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SCIENTIFIC INVESTIGATIONS

Meeting ACGME and ABMS Quality Improvement Requirements in a Sleep Medicine Fellowship Program

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Study Objectives: To describe a sustainable program of teaching and implementing quality improvement (QI) in a 12-month sleep medicine fellowship.
Methods: We created a QI curriculum based on Accreditation Council for Graduate Medical Education (ACGME) and American Board of Medical Specialty (ABMS) Part IV Maintenance of Certification (MOC) requirements for QI. Two program faculty with prior QI training volunteered to mentor fellows. Our institution's central QI office houses QI experts who teach QI across the health system. One of these experts, referred to as the "QI consultant," helped us adapt QI teaching materials to include 4 online modules and 5 group sessions. Fellows worked in teams to complete 2 data-guided QI cycles.
Results: The curriculum required 29 hours for fellows, 18 hours for faculty, and 55 hours for the QI consultant; now that teaching materials have been created, the QI consultant's involvement will decrease over time. Post-curriculum surveys showed that fellows' knowledge of QI concepts increased, as did their confidence performing QI activities. Fellows' QI projects objectively improved timeliness and quality of care for patients. Sleep medicine fellows and QI faculty mentors evaluated the curriculum positively. The curriculum met ACGME requirements for QI, and fellows and mentoring faculty received ABMS Part IV MOC credit upon completion of the curriculum.
Conclusions: A QI curriculum can successfully be implemented into a 12-month sleep medicine fellowship to increase sleep medicine fellows' QI knowledge and confidence, meet ACGME and MOC requirements, and contribute to care of patients with sleep disorders.
Keywords: education, fellowship, maintenance of certification, quality improvement, sleep disorders
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INTRODUCTION

The Accreditation Council for Graduate Medical Education (ACGME) 1-year common program requirements[1] include the following:

- "Fellows are expected to develop skills and habits to be able to…systematically analyze practice using quality improvement methods, and implement changes with the goal of practice improvement" (IV.A.2.c)
- "Fellows must demonstrate the ability to analyze the care they provide, understand their roles within health care teams, and play an active role in system improvement processes. Graduating fellows will apply these skills to critique their future unsupervised practice and effect quality improvement measures." (VI.A.1.)
- "Fellows must receive training and experience in quality improvement processes, including an understanding of health care disparities. (VI.A.1.b).(1).(a)
- "Fellows must have the opportunity to participate in interprofessional quality improvement activities." (VI.A.1.b).(3).(a)

These requirements inspired our discussion about what types of systems-based improvement experiences our fellows need during their training year. We recognized that performance improvement (PI) and quality improvement (QI) both pertain to systems-level improvement, with the main difference being that PI emphasizes human performance whereas QI highlights processes.[2] QI "consists of systematic and continuous actions that lead to measurable improvement in health care services and the health status of targeted patient groups."[3] QI projects are team-based endeavors in which participants collect data to understand the current state of a process, define the gap between the process' current state and goal state, develop and implement a countermeasure to improve the process, then collect data to determine if the countermeasure achieved the goal state of the process.

Given that the ACGME requirements specify that fellows must have QI training and experience, we set out to create a

BRIEF SUMMARY
Current Knowledge/Study Rationale: Continuous quality improvement (QI) in the clinical setting is a requirement for both physicians in a fellowship training program and those in practice.
Study Impact: This article describes the successful implementation of a QI curriculum into a sleep medicine fellowship. The curriculum was designed to meet QI requirements of both the Accreditation Council for Graduate Medical Education and the Multi-Specialty MOC Portfolio Program of the American Board of Medical Specialties. This article provides tips for other sleep medicine fellowship programs who seek to incorporate QI activities for their fellows.

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Table 1—Two linked cycles of data-guided quality improvement effort.

Cycle	Step	Activities
First Cycle	Plan	Review baseline data, identify causes, determine interventions
	Do	Implement interventions
	Check	Review postintervention data
Cycle Linkage	Act, Re-Plan	Identify causes, determine adjustments (first cycles leads into second cycle)
Second Cycle	Re-Do	Implement adjustments
	Re-Check	Review postadjustment data
	Re-Act, Further-Plan	Identify causes, determine further adjustments

For 2 linked data-guided improvement—"Plan / Do / Check / Act" (PDCA)—cycles, the results review portion of the first cycle becomes the planning step of the second cycle.

thorough QI curriculum for our sleep medicine fellows. We wanted to ensure that our sleep medicine fellowship program teaches fellows foundational QI concepts and provides robust experience in applying this knowledge to real-life scenarios. Literature review showed that many scholarly articles detail QI curricula for residency programs,[4–8] but fewer describe QI curricula in fellowship programs.[9–11] Moreover, scant guidance is available on development and implementation of a QI curriculum into a single-year graduate medical education training program.

