

SCIENTIFIC INVESTIGATIONS

Enhancing the patient and family experience during pediatric sleep studies

Julie M. Baughn, MD¹; Hannah G. Lechner, MHA²; Daniel L. Herold, RPSGT¹; Virginia A. Brown, RPSGT¹; Wendy R. Moore, MSN, RN, NE-BC¹; Cameron D. Harris¹; Heidi I. Stehr, MBA³; Channing M. Sorensen, APRN, CNP, MSN¹; Eric J. Cleveland⁴; James D. Akason⁵; Timothy I. Morgenthaler, MD¹; Robin M. Lloyd, MD¹

¹Center for Sleep Medicine, Mayo Clinic, Rochester, Minnesota; ²Department of Management Engineering & Internal Consulting, Mayo Clinic, Rochester, Minnesota; ³Office of Patient Experience, Mayo Clinic, Rochester, Minnesota; ⁴Internal Medicine Administrative Services, Mayo Clinic, Rochester, Minnesota; ⁵Medical Specialties Administrative Services, Mayo Clinic, Rochester, Minnesota

Study Objectives: Pediatric polysomnography can result in suboptimal patient and provider (physician and advanced practice provider) experiences. We embarked on a project aimed at increasing the proportion of maximal satisfaction survey scores by a minimum of 10% in 1 year without adding personnel or major expenses.

Methods: We used a Six Sigma framework, define, measure, analyze, improve, and control (DMAIC), to conduct our analysis. For measurement, we designed a project-specific survey that was given to caregivers of children who underwent PSG in February 2018 and repeated the survey after interventions in February 2019. Lean and Six Sigma quality improvement tools were used to define important processes that influence patient satisfaction, including: supplier, input, process, output, customer, and requirements (SIPOC-R); journey mapping; 1-2-4-All brainstorming; and views solicited from our center's Patient and Family Advisory Council. We analyzed the relationships between identified processes and outcomes using usual descriptive statistics. We prioritized interventions using a Kano model and a quality function deployment (QFD) technique to rank priorities for interventions. Multiple opportunities to improve patient and family satisfaction before, during, and after a pediatric polysomnography were identified. Many were simple, one-step interventions and were implemented simultaneously. For those that required substantial training and/or scheduling changes, pilots were performed and plan, do, study, act (PDSA) cycles were used to check effectiveness.

Results: After implementation, top box scores rose 20%, from 51% (n = 47) in 2018 to 71% (n = 50) in 2019.

Conclusions: Various quality improvement techniques employed in business, engineering, and manufacturing were used to identify and address areas of improvement in the pediatric polysomnography experience.

Keywords: pediatric, polysomnography, Six Sigma, quality improvement, patient satisfaction

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BRIEF SUMMARY

Current Knowledge/Study Rationale: There is little guidance in the medical literature to inform practices for improving patient satisfaction. Pediatric sleep medicine is further complicated by the need to improve the satisfaction of both child and caregiver. We drew on business literature to create a multidisciplinary approach to improving our patient/family satisfaction during pediatric polysomnography.

Study Impact: A business approach can be used by other areas of sleep medicine to improve patient satisfaction.

INTRODUCTION

Pediatric polysomnography (PSG) requires an overnight stay in a setting that is unfamiliar to both child and caregiver. Many children who are asked to undergo PSG are medically complex and may require multiple sleep studies throughout their lives. In addition, their caregivers are already considerably impacted by the medically complicated needs of their children. At our institution, providers (at our institution, this includes three pediatric sleep medicine physicians and one advanced practice provider) typically meet with caregivers and children for a consultation both before the PSG and the morning after PSG to discuss results. Verbal feedback is given frequently to providers on the need to improve the process. We have learned that parents and caregivers of children with special needs are active on parent-focused websites and blogs to exchange recommendations on where to

get the best care for their children. Additionally, our technologists shared that they were stressed by and not entirely satisfied with their interactions with children and their families. Based on this feedback, we determined there was ample opportunity for improvement.

