Journal of Nursing & Interprofessional Leadership in Quality & Safety

Volume 4 | Issue 1 Article 5

October 2021

Reducing Pulmonary Function Testing Procedure Times in Pediatric Patients

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Abstract

Problem. The Pulmonary Function Test Time Project (PFT Project) is a quality improvement (QI) initiative designed to decrease PFT testing time and PFT total time in pediatric patients and improve the overall process for both providers and patients. Patients scheduled to see a pulmonary provider were also scheduled for a PFT prior to the provider's visit. Data showed that the length of time to perform a pulmonary function test (PFT) was causing: (1) a delay in the pulmonary provider seeing patients at the intended appointment time, (2) a disruption to clinic workflow, resulting in scheduling difficulties, and (3) a decreased number of patients seen by the providers. Any delays with the PFT appointment could have a negative impact on the flow of clinic appointments. The aim of the PFT Project was to reduce the length of time for pulmonary function testing without compromising the quality of the test results.

Methods. The initiative applied a quality improvement approach using Plan, Do, Study, Act (PDSA) cycles to implement a change plan and achieve desired project outcomes. Monthly reports showing average PFT testing time, average PFT total time, and acceptability and repeatability (A/R) percent success rates were generated and utilized to discuss goal progress and to celebrate successes with the PFT lab team.

Results. 2973 patients were included in the procedure time portion of the initiative, and 4874 patients were included in the A/R percent success rate portion of the analysis. The average PFT testing time and average PFT total time were reduced by 49% and 24%, respectively, for spirometry. The average PFT testing time and average PFT total time for spirometry before and after administration of a bronchodilator (B&A BD) were reduced by 23% and 15%, respectively. There was an improvement in the acceptability and repeatability percent success rate within 22 months of initiating the project.

Conclusion. The implementation of improved PFT lab processes allowed us to meet the desired goal to decrease PFT testing time and PFT total time for both spirometry and spirometry B&A BD testing without negatively impacting quality.

Keywords

pulmonary function test, pulmonary function test time, PFT procedure time

Authors

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Introduction

Testing for pulmonary function is an important procedure in the diagnosis and treatment of children who experience problems with breathing. Pulmonary function tests (PFTs) are an essential component in the diagnosis and ongoing treatment of pediatric pulmonary diseases such as respiratory infections, asthma, cystic fibrosis, and pneumonia (Visser et al., 2010; Miller et al., 2005). PFTs are noninvasive, effort-dependent tests that can include measures of lung volume and capacity, flow rates, and gas exchange. A successful PFT is dependent on both patient cooperation and a skilled respiratory therapist (RT) who can properly perform an acceptable and repeatable test.

The challenge of a successful pulmonary function testing lab is to have skilled RTs who use a standardized format, achieve accurate information to assist interpretation of PFT findings, and communicate test results to end users (Culver et al., 2017). The failure to keep on-time clinic appointments is a major barrier to continuity of care, clinic efficiency, and the relational aspects of provider-patient interactions. There are financial concerns to delayed and canceled appointments, clinician and family time wasted, and interruption of care progression (Hixon et al., 1999).

This paper describes a quality improvement (QI) initiative designed to decrease PFT testing time and PFT total time, and improve the overall experience for providers and patients.

Problem

The PFT lab at Primary Children's Hospital in Salt Lake City, Utah discovered that the long length of time to perform a diagnostic PFT was having a negative impact on the flow of patient appointments. In August 2016, pulmonary providers reported that prolonged pulmonary function testing times were impacting provider workflows and templates as well as making the appointment duration for families longer than expected or needed. Negative impacts included situations such as delays in pulmonary providers seeing patients at the intended appointment time, disruption to clinic workflow and scheduling, and decreased number of patients seen by the providers. It was common during one half-day clinic for each provider to have one unfilled patient slot due to the length of PFT time. This was a result of RTs spending extra time ensuring the data reported to the providers met the American Thoracic Society (ATS) standards for acceptability and repeatability.