We thus set out to develop, implement, and evaluate a QI curriculum in our sleep medicine fellowship program. We recognized that our QI curriculum needs to:

- Meet ACGME requirements for QI
- Be practical within the 12-month fellowship program
- Include QI projects that are fellow-driven
- Be deliverable year after year with successive cohorts of fellows

This article describes our sleep medicine fellowship QI curriculum, which was specifically designed to encompass each of these 4 features.

METHODS

Curriculum Design

Our first step was to describe ACGME requirements for QI to our program faculty and sleep center leadership, to provide context and garner support for this new curriculum. We identified the following resources needed to create and implement a QI curriculum: time to design the curriculum; expert input to guide the content of the curriculum; time for participants (fellows and faculty mentors) to complete the curriculum; space to hold the group sessions; and time for fellows to present their projects and results to other members of our sleep disorders center.

We next reached out to the QI infrastructure within the University of Michigan Health System. Our institution's central QI office—the Performance Improvement Unit within the Quality Department—houses full-time QI experts who teach QI concepts to personnel all across our health system. One of these institutional QI teachers, referred to as the "QI consultant," helped us adapt institutional QI teaching materials to fit the needs of our sleep medicine fellowship program.

The Michigan Quality System uses Lean Thinking,[12] a systematic process for continuous QI. Lean Thinking stems from the Toyota Production System[13] and has been assimilated in many industries, including health care.[14] A data-guided improvement cycle—"Plan / Do / Check / Act" (PDCA)—represents a basic component of QI curricula taught within our institution and elsewhere. Most project-based QI training in residency programs involves only 1 PDCA improvement cycle. We wanted our QI curriculum to provide our fellows with experience that most mirrors QI in clinical practice. We thus incorporated 2 linked PDCA cycles into our fellowship QI curriculum. For 2 linked PDCA improvement cycles, the review of results from the first PDCA cycle becomes the planning for the following cycle (**Table 1**).

Sleep medicine fellows are held to ACGME requirements for QI during their training year. In addition, fellows who are board eligible or board certified in their primary discipline(s) must meet requirements to maintain that certification. We thus designed our QI curriculum to meet ACGME and American Board of Medical Specialties (ABMS) Maintenance of Certification (MOC) requirements for QI. The Multi-Specialty MOC Portfolio Program of the ABMS[15] has approved our institution to award Part IV (practice assessment and improvement) credit to physicians who perform 2 linked cycles of data-guided QI effort. Our health care system's Quality Department has a MOC for QI Program that provides local approval and awarding of Part IV MOC. That program facilitated our ability to provide fellows and faculty QI mentors in multiple specialties the opportunity to receive MOC credit for their QI activities. This also allowed our QI curriculum to meet the MOC needs of the supervising faculty who mentored fellows' QI projects.[16]

We designed the curriculum to span approximately 6 months. It started nearly one-third of the way into the fellowship so that fellows would be familiar with processes in our sleep disorders center and health system. The QI consultant helped us adapt institutional materials to teach our sleep medicine fellows (1) a basic overview of QI and Lean

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Figure 1—Course map for the sleep medicine fellowship program quality improvement curriculum.

	Kick Off 8-Oct	Mentor Session	Module 1 15-Oct	Mentor Session	Module 2 3-Nov	Mentor Session	Module 3 19-Nov	Mentor Session	Module 4 17-Dec	Mentor Session	Module 5 21-Jan	Report Out 18-Feb
Before Class Online Modules & Resources	Pre-knowledge assessment Identify potential projects		Intro to Lean Problem solving (A3) Project selection Scoping Gemba (observations) Value stream map Current state		Problem statement Goals Current state analysis Value and waste Root causes		Review root cause analysis Future state Countermeasures		PDCA cycles of experiments Sustaining Improvements			Post-knowledge assessment
During Class Knowledge Check	Purpose Objectives Structure Expectations Roles Problem selection Ctools		Intro to Lean Problem solving (A3) Project selection Gemba (observations) Value stream map Current state		Problem statement Goals Current state analysis Value and waste Root causes		Review root cause Analysis Countermeasures Future state Action plan Follow up		PDCA cycles Experiments Sustaining Improvements		Present results of experiment, successes and challenges Plan next experiment	Final team presentations at grand rounds
During Class Guided Group Work			Validate current state Collect metrics Update background Update current state		Team presentations Draft problem statement Draft goals Begin analysis		Team presentations Refine root causes Draft future state map Draft countermeasures Draft action plan		Teams present results, successes and challenges Plan next experiment			
After Class Group Work			Select projects Form teams Begin scoping Draft current state map Draft data collection plan		Gemba walk for waste Complete problem statement Define goals Continue root cause analysis		Update A3 Complete future state map Run the experiment		Adjust first experiment and begin next experiment		Adjust experiment Begin next experiment Complete A3	Summarize feedback from presentation/ report out

