

Efficacy of a Longitudinal Project-Based Quality Improvement Curriculum in Pediatric Cardiology Fellowship

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Research Article

Keywords: Quality Improvement, Patient Safety, Medical Education, Curriculum, Cardiology

Posted Date: June 29th, 2023

DOI: <https://doi.org/10.21203/rs.3.rs-3104813/v1>

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Additional Declarations: No competing interests reported.

Version of Record: A version of this preprint was published at Pediatric Cardiology on November 15th, 2023. See the published version at <https://doi.org/10.1007/s00246-023-03340-5>.

Abstract

Our goal was to create a robust quality improvement and patient safety (QI/PS) curriculum that gives fellows both didactic knowledge and first-hand experience with improvement science and produces a longitudinal QI/PS project to improve patient care and safety over their three-year fellowship. The curriculum will meet Clinical Learning Environment Review (CLER) requirements. A series of six 30-minute didactic lectures is paired with designated group work time over the course of 1 year. Each class chooses a QI/PS project which they will continue for the entirety of fellowship. Faculty mentors coach these projects. Knowledge assessment is obtained through pre- and post-surveys. A secondary measure of success is academic products resulting from fellows' QI/PS work, and future participation in QI/PS efforts. Since 2019, 51 pre-tests and 36 post-tests were completed, showing improvement across all competencies. Fellows have produced one published manuscript, two poster presentations, and two oral presentations describing their improvement work. Additionally, mentoring faculty members have gone on to lead other QI work throughout the division. This longitudinal QI/PS curriculum provides both knowledge and experience in QI/PS work. It also creates opportunities for academic publications and presentations, builds faculty expertise, and most importantly, works to improve multiple aspects of patient care. This curriculum can serve as a model for other cardiology fellowships working to meet CLER requirements.

Introduction

Education in quality improvement (QI) and patient safety (PS) is an essential component of fellowship training, as outlined by the American Council for Graduate Medical Education (ACGME) in 2007.[1] The ACGME mandates that this training is comprised of both formal didactics and a hands-on learning experience. The ultimate goal is for fellows to graduate with the tools needed to progress improvements in quality of care, patient safety, and towards minimizing and extinguishing inequities in patient care.[2] Academic training programs are challenged to easily incorporate QI/PS education into fellowship curricula. A recent study by Kahn et al, surveyed programs and found that 85% of programs identified QI as an important component of fellowship training. However, due to multiple factors, including lack of faculty expertise, lack of interest among trainees, and lack of dedicated educational time, the majority of programs (~ 80%) have struggled to create an effective formal QI/PS curriculum.[3–5] Without formal structures in place, QI/PS education in postgraduate medical education lacks consistency. In many settings curricula consist of didactic sessions that are either not linked to hands-on QI project work or are paired with projects that learners can complete within one academic year, so that the work may be balanced with the many clinical demands of residency and fellowship.[6–11] This set-up provides some QI project experience but limits a trainee's ability to follow their project through multiple plan-do-study-act (PDSA) cycles, which are necessary for fine-tuning measures. It also limits the ability to follow the project into the sustain phase, in which the long-term effects of a change can best be observed. Longitudinal QI/PS project work provides a more comprehensive QI experience for learners that is well received by

learners and has been shown to result in more impactful and sustained changes within the system.[12–14]

We developed and implemented a QI/PS curriculum designed to meet ACGME requirements and collected data to show effectiveness in the short-term and through early career. Our QI/PS curriculum also acts as a springboard for interested faculty to develop as coaches and local QI/PS experts. We report our experience to provide a model for other Pediatric Cardiology fellowship programs to initiate or enhance their current QI/PS curriculum, and expand the QI/PS capacity within their division.

Methods

Setting and Study Population

This study describes the development and outcomes of a single-center longitudinal quality improvement curriculum. This curriculum was designed and implemented in a large volume, quaternary care, freestanding children's hospital, specifically to meet the ACGME requirements for our pediatric cardiology fellows. The curriculum was developed in 2019 and, over the past 5 years, 37 cardiology fellows have participated. Additionally, a total of seven faculty members were utilized as quality improvement coaches, to both support and assist the trainees with design implementation of QI projects.