The PFT scheduling process was complicated and required the scheduling team to determine the length of time needed for the PFT appointment. A one-hour PFT appointment was scheduled prior to the provider appointment for new clinic patients aged 4 years and older who could perform a PFT. For return clinic patients, the patient was scheduled for a PFT prior to the provider appointment based on the previous clinic visit discharge orders listing the specific PFT testing needed. The time period scheduled for the PFT appointment was based on procedure testing times. Baseline PFT appointment times ranged from 30-120 minutes based on ordered testing.

Purpose of the Quality Improvement Initiative

The purpose of the PFT Project was to improve PFT lab processes while maintaining or improving the quality of the PFT testing.

Methods

Context

Primary Children's Hospital is a 300-bed teaching hospital, averaging 13,000 admissions per year, with an adjacent outpatient services building. The PFT team provides services in two locations, with one testing room in the main hospital and three testing rooms located in the outpatient clinic building. The PFT team has a clinical staff of six respiratory therapists ranging in work history from 2 to 26 years. This team is responsible for performing a variety of lung function diagnostic testing for pediatric patients (ages 3-20 years) serving many pediatric clinical subspecialty divisions including Pulmonology, Hematology, Oncology, Surgery, Allergy, Immunology, Rheumatology, Cardiology, Orthopedics, and Community Based Physicians. The RTs also provide respiratory education for pulmonary disease management, medication delivery, proper use of equipment, and airway clearance techniques.

The pediatric pulmonary division comprises six pulmonologists, one physician assistant (PA), and two nurse practitioners (NP). They average 3-5 half-day clinics per week, seeing 6-7 patients per clinic. These patients range in age from newborn to 20 years of age.

It is essential to ensure data integrity for every PFT. Key elements include proper performance of the testing equipment, training of the PFT technician, and proper application and utilization of the ATS standards when performing lung function testing. Quality control measures consist of daily calibration of testing equipment.

Biologic control testing is performed and reviewed bi-monthly to control for variation. Bi-annual reports are generated and signed off by the PFT medical director, and all systems receive annual maintenance by the vendor.

RTs are trained with formal education protocols and learning objectives, using the ATS Standards and Procedure Manual (Wanger, 2016). Continuing education occurs monthly. Audit reports are generated for each RT, listing patients tested in the previous month. Each RT is assigned to review a sample portion of PFTs performed by another RT for agreement of acceptability and repeatability criteria (met or not met) and accuracy of test results. If there is clinical judgment difference between tester and reviewer, the PFT is reviewed with the RT group at a monthly PFT lab meeting for discussion and consensus. These efforts help ensure the validity and consistency in testing and reporting of PFTs.

PFT Project Population

The population focus of the procedure time portion of this initiative are the pediatric patients seen by a pulmonary provider in a General Pulmonary, Sleep, or Cystic Fibrosis (CF) clinic. The acceptability and repeatability percent success rate portion of the project encompasses all PFT testing.

Interventions

Development of PFT Protocol

The PFT Project began with the aim to reduce the length of testing time without compromising the quality of testing. The team utilized Plan Do Study Act (PDSA) cycles (Berwick, 2008) to implement the change plan:

- Timers were purchased for each PFT lab and portable PFT system to track procedure times.
- Total time from start to finish of procedure was defined as front end equipment set-up, order verification, back-end clean up, and documentation.
- Procedure times were collected and recorded by the RTs for PFTs associated with a clinic visit (those patients seeing a pulmonary provider) in an Excel spreadsheet for spirometry and spirometry before and after administration of a bronchodilator (B&A BD). These tests represent the largest volume of testing performed and preempt any other possible testing ordered.
- A "Reasons" column was added to the Excel spreadsheet to record why testing time went over the goal.

PFT Project ideas implemented to decrease PFT times include:

- Use of inexpensive party blowers for younger patients to pre-assess patient ability to perform a PFT.
- Recognizing the need for a second RT to attempt testing sooner (a common practice in the PFT lab to alleviate any question or concern of the ability of the RT to obtain or not obtain data).
- Ensuring PFT labs were properly stocked with equipment and supplies prior to testing to help minimize disruptions in care.
- Notification of the RT by the medical assistant of the patient's arrival to reduce wait time and help minimize total PFT time.