Gemba = location where the process/work is happening, PDCA = "Plan / Do / Check / Act", QI = quality improvement, SIPOC = suppliers, inputs, process, outputs, and customers.

Thinking and (2) how QI concepts directly apply to clinical care processes. The QI curriculum was based a conceptual framework of social experiential learning,[17] which emphasizes the importance of teamwork in a familiar environment; fellows thus worked in groups, under guidance of a faculty mentor, and developed QI projects directly related to their clinical responsibilities.

We designed our QI curriculum using a flipped classroom approach,[18,19] in which the conventional order of events is "flipped" and homework is to be completed before (not after) the classroom session. Using a flipped classroom method for our QI curriculum liberated time constraints with scheduling in-class sessions. Also, fellows tend to be self-directed learners who often engage in independent reading, so assignment of "homework" was acceptable for the fellows. Foundational QI concepts were taught via online modules, which fellows completed before each class session. These modules were interspersed throughout the curriculum and contained short instructional readings and videos. "Flipping" the didactic presentation of material gave flexibility for fellows to complete the modules.

The flipped classroom approach also allowed group time to be "hands-on" application of the didactic material. Scheduled group time corresponded to an online module and related interval of each QI project. **Figure 1** shows the detailed course map, which shows the longitudinal QI curriculum including online modules, group sessions, and topics covered. Because our sleep medicine training program is a single-year fellowship, all participants are first-year sleep medicine fellows with similar schedules. We were thus able to carve out dedicated group time and held the group sessions in a conference room within our sleep disorders center.

Once the curriculum was established, we met again with fellowship program faculty to request faculty to mentor fellows' QI projects. Two program faculty, both of whom had previous QI training through the institution, volunteered to mentor fellows throughout the QI curriculum. Both faculty members were shown the course map at the start and agreed to participate throughout the entire curriculum.

QI Projects

Fellows identified problems in patient care that were personally and clinically meaningful, within a reasonable scope of their direct influence, and for which 2 PDCA improvement cycles could be completed within 6 months. Fellows and faculty mentors refined these ideas into 2 projects with teams of 3 or 4 fellows working on each project. Both projects selected by the fellows involved aspects of patient care related to polysomnography; one project pertained to electrocardiograms (EKGs) and the other to inpatient sleep studies. Fellows and

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Table 2—Time commitments for participants in the sleep medicine fellowship quality improvement curriculum.

Participant and Responsibilities	Approximate Time Involved
Fellows	**29 hours total**
Online learning site participation	3.5 hours (independent)
Group and mentor sessions with project work time	10.5 hours (within regular work schedule)
Additional project work time	10 hours (independent)
Drafting final report for Part IV MOC	3 hours (independent)
End-of-project presentations (including preparation time)	2 hours (within regular work schedule)
Local Faculty Mentors	**18 hours total**
Online learning site participation	3.5 hours (independent)
Group and mentor sessions with project work time	10.5 hours (within regular work schedule)
Preparation for kick-off session	2 hours (independent)
Additional project supervision and evaluation	2 hours (within regular work schedule)
Lean Coach/QI Consultant	**55 hours total**
Online learning site customization*	16 hours (independent)
Group and mentor sessions with project work time	11 hours (within regular work schedule)
Preparation for kick-off session	4 hours (independent)
Additional project supervision and evaluation	24 hours (within regular work schedule)

* = initial development of the core online learning site (eg, creating modules and evaluation tools) took 116 hours. The core site is duplicated and customized for specific learner groups within the institution, such as a residency program or fellowship program. MOC = maintenance of certification.

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faculty mentors collaboratively refined the project's scope to address at least 1 of the 6 Institute of Medicine Quality Dimensions (safety, equity, timeliness, effectiveness, efficiency, patient-centeredness).[20]

Evaluation

Curricular planning included estimating, monitoring, and modifying program elements to minimize participants' time involvement and maximize individual fellows' knowledge and confidence, quality of the QI projects performed, and of the overall curriculum. Assessment measures included a post-curriculum test to self-assess knowledge of foundational QI concepts and fellows' self-reported confidence related to application of QI concepts.