Demand for pediatric sleep specialists and, ultimately, PSG outpaces access in many areas of the country.¹ Obstructive sleep apnea is common and may affect up to 5% of children.^{2–4} The American Academy of Sleep Medicine (AASM), the American Board of Pediatrics (ABP), and the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) have published recommendations for PSG to diagnose OSA in children prior to adenotonsillectomy.^{2–5} The AASM has also published nonrespiratory indications for PSG.⁶ In contrast to adults, home sleep apnea testing is not recommended for children.⁷ Our institution has seen continuous growth in PSG

during this project's implementation. Based on data tracked in our sleep lab, in 2018 our institution performed 3,853 PSGs, with 21% of the studies assessing pediatric patients. During the first three quarters of 2019 this percentage increased to 28% (total PSG during the first three quarters of 2019 were 3,066). It is important for our center to provide PSG in a way that best serves our patients. There is a wider impact of creating a patient and family-centered approach to pediatric PSG.

Zaremba et al⁸ created a description of a family-centered approach to PSG using the expertise of child life specialists to suggest practices to improve the PSG experience for children and their families. They describe numerous suggestions in 13 different categories that were developed in their pediatric center. No data were presented regarding the effectiveness of the interventions. Otherwise, very little has been published to guide improvement in the patient and family experience of pediatric PSG.

Our institution has experience performing improvement projects using the design, measure, analyze, improve, control (DMAIC) framework, a Six Sigma template for improvement that has been incorporated into the Mayo Clinic Value Creation System.^{9,10} The different aspects of the Value Creation System are taught in more than a dozen courses within the Mayo Clinic Quality Academy in order to provide familiarity with or expertise in quality improvement science to our employees.⁹ We used several quality improvement tools to help inform improvement efforts for this project and will use the DMAIC framework to describe our work. Because of the size of this project, we obtained expert consulting and systems engineering assistance from our Department of Management Engineering & Internal Consulting (previously known as the Division of Systems and Procedures, established at Mayo Clinic in 1947).¹¹

METHODS

Fundamentally, our project was about improving our patients' (and caregivers') subjective assessment of the overall quality of services. Our institution uses Press Ganey Associates (South Bend, IN) to survey patient satisfaction following care episodes. However, for this project we were unable to properly gauge patient satisfaction scores through Press Ganey because their survey applied only to the interaction with the provider during the consultation appointment and did not capture data on the entire PSG experience. Therefore, we created a project-specific postsleep questionnaire using an anchored Likert scale (**Figure S1** in the supplemental material) similar to the Press Ganey survey. The top box score was "very satisfied." Our goal was to increase the proportion of top box responses by at least 10% without adding Center for Sleep Medicine staff. We were open to exploring architectural or equipment changes but favored improvement strategies that involved enriched patient-centered design rather than substantial added expense. We used February 2018 as our baseline (51% top box) and February 2019 as the final date for the measure.

To frame our project, we completed a supplier, input, process, output, customer[s], and requirements (SIPOC-R) analysis. For the purposes of this project, our main customer was considered to be the patient, although pediatric patients are

often unable to completely voice their opinions, so the child's caregivers were solicited to provide the "voice of the customer" (VOC). To an extent, our sleep center staff also served as customers of the processes involved in delivering PSG. We anticipated these two customers would have a synergistic relationship, ie, improving the service provider's satisfaction would improve that of the patient, and vice versa. Suppliers to the project were our pediatric sleep specialists, who are responsible for ordering all PSGs at our center. The inputs included not only PSG orders but also all of the processes that preceded PSG orders, including preappointment communications, scheduling, etc. The "process" was described by a customer or patient journey (outlined below). The outputs were considered to be the impressions of our patients (or caregivers) in addition to those of our service providers interfacing with the patients. The requirements for the project were that improvements would need to be implemented within one year and require no new personnel or substantial outlays.

Our service providers included sleep medicine specialists, registered nurses, sleep technologists, and clinical assistants who helped manage patient flow and scheduling. Our improvement team included therefore many members from each of these roles, along with center administrative and medical leadership. We included a representative from the Office of Patient Experience. In addition, we sought to codesign our improvement project by closely soliciting input from our patients.

To define and gain a clear understanding of customer needs, including the desires of staff, patients, and families, several methods were implemented to generate qualitative and quantitative data. These included the creation of a patient journey map, 1-2-4-All brainstorming (described following), a patient/family feedback survey, and solicitation of views from our center's Patient and Family Advisory Council (PFAC), which is composed of a physician leader, a social worker, nursing staff, and parents of children who received care at our institution.^{12,13}

We pictured the process of consultation, test preparation, and obtaining the PSG as a journey. Characterizing the patient journey using typical process mapping would have been overly technical for most PFAC members, so the team created a mapping tool using pictorial diagrams to help others visualize the current state of the pediatric sleep study process (**Figure S2**). This method, known as patient journey mapping, has been described as a way to address inadequacies in typical process mapping when applied to a health care process.¹⁴ The patient journey map helped team members empathize with patients and family members, because the team purposefully detailed each segment and step in the care continuum. The pictorial made handoffs noticeable, highlighted time constraints, and helped the multidisciplinary team visualize portions of the journey they may not be involved in directly.