Curriculum Development

The curriculum was originally developed jointly by a cardiology faculty with interest and expertise in QI/PS, who acted as the course director, and a fellow with interest in QI/PS and medical education, who could represent fellow academic needs and challenges. Goals during curriculum design included: 1) creating a lecture series conducive to a busy clinical fellow schedule, 2) focusing on relevant content to the scope of practice for pediatric cardiology fellows, 3) meeting ACGME clinical learning environment review (CLER) requirements (2), and 4) designing longitudinal projects to practice QI methods and tools. This ultimately resulted in a six-session curriculum spaced throughout the academic year. Individual sessions were one hour and included 30 minutes of didactics, followed by 30 minutes devoted to group project work. Online tools and resources were readily available through the Institute for Healthcare Improvement and used to support didactic and experiential learning.[15] The curriculum is summarized in Fig. 1, and underwent strategic updates based on learner feedback.

Additionally, each fellow class started a longitudinal QI project during their first year of fellowship and continued it for the duration of their categorical training. QI project topics were chosen by considering relevance to the fellows' daily work, and incorporated a variety of clinical settings within the Division of Cardiology. Projects were designed using the Institute for Healthcare Improvement model for improvement and meant to improve one or more of the Institute of Medicine six dimensions of quality healthcare (Safety, Effectiveness, Patient-centeredness, Timeliness, Efficiency, and Equity).[16] Use of quality tools was required for each project, including development of a clear aim statement, key driver or

Ishikawa diagram, and specified project metrics including process, outcome and balancing measures. Fellows took their projects through multiple plan, do, study, act (PDSA) cycles, and into the sustain phase.

Pediatric cardiology faculty were recruited as mentors based on interest in QI work and area of clinical expertise. No formal QI knowledge was required. These faculty were encouraged to attend the didactic lectures and worked with fellow groups to carry out the chosen improvement project. Maintenance of Certification (MOC) credit was available to faculty who served as mentors. QI expertise was provided through both the curriculum sessions and regular consultation with QI/PS course director. Project reports were presented to the entire Heart Center annually to summarize progress milestones and obtain key stakeholder feedback. Fellows were encouraged to submit their work to regional and national conferences and write up their project for submission to peer-reviewed journals. QI educational leadership provided writing support for abstracts and manuscripts as needed.

Data Collection and Analysis

Outcomes from this curriculum have been assessed in both subjective and objective formats, and divided into short-term outcomes related directly to measures during the course of the curriculum, and long-term outcomes extending beyond the curriculum experience.

Short-term outcomes

We designed an 8-question survey in order to assess fellow competency of learning objectives (Table 1). Participants quantified their proficiency in QI core competencies on a five-point Likert scale. Self-reported surveys were performed both before and after completion of the curriculum each year. An unmatched/unpaired comparison of survey results before and after completion of the curriculum was performed, secondary to variable sample sizes over each cohort. Statistical analysis was completed using IBM SPSS Statistics (Version 29). Statistical significance was determined by Mann-Whitney U test, and p-values < 0.05 were considered significant.

Long-term outcomes

We tracked the academic products that resulted from this curriculum, as well as graduated fellows' early career achievements and leadership positions related to QI/PS. We also followed faculty mentors' ongoing participation in QI/PS work and leadership within our division.

Results

Between program initiation in 2019 until data analysis in 2023, 51 pre-tests and 36 post-tests have been collected from the curriculum participants. Analysis showed statistically significant improvement across all 8 competencies, with mean values for each competency shown in Table 1 and Fig. 2.

Prior to this curriculum, fellows were largely inactive in QI work with no formal projects in practice for several years. Six fellow classes have now completed at least one year of the curriculum, and a new QI

project has been started each year since 2019. The aims, outcomes, and sustain plans have been summarized in Table 2.