Ethical Approval

The routine evaluation and improvement of existing educational and clinical activities using known methods is not considered research on human subjects that is regulated by an Institutional Review Board. However, the clinical leadership of our sleep disorders center approved and oversaw the educational and clinical improvement initiatives involved in the QI curriculum for sleep medicine fellows.

RESULTS

Project Participation

All 7 fellows completed the curriculum, including performing a QI project involving two PDCA cycles of data-guided improvement.

Time Involved of Various Participants

Table 2 lists the responsibilities and approximate time commitments of fellows, local faculty mentors, and the QI consultant. Overall engagement was 29 hours for fellows, 18 hours for faculty mentors, and 55 hours for the QI consultant.

The QI consultant spent time customizing the institutional QI teaching materials so that they related directly to the curriculum designed for our sleep medicine fellowship. This process included creation of the online learning site used as part of the flipped classroom teaching method. The customization of didactic materials took the largest amount of time and represents an initial "up-front" time commitment; now that these customized materials are completed this preparation-related time will decrease drastically for future years. The QI consultant also spent time preparing for each group session and assisting program faculty with project supervision and evaluation.

The QI consultant and program faculty agreed to a 3-year approach, with the QI consultant largely developing and leading the first year, leadership shared with program faculty in the second year, and the majority of leadership transferred to program faculty in the third year and thereafter. Over this 3-year period, the QI consultant will "train the trainer" and will regularly meet with the program faculty to cultivate the trainer's expertise in structured problem solving and in teaching QI skills to other health professionals.

Individual Knowledge and Confidence

Each fellow took a postcurriculum knowledge test as a self-assessment about knowledge of foundational QI concepts. On a scale ranging from 1 to 10, with 1 equals "none" and 10 equals "very high," fellows' retrospective self-assessment of knowledge about 11 QI concepts increased from a mean of 3.5 before training to 6.2 after training ($P < .001$). Fellows also took a postcurriculum self-assessment of confidence applying QI concepts to clinical care. On the same 1 to 10 scale noted previously, the fellows' retrospective self-assessment of confidence in applying 11 QI concepts increased from a mean of 3.7 before training to 6.1 after training ($P < .001$).

Table 3—Tips to implement a quality improvement curriculum commitment in a sleep medicine fellowship program.

1. Explain ACGME requirements for QI to departmental leadership, program faculty, and fellows.
2. Identify faculty lead(s) to oversee curriculum development, implementation, and evaluation.
   a. Consider faculty who have some basic QI experience, want to learn more about QI, and are interested in teaching basic QI concepts and in overseeing simple QI projects
3. Ensure that QI curriculum design meets QI requirements of the ACGME and, if desired, the American Board of Medical Specialties.
4. Locate QI resources to provide foundational knowledge of QI concepts.
   a. If available, use existing department and/or institutional QI resources.
   b. Consider online materials such as the those provided by:
      - Association of American Medical Colleges at **https://www.aamc.org/initiatives/cei/te4q/267686/general.html**
      - Health Resources and Services Administration at **https://www.hrsa.gov/quality/toolbox/index.html**
5. Help fellows select QI projects that are within the scope of their daily work and, if possible, align with departmental and/or institutional priorities.
6. Determine QI meeting times and locations for fellows to apply foundational knowledge to their projects.
   a. Consider ways to address time limitations of fellows and faculty.
   b. Try to "flip" the didactic presentations, so that foundational reading is done individually and group time focuses on application of QI concepts to the fellows' projects.
7. Provide consistent faculty guidance to fellows throughout the QI process.
8. Have fellows present their completed QI projects to program faculty and other relevant stakeholders.
9. Ask fellows to reflect on what they learned from the QI process and how this will contribute to their future practices.
   a. Fellows should understand that continuous QI is a component of clinical practice for all physicians, not just for those in training.
10. Continuously improve the curriculum.
   a. Evaluate the curriculum upon its completion and identify improvements for the next time it is offered.
   b. Recheck available resources (including faculty interested in QI) within the department, the institution, and nationally. QI resources are evolving rapidly.

ACGME = Accreditation Council for Graduate Medical Education, QI = quality improvement.