Using the patient journey map and a more technical process map, the team conducted a brainstorming activity to generate ideas for improvement. Our team used a 1-2-4-All brainstorming activity to develop ideas for interventions with potential for making a positive impact on patient and family satisfaction before, during, and after a pediatric sleep study. It began as an individual (1) exercise; then after ten minutes moved to a partner (2) exercise; then after another ten minutes became a group (4) exercise; and finally, each group (All)

reported their ideas and grouped them through an affinity exercise (Figure S3).¹⁵ This exercise yielded nine domains of ideas for improving the process: staff training, setting expectations/roles, child life specialist involvement, earlier check-in times, sleep patient education, distraction and reward techniques, and three environments (waiting area, consultation room, and sleep laboratory) (Table 1). A key driver diagram was created to show the relationship between the global aim statement, the specific, measurable, attainable, relevant, and time-bound (SMART) aim, the primary drivers (sometimes called “key” drivers), and the possible interventions associated (Figure 1). A driver diagram was used when communicating with stakeholders to show a clear picture of the team’s shared view.

To define the current state of satisfaction, in February 2018 we surveyed parents/caregivers as to their level of satisfaction in seven areas of the experience, including communication of expectations and preparedness, accommodations, lead/monitoring and hook-up process, lead removal process, staff sensitivity to

caregiver’s and child’s needs, staff coordination of care and communication, and confidence in returning or referring a family or friend. A Likert scale was used, with 5 being “most satisfied” and considered “top box.” Baseline and post-intervention data can be seen in Figure 2. There were 55 completed pediatric studies that month with a response rate of 85% (n = 47). Five caregivers reported a history of having a PSG at another institution. Comments from those caregivers included that another institution’s room was bigger, the caregiver slept in a separate room, and the hall light was on a dimmer so that it did not wake their child.

Some improvement ideas were easy to implement and required less analysis and prioritization. However, we realized that other ideas would require considerable work and allocation of time. Prioritization was needed, and we thought it was important to prioritize based on which tasks would provide the most improvement as experienced by the customers of the process. We also utilized two quality tools designed to help prioritize potential improvement