From the six curriculum projects, fellows have had numerous opportunities to share their work with the larger medical community through academic products. To date, this curriculum has produced one peer-reviewed manuscript [17], two manuscripts in progress, two posters, and two oral abstracts at various peer-reviewed regional and national conferences. Three current fellows have participated in QI/PS projects that were not part of the curriculum, but based on their own interests and with faculty mentorship, and they have presented these as abstracts at national conferences, with manuscripts in progress. Two former fellows have pursued an additional formal QI/PS fellowship training year after completion of their three-year categorical pediatric cardiology fellowship. Additionally, three graduated fellows now serve in formal QI/PS leadership roles in their current academic faculty positions at hospitals outside of our own.

In addition to fellow QI knowledge and participation, this curriculum has increased faculty involvement in QI work. Prior to this QI curriculum, very few faculty members were active in QI projects. Since 2019, six faculty members have participated in the didactic sessions, and all are leading or collaborating on QI projects within the division. The number of QI coaches involved in guiding the fellows in their projects has grown from one in 2019, to six by 2023. Three faculty members have taken formal QI leadership roles in their sections.

Discussion

This curriculum has proven successful by all observed measures including fellow competency, production of academic work for fellows and faculty, and future career development. The curriculum itself has gone through improvement cycles. In our first year we started a single project for the entire fellowship. We observed that, with such a large team, meaningful individual experience was very limited. We subsequently adapted the project work, so that each fellowship class would carry out a unique QI project for the entirety of their categorical training, allowing for increased individual participation. We have improved the content of didactic sessions from year to year, based on learner feedback. In order to optimize fellow attendance, we have also slightly altered the timeline of lectures within each year.

Sustainability planning is an important component within the final year of the curriculum, so the improvements made can remain in place and grow beyond the fellows' training period. Carrying the longitudinal work through all three years of fellowship allows the projects to complete multiple PDSA cycles and enter the sustain phase. While many residencies and fellowships are implementing longitudinal QI projects into their curriculums, these rarely span longer than 9 months to a year. We believe this is an inadequate experience in sustaining implemented changes, and in learning how to monitor for drift of the process back to prior practice over time.

To promote collective learning, it is imperative that we all share our improvement experiences with others, though the nuances of improvement science reporting can be challenging to master. Expanding the QI

curriculum over three years also allows for mentorship in production of academic products during an otherwise clinically heavy fellowship.

Future work in this program will focus on further building an internal team of QI/PS trained Pediatric Cardiology faculty. As more faculty engage in the curriculum, more providers could teach the curriculum to help meet their requirements towards Maintenance of Certification (MOC). As the curriculum continues, we are also considering formal QI project evaluation using the QIKAT-R scoring rubric.[18]

Limitations:

This is a single center study with self-reported outcomes. Weaknesses of our program include inconsistent fellow participation in all elements of the curriculum. This includes regular completion of all pre- and post-tests at the beginning and conclusion of each academic year, attendance at all didactic sessions, and equally shared involvement of all fellows on their respective class projects.

In retrospective analysis, every eligible fellow participated in at least one pre- and post-course assessment over their 3 years of fellowship, but this participation was not required, and so very few fellows have a complete longitudinal data set. Consequently, our data is unmatched, and may bias towards fellows who expressed their interest in the subject matter through increased participation. We could improve this data collection in the future by mandating responses from each fellow at the beginning and end of each academic year.

Another limitation is the scheduling challenge for clinically busy fellows to engage in QI/PS didactics. While this is still a barrier to reaching 100 percent attendance at every session, hosting our QI didactics during the lunch hour and creating protected educational time has improved participation. While objective markers of project success via tools like QIKAT-R would be ideal, we have not yet utilized formal project evaluation tools.

Conclusions

Improvement science is an essential component of medical education at every level, from medical school training to faculty positions. QI/PS work is also receiving more recognition and value as a career path in academic institutions. Not only is training in QI/PS among the ACGME CLER requirements in fellowship programs, but it is critical in optimizing both patient and trainee experience, and clinical outcomes. As our QI training strengthens for today's learners, it amplifies the production of knowledgeable and qualified attending physicians as improvement scientists and mentors.