Outcomes of QI Projects

One project increased sleep study requests called directly to the fellow from 17% (n = 18) at baseline, to 59% (n = 22) postintervention, to 84% (n = 25) postadjustment (increase of 67 percentage points, $P < .0001$), which improved timeliness of care. The other project increased ability of sleep technologists to correctly identify electrocardiographic priorities, with calls to the on-call fellow who correctly identified electrocardiographic priority studies increasing from 70% (n = 10) at baseline, to 75% (n = 8) postintervention, to 88% (n = 8) postadjustment (small n not powered to detect increase of 18 percentage points at $P < .05$), which improved quality of care.

Project Presentations

Each fellow team presented its completed QI projects to sleep medicine faculty, fellows, and staff. Presentations included: reason for action, review of the current state, how a given project was selected, step-by-step explanations of their data collection, root cause analyses, countermeasure selection and implementation, results, and further recommendations.

Curriculum

On a postcurriculum survey, fellows and faculty mentors reported a positive QI curricular experience and gave suggestions for ongoing curricular refinements.

ACGME

Individual fellows' experience and the overall QI curriculum met ACGME expectations.

ABMS MOC

As fellows' QI projects met ABMS MOC Program requirements, fellows and faculty mentors received ABMS Part IV MOC credit. Each team submitted a written report of the step-by-step activities of 2 cycles of improvement and results. The reports are available at www.med.umich.edu/moc-qi/approved.htm for the fellow QI projects entitled, "Timely and Accurate Interpretation of EKGs on Polysomnograms" and "Improving Inpatient Portable Sleep Study Requests."

DISCUSSION

The ACGME's Clinical Learning Environment Review Program[21] emphasizes incorporation of coordinated QI and patient safety processes within individual programs and throughout the institution.[22] The combination of QI need, interested faculty, institutional curricula that could be customized to fit our program, and opportunity to fulfill ACGME and ABMS requirements encouraged us to develop a QI curriculum in which sleep medicine fellows could use their daily clinical work to develop meaningful QI projects.

Ensuring that fellows have significant participation in QI activities can be difficult in a 1-year program. This study describes successful implementation of a QI curriculum into a single-year sleep medicine fellowship, and adds to the existing literature on incorporation of QI training into residency programs and multi-year fellowship programs.

A major challenge was scheduling the group sessions so that the QI consultant, fellows, and faculty mentors could attend

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without disruption of clinical responsibilities or other program didactics. Time constraints were addressed in part by (1) drawing on existing QI institutional materials and (2) using the described flipped-classroom format with online modules for delivery of didactic content. Performing the second PDCA cycle of improvement required less curricular time because learning the didactic material and how to perform the steps for the project had occurred during the first PDCA cycle.

Table 3 lists tips other fellowship programs can use to guide implementation of a QI curriculum. Programs who want to build a similar QI curriculum may not currently have local faculty QI expertise. In this case, possible options include (1) collaboration with other programs that have faculty QI expertise; (2) if available, utilization of institutional QI resources to initiate and maintain a QI curriculum; and/or (3) use of publicly available online QI courses (**Table 3**) to provide the didactic content for a QI curriculum. The broader national interest in advancing QI within health care may give a fellowship program access to a greater number of QI resources and faculty with basic QI expertise. Also, an expanding number of institutions approved by the ABMS MOC Portfolio Program to approve local QI efforts may also translate into more support for an individual training program to implement a QI program.

The QI curriculum we described will always need to be examined for ongoing improvement. As the QI curriculum leadership transitions from the QI consultant to program faculty, the latter will need to stay current with QI concepts to lead and enhance the QI curriculum. Ongoing faculty development can be expanded to teach faculty members how to supervise fellow QI projects as a way participate in education *and* fulfill MOC requirements.[16] The multidisciplinary nature of sleep medicine readily provides opportunities to collaborate with other training programs and enhance fellows' abilities to incorporate continuous QI into their clinical responsibilities.

CONCLUSIONS

The described sleep medicine fellowship QI curriculum integrated the fellows' education into a larger framework of improved patient care within our sleep disorders center and our institution. This experience equips fellows with skills they can incorporate into clinical practice upon graduation from fellowship. For other programs that are developing a QI curriculum, we recommend spending initial time and effort to build relationships with institutional QI units to identify resources and develop and implement a QI curriculum for fellows that links to an institutional network of QI education for all physicians, reflects how fellows will perform QI in independent practice, and prepares fellows to meet MOC requirements in independent practice.

ABBREVIATIONS

ABMS, American Board of Medical Specialty
ACGME, Accreditation Council for Graduate Medical Education
EKG, electrocardiogram
MOC, maintenance of certification
PDCA, "Plan / Do / Check / Act"
PI, performance improvement
QI, quality improvement

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DISCLOSURE STATEMENT

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