Methods of Evaluation and Analysis

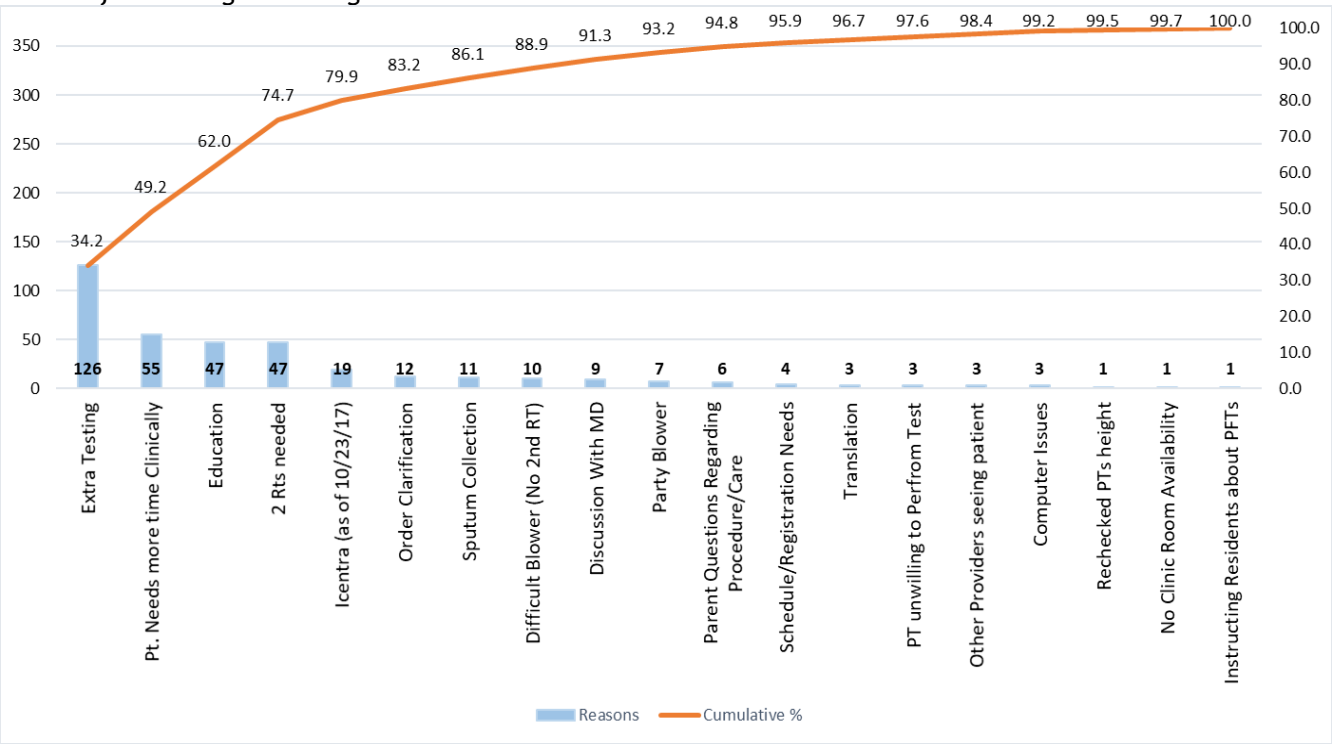
Data for the PFT Project was self-reported by the RTs performing the PFTs. The A/R criteria for spirometry and spirometry B&A BD was determined by the RT at point of care and documented on the PFT report prior to presenting the test results to the provider and importing to the patient's chart. The A/R rating was entered into Excel to then calculate an A/R percent success rate.

Data was analyzed in R programming and displayed as density plots to determine mean and median PFT testing time and PFT total time for spirometry and spirometry B&A BD. The A/R percent success rate was determined by the number of acceptable and repeatable patient tests divided by the total number of patient tests. The result by age group and test categories along with the goal rate were displayed as graph lines in Excel. Desired goals were established based on these reported values.