Our curriculum serves as a blueprint for QI/PS education in clinically busy training programs. It is an effective means to teach improvement science with a blend of didactics, learner interaction, and involvement in QI projects. Our trainees are learning that their efforts can effect positive changes in the systems they work in and improve care for their current and future patients. We hope this inspires former,

current, and future fellows to integrate QI science and PS work in their future careers. We strongly believe this curriculum can be successfully applied in Cardiology fellowship programs across the country.

Declarations

Author contributions: Shreya Sheth and Judson Moore contributed to the study conception and design. Material preparation, data collection and analysis were performed by Cara Bird, Sonia Kaushal, and Mira Trivedi. The first draft of the manuscript was written by Cara Bird, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Competing Interests: The authors have no relevant financial or non-financial interests to disclose.

Funding: No funding was received to assist with the preparation of this manuscript.

Ethical Approval: This study was performed with Institutional Review Board approval (protocol number H-53926).

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Tables

Table 1: Pre-test vs post-test scores on the eight measured quality improvement objectives.

	Pre-Test (n = 51), mean (SD)	Pre-Test (n = 36), mean (SD)	P value
Identify a quality problem related to patient care.	3.49 (0.784)	3.97 (0.654)	0.006
Develop and focus an aim related to a quality problem.	3.06 (0.732)	3.86 (0.683)	< 0.001
Identify outcome and process measures appropriate for a clinical problem.	2.84 (0.758)	3.69 (0.749)	< 0.001
Demonstrate how to use several cycles of change to improve care delivery.	2.73 (0.750)	3.50 (0.561)	< 0.001
Formulate a data plan related to demonstrating that a change results in improvement.	2.67 (0.792)	3.36 (0.723)	< 0.001
Use run/control charts to display results of change in an effective manner.	2.33 (0.841)	3.11 (0.919)	< 0.001
Create an improvement team and assign roles necessary for improvement success.	2.76 (0.885)	3.75(0.554)	< 0.001
Ensure changes tested are put into practice and sustained.	2.59 (0.829)	3.33 (0.632)	< 0.001

Table 2: Summary of Fellow QI Projects to date

AIM	Timeframe	Clinical Space	Project Phase	Outcomes at curriculum completion	Dissemination
Reduce the latency time between CICU handoff and patient transfer to the ACCU to less than 60 minutes within six months of process start	2019-2022	Inpatient: Acute and Critical Care Units	Sustain	Lag time between handoff and floor arrival decreased from 173 mins to 61 mins. Patients generally arrived nearly 2 hours earlier to the floor. Based on survey data, overall provider satisfaction improved from 20% to 69%.	Poster Presentation - Regional Quality Conference (2019) Poster Presentation National Quality Conference (2020) Manuscript published (2022)
Improve the accuracy of post-cardiac intervention planned patient disposition to 80% accurate by 1 year after project implementation	2020-2022	Interventional Lab, Inpatient	Sustain	Accuracy of planned post-intervention disposition improved from 40% accurate to 53% accurate after project implementation.	Manuscript in progress
Increase the Fellows' Clinic family feedback survey completion rate to above 15% over a 3-year period	2020-2022	Outpatient Clinic	Sustain	Weekly feedback survey completion rate from families increased to >50% after project implementation.	Oral Presentation - National Conference (2022) Manuscript in progress
Improve PCP satisfaction with overall discharge communication process from a score of 70% to >90% following implementation of new communication plan	2020-2023	Inpatient: Acute Care, Outpatient Clinic	Entering sustain	PCP satisfaction with overall discharge communication process score 87% at 18 months following implementation	
Decrease time from inpatient echo order entry to echo report finalization by 20%, by December 2023	2021-present	Inpatient, Echo Lab	PDSA progress	Significant reduction in time from final image acquisition to ready for formal reading by attending physician across all stratifications	Oral Presentation - Regional Quality Conference, Award for top trainee abstract (2023) Submitted to National Conference
By December 15, 2023, to have a 70% success rate in providing resources to families who screen positive for food insecurity in the outpatient Fellows' Clinic	2022-present	Outpatient Clinic	Implementation	In progress	

