PATIENT REGISTRY 2021
ANNUAL DATA REPORT

CYSTIC FIBROSIS FOUNDATION

MISSION OF THE CYSTIC FIBROSIS FOUNDATION

The mission of the Cystic Fibrosis Foundation is to cure cystic fibrosis and to provide all people with the disease the opportunity to lead full, productive lives by funding research and drug development, promoting individualized treatment, and ensuring access to high-quality, specialized care.

SOURCE OF DATA

Cystic fibrosis patients under care at CF Foundation-accredited care centers in the United States, who consented to have their data entered.

SUGGESTED CITATION

Cystic Fibrosis Foundation Patient Registry
2021 Annual Data Report
Bethesda, Maryland

FIGURE PERMISSIONS

To request use of charts and data provided in this report, contact the CF Foundation Patient Registry team by email at **reghelp@cff.org**.

PHOTOGRAPHY BY

Rebecca Emily Drobis
Courtesy of the Ellis family

SPECIAL ACKNOWLEDGMENTS

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CYSTIC FIBROSIS FOUNDATION

September 2022

Dear Friends and Colleagues:

We are pleased to share the 2021 Patient Registry Annual Data Report. Many of the positive trends in last year's report continued and are likely related to the uptake of elexacaftor/tezacaftor/ivacaftor (ETI). As compared to 2019, median predicted survival increased, pulmonary exacerbations treated with intravenous antibiotics and lung transplants were substantially lower, and reported pregnancies remained high.

There are also some concerning findings on obesity and mental health. The 2021 data show that 40.4 percent of adults were overweight or obese as compared to 15.3 percent in 2001. With regards to mental health, the percent of adolescents with reported anxiety (13.4 percent) and depression (10.2 percent) were more than double the rates in 2019. In addition, adults with CF continued to have high rates of anxiety (28.0 percent) and depression (29.6 percent), many of whom have both. Although some of the observed increases likely relate to improved systematic screening, these challenges deserve the continued attention of the CF community.

This report shows that CF care delivery has not returned to the previous baseline. The number of clinical encounters in 2021 was well below that of 2019 with a significant number being telehealth visits. There were also fewer measures of pulmonary function and fewer respiratory cultures as compared to 2019. Decreased CF health care utilization may reflect improved health status for many on ETI, however less clinical data invariably impacts the completeness of the Registry data set and may create bias. We strongly encourage you to carefully read the "About this Report" subsection to gain an understanding of how these changes may affect some of our findings.

Many thanks to each of you who contribute to the success of the Registry — most importantly, people with CF and their families who generously agree to share their data and the Registry coordinators and care team members who collect and enter the data.

Thank you all for your hard work throughout the year and your commitment to the CF Foundation and the CF community.

Bruce C. Marshall, MD
Executive Vice President and
Chief Medical Officer
Cystic Fibrosis Foundation

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ABOUT THIS REPORT

The Annual Data Report is based on data entered in the CF Foundation Patient Registry through our online portal, PortCF©. Data are entered by teams of dedicated health professionals in our nationwide network of more than 130 CF Foundation-accredited care centers.

Inclusion and Exclusion Criteria

This Annual Data Report contains data from individuals diagnosed with CF who (a) have consented to participate in the Registry and (b) were seen in a CF care center during the 2021 calendar year, including those who were born, diagnosed, or died in the year. Data from lung transplant recipients are only included in the chapters on Demographics, Diagnosis, CFTR Gene Mutations, Transplantation, and Survival.

The included populations represented in the figures vary and are based on the eligibility criteria described in the title and/or footnotes. Figures titled in **gray** reflect patient-level data that include individuals who have received a transplant. Figures titled in **purple** reflect patient-level data and figures titled in **blue** present data on center-level variation across the CF Care Network. Neither the purple or blue titled figures include data reported post-lung transplant. To reduce outliers, the majority of the center-level variation figures exclude centers with fewer than 10 individuals for that measure. Some center-level variation figures, such as cystic fibrosis-related diabetes (CFRD), infant, and pulmonary exacerbation measures, include centers with five or more eligible individuals to allow for sufficient comparison.

Graphics in gray include data from all individuals with CF.

Graphics in purple show patient-level variation excluding data from lung transplant recipients.

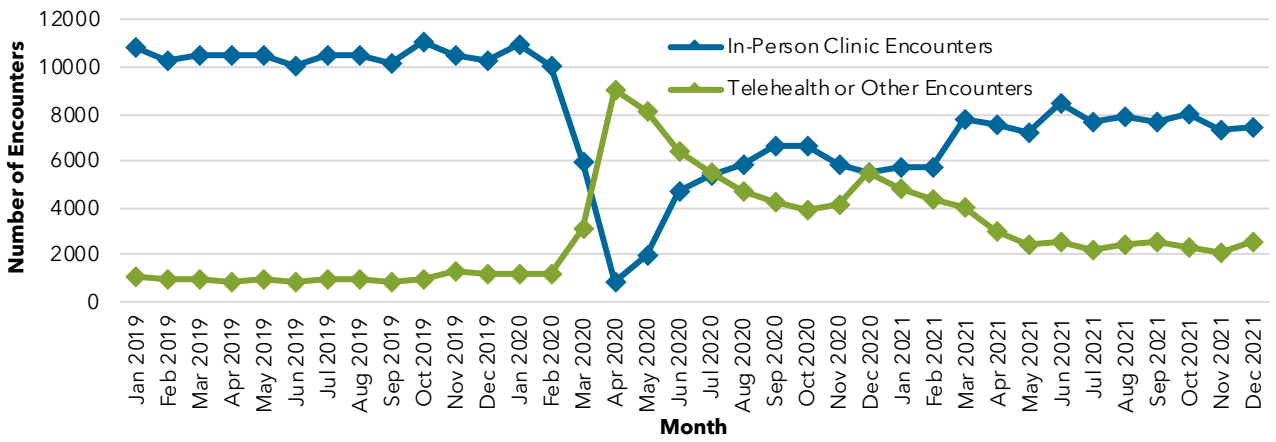
Graphics in blue show center-level variation excluding data from lung transplant recipients.

Data from individuals with a diagnosis of CFSPID/CRMS (CF screen positive, inconclusive diagnosis/CFTR-related metabolic syndrome) or CFTR-related disorder are excluded from all figures except for the one on new diagnoses in the reporting year. In the past, data from individuals who received a lung transplant were included in many of the figures. This impacted reporting of prevalent complications such as CFRD and osteoporosis. However, since 2017, data from transplant recipients have been excluded from any chapters not specified in the inclusion criteria which has resulted in a lower prevalence of these complications.

Trends for In-Person Clinic and Telehealth/Other Encounters

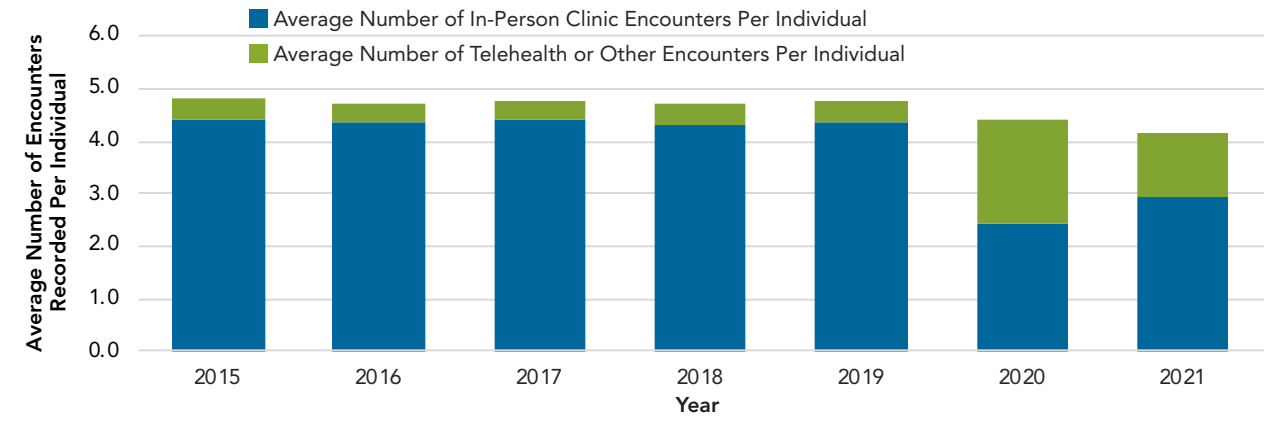
The chart on the next page shows the monthly total number of in-person clinic and telehealth or other encounters from January 2019 through December 2021. During this three-year time period, most encounters between people with CF and their care teams occurred in-person in the clinic. The total number of encounter records in 2021 (124,120) was lower than the previous two years (3.0 percent and 10.0 percent lower than in 2020 and 2019, respectively). The number of in-person clinical encounters in 2021 (88,587) was 25.4 percent higher than in 2020, but 30.0 percent lower than in 2019. Between May and December 2021, the proportion of monthly non-clinic visits (excluding hospital and home IV visits) has remained relatively stable at 28.6 percent. Of all encounters, 18.1 percent and 31.6 percent of visits were reported as non-clinic among pediatric and adult programs, respectively.

Number of Encounters by Location, 2019-2021



Also of note, the average number of clinical encounters and the proportion of in-person clinic encounters in 2021 remains below pre-pandemic values.

Average Number of Encounters Recorded Per Individual, 2015-2021



Reporting of Care in 2021

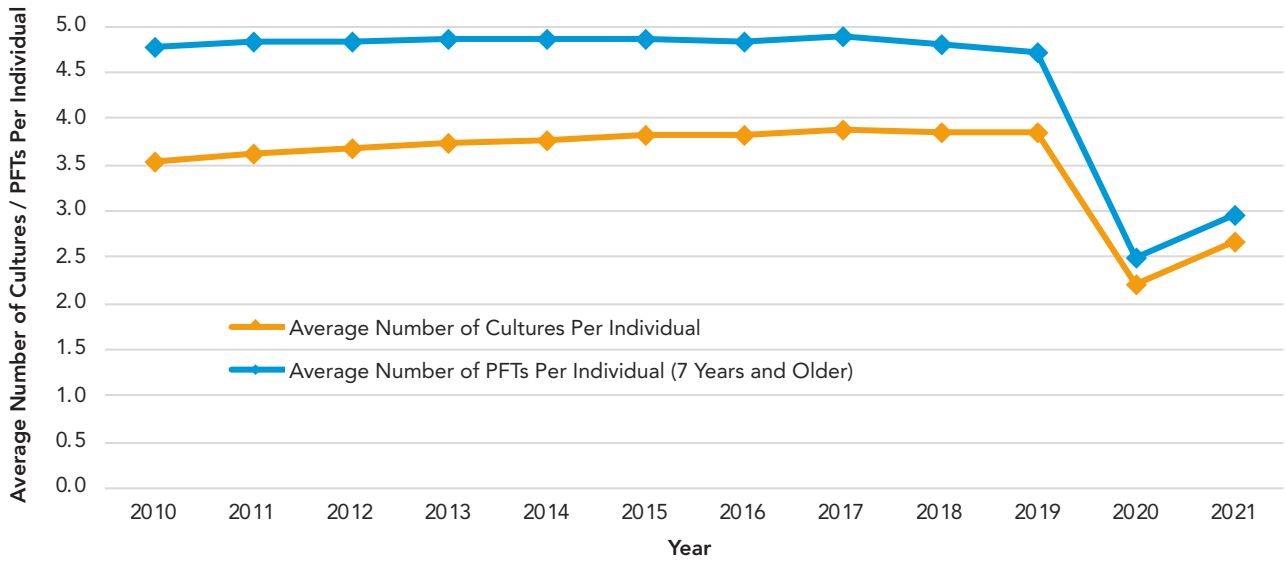
In addition to a decrease in the overall number of encounters reported, there was also a reduction in the completeness of measurements taken at each encounter. Based on established guidelines for CF care, encounters reported to the Registry typically include assessments of nutritional status, lung function, infection status, prescribed medications, and CF-related complications. The number of measurements per individual for various metrics remained notably lower in 2021 as compared to 2019. This is important because annualized measures of lung function, weight, and height are reported as the mean of the maximum value from each quarter. Through 2019, the average number of pulmonary function test (PFT) measurements (among those age 7 years and older) reported per individual was approximately 4.8 measurements per year, which fell to an average of 2.5 measurements in 2020 with modest recovery to 3.0 in 2021. The lower number of PFT measurements may impact the precision of the FEV_1 results.

In addition, prior to 2020, microbiology cultures reported per individual were between 3.5 and 4.0 average cultures per year, which dropped to 2.2 cultures per individual in 2020 with modest recovery to 2.7 in 2021. While some of this decrease is attributable to CFTR modulators, it is important to note that fewer cultures may impact the detection of microorganisms.

Percentage of Individuals with Specific Data Elements Entered

Review Year	Individuals with Height/Weight Reported	Individuals 7 and Older with a PFT Reported	Individuals with Microbiology Culture Reported	Individuals with Mycobacterial Culture Reported	Individuals with Medications Reported	Individuals with Complications Reported
2018	98.3%	98.7%	97.0%	51.6%	98.2%	97.8%
2019	98.6%	98.9%	97.3%	52.5%	98.5%	98.2%
2020	97.3%	98.4%	88.2%	34.3%	97.8%	97.6%
2021	97.7%	98.2%	91.1%	32.2%	98.0%	97.5%
Change from 2019 to 2021	*-0.9%*	*-0.7%*	*-6.2%*	*-20.4%*	*-0.5%*	*-0.7%*

Average Number of Cultures and PFTs Entered Per Individual, 2010-2021



Summary

The year 2021 continued to present challenges associated with the COVID-19 pandemic that impacted delivery of care for individuals with CF and data entry into the Registry. We encourage readers of this report to interpret the prevalence or incidence reported in both 2020 and 2021 data in the context of reduced frequency of in-person care, which impacted availability of microbiology cultures, pulmonary function testing, and other clinical measures.

More information about data included in the Annual Data Report and interpretation of the tables and figures can be found in the online Technical Supplement on cff.org.

Summary of the Cystic Fibrosis Foundation Patient Registry, 2006-2021

Demographics[A]	2006	2011	2016	2020	2021
People with CF (n)	23,947	27,029	29,577	31,534	32,100
Newly diagnosed individuals (n)[B]	1,017	991	994	820	779
Detected by newborn screening (NBS, %)	21.2	56.9	60.0	60.9	64.4
Median age at diagnosis for all people with CF (months)	6	5	4	3	3
Mean age (years)	18.3	19.6	21.3	23.2	23.8
Median age (years)	16.3	17.5	19.0	20.7	21.4
Adults ≥18 years (%)	44.2	48.4	52.7	57.0	58.3
Race (mutually exclusive)[C]					
White (%)	93.8	92.9	92.0	91.5	91.4
African American (%)	3.4	3.5	3.5	3.5	3.5
Other race (%)	2.8	3.6	4.5	5.0	5.1
Hispanic (any race) (%)	6.4	7.6	9.0	9.7	9.8
Males (%)	52.0	51.8	51.5	51.8	51.7
Mortality[A]					
Total deaths (n)	368	461	380	255	232
Annual mortality rate (per 100) (%)	1.5	1.7	1.3	0.8	0.7
Predicted median survival (five-year increments)	36.3	37.9	42.6	49.9	53.1
95% confidence interval (five-year increments)	35.1 - 37.9	36.8 - 38.9	41.7 - 43.8	48.5 - 51.2	51.6 - 54.7
Median age at death (years)	25.6	27.0	29.6	34.1	33.9
GI/Nutrition					
Body Mass Index (BMI) percentile in individuals 2 to 19 years (median)	47.7	51.7	55.9	61.3	62.1
Weight <10th Centers for Disease Control and Prevention (CDC) percentile (%)	17.7	14.2	11.1	9.2	8.3
Height <5th CDC percentile (%)	13.6	11.3	10.0	9.5	8.5
BMI in individuals 20 to 40 years (median)	21.3	21.7	22.2	23.1	23.4
Pancreatic enzyme replacement therapy (%)	85.5	87.8	86.3	83.7	83.1
Supplemental feeding - tube (%)	9.6	10.4	10.8	9.0	7.4
Supplemental feeding - oral only (%)	37.5	39.5	43.8	39.2	36.3
Pulmonary[D]					
FVC % predicted (mean)	85.3	87.2	88.5	93.0	94.4
FEV_1 % predicted (mean)	74.4	75.7	76.9	82.8	84.5
FEV_1/FVC ratio (mean)	75.1	74.5	74.2	75.8	76.2
Respiratory Microbiology					
Number of Microbiology cultures per patient (mean)	3.1	3.6	3.8	2.2	2.7
Pseudomonas aeruginosa (P. aeruginosa or *PA) (%)*[E]	55.1	50.9	46.4	31.9	28.4
Burkholderia cepacia (B. cepacia) complex *(%)*	2.9	2.6	2.7	1.6	1.4
Staphylococcus aureus (S. aureus) (%)[F]	64.6	68.0	71.1	63.3	63.8
Methicillin-sensitive *Staphylococcus aureus* (MSSA) (%)	51.6	50.8	55.1	48.9	51.7
Methicillin-resistant *Staphylococcus aureus* (MRSA) (%)	19.0	26.0	26.1	19.6	18.0
Stenotrophomonas maltophilia (S. maltophilia) (%)	12.7	14.0	13.1	6.3	5.6
Mycobacterial species (%)[G]	-	10.8	12.7	10.0	9.6

Table continues on the next page

Summary of the Cystic Fibrosis Foundation Patient Registry, 2006-2021 *continued*					
Health Care Utilization and Pulmonary Exacerbations (PEX)[H]	**2006**	**2011**	**2016**	**2020**	**2021**
Outpatient visits to CF centers reported per year (mean)	4.2	4.7	4.4	2.4	3.0
Phone, Phone w/Video, or Other visits per year (mean)	N/A	N/A	N/A	1.9	1.6
Treated with IV antibiotics for a PEX (%)	35.6	35.9	34.4	13.9	12.1
Number of PEX per year (mean)	0.66	0.68	0.68	0.22	0.19
Number of days of treatment for all PEX per year (mean)[I]	29.2	28.6	28.8	21.1	21.1
Number of days of home IV treatment for all PEX per year (mean)[I]	13.1	11.2	10.5	6.9	6.4
Number of days of hospitalization for all PEX per year (mean)[I]	16.1	17.5	18.3	14.2	14.7
Pulmonary Therapies[J]					
Dornase alfa (≥6 years) (%)	77.2	86.1	91.0	91.5	88.4
Inhaled tobramycin (PA+ and ≥6 years) (%)[K]	64.1	66.2	69.7	65.3	59.6
Inhaled aztreonam (PA+ and ≥6 years) (%)	-	35.9	43.2	42.8	39.0
Azithromycin (PA+ and ≥6 years) (%)[L]	58.4	70.5	65.5	61.8	56.4
Hypertonic saline (≥6 years) (%)	24.4	55.7	70.8	73.5	70.0
Oxygen (%)[M]	10.1	11.0	10.4	7.4	6.7
Noninvasive ventilation (%)	1.8	2.3	2.8	2.4	2.3
CFTR Modulators					
Individuals <2 years prescribed a modulator (%)	-	-	0.1	6.6	9.1
Individuals 2 to 5 years prescribed a modulator (%)	-	-	5.8	44.4	46.8
Individuals 6 to 11 years prescribed a modulator (%)	-	-	16.4	51.9	75.6
Individuals ≥12 years prescribed a modulator (%)	-	-	35.4	82.3	85.1
Transplants[A]					
Lung (all procedures) (n)	197	226	271	91	54
Liver (n)	16	17	21	23	18
Kidney (n)	7	10	9	12	21
Lost to Follow Up[A]					
Lost to follow up (%)[N]	-	4.1	3.3	3.2	3.1