Three months after implementation of the PFT Project, daily morning huddles were initiated to review the "Reasons" list from the previous day to evaluate why PFT testing went over the allotted time (See Figure 1). Evaluation of the reasons for prolonged testing time identified leading indicators, and the team huddle generated ideas on how to decrease testing time without compromising quality. Incorporating this initiative into already established workflow processes, such as daily morning safety huddles and Excel metric tracking, allowed for easy acceptance and participation by all RTs.

Figure 1

Reasons for Prolonged Testing Time



Prior to monthly PFT lab staff meetings, a systems improvement analyst generated reports with average PFT testing time, average PFT total time for spirometry and spirometry B&A BD, and the A/R percent success rate. Analysis of procedures that did not have a time recorded (percent error recording rate) were also reviewed and discussed. During staff meetings, the metrics were shared with all RTs, which allowed for monthly review of our goal progress and opportunity to celebrate successes.

Bi-monthly meetings with clinical operations leadership and the PFT lab supervisor allowed for brainstorming of ideas and tweaking of processes. Administrative direction was key in the identification and exploration of lagging versus leading indicators, such as the "Reasons" list being incorporated into the daily safety huddle.

In October 2017, the hospital implemented a new electronic medical record (EMR). In preparation, new provider templates were developed, including new templates for pulmonary function testing. Due to the PFT Project, by September 2017, the PFT lab had six months of timed PFT data showing a decrease in both PFT testing time and PFT total time. Subsequently, new schedule templates for both providers and the PFT lab were developed that reflected this decrease in time. Revised templates for PFT times range from 15-90 minutes based on ordered testing.

Results

Spirometry Times

During the 22-month period of the PFT Project, 2,973 patients were included in the procedure time portion of the analysis, and 4,874 patients were included in the A/R percent success rate portion of the analysis. Figure 2 shows that the results for the average PFT testing time and average PFT total time were reduced by 49% and 24% respectively for spirometry.

Figure 2
PFT Spirometry Improvement (2017-2018)