Figures

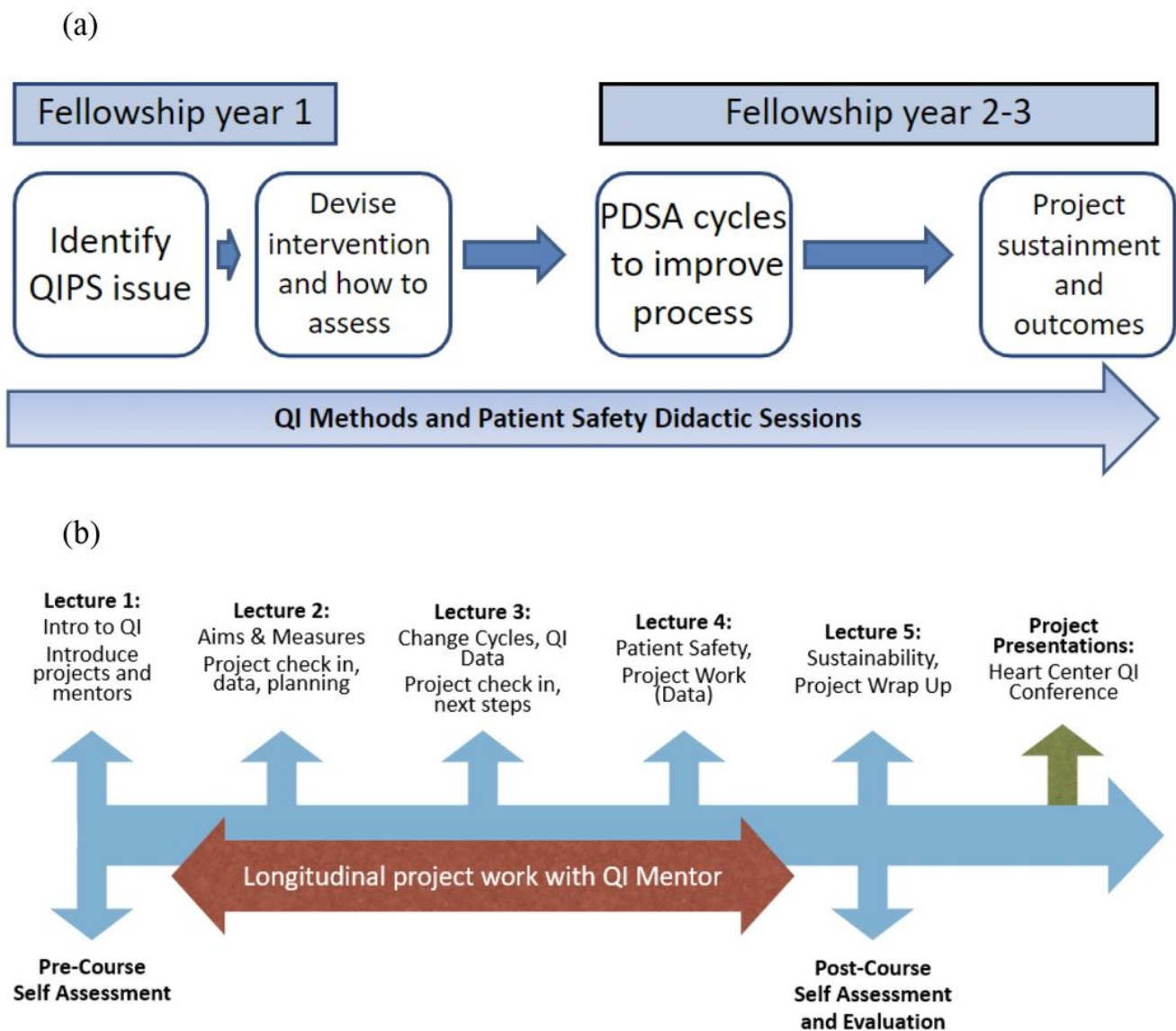


Figure 1

(a) Overview of curriculum structure over three-year fellowship (b) Timeline of annual didactic sessions and topics covered