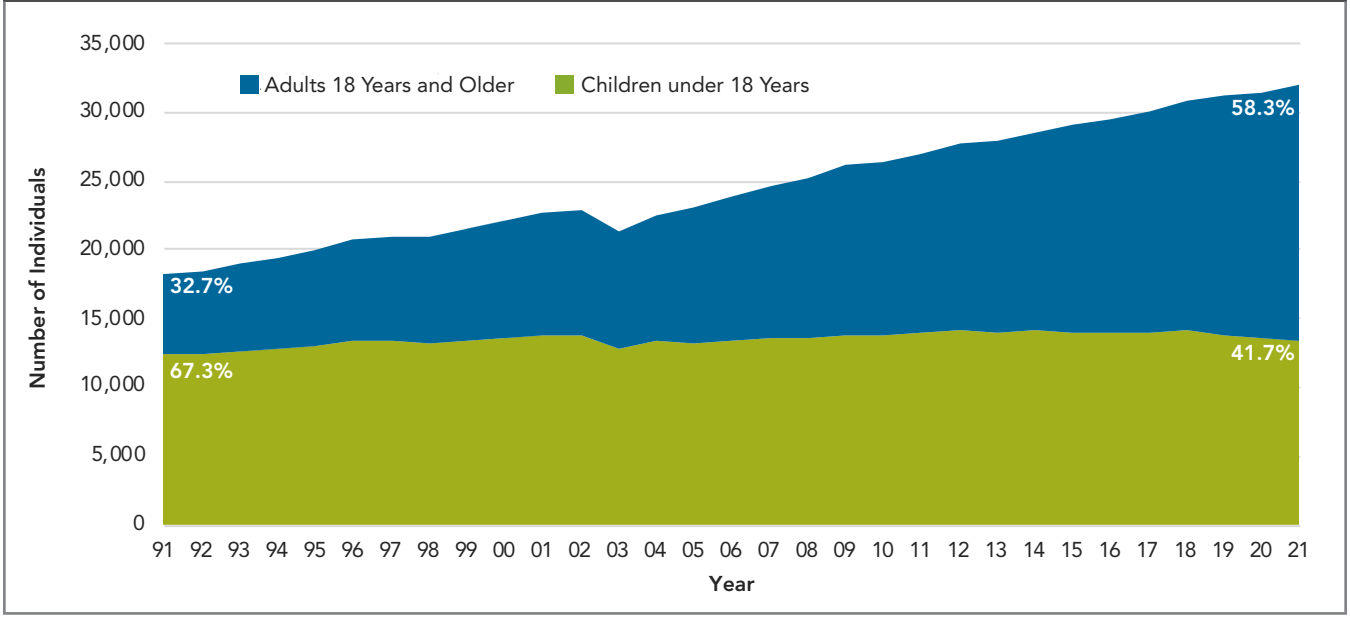
[A] *Includes data from transplant recipients.*
[B] *We anticipate that additional 2021 diagnoses will be entered into the Registry in 2022.*
[C] *Reporting of race in years prior to 2021 included individuals in more than one race category (were not mutually exclusive).*
[D] *Pulmonary function data throughout this report reflect the use of Global Lung Initiative (GLI) equations.*[1]
[E] *Includes PA and multidrug-resistant PA found in any culture during the year.*
[F] *Includes MSSA and MRSA and reflects the prevalence of* S. aureus *among individuals who had a bacterial culture during the year. The percentages for MSSA and MRSA individually are greater than the total* S. aureus *percentage because MSSA and MRSA are not mutually exclusive.*
[G] *Percentage of people with CF with one or more mycobacterial species isolated out of those who had a mycobacterial culture during the year.*
[H] *Defined as a period of treatment with IV antibiotics in the hospital and/or at home.*
[I] *Among those with one or more pulmonary exacerbations in the year.*
[J] *Percentage of people with CF on therapy at any clinical visit in the year. All individuals noted as intolerant or having an allergy to a specific therapy were excluded.*
[K] *Includes Tobramycin solution for inhalation (i.e., TOBI®), TOBI™ Podhaler® (Tobramycin Inhalation Powder), and Bethkis® since 2013. In prior years, only TOBI® was available.*
[L] *Individuals were considered eligible if they met the selection criteria used in the first U.S. azithromycin trial.*[2]
[M] *Includes continuous, nocturnal, or with exertion.*
[N] *Defined as patients seen in the previous reporting year (2020) but not the current reporting year (2021), and not known to have died.*

DEMOGRAPHICS

The Registry contains data on people with CF from 1986 to 2021. During that time, substantial changes in specialized CF care have led to improved survival. This section shows the current and longitudinal distribution of demographic characteristics of individuals with CF in the Registry.

In 2021, there were 32,100 individuals with CF in the Registry. The number of adults with CF continues to increase, while the number of children remains relatively stable. In 2021, adults were 58.3 percent of the CF population, compared with 32.7 percent in 1991.

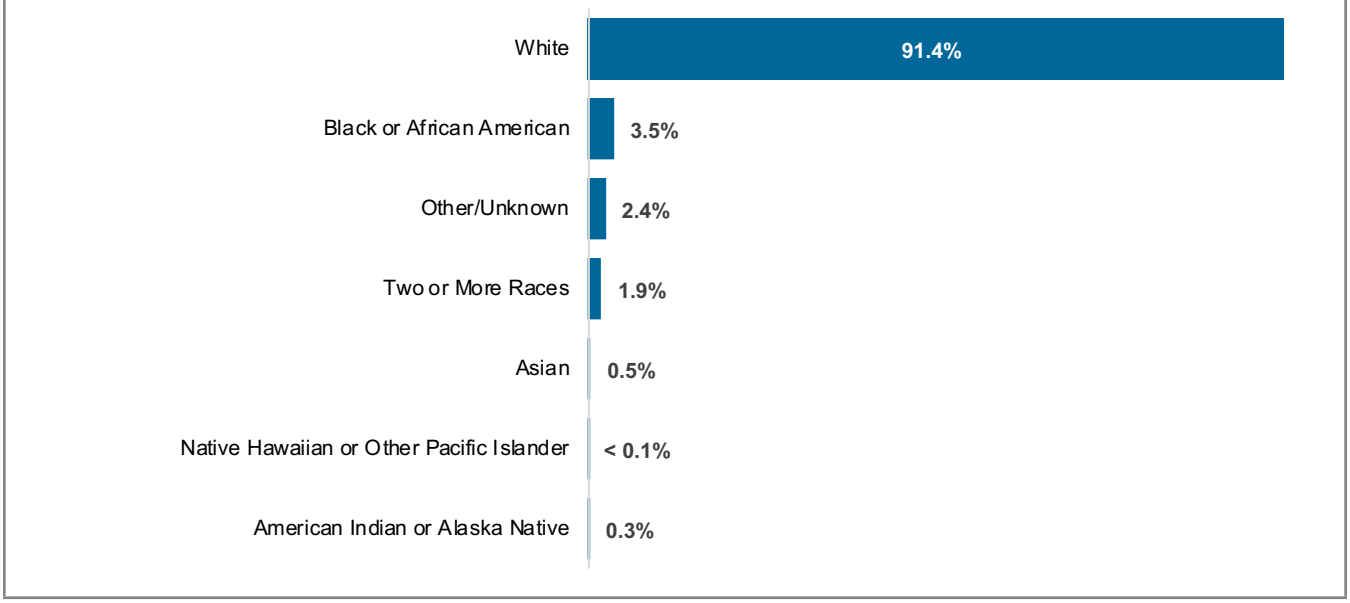
Number of Children and Adults with CF, 1991–2021



The decrease in the number of individuals reported in 2003 is due to a delay in obtaining informed consent forms before the close of the calendar year at some CF care centers.

In 2021, 9.8 percent of the individuals in the Registry identify as Hispanic. There has been a steady increase over the past 15 years, reflecting national population trends.[3] Hispanics with CF tend to be younger than the overall CF population, with a median age of 14.9 years. In 2021, 3.5 percent of participants identified as Black or African American and 1.9 percent identified as two or more races.

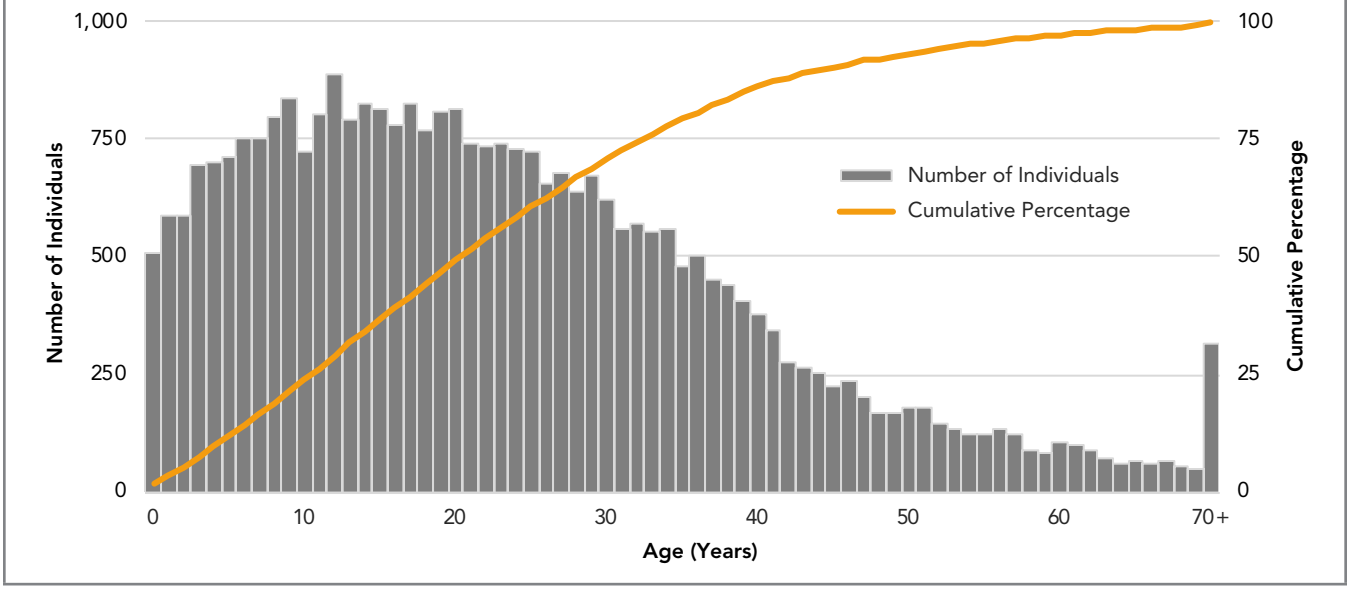
Race Distribution of the CF Population in 2021



The percentages in this chart and the summary table differ from those in prior annual data reports. Data in this chart and summary table include individuals in only one race category.

The median age of all people with CF in the Registry is 21.4 years. The range is from birth to 91.7 years. The age distribution remains markedly skewed toward younger ages as compared to the general U.S. population.

Age Distribution of the CF Population in 2021

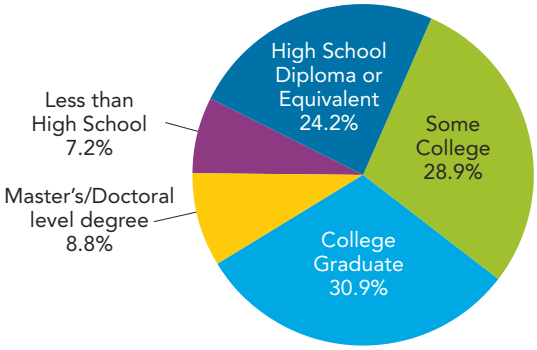


Characteristics of Adults with CF

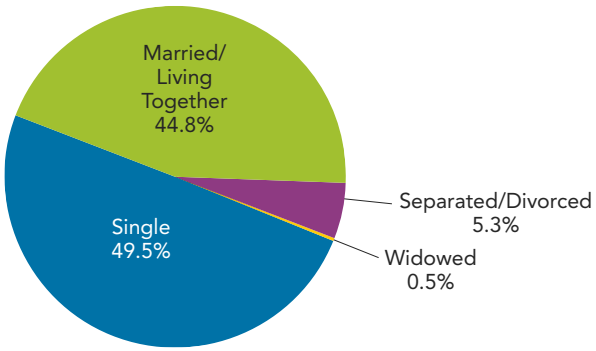
As a growing number of individuals with CF enter adulthood, it is encouraging to note that many are pursuing higher education and employment, are in committed relationships, and are having children of their own. Nearly three-fourths of adults with CF are either in school or working. However, these charts also highlight the nearly one-quarter of adults who report being disabled or unemployed.

Socioeconomic Characteristics of Adults 18 Years and Older with CF, 2021

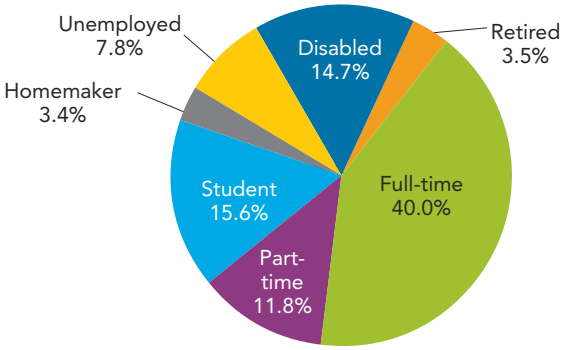
Education



Marital Status

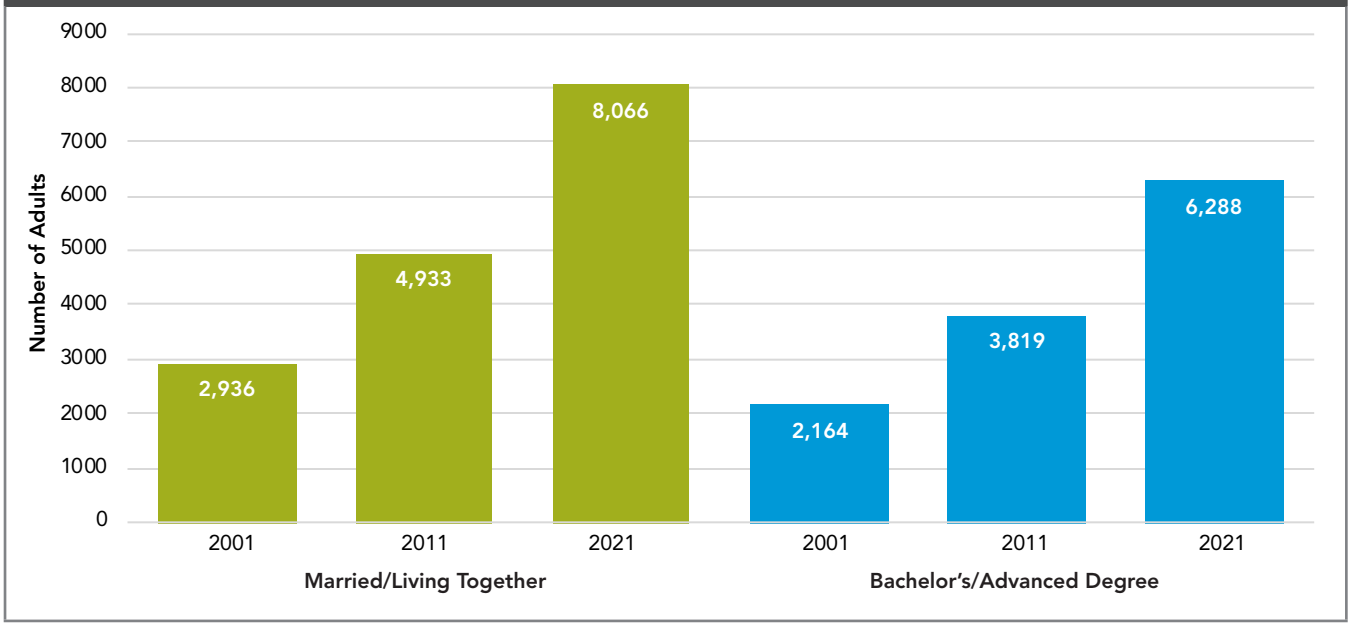


Employment



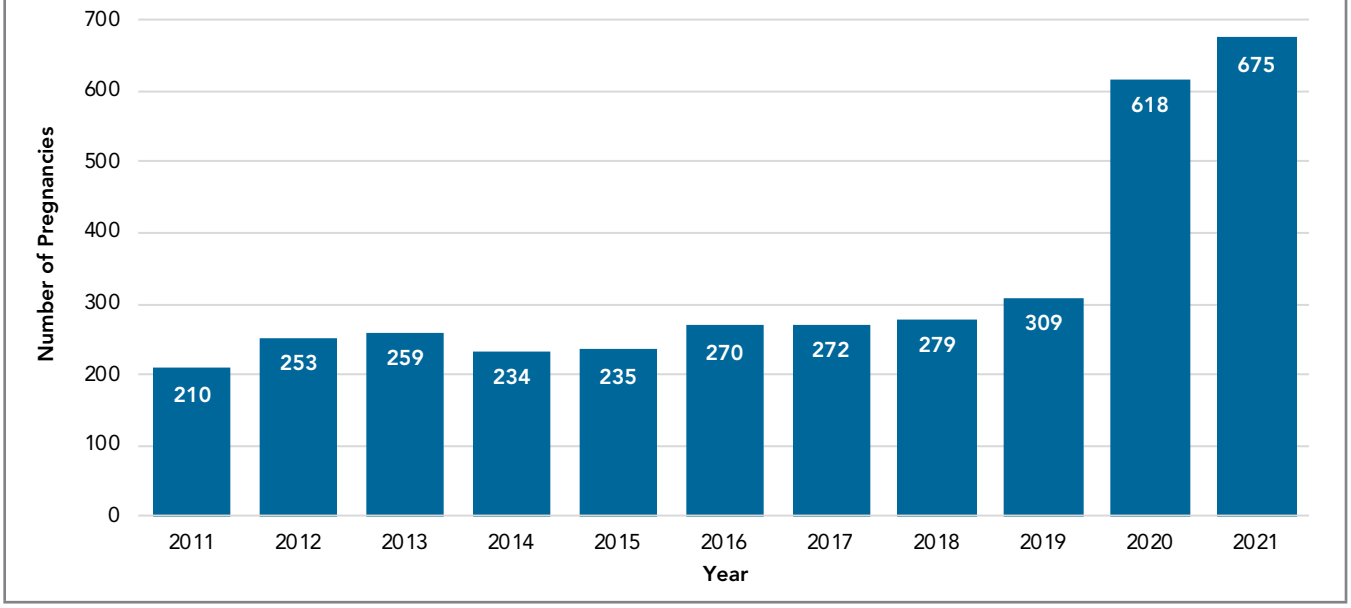
Over the last 20 years, there has been almost a tripling of the number of people who are married or living together as well as the number of people with a college degree.

Characteristics of Adults with CF, 2001, 2011, 2021



The number of pregnancies among women with CF gradually increased through 2019 and then dramatically increased in 2020. Registry data show that 675 women with CF were pregnant in 2021. Nearly 40.0 percent of the pregnancies were unplanned, underscoring the importance of proactive discussions with adolescents and adults regarding reproductive health and family planning.[4]

Number of Pregnancies in Women 14 to 45 Years with CF, 2011–2021



Health Insurance Information

Barriers to access insurance coverage for specialized care and treatments exist for some individuals with CF. Across all age groups, about half of the individuals in the Registry receive at least some component of their health insurance through federal or state-funded programs. Registry data show that in 2021, a majority of individuals with CF who were age 18 to 25 were covered under their parents' health insurance plan.