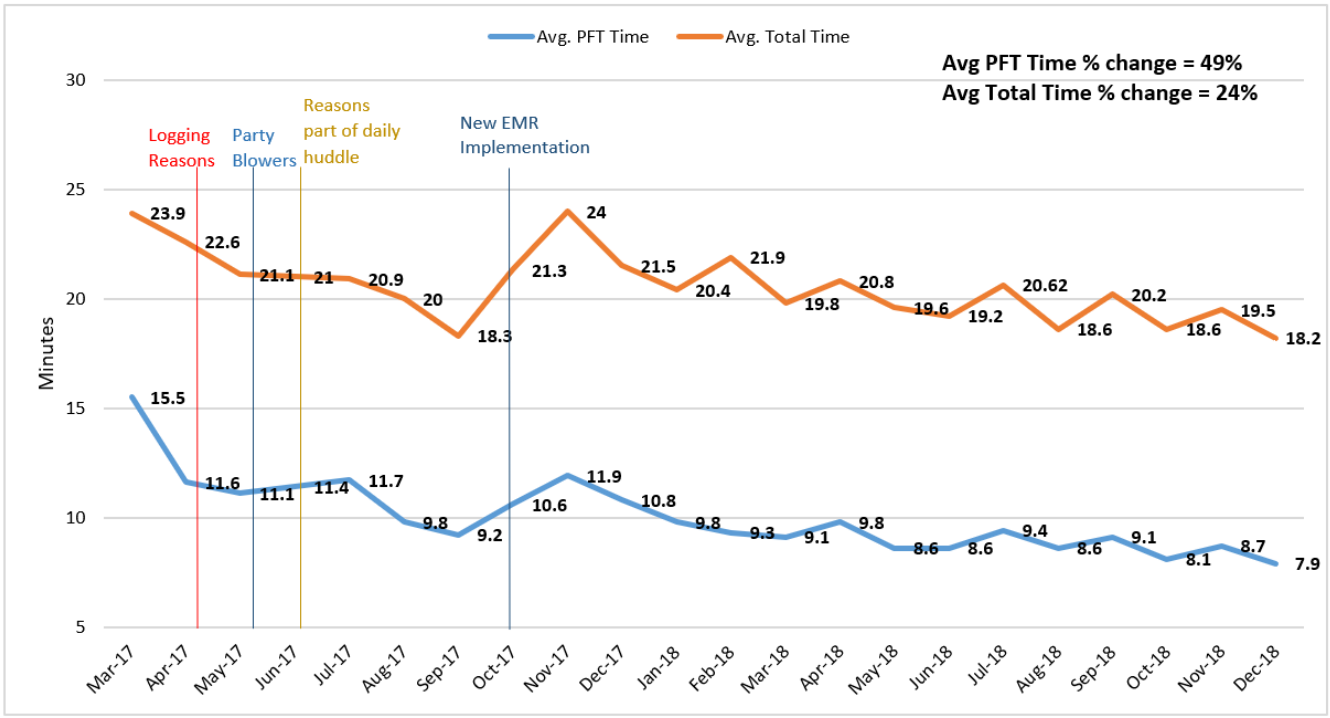
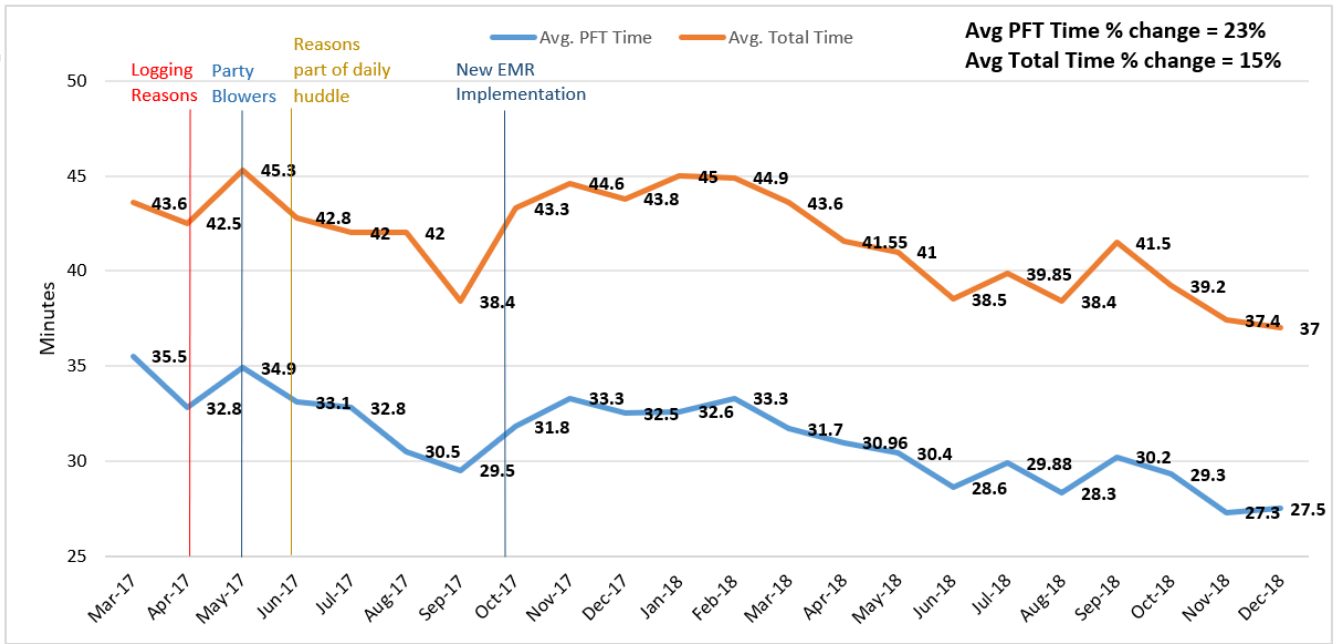


Figure 3 shows that the average PFT testing time and average PFT total time for spirometry B&A BD were reduced by 23% and 15% respectively.