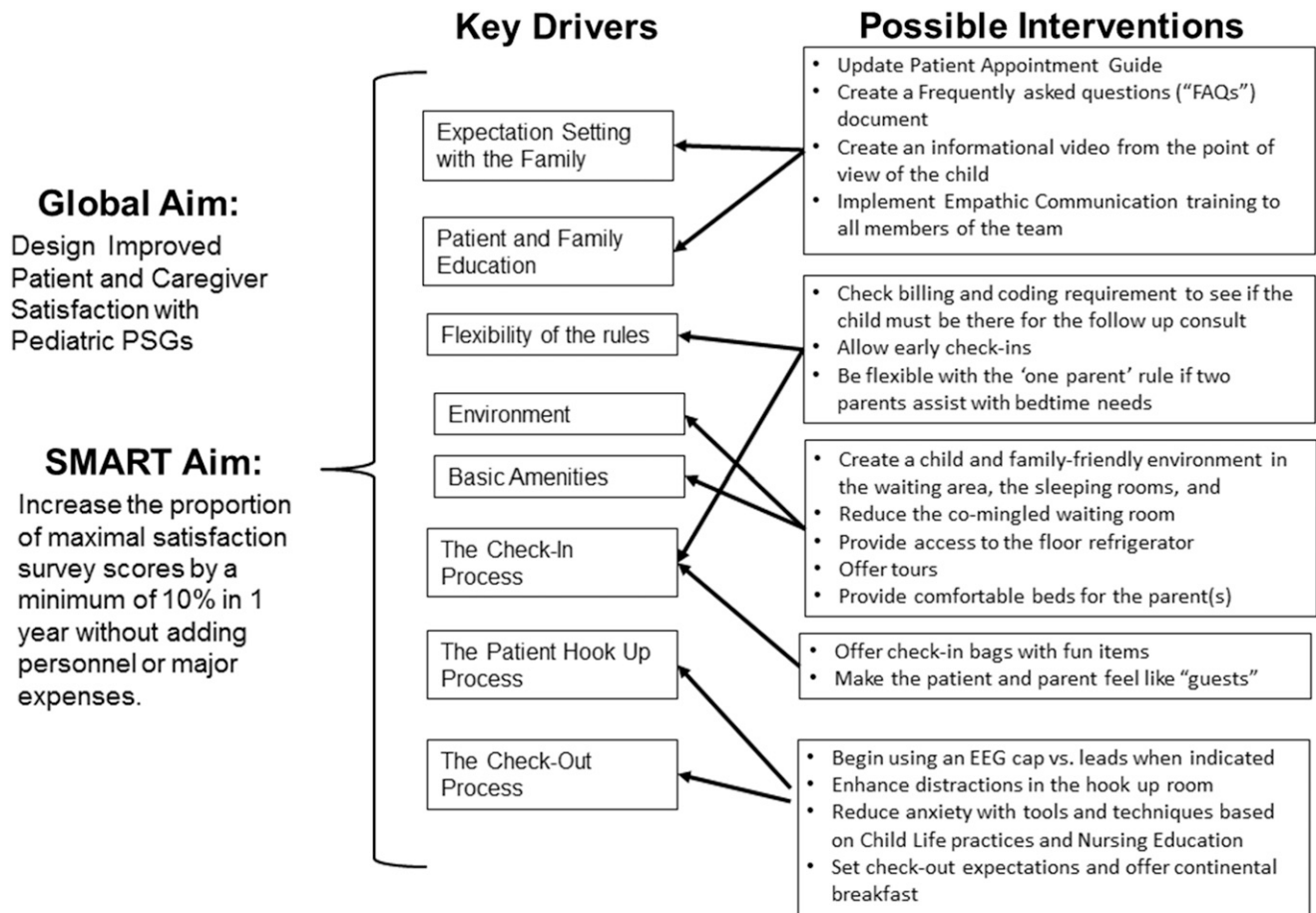
Table 1—Description and rank of identified improvement domains and action items (completed or in-process).

Domain of Improvement	Description	Action Items
1. Staff training	The brainstorming process was multidisciplinary and allowed sleep technologists to discuss their need for further training in caring for children and caregivers. The advisory council also mentioned that staff seemed ill-equipped to deal with difficult pediatric patients.	Office of Patient Experience provided empathic communication training to all members of the team (technologists, desk staff, nurses, providers).
2. Setting expectations and roles	Preparation for caregivers was inconsistent.	Child life pilot was initiated.
	Sleep technologists felt unprepared to care for children.	Office of Patient Experience provided empathic communication training to all members of the team (technologists, desk staff, nurses, providers).
3. Child life involvement	All members of the team identified this as a key area of improvement to enhance the hook-up experience in particular.	Child life pilot was initiated to determine feasibility in the care process and timing of intervention for best practice.
4. Hook-up room environment	Hook-up rooms did not have child friendly options for distraction, and child friendly aesthetic was not present.	Distraction kits were made available during hook-up.
5. Early check-in time	Check-in time was the same for both children and adults. Frequently children would start their study after their age-appropriate bedtime. Many members of the team and the PFAC identified this as a major source of stress/dissatisfaction.	A staffing model was created to move sleep technologist FTE to earlier in the evening. No additional FTE was used
6. Patient education	Patient and caregiver were inconsistently prepared for the PSG.	Patient appointment guide was updated.
		Frequently asked questions (FAQs) document was created.
		An informational video from the point of view of the child going through consult and PSG was created.
7. Distraction and rewards	Members of the team identified a need for tools and toys to provide distraction for children during hook-up and motivational rewards to be provided throughout the process.	A grant from volunteer services at our center was applied for and awarded to provide distraction kits with toys and books for initial consultation and hook-up.
8. Consultation room environment	Consultation rooms in the Center for Sleep Medicine were set for adults and did not include small tables and chairs, age-appropriate books, or art work.	Small chairs, books, and dry-erase boards were purchased.
9. Waiting area environment	A separate space with child friendly games, television programming, and books was identified for children currently waiting in our waiting area.	Our center had already identified our lobby as needing remodeling, and a separate space for children is planned.

