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One center's journey to improve the endocrine health of patients

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Background: Data show that 20% of children and 50% of adults with cystic fibrosis (CF) have cystic fibrosis-related diabetes (CFRD). CFRD can occur without symptoms, so the Cystic Fibrosis Foundation recommends annual screening starting at age 10. In 2020, registry data revealed that the University of Mississippi Medical Center (UMMC) fell below the national average for oral glucose tolerance test (OGTT) screenings. The national median for OGTT screening in patients 10 years and older without diabetes was 51.3%, but UMMC was screening only 43.8% of the target population. Because impaired glucose tolerance (IGT) is associated with pulmonary function deterioration and risk of progression to diabetes, our goal was to increase the number of patients completing OGTTs. The target population for the intervention was patients aged 10 and older because of Cystic Fibrosis Foundation guidelines.

Methods: A multidisciplinary team including the CF center director, center coordinator, dietitian, social worker, nurses, respiratory therapists, pharmacists, endocrinologist, and the parents of a patient with CF was assembled; met weekly; and participated in the Virtual Improvement Program Fundamentals (VIP-F7) quality-improvement course. Patients aged 10 and older who completed an OGTT were assessed by reviewing center-specific data for 2021. Global and specific aims for improvement were written. The team developed a flowchart assessing current practices for completing OGTTs, and ideas for change were evaluated using a plan-do-study-act (PDSA) model. Using the PDSA model, several change ideas were tested including:

1. Identify patients needing OGTT during weekly huddle meeting. Before our VIP-F7 cycle started, there was no systematic identification method for patients needing annual screening.
2. Increase reminders for patients completing OGTTs at UMMC and locally at outside facilities. Reminders for UMMC OGTTs are provided the week before the patient's pulmonology appointment. Local OGTTs completed at outside facilities are provided 6 weeks before the next appointment at UMMC. Since implementing patient reminders, only one in seven patients has arrived for their scheduled OGTT without being fasted.
3. Start a combined endocrinology-pulmonology multidisciplinary clinic. Before starting our VIP-F7 cycle, our center had 36 patients aged 10 and older, of whom 18 had some form of glucose intolerance, but only half of those patients had established care with endocrinology.

Results: Before the start of the VIP-F7 cycle in October 2021, 13 patients aged 10 and older completed an OGTT in 2021. As of March 2022, seven patients aged 10 and older have completed an OGTT screening. UMMC is on track for 21 patients to complete an OGTT by October 2022, when the VIP-F7 cycle concludes. The number of patients established with endocrinology care also increased from five in 2021 to eight as of March 2022, a 160% increase.

Conclusions: This project increased focus on endocrine health in all disciplines and improved the screening and completion process of OGTTs in our target population. Our center has also expanded our multidisciplinary approach by creating a combined endocrinology-pulmonology clinic.

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Predicting high blood glucose levels through voice characteristic analysis in patients with cystic fibrosis-related diabetes

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Background: Cystic fibrosis (CF)-related diabetes (CFRD) is usually clinically silent, and patients may remain asymptomatic for years [1]. Prolonged high blood glucose levels in people with CFRD exacerbate lung disease, decrease nutritional status, and increase mortality [2]. It is important to monitor glucose levels and give the appropriate dose of insulin to prevent complications. CFRD patients need finger pricks up to four times a day to track their sugar levels. This procedure is painful and unpleasant, which reduces willingness to control the disease. Moreover, it was difficult to perform the blood draw procedure in a telemedicine clinic during the pandemic. We are interested in developing a noninvasive tool to monitor glucose levels by analyzing voice characteristics. We hypothesized that high blood glucose levels cause laryngeal soft tissue swelling and thereby change voice characteristics [3]. Studies in patients with diabetes without CF have demonstrated the potential use of this technology [4]. The purpose of this study is to predict high blood glucose levels using voice characteristic analysis in people with CFRD.

Methods: A prospective cross-sectional study was performed on adults with CF recruited from the CF Clinic at Emory Health Care from March to December 2021. We recorded 3-second voice samples of a sustained /a/ vowel sound. Voice characteristics including fundamental frequency (F0), fundamental frequency variation (vF0), jitter, shimmer, noise-to-harmonic ratio, and relative average perturbation were analyzed using the Multi-Dimensional Voice Program in the Computerized Speech Lab. Statistical analysis was based on matching voice characteristics with individuals' point-of-care blood glucose testing (POCT) during their visit.