Figure 3
PFT Spirometry B&A BD Improvement (2017-2018)



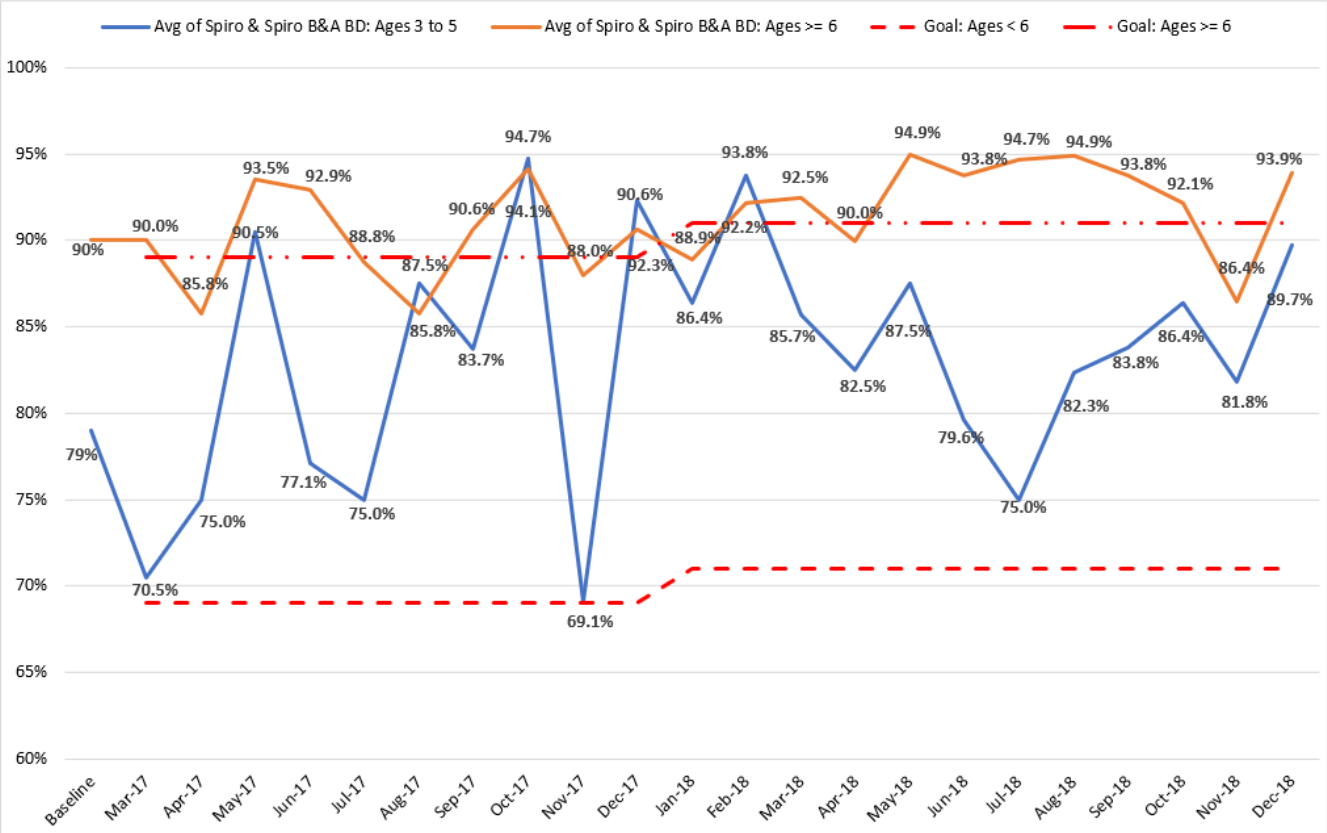
After implementing the PFT Project, average spirometry test times were reduced by as much as 6.2 minutes within 12 months (March 2017=15.5 minutes, February 2018=9.3 minutes). A reduction in procedure times resulted in the PFT lab no longer experiencing a bottleneck. The improved, on-time completion of PFTs enabled providers to see an increased number of patients (See Appendix A for a commendation letter from the chief of the Division of Pediatric Pulmonary Medicine).