Insurance Coverage in 2021

	Age < 18 (%)	Age 18 - 25 (%)	Age ≥ 26 (%)	All (%)
Number of Individuals (n)	**13,165**	**5,939**	**12,346**	**31,450**
Health insurance (e.g., private insurance)	49.9	62.7	65.3	58.4
Medicare/Indian Health Service	1.3	5.0	24.5	11.1
Medicaid/state programs	55.6	43.8	26.4	41.9
Tricare or other military health plan	3.1	2.0	1.9	2.4
Other	1.3	1.7	1.2	1.4
No health insurance	0.5	0.8	0.8	0.7

"Insurance coverage" reflects coverage at any point during the year; thus, these categories are not mutually exclusive (except for the "no health insurance" option).

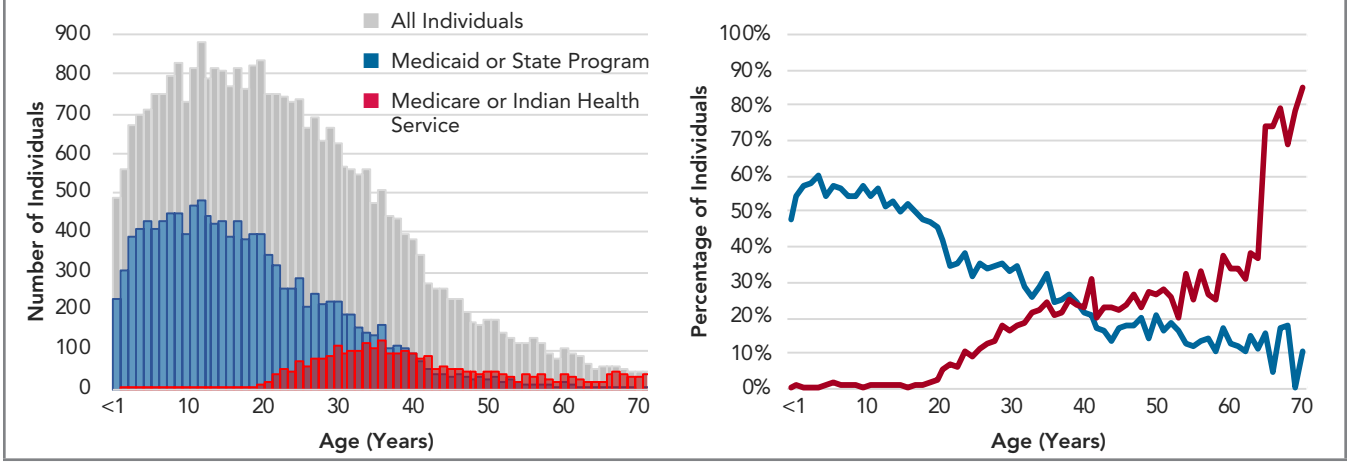
Additional Insurance Information in 2021

Individuals who participated in a patient assistance program (%)	47.1
Individuals 18 to 25 years covered under parents' insurance (%)	51.8

"Patient assistance program" refers to any program that provides free medication or co-pay assistance.

A large proportion of children with CF use Medicaid or state programs, including 56.2 percent of children younger than 10 years of age. Though the overall prevalence of Medicare use is low among the entire population, it increases with age. Among adults aged 30 to 35 years, 19.3 percent report Medicare coverage. This increases to 27.0 percent among adults aged 40 to 64 years. Individuals aged younger than 65 years who receive Medicare have qualified based on the federal criteria for disability. It is also worth noting that individuals receiving Indian Health Service coverage are members of a federally recognized American Indian or Alaska Native tribe or their descendants.

Medicare/Indian Health Service and Medicaid/State Programs by Age in Years, 2021



DIAGNOSIS

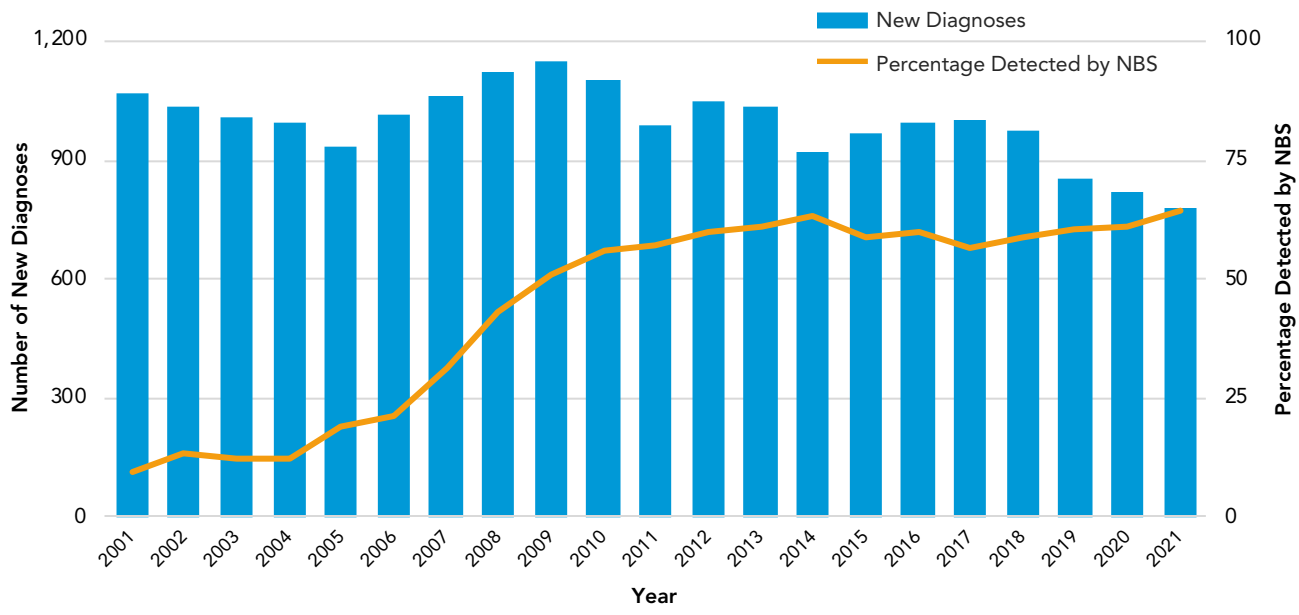
Diagnostic Characteristics of Individuals with CF

This section examines characteristics of individuals diagnosed with CF, as well as trends over time for two key diagnostic tests: genotyping and sweat chloride test.

In 2021, 64.4 percent of all new diagnoses and 93.8 percent of diagnoses among those less than 6 months old were reported as being detected by newborn screening (NBS). Babies diagnosed by NBS were found to have better nutritional outcomes, a more rapid increase in lung function by age 10, and longer time to chronic pseudomonal infection than those diagnosed clinically.[5] Diagnosis in the newborn period also represents an important opportunity for CF care centers to partner with community physicians and families to ensure the best possible care and outcomes for infants with CF.

There may be a lag in reporting of newly diagnosed individuals, particularly infants born late in the year (i.e., late 2021), who were not seen at a CF care center before the end of the calendar year. Future reports will be adjusted to include these individuals for the 2021 diagnosis year.

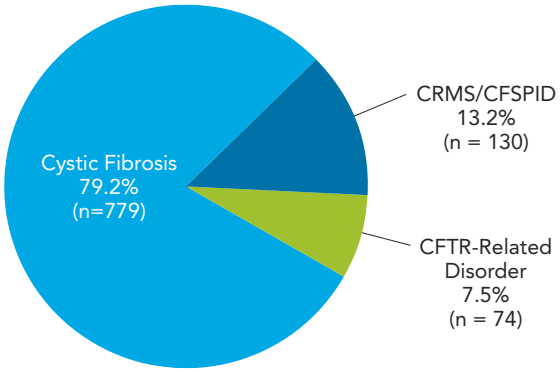
Number of New CF Diagnoses, 2001–2021



With the widespread use of NBS for CF, it was necessary to develop terminology for individuals with a positive NBS who have inconclusive sweat test results and/or fewer than two CF-causing variants. In the United States, this is referred to as CFTR-related metabolic syndrome (CRMS)[6]; other countries use the term CF screen positive, inconclusive diagnosis (CFSPID). Diagnosis guidelines, published in 2017, harmonized the criteria for CRMS/CFSPID.[7] CRMS was added to the Registry as a diagnostic option in 2010. Entry of a diagnosis of CF versus CRMS into the Registry is a clinical decision; there is no requirement that individuals meet published diagnostic criteria for CF or CRMS. The percentage of CRMS/CFSPID increased from 11.9 percent of new diagnoses in 2020 to 13.2 percent in 2021.

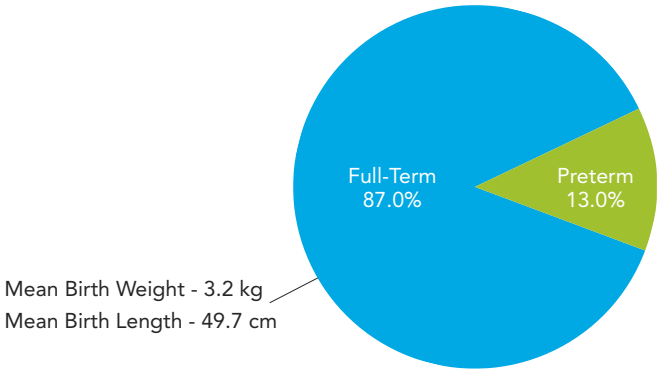
Individuals can also be diagnosed with CFTR-related disorder. This option has been available in the Registry since 2010. Individuals with this diagnosis do not meet diagnostic criteria for CF or CRMS, are affected by CF-related conditions such as congenital bilateral absence of the vas deferens (CBAVD), and often have mutations in the CFTR gene.[8] The percentage of individuals reported to have CFTR-related disorder increased from 6.7 percent of those diagnosed during the year in 2020 to 7.5 percent in 2021. Collection and analysis of data from individuals with CRMS and CFTR-related disorder will provide new and important information for these distinct populations.

CF, CRMS/CFSPID, and CFTR-Related Disorder New Diagnoses, 2021



In 2021, 510 newborn infants were diagnosed with CF. Of the 408 infants with a known gestational age at birth, 87.0 percent were born full-term, comparable with the figure for the general U.S. population.[9] The mean birth weight for full-term infants with CF is also about the same as for the U.S. population,[10] suggesting that babies born with CF do not show nutritional deficiencies at birth.

Gestational Age of Infants Born and Diagnosed with CF in 2021



"Preterm" refers to infants born at a gestational age less than 37 weeks. "Full term" refers to infants born at a gestational age greater than or equal to 37 weeks. Because birth weight and length are greatly influenced by weeks of gestation, mean birth weight and length are not reported for preterm infants in this chart.

The majority of those diagnosed in their first year via NBS are asymptomatic or minimally symptomatic at time of diagnosis. The most prevalent symptom among the population diagnosed before age one year was meconium ileus, reported in 11.2 percent of infants diagnosed in 2021. Among those diagnosed with meconium ileus (or other intestinal obstruction), 24.6 percent had bowel perforation. Since the number of infants with meconium ileus is small, the percentage with bowel perforation may fluctuate year to year, ranging from 15.9 percent to 34.9 percent over the last several years. Among individuals diagnosed after age one, the most prevalent symptoms reported are acute or persistent respiratory abnormalities.

Symptoms Reported at CF Diagnosis

	All Individuals (%)	Diagnosed in 2021 (%)	Diagnosed in 2021 Age < 1 (%)	Diagnosed in 2021 Age ≥ 1 (%)
Number of Individuals (n)	**32,100**	**779**	**563**	**216**
Asymptomatic				
DNA analysis	14.2	26.1	22.2	35.2
Family history	14.4	9.9	9.2	11.6
Newborn (neonatal) screening	30.1	64.4	88.3	N/A
Prenatal screening (CVS[A], amniocentesis)	2.6	3.5	4.8	N/A
Symptomatic				
Acute or persistent respiratory abnormalities	34.0	16.3	1.8	50.2
CBAVD[B] or infertility/GU[C] abnormalities	0.8	2.8	0.2	9.0
Digital clubbing	0.5	0.8	0.0	2.6
Edema	0.5	0.0	0.0	0.0
Electrolyte imbalance	2.8	0.1	0.0	0.4
Failure to thrive/malnutrition	25.6	3.9	2.6	6.9
Liver problems	1.0	0.8	0.4	1.7
Meconium ileus/other intestinal obstruction	16.5	8.2	11.2	N/A
Nasal polyps/sinus disease	3.8	4.8	0.2	15.5
Rectal prolapse	2.5	0.1	0.0	0.4
Steatorrhea/abnormal stools/malabsorption	20.0	4.1	2.6	7.7
Other	5.2	8.1	2.8	20.6

Data are not mutually exclusive. We anticipate that additional 2021 diagnoses will be entered into the Registry in 2022.

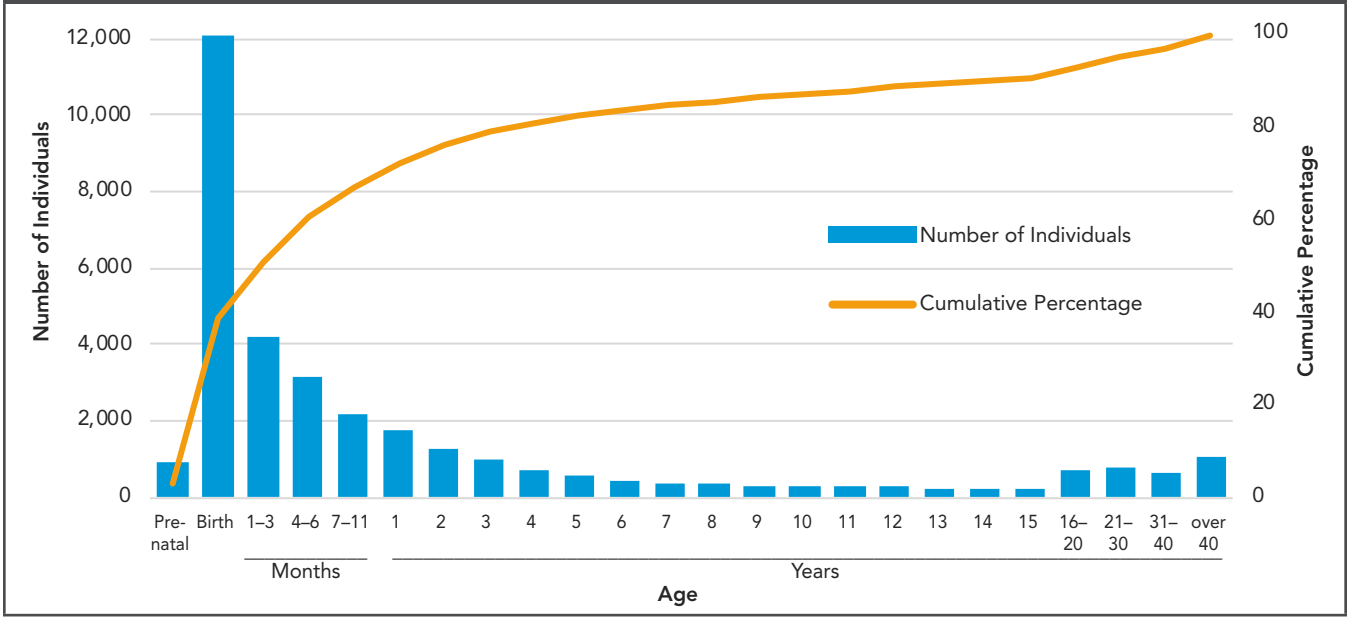
[A] *Chorionic villus sampling.*

[B] *Congenital bilateral absence of the vas deferens.*

[C] *Genitourinary.*

Previous figures in this section refer to infants born or diagnosed in 2021; the following figure includes all individuals followed in the Registry in 2021.

Age at Diagnosis of All Individuals with CF Seen in 2021

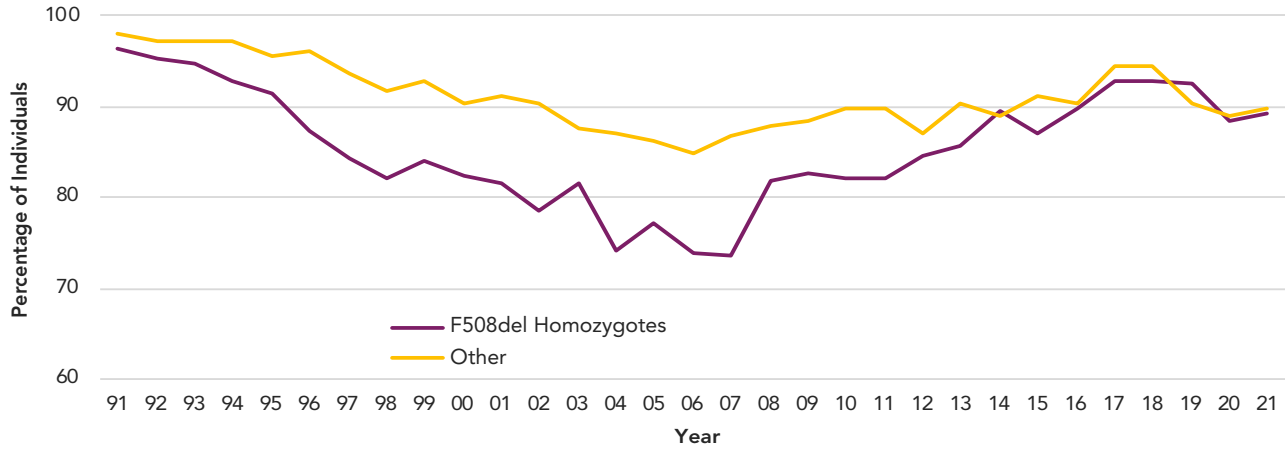


Diagnostic Tests

Sweat Chloride Testing

Sweat chloride testing is an important diagnostic test recommended for all individuals regardless of genotype.[8] In 2021, 90.6 percent of individuals in the Registry had a sweat chloride test result (at any time) recorded. Baseline sweat chloride tests are becoming more important, as changes in sweat chloride are now viewed as indicators of the physiological effects of CFTR modulators. Access to sweat chloride testing may have been impacted by the pandemic. As genetic tests to establish a CF diagnosis became more widely available in early 2000s, the proportion of individuals for whom a sweat chloride value was reported to the Registry declined through 2007, with a lower proportion of F508del homozygous individuals reporting compared to those with other CFTR variant combinations. Since 2007, reporting of sweat chloride values has increased for both F508del homozygotes and other genotypes.