Results: There were 43 people with CFRD in this study (25 male, 18 female). Patients with POCT glucose levels of 200 mg/dL or greater had a mean age (32 ± 13) similar to that of patients with POCT glucose levels less than 200 mg/dL (35 ± 14) ($p = 0.50$). Patients had been diagnosed with CFRD for 9 ± 7 years. Mean glycosylated hemoglobin (HbA1c) in CFRD patients was 7.2 ± 2.2%. An acoustic parameter analysis categorized according to gender (Table 1) showed that vF0 was significantly lower in individuals with a POCT glucose level of 200 mg/dL or greater than in those with POCT glucose level less than 200 mg/dL (male: 1.14 ± 0.14% vs 1.58 ± 0.73%, $p < 0.05$; female: 0.75 ± 0.07% vs 1.26 ± 0.56%, $p < 0.05$). Multivariate analysis showed that vF0 was significantly associated with duration of CFRD diagnosis ($p = 0.02$) and glucose level ($p = 0.01$) after controlling for age and body mass index (Table 2). Logistic regression analysis showed that vF0 ($p = 0.04$) and duration of CFRD ($p = 0.03$) predicted high blood glucose levels when other patient characteristics were considered (Table 3). Moreover, there was a significantly lower noise-to-harmonic ratio ($p = 0.049$) in female subjects with poor glycemic control (HbA1c > 7%) than in those with good glycemic control (HbA1c ≤ 7%).

Conclusions: There is potential to use the human voice as a noninvasive tool for glucose level measurement in CFRD patients. Fundamental frequency variation predicted high blood glucose levels. This study is ongoing and will collect additional data on other ranges of glucose level.

References

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Table 1 (abstract 8):

Table 1 Mean and standard deviation of acoustic parameter among cystic fibrosis-related diabetes patients who have POCT glucose level ≥ 200 mg/dL and those who have POCT glucose level < 200 mg/dL, categorized by sex (Male/ Female)

| Acoustic parameters | Male (n = 25) | | | Female (n=18) | | |
|---------------------|-------------------------------------|-----------------------------------|--------------|-------------------------------------|-----------------------------------|--------------|
| | POCT glucose level ≥ 200 mg/dL | POCT glucose level < 200 mg/dL | P-value | POCT glucose level ≥ 200 mg/dL | POCT glucose level < 200 mg/dL | P-value |
| F0(Hz) | 150.69 \pm 56.14 | 132.58 \pm 24.02 | 0.493 | 231.40 \pm 33.25 | 211.39 \pm 58.29 | 0.493 |
| vF0(%) | 1.14 \pm 0.14 | 1.58 \pm 0.73 | 0.017 | 0.75 \pm 0.07 | 1.26 \pm 0.56 | 0.002 |
| Jitter(%) | 0.97 \pm 0.36 | 1.24 \pm 0.77 | 0.271 | 0.52 \pm 0.21 | 1.04 \pm 0.85 | 0.053 |
| Shimmer(%) | 6.15 \pm 2.56 | 6.48 \pm 3.33 | 0.818 | 4.19 \pm 1.06 | 4.85 \pm 2.45 | 0.613 |
| NHR | 0.17 \pm 0.03 | 0.17 \pm 0.04 | 0.991 | 0.13 \pm 0.01 | 0.15 \pm 0.02 | 0.294 |
| RAP(%) | 0.56 \pm 0.24 | 0.74 \pm 0.47 | 0.264 | 0.31 \pm 0.13 | 0.66 \pm 0.50 | 0.040 |

Table 2 Multivariate linear regression analysis with fundamental frequency variation (vF0) as an outcome

| Variables | Fundamental frequency variation (vF0) | |
|---------------|---------------------------------------|--------------|
| | Coefficients | P-value |
| Age | 0.013 | 0.065 |
| BMI | -0.016 | 0.348 |
| Male | 0.227 | 0.180 |
| Duration | 0.030 | 0.019 |
| Glucose level | -0.003 | 0.012 |

Table 3 Logistic regression analysis of fundamental frequency variation (vF0) and relevant variables on high glucose levels (POCT glucose level ≥ 200 mg/dL)

| Variables | High glucose levels (POCT glucose level ≥ 200 mg/dL) | |
|-----------|---|--------------|
| | Coefficients | P-value |
| vF0 | -4.392 | 0.042 |
| Age | -0.021 | 0.653 |
| BMI | -0.037 | 0.764 |
| Male | 1.075 | 0.348 |
| Duration | 0.175 | 0.028 |

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Automated insulin delivery with the iLet bionic pancreas for the management of cystic fibrosis-related diabetes

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Background: Management of cystic fibrosis-related diabetes (CFRD) requires intensive insulin therapy, frequent blood glucose monitoring, and close attention to carbohydrate intake. Advances in diabetes technology have led to the development of systems that partially automate insulin delivery by employing continuous glucose monitoring (CGM) and insulin pumps that automatically adjust insulin delivery based on