PROCEDURE MANUAL

Enhanced Community-Based Asthma Monitoring Through Novel Technology

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Study Site Contact Information

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Overview of the Study

The primary objective of the proposed study is to pilot test implementation of a protocol for enhanced asthma monitoring using novel technology, including mobile spirometry and remote study visits, for rural and medically underserved children with persistent asthma in Delaware and to determine its feasibility, acceptability, and accessibility. Additionally, the proposed study aims to explore patient and family demographic characteristics and social factors associated with successful completion of the program and to explore the preliminary effect of the enhanced asthma monitoring program on asthma control and sleepiness as a measure of daytime functioning.

Scientific Rationale

Asthma is the most common chronic disease of childhood with significant morbidity, mortality, and economic burden in the United States and in Delaware. Asthma affects up to 6 million children in the United States (US) with estimated healthcare costs of $81 billion annually.[1,25] Despite the significant financial resources utilized for asthma and despite advances in preventative medications, asthma-related deaths continue to occur with over 3,000 deaths annually in the US.[1] DE, in particular, is a national asthma hotspot with a higher than average prevalence of childhood asthma (12%).[2] Over 25% of DE high school students report a lifetime diagnosis of asthma, with even higher rates for racial and ethnically minoritized children. Of those children with asthma in DE, 65% experienced an asthma-related visit to their doctor in the past year.[2,26]

Asthma disproportionally affects minoritized and underserved children who are also less likely to receive specialty care and routine lung function measurements. In the US, asthma burden disproportionally affects minoritized and economically disadvantaged children with higher rates among non-Hispanic Black children (14.5%) compared to non-Hispanic White (8.2%) children.[1] There are also higher rates of asthma among individuals of lower socioeconomic status[1] and children who live in rural areas.[27] Rates of asthma-related deaths are twice as high for Black Americans compared to White Americans (21.8 v. 9.5 deaths per million).[1] Among children with asthma in DE with near-fatal asthma requiring ECMO support, 100% were Black and utilized Medicaid as insurance.[28] The reasons for these disparities are multifaceted, but include reduced access to specialty asthma care,[29,30] financial and transportation constraints,[31] and beliefs about medications and self-management.[30] Specialty care is associated with better outcomes for youth with asthma.[32,33] NHLBI guidelines recommend both specialty care and spirometry, a type of lung function testing, as standard components of the diagnosis and management of asthma.[10] Spirometry provides objective measures of lung function and is necessary to monitor asthma control and response to therapy, especially in children, who may not perceive or report ongoing asthma symptoms.[34] Although guidelines recommend routine measurements of lung function,[10] current devices available for home use are peak flow meters, which may be inaccurate or even underestimate asthma symptoms.[35,36]

Chronic and uncontrolled asthma causes daytime and nighttime symptoms and increases risk for severe exacerbations that may be life-threatening. These chronic symptoms are associated with missed school and work days,[3-5] decreased quality of life,[3,36] and daytime sleepiness.[6-9] Improving asthma control has the potential to improve daytime sleepiness and quality of life in children with asthma.[9] Therefore, novel and innovative approaches to enhance asthma monitoring and access to specialty care, in ways that are acceptable and convenient to families, may be transformative for youth with asthma.

Technology-enhanced interventions have the potential to empower families to monitor asthma more closely and reduce disparities in asthma care. The use of telehealth for specialty care visits and mobile spirometry for monitoring asthma symptoms has the potential to improve outcomes among children from rural and underserved areas by reducing the burdens of time and travel to specialty care centers. The use of telehealth has been studied in children with asthma with some studies showing non-inferiority to standard in-person visits and high patient satisfaction.[38] Additionally, small, uncontrolled studies have shown improved symptom control;[39,40] however, lack of objective measurements of lung function, typically gathered during in-person visits, may reduce the effectiveness of telehealth visits. This limitation of telehealth care, however, may be surmounted by

the increased availability of hand-held, mobile spirometers that allow for monitoring of airway function in the home setting and provide objective data to both patients and care teams. Preliminary data show positive acceptance and feasibility of using this novel technology with children with asthma and CF.[17-21] However, there are limited data regarding the use of mobile spirometers in children. In particular, there is little data regarding their use in children from rural and underserved areas, a group at higher risk for asthma-related morbidity and mortality due to decreased access to care. The utilization of technology-enhanced monitoring for asthma in the home setting is a novel approach to engaging patients and families in specialty care without the excessive burden of travel and time. Prior to large-scale interventional studies, it is imperative to assess the feasibility, accessibility, and acceptability of this approach as well as any unique concerns regarding the use of such technology specific to this population.

Recruitment and Enrollment

Study Eligibility

- Children with persistent asthma (defined as using at least one controller medication or asthma) ages 12-17
- Followed by Nemours Pulmonology and by a primary care practice which meets HRSA criteria as rural or medically-underserved
- Participants must be able to speak and read English.
- Access to a mobile device with internet connectivity
- Ability to follow directions to perform study measures

Exclusion criteria

- Significant cardiopulmonary disease other than asthma (Examples: Cystic Fibrosis, complex congenital heart disease)
- Non-English Speaking

Enrollment targets

- 15 participants

Identifying and Recruiting Participants

A member of the research team will contact eligible participants by telephone and provide a brief summary of the study after review of EMR.

If the potential participant expresses interest in participation, the initial research visit (including consent/assent discussion and documentation and completion of initial study measures) will be scheduled at the Milford or Wilmington outpatient pulmonology office.

Study Procedures

This technology-enhanced asthma pilot study will be completed over 24 weeks using a hybrid approach with remote and in-person research visits. Participants with persistent asthma ages 12-17 will be recruited from Nemours DE Healthcare System Pulmonology Division.