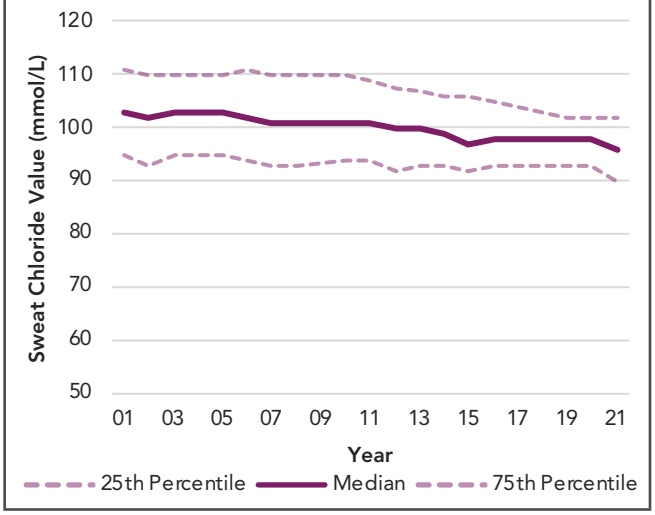
Percentage of Individuals with a Sweat Chloride Test Reported by Year of Diagnosis, 1991-2021



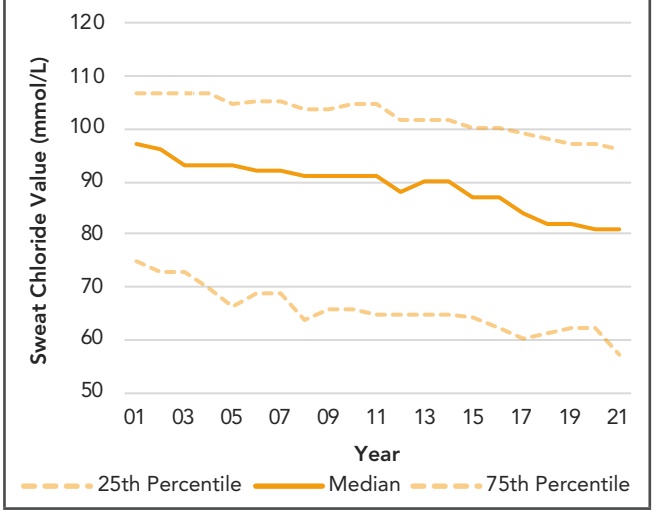
Sweat chloride testing is a critical component of the CF diagnosis regardless of genotype. Some individuals diagnosed in 2021 may not have had a sweat chloride test result entered in the CFFPR before the close of the reporting year.

Median sweat chloride test results have remained fairly consistent over time for individuals who are F508del homozygous. In contrast, there has been a gradual decline in median sweat chloride values among individuals who are not homozygous for F508del, suggesting that more individuals with other variants are being entered into the Registry.

Sweat Chloride Value of F508del Homozygous Individuals by Year of Diagnosis, 2001-2021



Sweat Chloride Value of Individuals Not Homozygous for F508del by Year of Diagnosis, 2001-2021



Genotyping

The cystic fibrosis transmembrane conductance regulator (CFTR) gene and the most prevalent CF-causing variant (F508del) were both discovered in 1989. Since then, genotyping has become a key component of the diagnostic evaluation. In addition, with the introduction of CFTR modulators, genotyping all people with CF is critical for both research and clinical care. In 2021, 99.4 percent of individuals (n=31,829) in the Registry had been genotyped.

CFTR GENE VARIANTS

To date, more than 2,000 variants have been found in the CFTR gene.[11] Some variants result in virtually no CFTR function, and others are associated with some residual function. Various strategies have been used to categorize variants with the goal of grouping individuals with CF with a similar disease course and prognosis. In previous reports, a five-variant class system was used.[12-14] This classification system is helpful for understanding the impact of variants on the biosynthesis and function of the CFTR protein. However, it is increasingly recognized that this classification schema is an oversimplification, given that many variants result in more than one defect in CFTR function.

In this era of CFTR modulators, a second approach is being evaluated for variant classification, referred to as theratyping. This system considers whether a variant responds to a specific CFTR modulator. However, theratyping is still early in its evolution and lacks a standardized format for reporting. In this section, we report data on specific variants and the difference in sweat chloride values between genotypes with little to no CFTR function versus those with residual CFTR function.

The most common CFTR variant is F508del: 85.5 percent of individuals in the Registry who have been genotyped have at least one copy of this variant. There is a substantial drop in prevalence to the next most common variants. No other variant is currently found in more than 5.0 percent of the population with CF in the Registry.

Prevalence of the 25 Most Common CFTR Variants in People with CF Seen in 2021				
CFTR Variant			Number of Individuals	Percentage of Individuals
Legacy Name	cDNA Name	Protein Name		
F508del	c.1521_1523delCTT	p.Phe508del	27,269	85.5
G542X	c.1624G>T	p.Gly542X	1,443	4.5
G551D	c.1652G>A	p.Gly551Asp	1,352	4.2
R117H	c.350G>A	p.Arg117His	1,048	3.3
N1303K	c.3909C>G	p.Asn1303Lys	752	2.4
W1282X	c.3846G>A	p.Trp1282X	708	2.2
3849+10kbC->T	c.3718-2477C>T		588	1.8
R553X	c.1657C>T	p.Arg553X	557	1.7
621+1G->T	c.489+1G>T		499	1.6
1717-1G->A	c.1585-1G>A		497	1.6
2789+5G->A	c.2657+5G>A		474	1.5
3120+1G->A	c.2988+1G>A		396	1.2
D1152H	c.3454G>C	p.Asp1152His	343	1.1
5T	c.1210-12T[5]		338	1.1
3272-26A->G	c.3140-26A>G		257	0.8
2184insA	c.2052dupA	p.Gln685ThrfsX4	252	0.8
R1162X	c.3484C>T	p.Arg1162X	248	0.8
I507del	c.1519_1521delATC	p.Ile507del	237	0.7
G85E	c.254G>A	p.Gly85Glu	225	0.7
L206W	c.617T>G	p.Leu206Trp	220	0.7
3659delC	c.3528delC	p.Lys1177SerfsX15	219	0.7
1898+1G->A	c.1766+1G>A		214	0.7
R334W	c.1000C>T	p.Arg334Trp	200	0.6
R347P	c.1040G>C	p.Arg347Pro	197	0.6
A455E	c.1364C>A	p.Ala455Glu	189	0.6

The number and percentage of individuals with a given variant include those with one or two copies of the variant.

F508del Variant Prevalence	
F508del Variant	Percentage of Individuals
Homozygous F508del	44.1
Heterozygous F508del	41.4
Neither F508del or Unknown	14.5

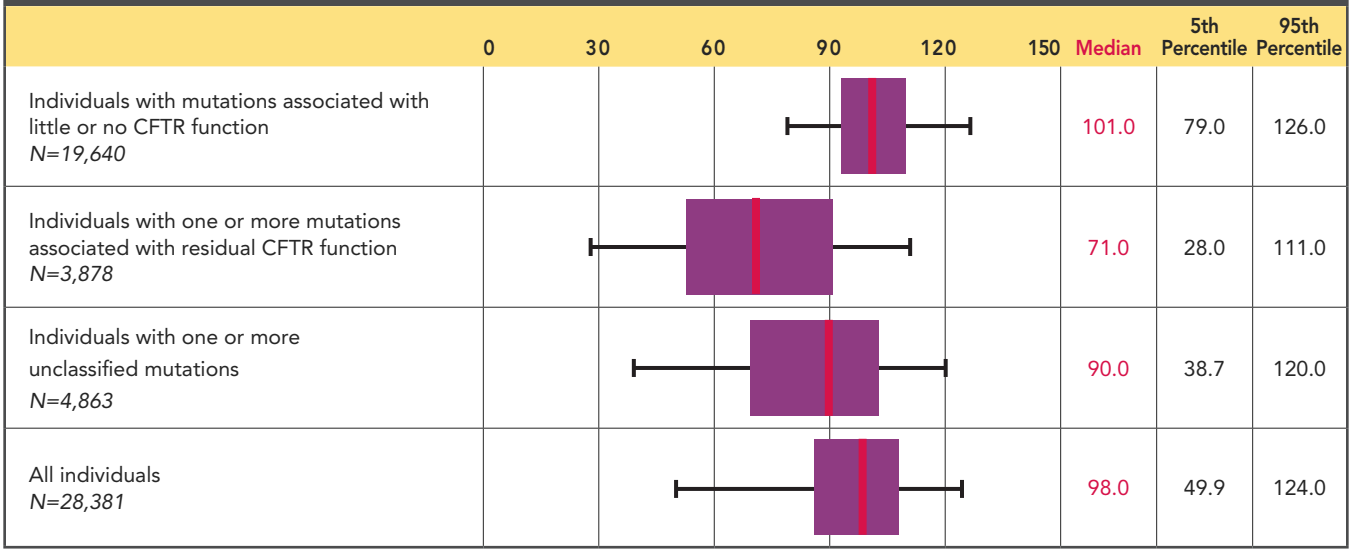
Prevalence is among individuals genotyped.

Among less common variants, the number of individuals with an R117H variant has increased over the years. Among those genotyped in 1993, less than 1 percent had an R117H variant, compared with 4.4 percent of those genotyped in 2021. This may be due to the inclusion of R117H in newborn screening algorithms. Of note, 116 (11.1 percent) of the 1,043 patients with an R117H variant had a sweat chloride value less than 30 mmol/L which adds to the diagnostic complexity.

The clinical significance of the R117H variant depends in part on the poly-T tract variant on the chromosome. Research indicates that a shorter poly-T tract is associated with a higher likelihood of having CF.[15,16] The Registry has incomplete information on the poly-T tract status for 59.4 percent who are reported as CF with an R117H variant. Of the 423 individuals with R117H and poly-T tract status recorded in the Registry, 152 (40.6 percent) are classified as having 5T.

Individuals with variants typically associated with little or no CFTR function tend to have higher sweat test values, and are more likely to be prescribed pancreatic enzyme replacement therapy (PERT) than individuals with a variant typically associated with residual CFTR function (e.g., 96.7 percent vs. 32.8 percent).

Sweat Chloride Value (mmol/L), by Genotypes



These charts use the highest sweat test value reported to the Registry. For 191 individuals, this value may reflect sweat chloride after initiation of CFTR modulator therapy as baseline value was not reported.

GUIDELINES: CARE, SCREENING, AND PREVENTION

The CF Foundation sponsors the development of clinical practice guidelines to promote high-quality care for both physical and mental health for individuals with CF during infancy, childhood, and adulthood.[17-26] Many CF care centers report four clinic encounters, two pulmonary function tests, and at least one microbiology culture annually for most of their CF patients. Similarly, among children aged 2 to 5, the majority have at least four encounters and one or more cultures each year.

CF care centers report that respiratory therapists/physical therapists, dietitians/nutritionists, and social workers evaluate most of their patients at least once per year, as recommended.

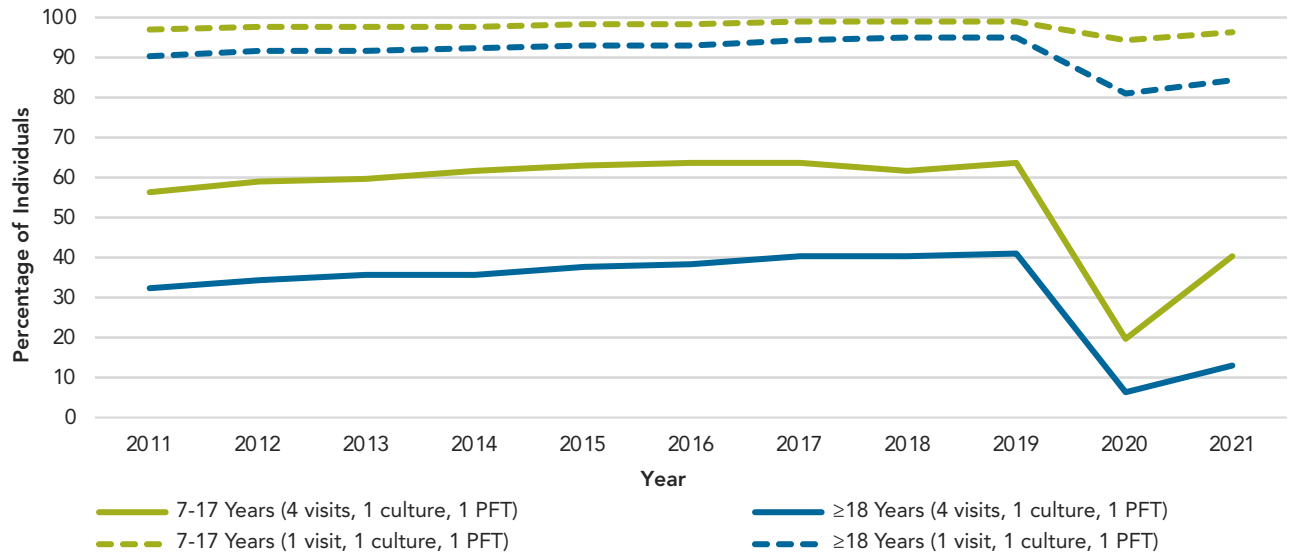
The influenza vaccination rate for people with CF age six months and older remains high across the CF Care Center network. Smoking and secondhand smoke exposure remain challenges, particularly for infants and young adults.

Patient Care Guidelines

The COVID-19 pandemic presented many challenges to providing care to individuals with CF including the redeployment of staff and the shift to telehealth. This required centers to be innovative in the delivery of care, the measurement of pulmonary function, and the collection of microbiology cultures. While the vast majority of individuals did not meet the recommended four clinic visits, four cultures, and two PFTs,[20] almost all patients were seen at least once with a culture and PFT. In 2021, 92.7 percent of individuals had at least one culture (of any kind), 29.4 percent of individuals had four or more respiratory cultures, and 76.2 percent of individuals had at least two PFTs.

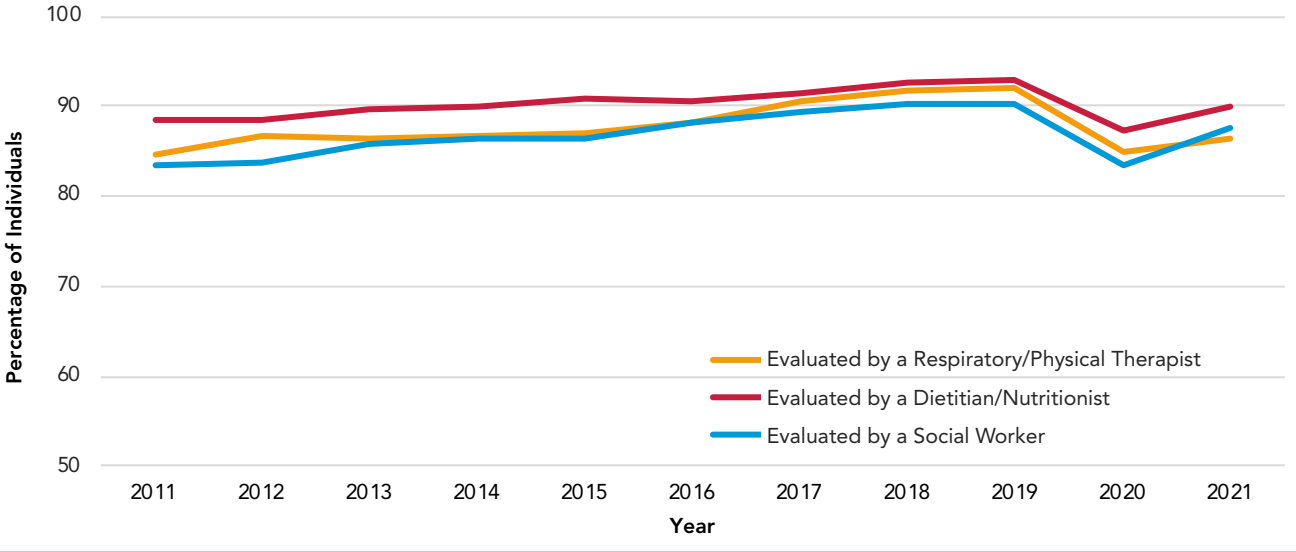
In addition, there were other touchpoints with the clinical team through telehealth visits and transmission of home spirometry data.

Clinical Encounters, Cultures, and PFTs: 2011-2021



The multidisciplinary care team plays an important role in CF care.[20] With the exception of 2020, there has been an increase in the number of individuals with CF who receive an evaluation by a respiratory/physical therapist, dietitian/nutritionist, and social worker each year compared to the prior. In 2021, 73.3 percent of individuals were evaluated by specialists from all three groups. In addition, given the complex treatment regimens in CF including CFTR modulator therapy, the Registry captures whether patients were seen by a pharmacist in clinic. In 2021, 50.6 percent of individuals were seen by a pharmacist at least once as compared to 45.8 in 2020 and 46.7 percent in 2019.

Percentage of Individuals Evaluated by Multidisciplinary Care Team Members, 2011-2021



The CF Foundation also recommends the inclusion of a mental health professional as part of the CF care team.[18] Information on screening for anxiety and depression is included in the Complications section (page 58).

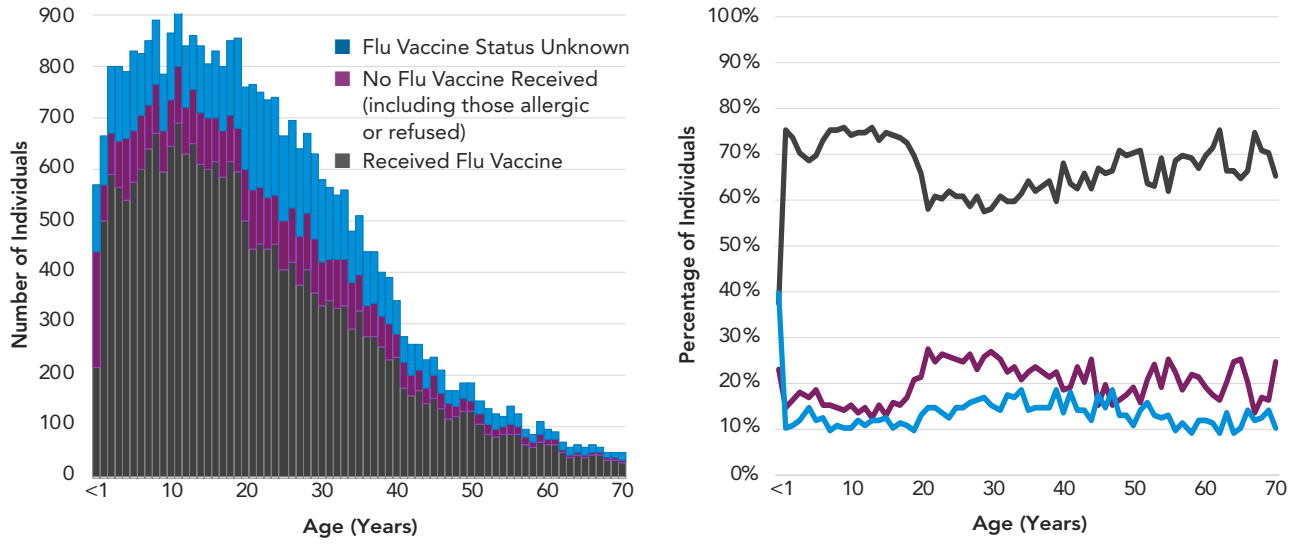
CF Foundation guidelines recommend annual measurement of fat-soluble vitamins to screen for vitamin deficiency.[20,24] The CF Foundation Hepatobiliary Disease Consensus Group recommends a yearly panel of liver blood tests for all people with CF to screen for possible liver disease.[25] Registry data suggest that these tests are being done for most individuals.

Percentage of Individuals Screened by or Monitored with Annual Labs, by Center

	0 — 50 — 100	Median	Min	Max
Individuals with Fat-Soluble Vitamins Measured		89.3	71.4	100.0
Individuals with Liver Enzymes Measured		90.9	73.6	100.0

Influenza immunization is recommended for individuals with CF age six months and older on an annual basis. In 2021, 78.1 percent of the total population was reported to have received a flu vaccine, compared to 68.8 percent in 2020. Flu immunization among children was similar to that of adults in 2021, with 78.8 percent of individuals younger than 18 years immunized compared to 77.1 percent of those 18 years or older with known immunization status. The proportion of individuals with an unknown vaccination status was 18.5 percent in 2021, a slight decrease compared to 18.6 percent unknown in 2020. The percentage with unknown vaccination status is approximately 5.0 percent higher than pre-pandemic levels.