Acceptability and Repeatability Percent Success Rate

Due to the challenges in performing and interpreting good quality, reliable PFTs in young children, the American Thoracic Society issued guidelines and standards for testing preschool-aged children (Beydon et al., 2007). Until September 2018, our PFT lab defined this age group as patients aged 3-5 years, at which point we extended preschool criteria to include patients 6 years of age, as recommended by ATS guidelines (Beydon et al., 2007; Culver et al., 2017). Comparison of the baseline data to the post project implementation data showed improvement in the A/R percent success rate for spirometry and spirometry B&A BD in both preschool aged children and older children/young adults. February 2017 baseline data placed the average A/R percent success rate for both spirometry and spirometry B&A BD for preschool aged patients (3-5 years) at 79%. The baseline average A/R percent success rate for older patients was 90%. In December 2018, the average A/R percent success rate for preschool aged patients (3-6 years) increased to 89.7%, and for older patients, the average A/R percent success rate increased to 93.9%. See Figure 4.

Figure 4

A/R Percent Success Rate by Procedure and Age (2017-2018)



Discussion

The implementation and continued evaluation of the PFT Project showed that improved processes achieved a decrease in both PFT testing time and PFT total time for both spirometry and spirometry B&A BD testing without negatively impacting the quality of testing.

It was critical to the success of the PFT Project that RTs documented the PFT testing time and PFT total time for all applicable patients. There were PFTs performed where the RT did not record PFT test time or PFT

total time. Each month a count of those patients who were not timed appropriately were tallied and reported as a percent error rate along with the reason for not timing the procedure. The percent error rate and reasons for not recording a test time were reviewed and discussed at monthly PFT lab meetings. The average error rate was 7%. The primary reason for not timing the testing was due to difficulty with the same RT testing two or three siblings sequentially in the same PFT lab or clinic room. In this situation, it was difficult to separate the PFT total time for each patient since some of the front and back-end testing responsibilities were skewed. The low percent error rate demonstrated commitment to the PFT Project and lent validity to the data.

For the majority of patients performing pulmonary function testing for the first time, there was a "learning curve," a period of time for instruction, performance, and then re-instruction to achieve accurate results. The potential for longer PFT testing times may occur for new patient visit types as compared to a return patient visit type. However, for this initiative there was no separate calculation of testing times or total times based on new or return patient visit type. The inclusion of PFT times from all visit types may have an impact on the reported data.

Nineteen months after implementing the initiative, our PFT lab changed our guidelines for preschool criteria to include patients 6 years of age (Beydon et al., 2007; Culver et al., 2017). This change of inclusion criteria for the preschool age group could have impacted the percent success rate for this age group since there is a possibility that a 6-year-old may be able to successfully meet the less stringent acceptability and repeatability criteria required for ATS preschool standards.

Sixteen months after implementation of the PFT initiative, the "reasons" listed for prolonged testing times and/or total times had not changed during an eight-month period. Due to no additional unique reasons added to the list, we decided to no longer discuss the previous day's reasons list at the morning safety huddle. The review process was changed to discuss as a group any new reason for prolonged testing or total test times, and brainstorm ideas and refine processes as needed.

Sustainability

Continued efforts to improve PFT times are ongoing. The initial goal of 18.2 minutes for PFT total time was achieved within 22 months of implementation of the PFT Project. We have continued to sustain the improvements in testing times despite changes in staffing, added providers and clinics, and continued growth of the practice.

Changes due to COVID 19 Protocols

PFTs are aerosol generating procedures (AGPs) and are high risk for transmission of disease. Due to the many unknowns about the possibility of transmission in this setting, the PFT lab stopped performing PFTs in March 2020. Once PFTs began to be performed again over a month later, testing was done for "urgent cases" only. Recommendations and measures for how to ensure safe and effective testing for patients were developed in coordination with the medical director and hospital infection control department. Also, the PFT lab implemented ATS formal recommendations for restoring pulmonary services (Wilson et al., 2020) which included PCR testing and screening of patients prior to scheduling and testing, respiratory therapists wearing full PPE and following strict don and doff institutional procedures, and adding "wait times" where the lab was unused prior to receiving enhanced cleaning. As a result, very few PFTs were performed and no PFT testing times or PFT total times were recorded for a year, and there was no monthly review or discussion of A/R percent success rates. However, the RTs did document whether A/R criteria was met or not met on every PFT report and also in the Excel spreadsheet.