The initial (week 0) and final (week 24) visits will be completed as in-person visits in the Wilmington or Milford, DE, Nemours outpatient pulmonology office. At the initial visit, study measures will be completed, and

participants will be trained on the use of technology for future remote visits (mobile spirometry device connected to mobile application for reporting of results and the use of the telehealth platform). At the initial study visit, in-office (gold standard) spirometry will be completed as well as mobile spirometry. Interval monthly visits at weeks 4, 8, 12, 16, and 20 will be completed using remote study procedures with completion of mobile spirometry and measures of asthma control and sleepiness. See Table 1 for study timeline. The final study visit at week 24 will include similar procedures as week 0, including in-office spirometry.

After completing consent/assent procedures during study visit 1, baseline study procedures including standard spirometry using clinic-based pulmonary function equipment (Carefusion Vitalmax™), mobile spirometry (using the MIR Spirobank Smart™ spirometer with the Zephyrx Breath Easy® mobile application) will be completed, as well as training on the mobile spirometry device and telehealth application. If participants are unable to complete reliable spirometry (either standard or mobile after 8 attempts and meet standard ATS criteria for acceptable technique), are unable to understand study measures, or if there are any other concerns about participation, the participant will be considered a screen failure and the reasons for screen failure recorded.

At the time of the initial study visit, participants will receive the mobile spirometry unit and will be instructed on the use of a mobile application for results report generation for future visits. The initial study visit will take approximately 2 hours for baseline testing, training, and collection of data. Subsequent study visits will be completed at 4-week intervals using a remote video platform with a member of the research team available to help complete study measures and, if needed, "coach" the participant during completion of mobile spirometry (see Table 1). The participants will be instructed to complete mobile spirometry using the mobile spirometer and the application for generation of results. The participant will be given 8 attempts to complete successful mobile spirometry. Although the remote application does provide instruction and some immediate feedback to the user, the research team member will be available on video for the remote visit for immediate feedback and guidance if there are difficulties obtaining the correct technique or technical concerns. If the participant is unable to achieve reliable results within 8 attempts, the participant will be instructed to stop testing at that time, and additional participant-specific re-training/education will be completed. Time for mobile spirometry completion is expected to be 5-10 minutes. Reasons for inability to complete the mobile spirometry (e.g. technical concerns, patient effort) will be recorded at each visit.

The estimated time for the remote visit is estimated to be 20-30 minutes. The study-specific Satisfaction and Usability Questionnaire will be completed at each visit, which will take approximately 5 minutes to complete. The study-specific demographic and psychosocial assessment tool will be completed at the baseline visit, which will take approximately 5-10 minutes to complete. The asthma history questionnaire will be completed at the baseline and final visit, which will take 5 minutes to complete. The 5-time asthma control test (ACT®)[23] will be completed at each study visit as well as the 10-item Epworth Sleepiness Scale for Children and Adolescents (ESS-CHAD).[24] Participants will receive a pre-paid gift card at the time of study consent, which will be loaded with $25 after each in-person study visit and $10 after each remote visit ($100 total for completion of all visits).

All paper forms used in the study (e.g., questionnaires) will be kept in a locked file cabinet. Only members of the research team will have access to the human subjects' data and identifying information. All data will be identified only by Subject ID and the master list linking the subjects' identities to the code numbers, as well as consent forms with participant names, will be kept in a password protected excel sheet on the Nemours secure server. All electronic study data will be stored in a folder on the Nemours secure shared drive, separate from the document linking participants to subject IDs, and only study personnel will have access to this folder.

Table 1. Study Timeline

Outcome measure	*Baseline	**Study visit 2	**Study visit 3	**Study visit 4	**Study visit 5	**Study visit 6	*Final
Time (Weeks)	0	4	8	12	16	20	24
Demographic and Psychosocial Assessment tool	X						
Asthma history questionnaire	X						X
Standard Spirometry	X						X
Mobile Spirometry	X	X	X	X	X	X	X
Asthma Control Test®	X	X	X	X	X	X	X
Epworth Sleepiness Scale (ESS-CHAD)	X	X	X	X	X	X	X
Satisfaction and Usability Questionnaire		X	X	X	X	X	X
*Visit and Measures will be completed in-person **Remote study visit using telehealth platform and mobile spirometry device							

Statistical Considerations

The primary outcome of ***feasibility*** will be evaluated by calculating recruitment and retention rates at each study time point (e.g. percent of approached individuals who consent to participant, percent of enrolled participants who complete each study visit). The percent of patients who are successful at producing mobile spirometry results at each study visit will be calculated. The percentage of participants who require additional training sessions due to difficulty using the device will be calculated. To measure ***acceptability***, the Satisfaction and Usability Survey will be reviewed at the item-level, and specifically, responses of "agree" or "strongly agree" will be used as benchmarks of acceptability and feasibility of each item. Responses to the open-ended questions will be analyzed for consistent themes across participants. Finally, to measure ***accessibility***, the investigators will measure the length of time required to complete all visits and the frequency of any technical or connectivity issues. The investigators will meet regularly to review data management procedures and discuss any errors. Prior to beginning analyses, the investigators will examine the distribution of the data and identify any potential outliers. The investigators will consult closely with the REACH Center biostatistician in analyzing the data.

Descriptive and comparative statistics will be employed to characterize patient factors associated with successful study completion (completion of ≥80% of study measures). Categorical variables will be summarized by frequencies and percentages, and continuous variables summarized by mean and standard deviation. Correlations will be utilized to determine whether any patient factors (e.g. age, grade in school, severity of asthma) are associated with successful completion of the pilot (completion of ≥80% of study measures). For specific Aim 3, changes in asthma control and sleepiness will be examined longitudinally for each participant. Data distributions and change over time will be evaluated. Mean differences will be tested for statistical significance using ANOVA.

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