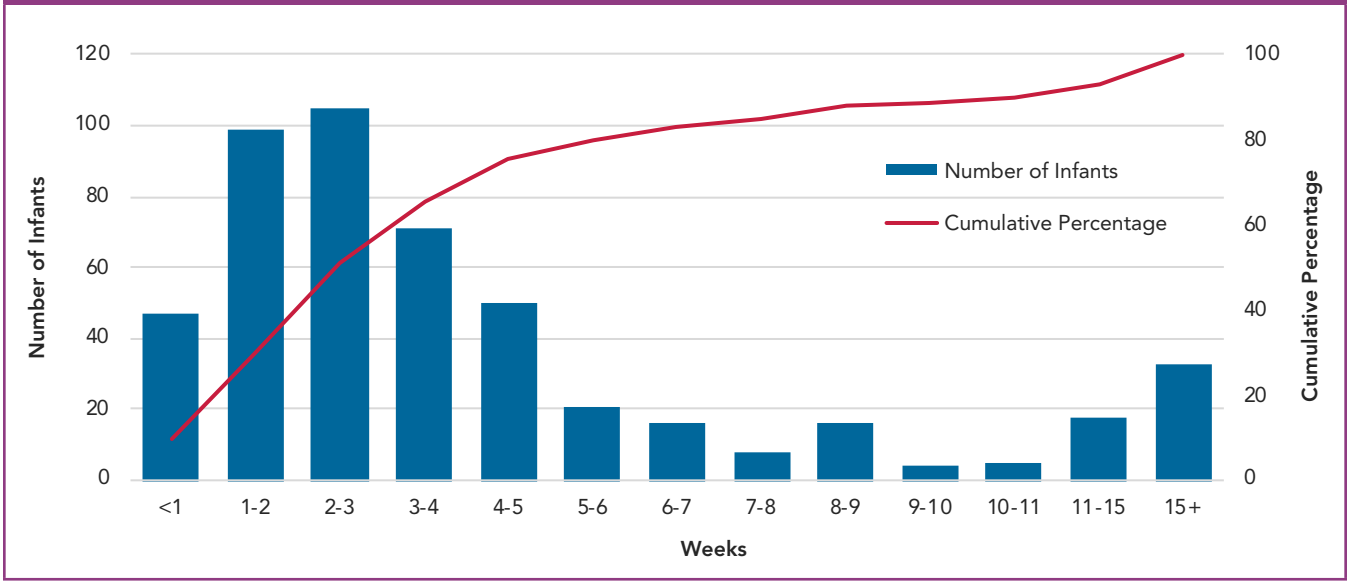
Flu Vaccine Status by Age in Years, 2021 *(Stacked Bar Chart)*



Infant Care Guidelines

The CF Foundation recommends that evaluation and treatment of infants detected by newborn screening be done at a CF Foundation-accredited care center, with the goal of an initial visit within 24 to 72 hours of diagnosis. It is important to make a definitive diagnosis as quickly as possible to minimize the stress and uncertainty for families. For those diagnosed with CF, families can be educated about the disease and treatment can be started.[27] Of infants identified by newborn screening in 2020, 86.7 percent had their first clinic encounter, care episode, or sweat test (first CF event) within 60 days of birth.

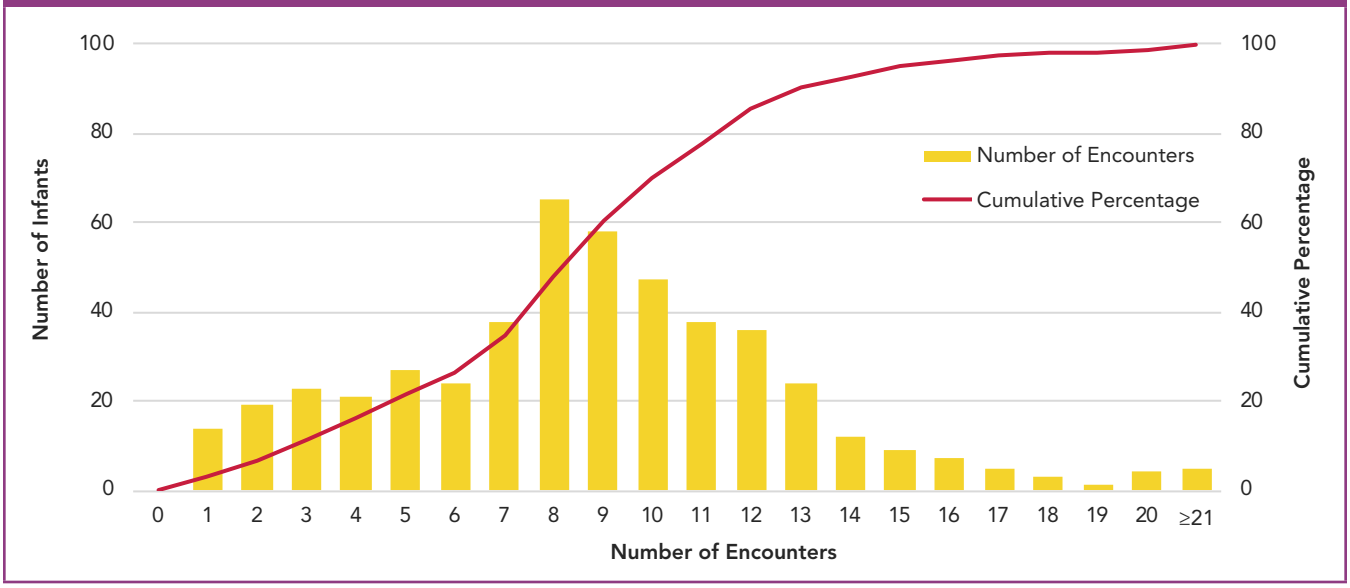
Time to First Clinic Encounter, Care Episode, or Sweat Test for Infants with CF Born in 2020 and Detected by Newborn Screening (n=493)



This chart shows data for children born in 2020 with a full year of follow-up data available. Median time to first CF event for these individuals was 20 days.

The CF Foundation infant care guidelines recommend monthly CF care center visits during the first six months of life and every one to two months in the second six months.[27] Therefore, the expectation is that infants with CF detected by NBS will have 9 to 12 visits in the first year of life. Despite the COVID-19 pandemic, CF care centers provided a similar level of care to infants compared to previous years based on median number of clinic visits, number of cultures, and fecal elastase tests performed during the first year of life.

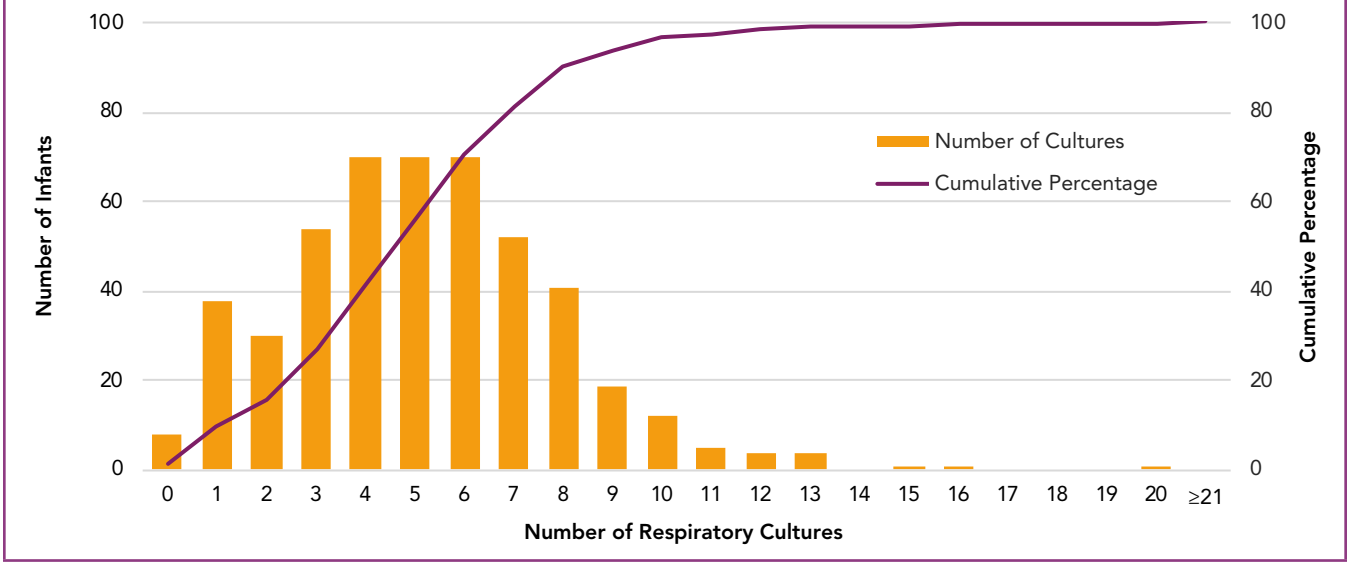
Number of Encounters in the First Year of Life for Infants with CF Born in 2020 and Detected by Newborn Screening (n=480)



The chart shows data for children born in 2020 because a full year of data is available for these individuals. The median number of visits in the first year of life was nine.

Respiratory cultures are being collected at the majority of clinic visits for infants with CF. Infant care guidelines recommend that cultures be performed at least quarterly during the first two years of life.[27]

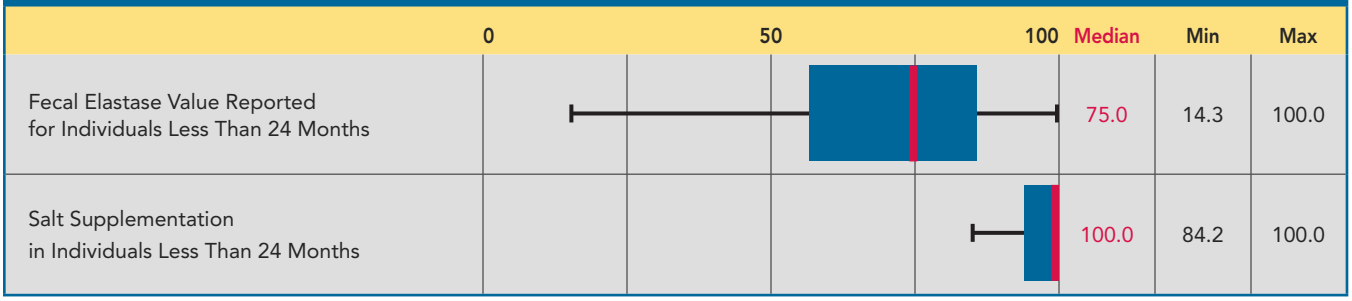
Number of Respiratory Cultures in the First Year of Life for Infants with CF Born in 2020 and Detected by Newborn Screening (n=480)



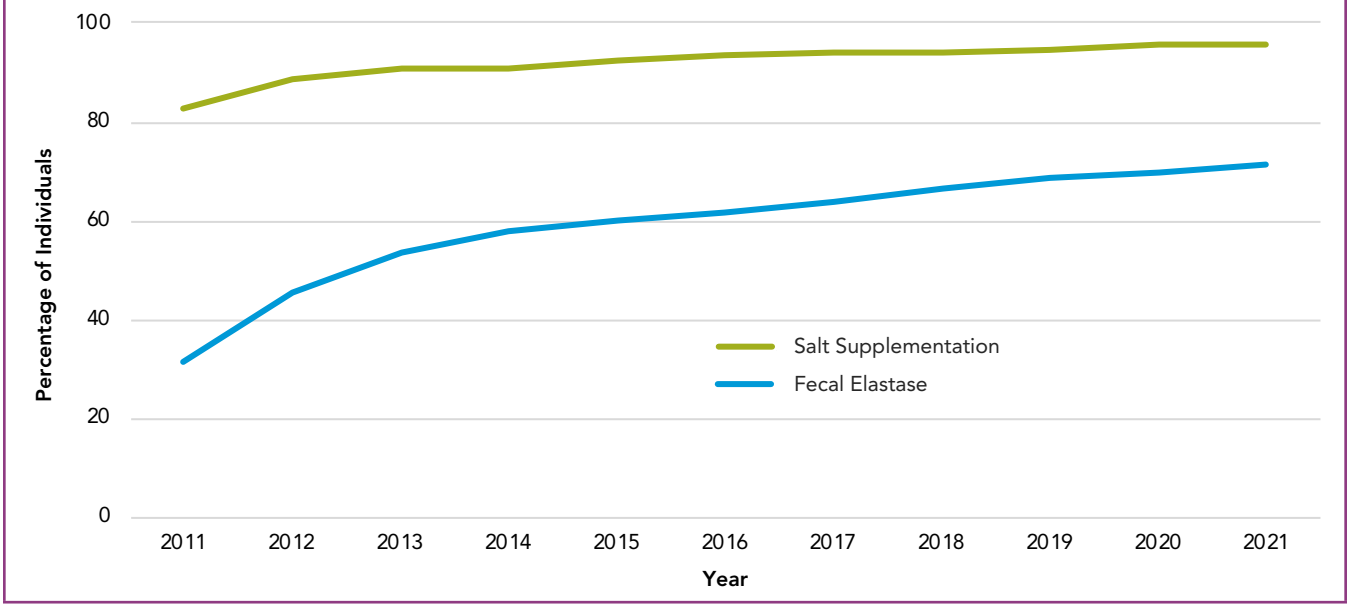
The chart shows data for children born in 2020 because a full year of data is available for these individuals. The median number of cultures in the first year of life was five.

Fecal elastase testing, which provides an objective measure of pancreatic function, is recommended in the infant care guidelines.[27] There is marked variation in the use of this test across the CF Care Center network. The guidelines also recommend that infants begin salt supplementation after diagnosis, and this is widely followed across the CF Care Center network.

Infant Care Guidelines, by Center



Testing and Therapies for Individuals Under 24 Months of Age, 2011-2021



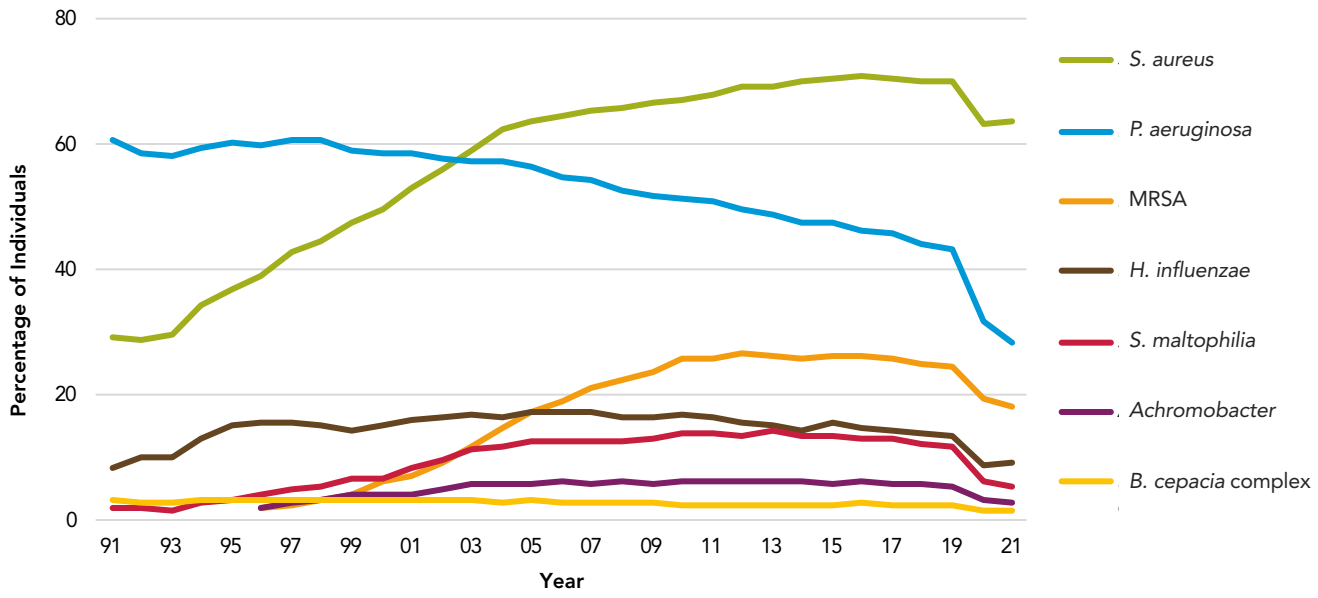
MICROBIOLOGY

This section provides information on trends in CF airway pathogens over time and by age group. Infection prevention and control guidelines provide current best practices for reducing exposure to CF pathogens in the health care setting and in everyday life.[21]

As noted in the About this Report section, the decreased number of cultures collected in 2021 is likely a contributing factor to the lower prevalence of bacterial and mycobacterial pathogens. Less frequent culture surveillance during the COVID-19 pandemic, increased use of highly effective modulator therapy (HEMT), and increased infection prevention and control strategies may have impacted prevalence of several microorganisms.

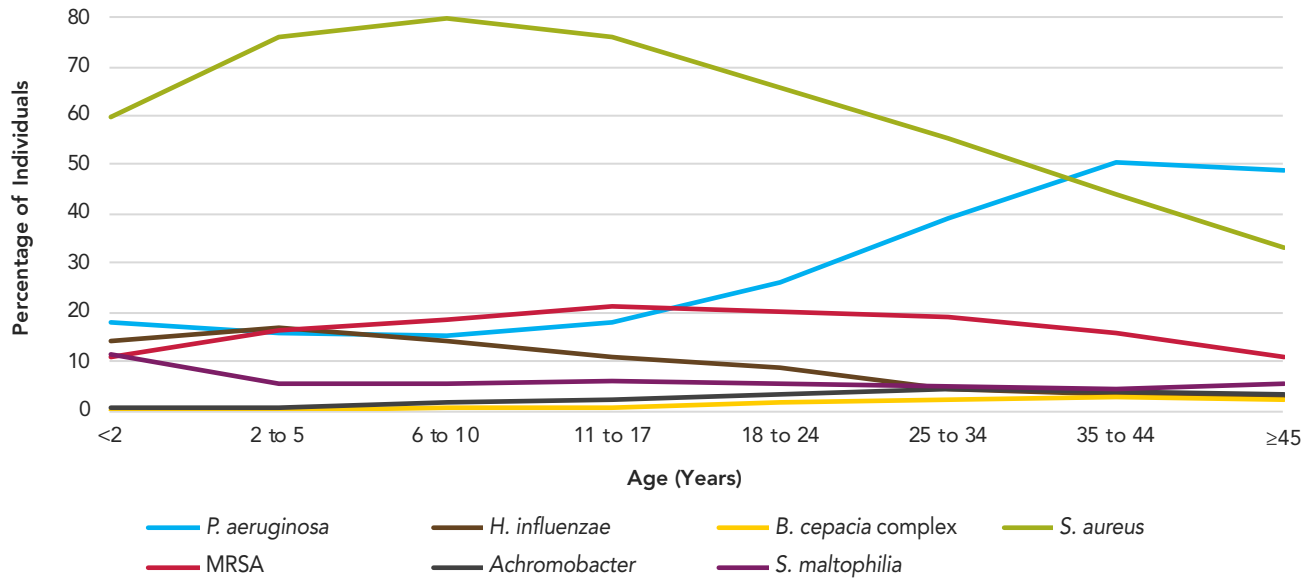
The graph shows that the prevalence of *Pseudomonas aeruginosa* (*P. aeruginosa* or PA) continues to decrease. This may relate in part to widespread implementation of eradication strategies at the time of initial acquisition.[26] The prevalence of infection with multidrug-resistant *P. aeruginosa* (MDR-PA) dropped from 4.2 percent in 2020 to 3.5 percent in 2021.