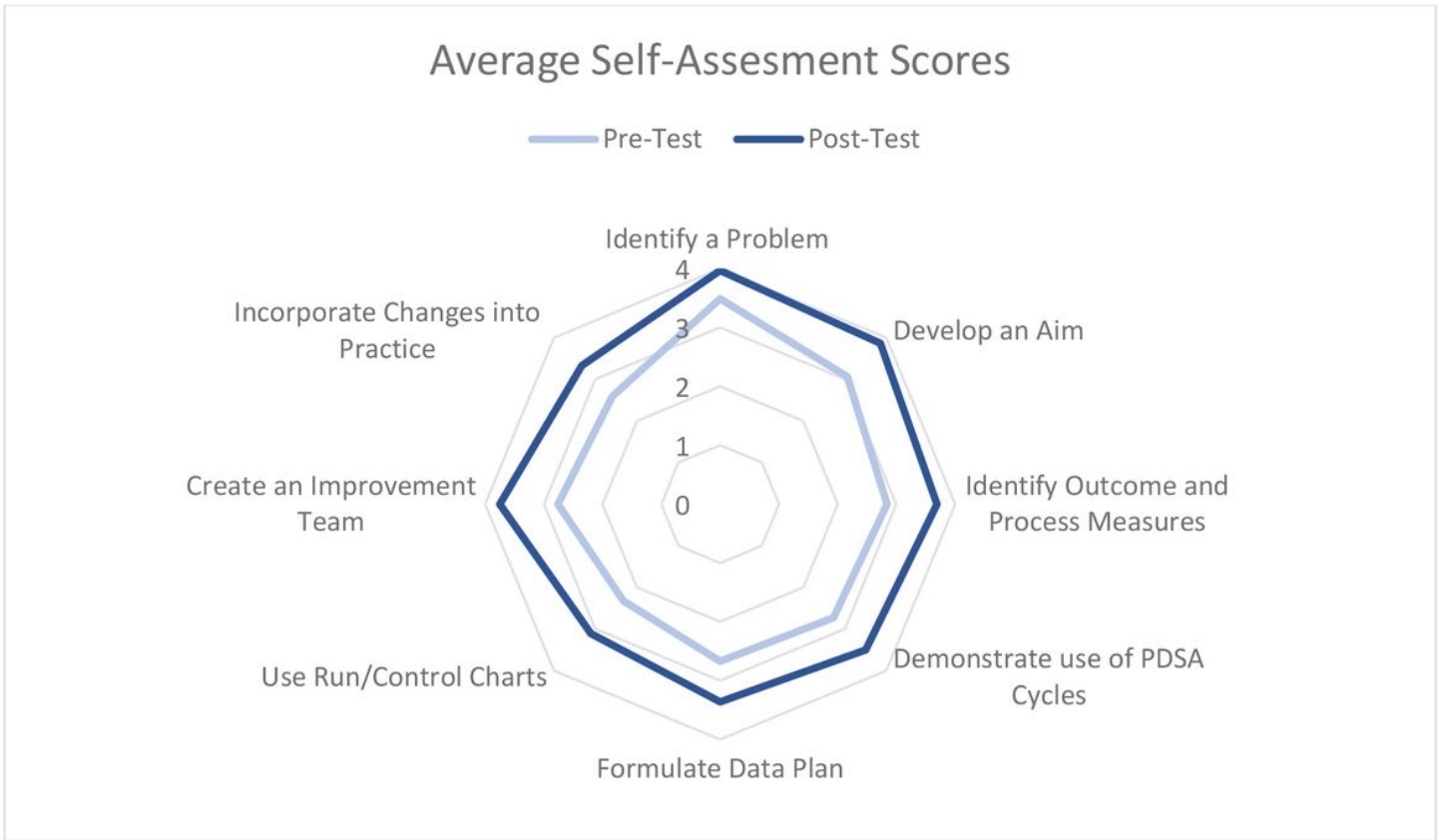


Figure 2

Radar graph demonstrating post- vs pre-test improvements in fellow understanding of eight improvement objectives