The monthly review of patients successfully meeting the ATS A/R criteria was re-implemented in March 2021. In May 2021, recording and documenting of PFT testing times resumed. Average times were established for don and doff procedures, unused room "wait time," and cleaning time for an average total time of 40 minutes. Since the total time for PFT procedures is now encompassed in this 40 minutes of don and doff time, unused room "wait time," and room cleaning time, the need to document PFT total time is no longer necessary; RTs only document the time it takes to perform the actual procedure. Other pre-pandemic PFT responsibilities that had previously been included in the total time are now accomplished during the unused room "wait time." The PFT lab tracks both A/R percent success rate and PFT testing time, and this data is reported monthly in a PFT Lab Department Quality Assurance Report. Currently, tracking of the percent error rate for recording of PFT testing time by the RTs has not resumed; however, there are plans to reinstate this measure since it speaks to the validity of the data.

Next Steps

There are other areas of the pulmonary function lab that quality initiatives could improve. One area is to better correlate A/R with interventions to decrease procedure time. For example, some questions to address include: are younger patients who can successfully use a party blower able to perform a PFT and meet A/R criteria, and how long does it take? When a second RT is brought in to help a patient perform a PFT, are they successful in meeting A/R, and how long does it take?

Conclusion

The PFT Project was started to address concerns with the length of time to perform a PFT, clinic workflow, and the number of patients that providers can see. The implementation of improved PFT lab processes and ongoing evaluation of pulmonary function testing procedures resulted in positive outcomes. The PFT lab achieved better clinic flow by eliminating a significant bottleneck in the PFT lab and reduced the length of testing time without compromising quality standards and outcomes. Patients achieved greater access to providers because the length of testing time was reduced. The continuous improvement mindset of the RTs in the PFT lab and the quality assurance culture at the institution significantly contributed to the ability of the PFT team to achieve a reduction in procedure times.

Acknowledgements: Ryan Christensen, Ernest Chan, Dustin Lipson, Doug Wolfe, Dr. Angelo Giardino

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Appendix A

Commendation Letter from Chief of the Division of Pediatric Pulmonary Medicine

UNIVERSITY OF UTAH HEALTH CARE | **Division of Pediatric Pulmonary and Sleep Medicine**

03/06/2018

To: Michael Richards

Writing a letter commending the outpatient respiratory therapy team led by Kathleen Richards RT, for improving access to care for Pediatric Pulmonary patients. We had previously identified difficulties scheduling appointments for Pediatric Pulmonary patients related to the restricted availability in the outpatient pulmonary function laboratory (PFT lab) for testing they provide. Our scheduling team demonstrated that one patient/half day of clinic (2 patients/day) could not be scheduled in the Pediatric Pulmonary clinic due to restriction in the PFT lab. After working with Kathleen we discovered that reduced availability in the PFT lab was largely a result of two factors. The first factor was length of testing. The second factor was the limited number of appointments in the PFT lab available to our schedulers. Kathleen Richards and her team have made significant strides on both fronts. First, the group has markedly reduced the time of testing, which has created more appointments per day for patients. Second, Kathleen met with the pediatric pulmonary schedulers to improve processes and communication, the result of which are more outpatient respiratory therapy appointments accessible to schedulers. As a result of this work we are not aware of any restrictions in scheduling outpatient pediatric pulmonary patients related to the PFT lab. The Pediatric Pulmonary and Sleep Medicine Division is extremely grateful for the initiative and hard work from Kathleen Richards and her team in the outpatient respiratory therapy group in this important endeavor.

Sincerely,

Brian McGinley MD
Division Chief
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