FTE = full-time equivalent, PFAC = patient and family advisory council, PSG = pediatric polysomnography.

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Figure 1—Key driver diagram.



activities, including the Kano “Attractive Quality” analytic tool (Kano model) and quality function deployment (QFD).¹⁶ The Kano model had already been used in our institution’s emergency department to improve the patient experience.¹⁷

Kano model

The Kano model was originally developed for product development and customer satisfaction and uses a method of feedback that sorts the VOC into three categories of requirements: “must-be,” “one-dimensional,” and “attractive” requirements (see Figure 3). We adapted the Kano model for simplicity to must-haves, satisfiers, and wow factors.¹⁸ In this analysis, only the voice of the patient and/or family, obtained via survey and interview with the PFAC, was considered. Team members met with the council to understand their needs and desires and posed open-ended questions about what amenities, services, and other expectations they had of our center and staff. Answers to the survey questions were plotted in the model to help convert the VOC into requirements for improvement.

Quality function deployment

The Kano model of customer satisfaction can be combined with QFD to create products, services, or experiences using prioritization techniques.¹⁸ QFD is an in-depth evaluation and focused methodology for understanding and responding to the

needs of the customer.¹⁹ In QFD literature, the Kano model is applied by assigning weights to the various customer requirements. For each of the nine improvement domains, the customer rating of how their satisfaction was affected as expressed in the Kano model exercise was weighted by the team’s input based on how improvements in that domain affected safety, experience, cost effectiveness, and ease of implementation, as obtained via a multiresponse poll, which allowed responders to rate more than one domain per question. After multiple rounds of ranking to obtain criteria weight and themes, the statistical analysis within the quality function helped to identify the order of importance (rank) for the improvement interventions. The weighting factors considered safety, experience, cost-effectiveness (value), ease of implementation, and the PFAC’s expectations.

Through the Kano model and QFD, we generated the nine areas for improvement with weighted ranking of the intervention (Table 1). Because QFD included analyses for ease of implementation and cost, the team was able to efficiently identify what our center could begin to change without further discussion or approval.

RESULTS

The DMAIC model, Kano model, and QFD allowed our project team to quickly and effectively identify areas of improvement,

Figure 2—Sleep questionnaire data gathered before and after intervention.

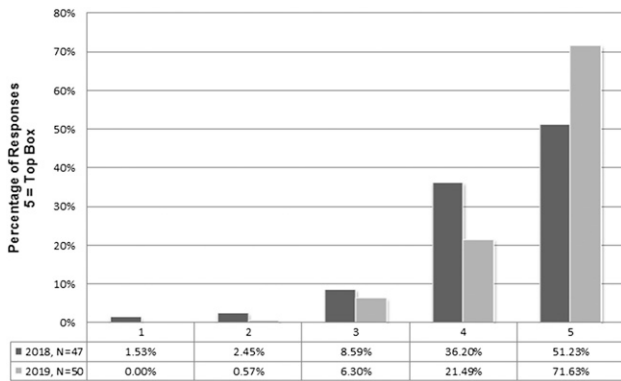
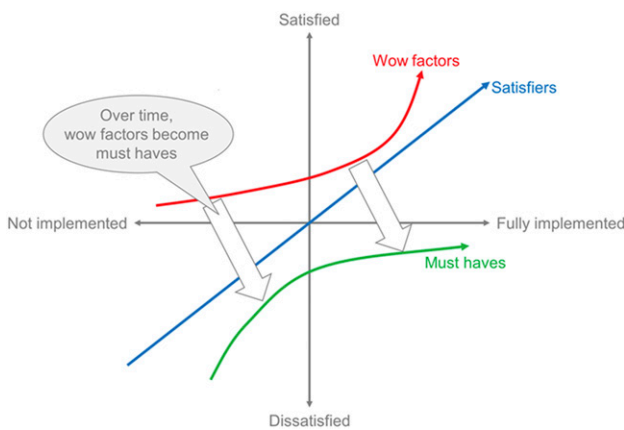


Figure 3—Kano model of must haves, satisfiers, and wow factors.



rank them in order of importance, and identify areas the team could quickly implement with little time or added cost. A summary of actions implemented can be seen in **Table 1**. Plan, do, study, act (PDSA) cycles were established on nearly all interventions to ensure continuous improvement and to extract lessons from each iteration. Feedback channels were, and still are, from staff, informal surveys, and comment cards.