Prevalence of Respiratory Microorganisms, 1991–2021



The graph shows the proportion of individuals in various age groups who cultured positive for the bacterial species indicated during 2021.

Prevalence of Respiratory Microorganisms by Age Cohort, 2021

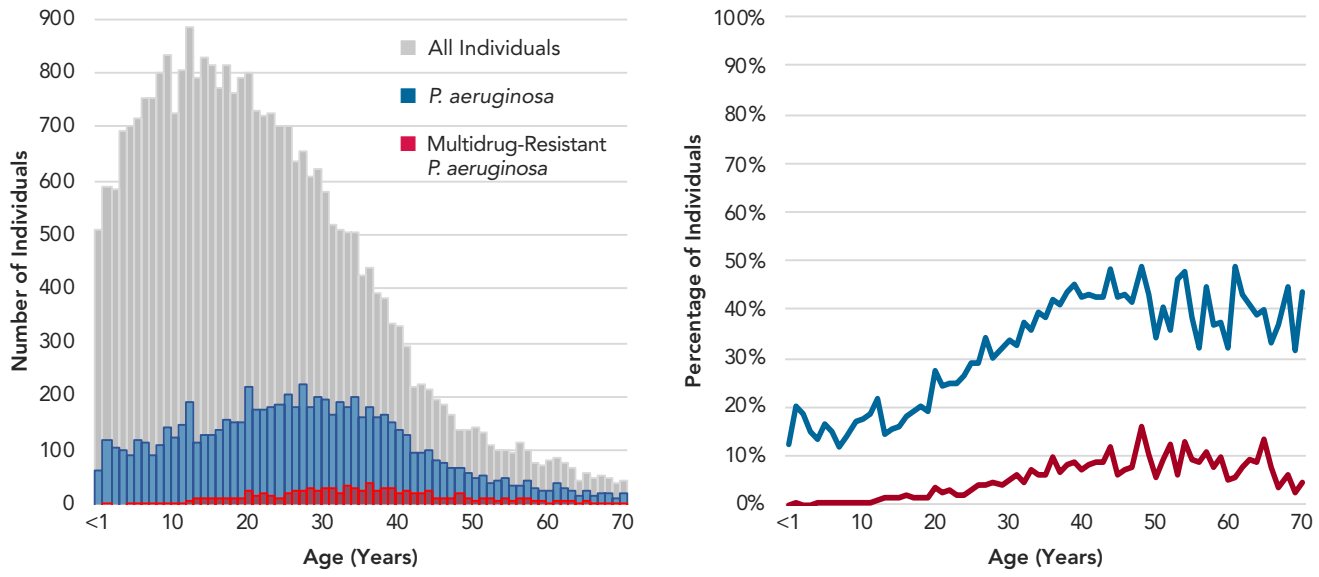


Pseudomonas aeruginosa

The percentage of individuals with a positive culture for *P. aeruginosa* has continued to decline over time, with the largest decrease observed among individuals younger than 18 years (44.6 percent had a positive culture in 2001 compared with 16.8 percent in 2021).

Rates of multidrug-resistant *Pseudomonas aeruginosa* (MDR-PA) infection are greatest in older adolescents and adults with CF. This finding likely reflects cumulative exposure to antibiotics. Among the individuals with CF who had at least one bacterial culture in 2021, 3.5 percent were reported to have MDR-PA. Among the individuals with CF and a culture that grew *P. aeruginosa* in 2021, 12.3 percent were reported to have MDR-PA.

P. aeruginosa and Multidrug-Resistant _P. aeruginosa_ by Age in Years, 2021

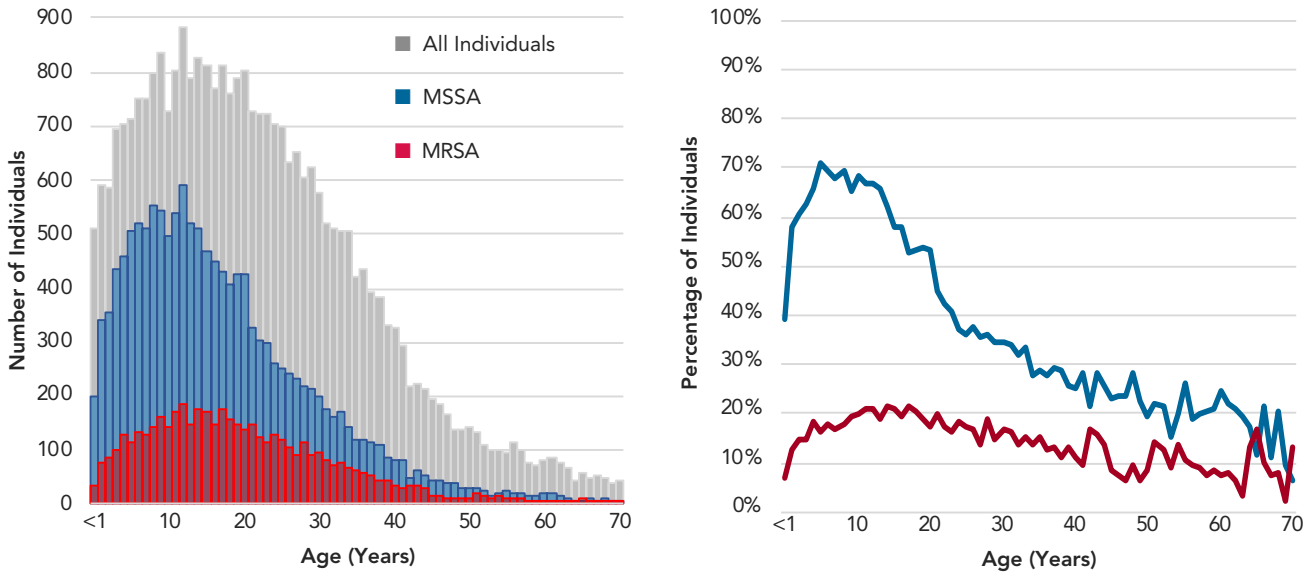


Multidrug resistance is defined as resistance to all antibiotics tested in two or more antibiotic classes in a single culture.

Staphylococcus aureus

More than half (51.7 percent) of individuals who provided a respiratory sample had at least one culture positive for methicillin-sensitive *S. aureus* (MSSA) in 2021. This chart shows that MSSA peaks among those younger than 15 years whereas the highest prevalence of methicillin-resistant *S. aureus* (MRSA) occurs in individuals between the ages of 10 and 20.

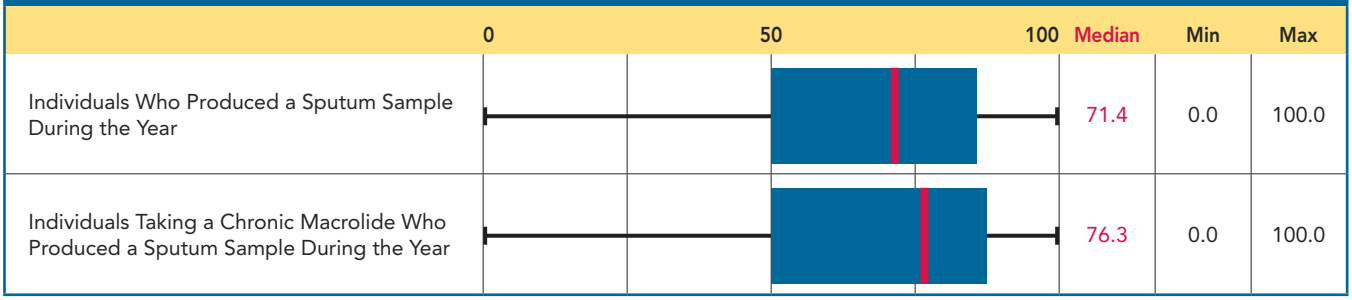
MSSA and MRSA by Age in Years, 2021



Nontuberculous Mycobacteria

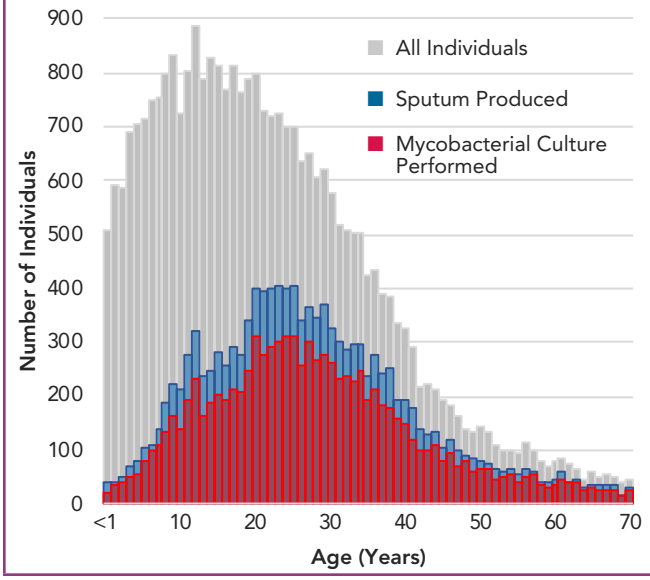
The CF Foundation/European Cystic Fibrosis Society Guidelines Committee recommends that individuals with CF who are able to expectorate sputum should be cultured for nontuberculous mycobacteria (NTM) infections annually.[28] Individuals should also be screened before and six months after beginning chronic azithromycin therapy and annually thereafter.[2] The data show improvement in screening rates over time, but wide variation by CF care center persists. In addition, the median percentage of individuals (by center) who produced a sputum sample in 2021 was higher than in 2020, 71.4 percent compared to 68.3 percent, respectively.

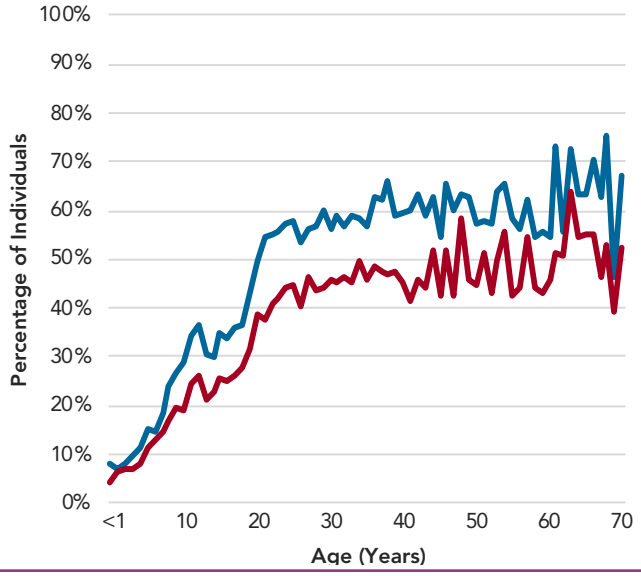
Percentage of Individuals with a Mycobacterial Culture, by Center



A throat swab is insufficient for a mycobacterial culture, so a patient must be able to produce sputum for this culture to be performed. A majority (68.9 percent) of the individuals who produced sputum for a bacterial culture also had a mycobacterial culture performed during the year, but this was lower than the 79.5 percent in 2019. In the graph below, the proportion of individuals providing a sputum sample for mycobacterial culture surveillance is highest in adults. Among those cultured, the percentage of positive mycobacterial cultures increases until age 20, after which the percentage with a positive culture plateaus and remains relatively constant until age 60.

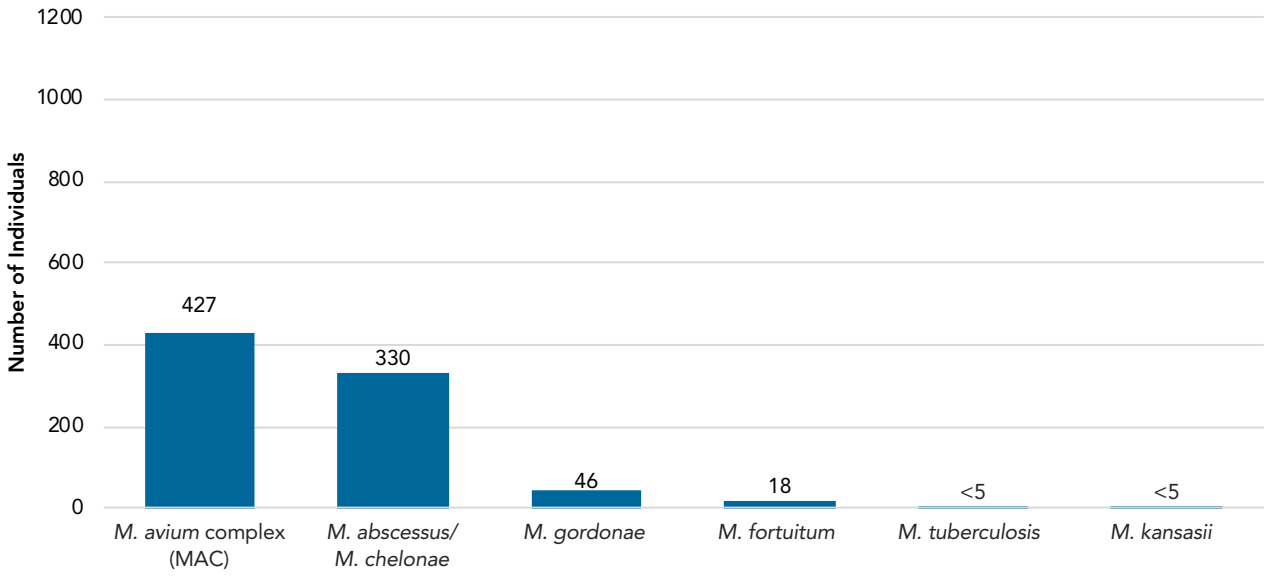
Sputum Produced and Mycobacterial Cultures by Age in Years, 2021





Of the 9,796 individuals who had a mycobacterial culture performed in 2021, 937 (9.6 percent) had a mycobacterial species isolated one or more times, a decrease from 10.0 percent in 2020 and 13.9 percent in 2019.

Mycobacterial Species Isolated in 2021



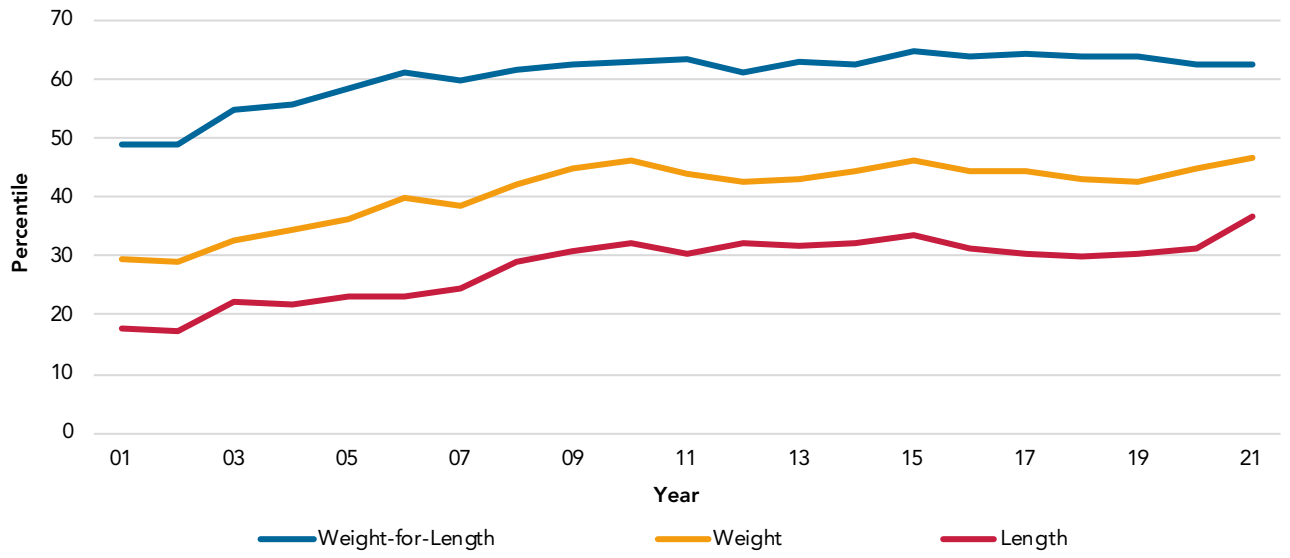
Data are not mutually exclusive. Some individuals had more than one species isolated in 2021.

NUTRITION

Nutritional outcomes are a key measure of health in people with CF. This section is divided into three age groups to report nutrition metrics: infants younger than 2 years, children 2 to 19 years, and adults 20 years and older. Overall improvements in nutritional metrics are observed for all ages. CF Foundation evidence-informed guidelines recommend enteral tube feeding to improve age-dependent anthropometrics and nutrition in individuals with CF who are unable to consume adequate nutrition to meet goals.[29] Conversely, the percentage of adults with CF in the overweight and obese BMI categories has more than doubled in the past 20 years.

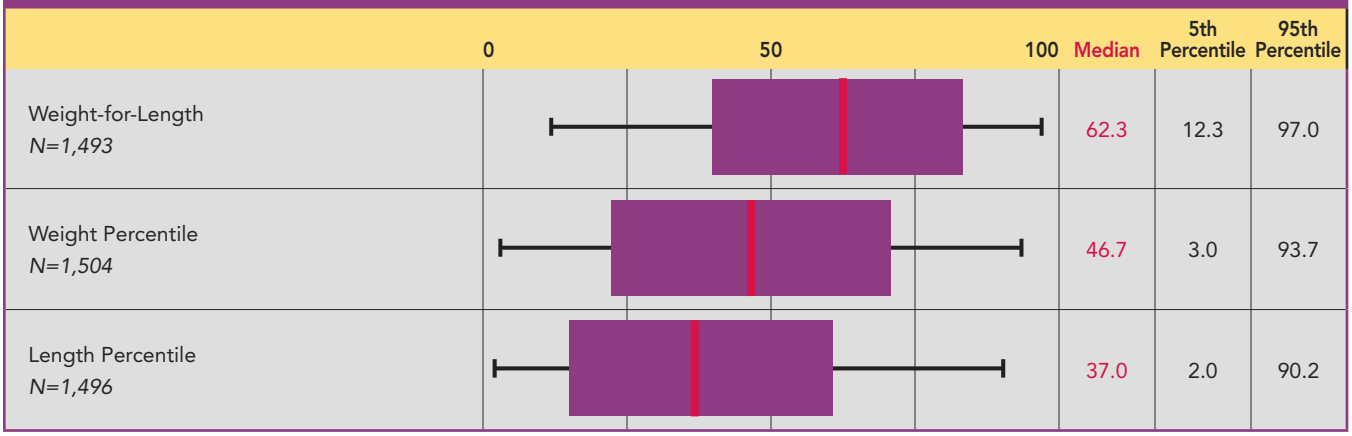
Goals for weight-for-length and BMI percentile in children are based on Centers for Disease Control and Prevention (CDC) growth curves. However, the CDC and the American Academy of Pediatrics recommend the use of World Health Organization (WHO) growth curves for children younger than 24 months of age.[30] WHO growth curves are used to report the data below. Of note, the length percentile for infants with CF has increased for the first time since 2010.

