015; 8: 428–436.
5. Brilli RJ, McClead RE Jr, Crandall WV, et al. A comprehensive patient safety program can significantly reduce preventable harm, costs, and hospital mortality. *J Pediatr* 2013; 163: 1638–1645.
6. Murphy DJ, Lyu PF, Gregg SR, et al. Using incentives to improve resource utilization: a quasi-experimental evaluation of an ICU quality improvement program. *Crit Care Med* 2016; 44: 162–170.
7. Parikh A, Huang SA, Murthy P, et al. Quality improvement and cost savings after implementation of the Leapfrog intensive care unit physician staffing standard at a community teaching hospital. *Crit Care Med* 2012; 40: 2754–2759.
8. Guillaumondegui OD, Gunter OL, Hines L, et al. Using the National Surgical quality improvement program and the Tennessee Surgical Quality Collaborative to improve surgical outcomes. *J Am Coll Surg* 2012; 214: 709–714.
9. Pasquali SK, Jacobs JP, Bove EL, et al. Quality–cost relationship in congenital heart surgery. *Ann Thorac Surg* 2015; 100: 1416–1421.
10. Sheth S, McCarthy E, Kipps AK, et al. Changes in efficiency and safety culture after integration of an iPASS supported handoff process. *Pediatrics* 2016; 137: e20150166.
11. Gaies M, Cooper DS, Tabbutt S, et al. Collaborative quality improvement in the cardiac intensive care unit: development of the Paediatric Cardiac Critical Care Consortium (PC4). *Cardiol Young* 2015; 25: 951–957.
12. Mahle WT, Nicolson SC, Hollenbeck-Pringle D, et al. Utilizing a collaborative learning model to promote early extubation following infant heart surgery. *Pediatr Crit Care Med* 2016; 17: 939–947.
13. Kaplan HC, Froehle CM, Cassidy A, Provost LP, Margolis PA. An exploratory analysis of the model for understanding success in quality. *Health Care Manage Rev* 2013; 38: 325–338.
14. Grooms HR, Froehle CM, Provost LP, Handyside J, Kaplan HC. Improving the context supporting quality improvement in a neonatal intensive care quality collaborative: an exploratory field study. *Am J Med Qual* 2017; 32: 313–321.