Integrating a child life specialist into pediatric PSG processes was identified as an important addition by all members of our multidisciplinary team (third highest priority, see **Table 1**). Parent members of the PFAC whose children benefitted from child life specialists readily recognized the benefit of their presence during PSG. Our sleep technicians, who function in an integrated adult and pediatric sleep center, had considerable anxiety in the process of hooking children up for PSG; the number and high turnover rate of these front-line technologists made it impractical to do individual training. Having the consistent presence of a child life specialist seemed ideal, but it required the addition of staff, which did not meet the requirements for this project. Therefore, a pilot project for child life interventions at the time of initial consult and pre-PSG was performed to gather data on the most effective time of intervention: daytime, evening, or both. Funds for a child life specialist were only approved

on a limited basis during this pilot project. This intervention is ongoing and initial feedback and results are positive; however, a consistent presence in the sleep center has not occurred.

The improve phase of DMAIC continue in our center, and we have implemented multiple improvements. While the implementation of these improvements all at once would make it difficult to identify the most impactful changes, many of the changes are intuitive and are present in other areas in pediatrics at our center. Numerous suggestions had minimal cost and used programs already in place. The team applied for and received a grant to fund take-home activity bags to be distributed at check-in and distraction kits for the hook-up rooms. Distraction kits to be used during a PSG hook-up now include the following: noise makers, a weighted lap pouch (not a blanket), light-up toys such as an orbiter, sensory toys such as a liquid motion timer, mini rainmakers, and fidget toys. Grant funding was obtained to provide cushion overlays for parent beds; this equipment is also used for caregivers in the inpatient setting. Our Office of Patient Education made an educational video narrated in a voice appropriate to the age of the child undergoing PSG to target the various age groups (infant/caregiver, school age, and adolescent). There are ongoing efforts to improve our educational booklet and patient appointment guide (PAG) to set expectations. The entire staff (providers, nurses, desk staff, and sleep technologists) also received empathic communication training provided by our Office of Patient Experience.

Patients were surveyed for follow-up data in February 2019. Results showed an increase in top box scores from 51% (n = 47) in the baseline data to 71% (n = 50) in the follow-up survey (**Figure 2**). There were 79 pediatric studies completed in February 2019 for a response rate of 63%. We are not able to describe our clinical population retrospectively from February 2018 due to an electronic medical record change that occurred mid-2018. Our patient population has not significantly changed and is likely represented by the diagnoses seen in our review of patients who underwent a PSG in February 2019. During that month, 43% of pediatric patients who underwent polysomnography were patients with special health care needs. Diagnoses included, but are not limited to, the following: trisomy 21, myotonic dystrophy, epilepsy, Joubert syndrome, Apert syndrome, cerebral palsy, autism, ADHD, tuberous sclerosis, CHARGE syndrome, Prader-Willi syndrome, and Pierre Robin sequence. Representative caregiver comments from this survey pre/postintervention can be seen in **Table S1** in the supplemental material.

After our next major intervention, the creation and implementation of age-appropriate educational videos, we repeated our project-specific survey in mid-October to mid-November 2019. Question 1 was modified as can be seen in **Figure S4**. Three videos were created. The first is intended for parents of infants and toddlers and is narrated in the voice of the parent. The second is intended for early school aged children and is in the voice of the child. The third is intended for teenagers and is narrated by the voice of a teenager. These three videos mirror our journey-mapping exercise (**Figure S2**), taking the parent and child through the process of sleep medicine consultation appointment, polysomnography, and follow-up appointment to receive results. A link to these videos is provided on the child’s PAG to be viewed prior to the child’s appointment if a

PSG is prescheduled. If not viewed already, the video is shown to the child and caregiver after the provider consultation appointment. Top box scores during this period were 64% (n = 84). Of those surveyed, 46% had seen the educational video prior to the PSG. Of those who saw the educational video, 81% felt they were “very prepared” or “somewhat prepared” by the video.

The control phase of an improvement project requires stability in the processes, with minimal ongoing improvement efforts. The control phase is when the changes are continued and maintained. We are currently operating in a highly dynamic environment. Patient demand is growing, yet access to our services is greatly influenced by changes in external forces, such as the insurance market and politics. Our Center for Sleep Medicine is also situated in the middle of a space that will be undergoing substantial changes to accommodate additions unrelated to pediatric sleep medicine requirements. We do not feel we are done implementing all of the above improvement ideas. Therefore, the control phase has not been reached; we remain in the improve phase.