Median WHO Nutritional Outcome Percentiles for Infants Under 24 Months, 2001–2021



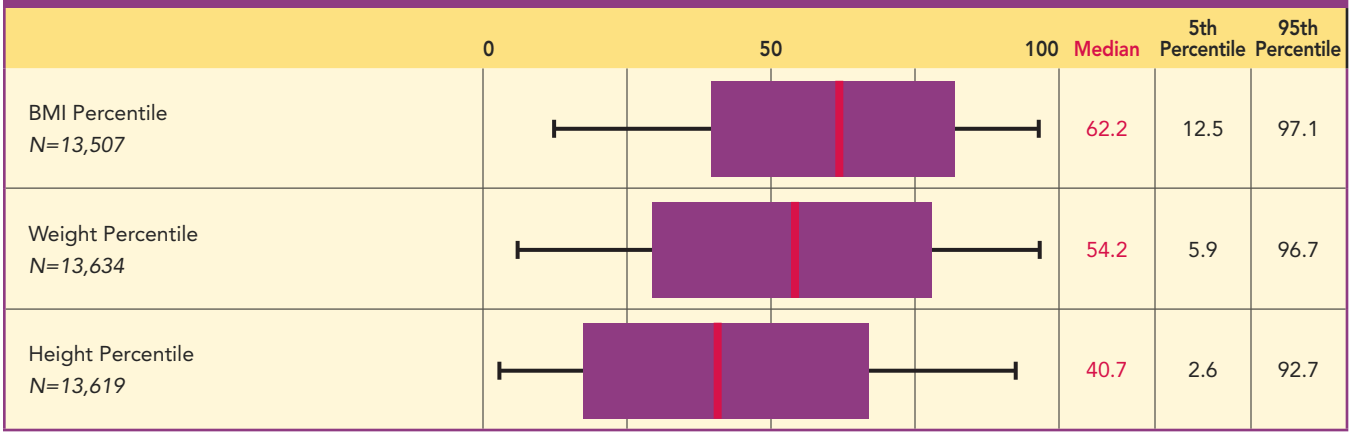
The following charts show the population-level variation for infants younger than 24 months using WHO weight-for-length, weight, and length percentiles by age and then for children aged 2 to 19 years using height, weight and BMI percentiles calculated from CDC growth standards. As would be expected for a large population, there is substantial variation observed for all three metrics in both age groups. Among infants under 24 months of age, the median values for weight-for-length are above the recommendation of 50th percentile. The length percentile has improved (31.5th percentile in 2021), but remains below what is expected for the U.S. population.[31]

WHO Nutritional Outcomes for Infants Under 24 Months



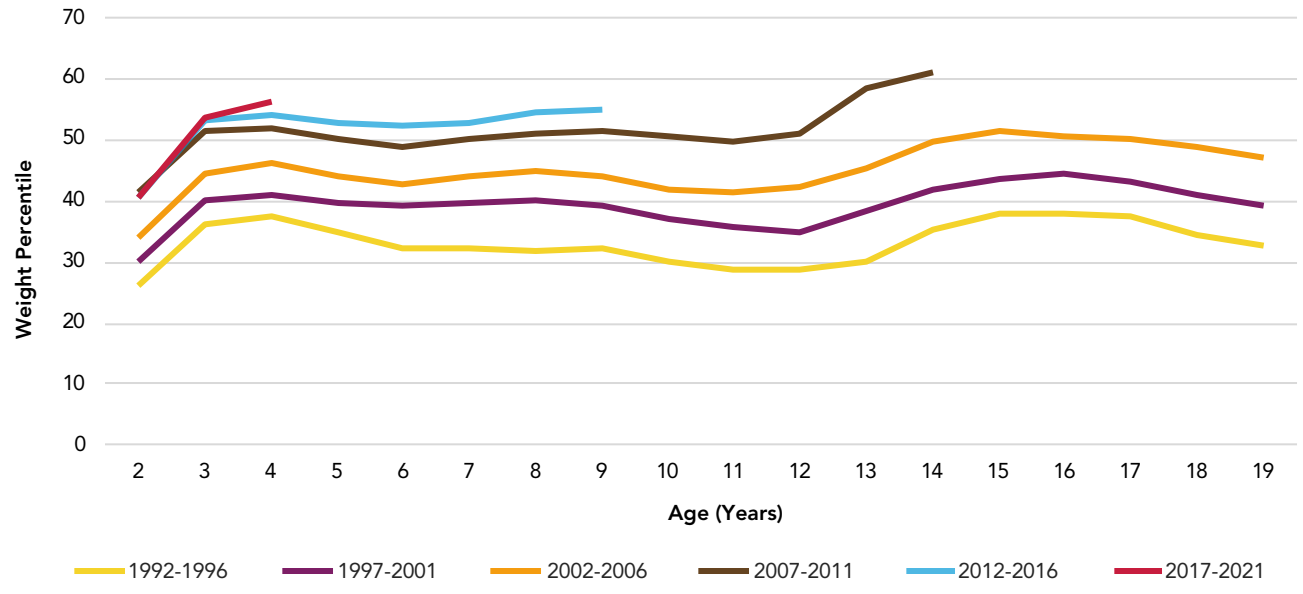
The goal BMI percentile established by the CF Foundation nutrition guidelines for children aged 2 to 19 years is at or above 50 using CDC growth curves.[24] In 2021, the median weight and BMI percentiles were above the 50th percentile; however, height percentile remains well below that of the general population.

CDC Nutritional Outcomes for Individuals 2 to 19 Years

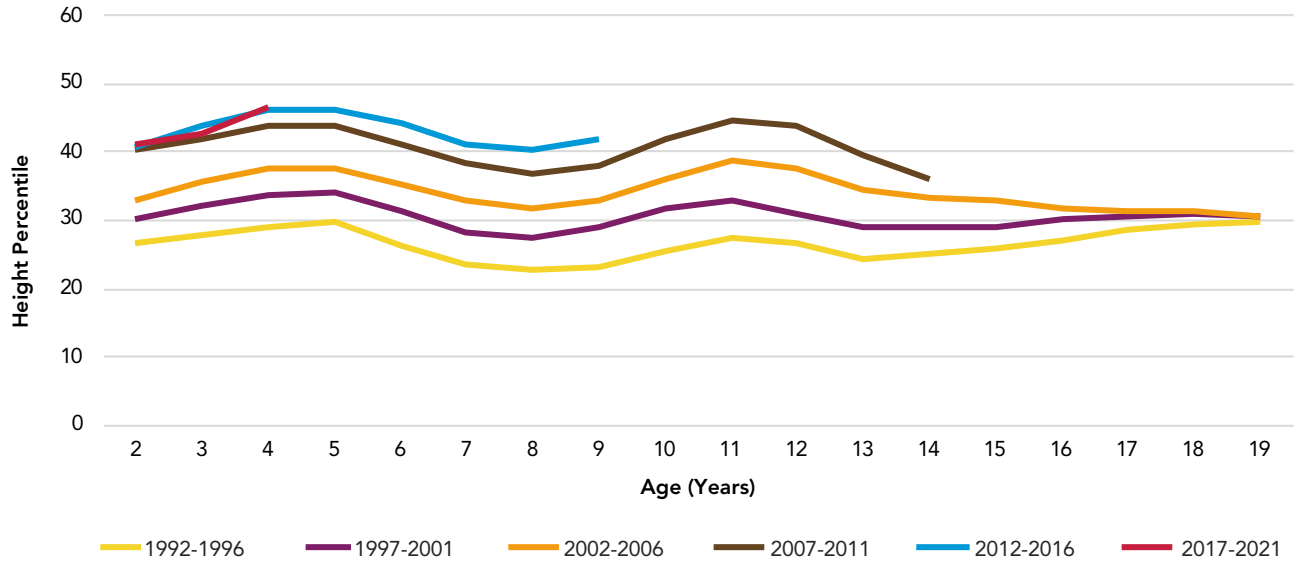


The median height percentiles reported among children 2 to 19 years of age do not exceed 50th percentile for all birth cohorts from 1992-1996 to 2017-2021. In contrast, median weight percentiles for those born after 2007 is at the 50th percentile or higher from age 3 onwards.[32] All percentile values are calculated in reference to the CDC growth standards.

Median CDC Weight Percentile, by Age and Birth Cohort in 2021

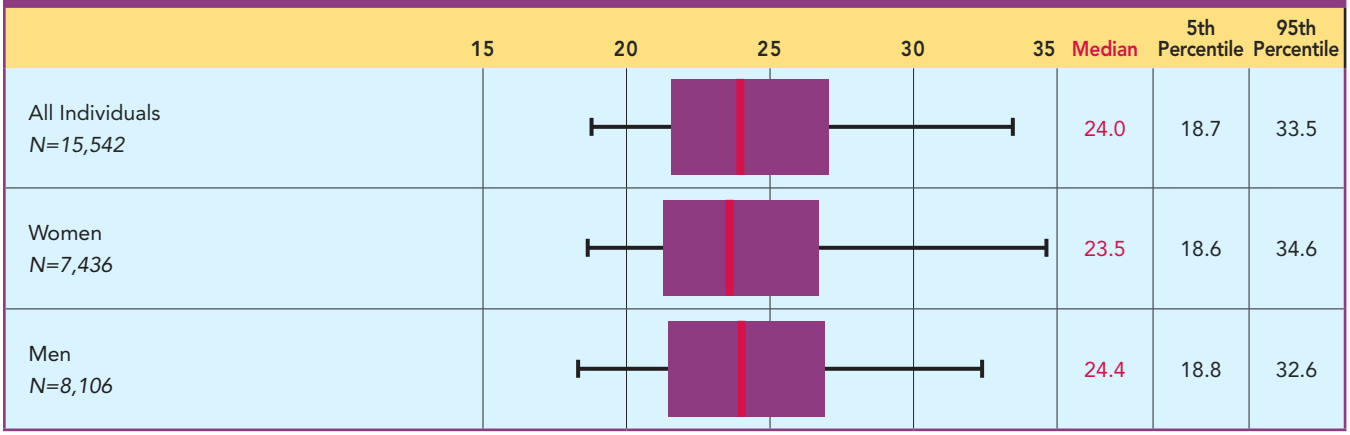


Median CDC Height Percentile, by Age and Birth Cohort in 2021



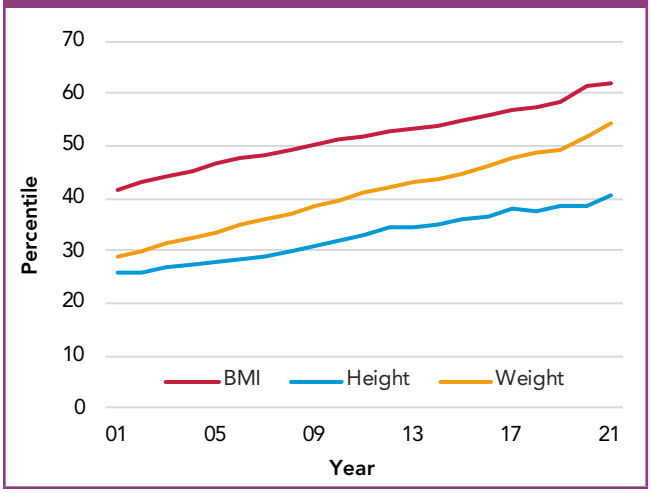
For ages 20 years and older, the goal BMI established by the CF Foundation nutrition guidelines is at or above 22 for women and 23 for men.[24] This chart shows that more than half of individuals in this age range achieved this goal in 2021. Improvements in nutrition and dietary interventions, and more recently the availability of CFTR modulators, have substantially decreased the percentage of adults that are underweight, defined as a BMI less than 18.5 (only 4.1 percent in 2021 compared to 16.2 percent in 2001).

BMI Value for Adults 20 Years and Older

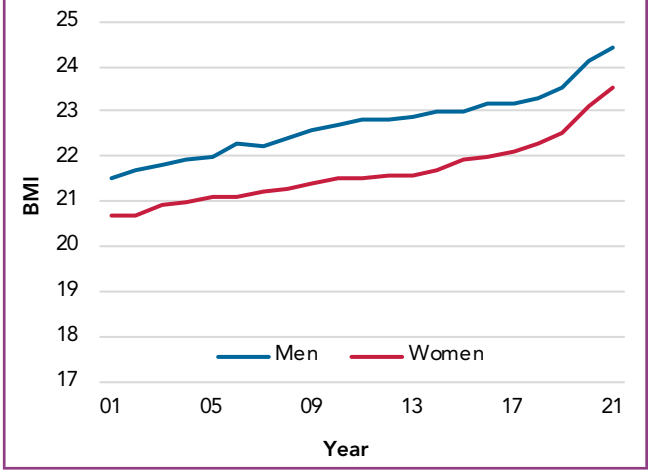


Conversely, 40.4 percent of adults have a BMI in the range categorized by CDC as overweight (28.7 percent) or obese (11.7 percent), with a higher prevalence in men (44.0 percent) than women (36.4 percent). The percentage of adults who are overweight or obese has more than doubled in the past 20 years (15.3 percent in 2001). Much of this increase is likely attributable to weight gain associated with CFTR modulator therapy.

Median Nutritional Outcomes Percentiles for Individuals 2 to 19 Years, 2001-2021

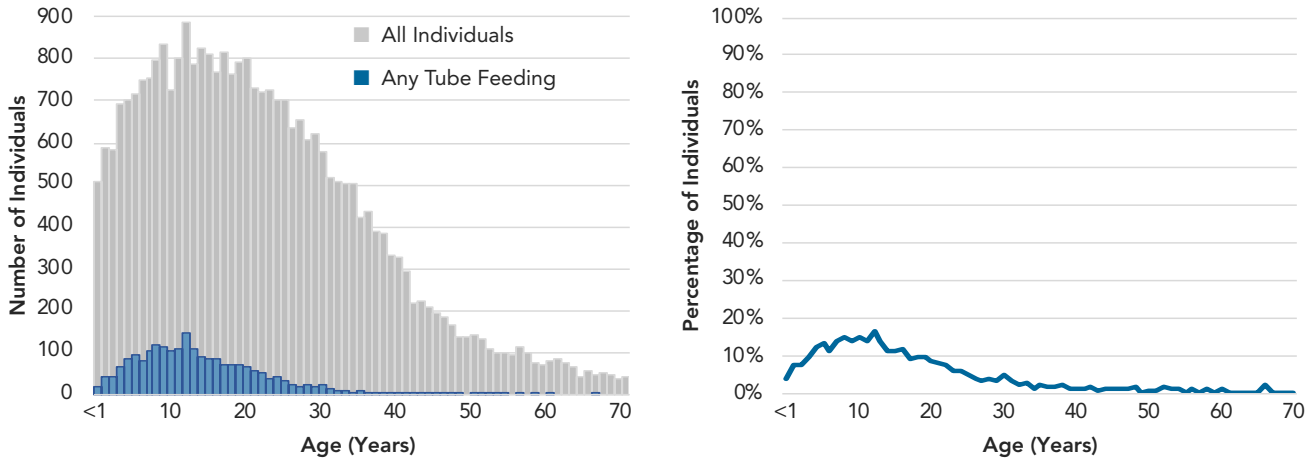


Median BMI Values for Adults 20 Years and Older, 2001-2021



Despite these gains, tube feeding is still used to improve nutritional outcomes primarily for children, adolescents, and young adults with CF.

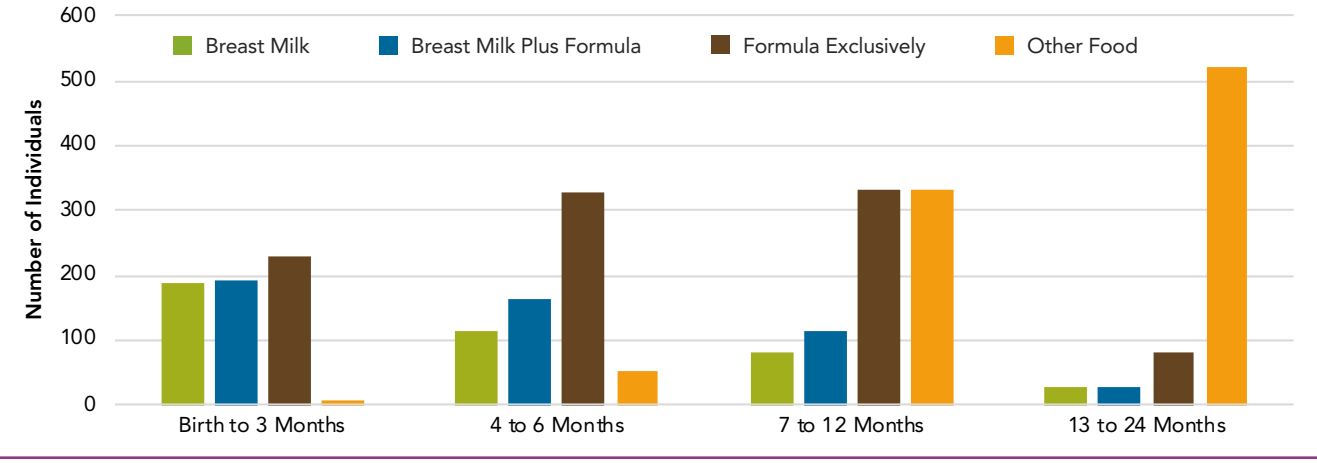
Tube Feeding by Age in Years, 2021



Infant Feeding

Most infants with CF receive formula feeding as the primary form of feeding or as a supplement to breastfeeding. Cow's milk-based formula with the standard caloric density of 20 calories per ounce is the most common feeding used from birth to age 3 months. More calorie-dense formulas are used after 3 months of age. CF Foundation infant care guidelines recommend human breast milk or standard infant formula as the initial form of feeding. Fortified human breast milk, calorie-dense formulas, or complementary foods are recommended if the infant is failing to gain weight adequately.[27]

Form of Feeding by Age in 2021*



**Infants may be included in more than one age category. They may also be counted more than once within an age category if different forms of feeding were recorded during separate clinic visits while within the same age category.*

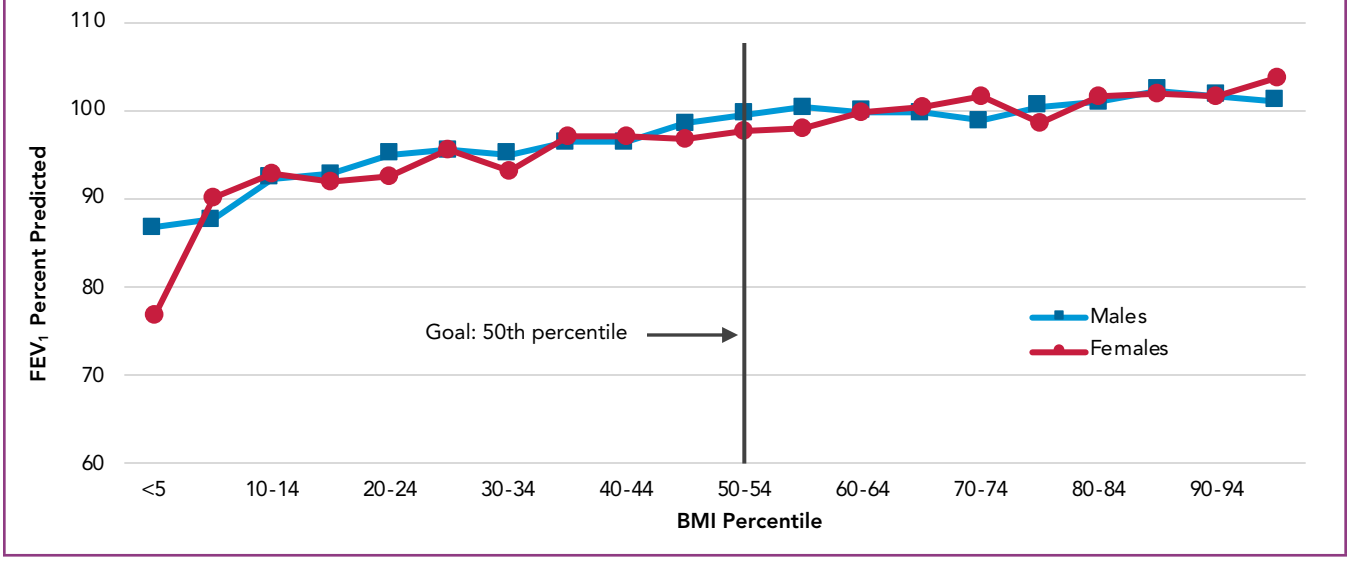
PULMONARY AND NUTRITIONAL OUTCOMES

Pulmonary and nutritional outcomes are two key measures of CF health. The data show that for all people with CF, better pulmonary function and higher BMI percentile are associated. However, it will be important to modify the diet to prevent obesity and associated comorbidities.