DISCUSSION

Our project improved the patient experience as demonstrated by the higher top-box scores on our post-sleep study survey. The multidisciplinary team was crucial to making an impact on the patient and family experience since all aspects of the patient journey were analyzed. Attending PFAC meetings was an invaluable experience and helped us obtain critical patient and family input. Their suggestions are being implemented in multiple areas. Meeting weekly with a health systems engineer from the center’s Department of Management Engineering & Internal Consulting team to kick off the project and biweekly thereafter helped the project gain momentum and ensured buy-in from stakeholders. The expertise of an engineer in clinical quality and process improvement along with the third party, data-driven-objective approach minimized bias and kept the team engaged and moving throughout the project lifecycle.

The improvement team benefitted from the cross-professional inputs as well. Many aspects of the patient journey and staff needs would not have been improved without the time taken for detailed communication among the participants. Leadership from the Center for Sleep Medicine and the pediatric center encouraged the team, met with them, and provided resources for project design and implementation. An indirect benefit of this project may be the ongoing engagement of the team and its problem-solving capability, which continue to make the sleep center a better place to work and to receive care.

Limitations of this project include the postintervention difficulty in sorting out which changes had the most impact, because improvements identified for multiple areas were implemented over time. We used our project-specific survey prior to beginning the project (February 2018) and at the end of the project (February 2019). We then resurveyed in October to November 2019 after our next major intervention, which was the implementation of the educational videos that went live in September 2019. It may have been of more benefit to survey monthly as time passed, but in reality, it still would have been difficult to identify the impact of any individual intervention

due to the rapid implementation and the multidisciplinary nature of each intervention. Again, our institution uses Press Ganey to gain patient satisfaction scores; however, we felt that these surveys represented only the doctor/patient interaction and did not accurately capture the complete experience of PSG. We also did not track employee satisfaction, because this was a patient and family-centered project, but the employee data would have been valuable also. Anecdotally, feedback from staff has been positive.

Although no new staff were added, there was a cost in time for group meetings, unaccounted for expenses of the institutionally supplied process engineering consultant and empathic communication training, and smaller costs associated with supplies that enabled some of the improvements listed in **Table 1**. In addition, there is the unmeasured impact on and change in the practices of stakeholders who participated in this project. While improvements are continuously being made, there is a danger of drift, wherein what is considered a “wow factor” now will become a satisfier and then a must-have by patients and families, and so new attractors may need to be developed.

Quality improvement techniques typically employed in business, engineering, and manufacturing were used to identify and were critical to addressing areas of improvement in the pediatric PSG experience. After implementation, the top box score rose 20%, from 51% in 2018 (n = 47) to 71% in 2019 (n = 50). This occurred without adding personnel or other major expenses and was accomplished while the number of pediatric PSGs performed increased. After implementation of an educational video, our top box score was 64%. This is still above our goal of a 10% increase in top box scores; however, we believe this drift downward is likely multifactorial. A decrease in the frequency of meetings has occurred. Roll-out of the video has been incomplete with only 46% viewing the video. While the child life pilot occurred before the data collection in February 2019, we have not been able to implement the child life intervention regularly in the center because approval is currently going through institutional channels outside the sleep center. The presence of a child life specialist was believed to have a significant impact on the PSG experience as well as impacting the staff’s experiences with the patients. We are still actively working on this implementation.

Future directions for our sleep center will include refining the project-specific survey to define the impact of our educational video and continuing to make changes, as we remain in the improvement phase.

ABBREVIATIONS

AAO-HNS, American Academy of Otolaryngology-Head and Neck Surgery
 AAP, American Academy of Pediatrics
 AASM, American Academy of Sleep Medicine
 DMAIC, define, measure, analyze, improve, and control
 PAG, patient appointment guide
 PDSA, plan, do, study, act
 PFAC, Patient and Family Advisory Council
 PSG, polysomnography
 QFD, Quality Function Deployment

SIPOC-R, supplier, input, process, output,
customer, requirements
VOC, voice of the customer

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Address correspondence to: Julie M. Baughn, MD, Center for Sleep Medicine, Mayo Clinic, 200 First St SW, Rochester, MN 55905; Email: baughn.julie@mayo.edu

DISCLOSURE STATEMENT

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