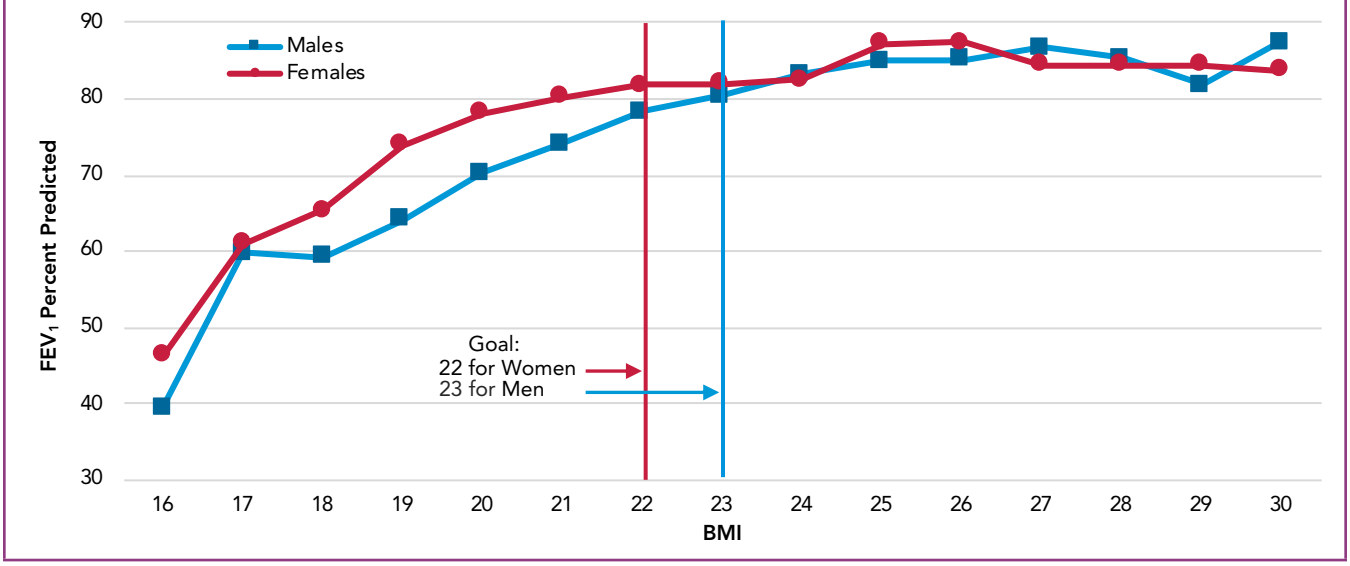
Pulmonary and nutritional goals[24] are as follows:

- *For children, FEV_1 percent predicted greater than or equal to 100, and BMI percentile meeting or exceeding the 50th percentile.*
- *For adults, FEV_1 percent predicted greater than or equal to 75, and BMI value greater than or equal to 22 for women and 23 for men.*

FEV_1 Percent Predicted vs. BMI Percentile for Children 6 to 19 Years in 2021

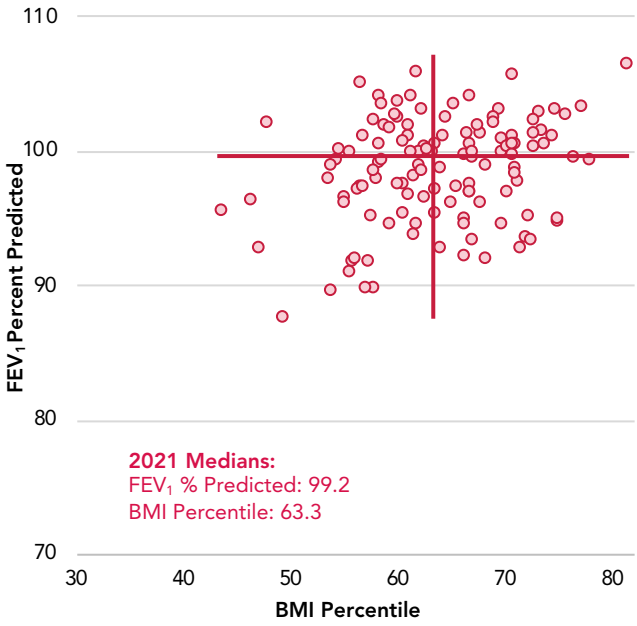


FEV_1 Percent Predicted vs. BMI Value for Adults 20 to 40 Years in 2021

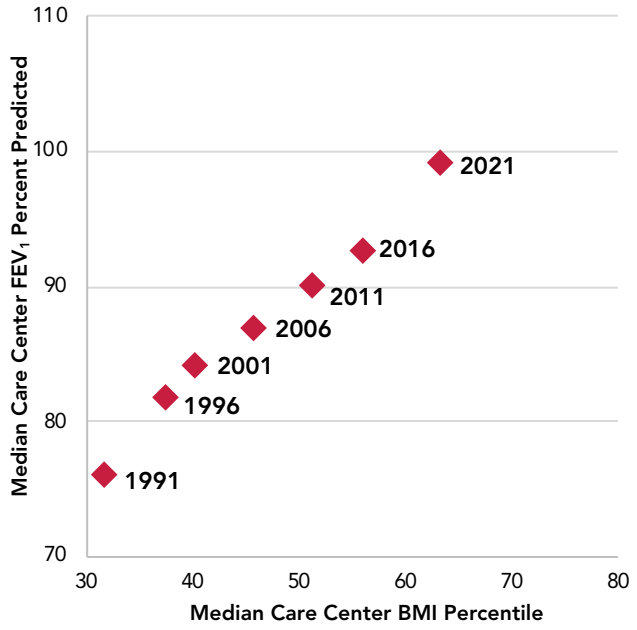


The figures below on the left show median BMI percentile (or BMI for adults) and median FEV_1 percent predicted values for each center in 2021. The figures on the right show how median values for all centers have improved over the last 30 years.

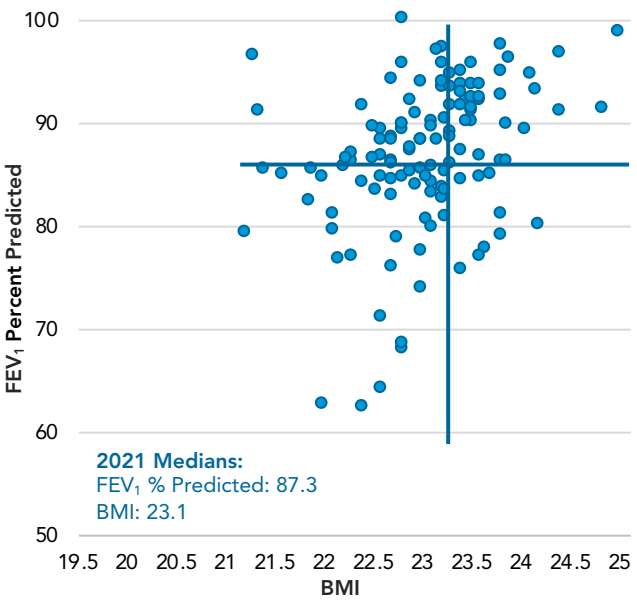
Median FEV_1 Percent Predicted vs. Median BMI Percentile for Individuals 6 to 19 Years, by Center



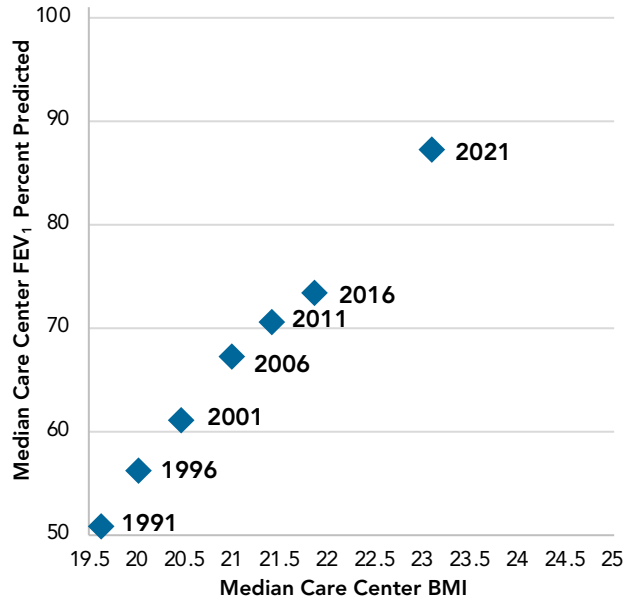
Median Care Center Value for Individuals 6 to 19 Years, 1991-2021



Median FEV_1 Percent Predicted vs. Median BMI Value for Individuals 20 to 40 Years, by Center



Median Care Center Value for Individuals 20 to 40 Years, 1991-2021



PULMONARY FUNCTION

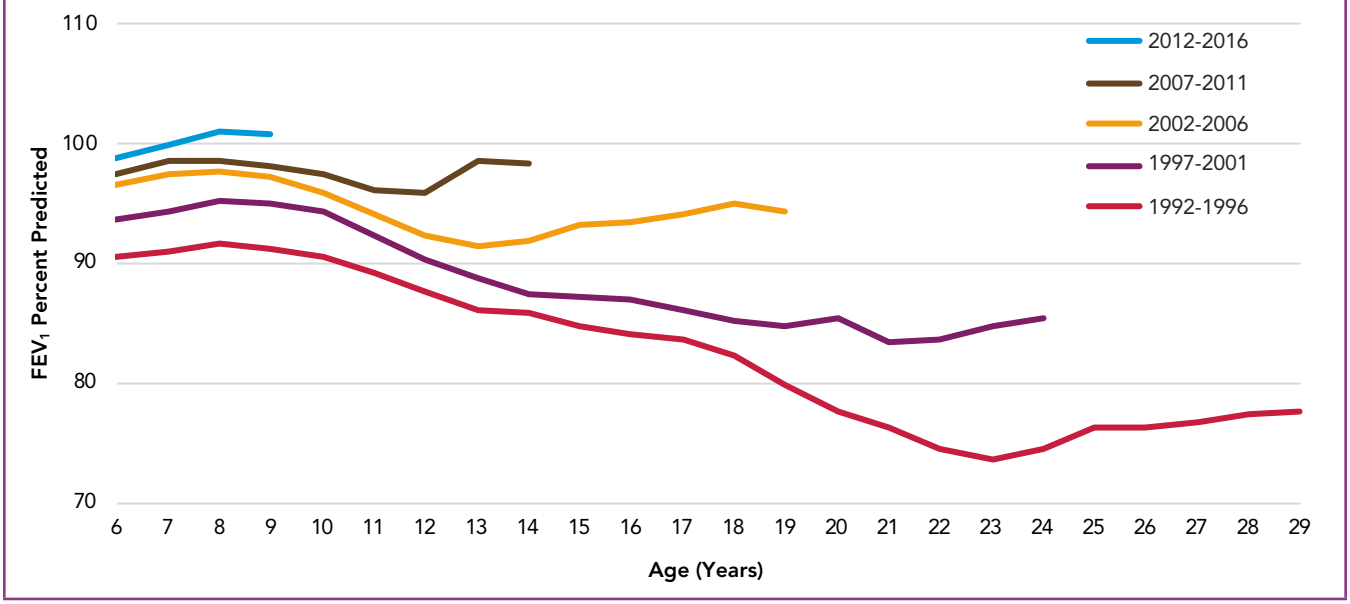
Pulmonary function is an important clinical indicator of the health of individuals with CF. Pulmonary function is assessed by FEV1 percent predicted as calculated using the Global Lung Initiative (GLI) reference equations.[1] Variations in pulmonary exacerbation treatment across CF care centers is also shown.

Successive birth cohorts show improved pulmonary function across all ages for individuals who are old enough to reliably perform pulmonary function testing.

As noted in the About this Report section, we captured approximately 60.0 percent of the usual number of spirometry measurements per individual in 2021 as compared to 2019, and some of that data was derived from home spirometers. Also of note, there were fewer height measurements reported for growing children less than 18 years of age. Less frequent measures or missing height data may have impacted the precision of the population, center, and individual-level annualized FEV_1 percent predicted values.

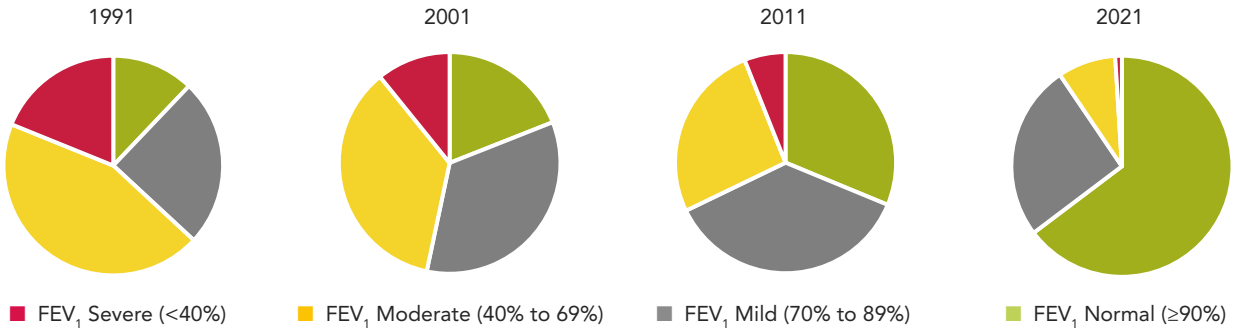
The figure below shows the median FEV_1 percent predicted by birth cohort. The birth cohorts diverge unlike similar graphs in annual Registry reports from 2019 and earlier. Among individuals born between 2012-2016, median FEV_1 percent predicted increased to 100 percent predicted among those who attained 8 to 9 years of age in 2021. For the older cohorts (1992-1996, 1997-2001) median FEV_1 percent predicted has increased or stabilized, recognizing that survivor bias may be contributing to this trend. Overall, improvements in lung function continue to be observed across all birth cohorts.

Median FEV_1 Percent Predicted, by Age and Birth Cohort



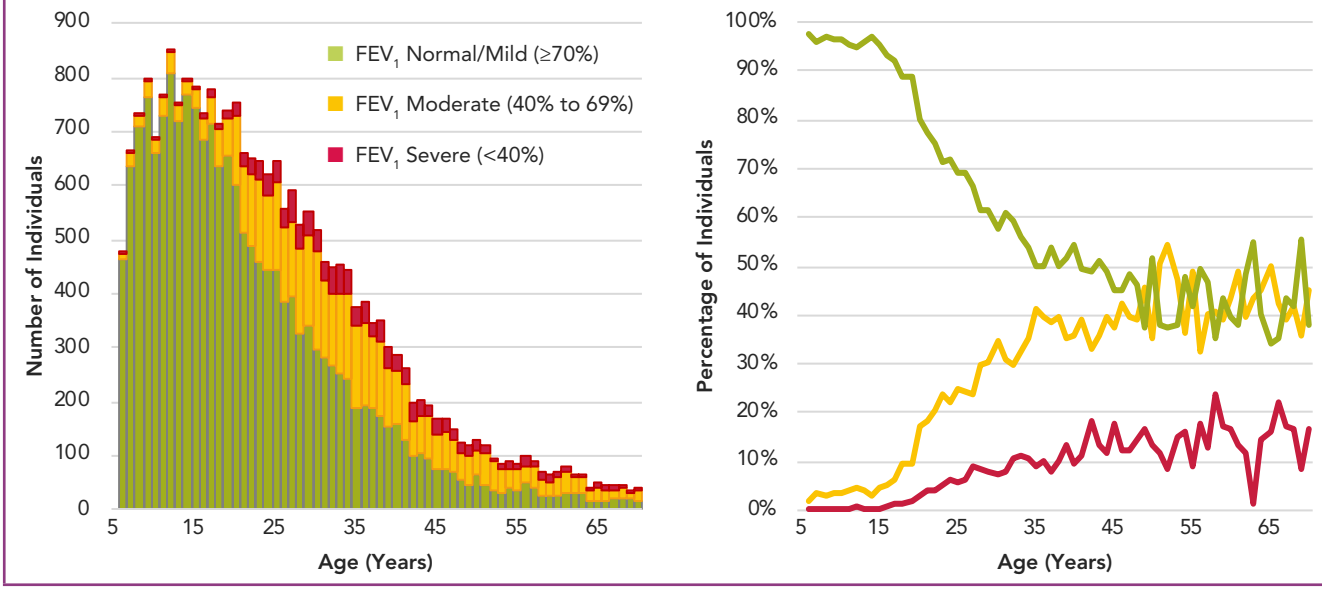
The proportion of people with CF aged 18 years who are in the normal or mild lung disease categories (FEV_1 ≥70 percent predicted) more than doubled from 39.4 percent in 1991 to 89.1 percent in 2021. The proportion with severely reduced lung function aged 18 years (FEV_1 <40 percent predicted) decreased from 18.6 percent in 1991 to 1.3 percent in 2021.

Median FEV_1 Percent Predicted in 18-Year-Olds, 1991–2021



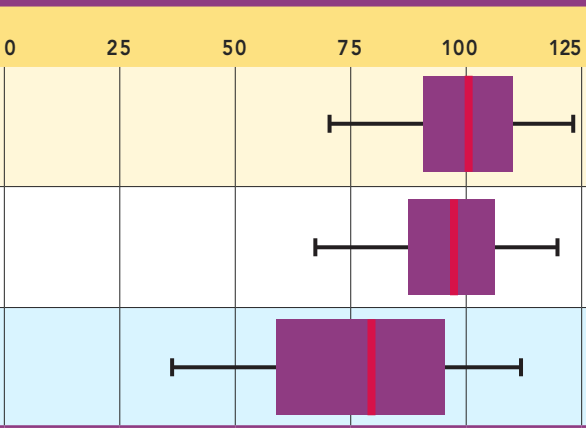
Although much focus is placed on spirometry, it is not a sensitive measure of early lung disease in CF and may underrepresent the extent of early structural lung disease. With that caveat in mind, the vast majority of children have normal or "mild" impairment in pulmonary function as defined by FEV_1 percent predicted. Moderate and severe impairment in pulmonary function become apparent in adolescence and early adulthood.

Pulmonary Function Impairment by Age in Years, 2021 (Stacked Bar Chart)



The median FEV_1 percent predicted among individuals aged 6 to 11 is 100.5 percent and for individuals aged 18 years or older it is 79.5 percent. Indeed, half of the individuals aged 18 years or older have only mildly reduced lung function with an FEV_1 percent predicted greater than 70.0 percent. However, a wide spectrum of lung function is observed among adults with a quarter having a FEV_1 percent predicted less than 50.0 percent.

FEV_1 Percent Predicted



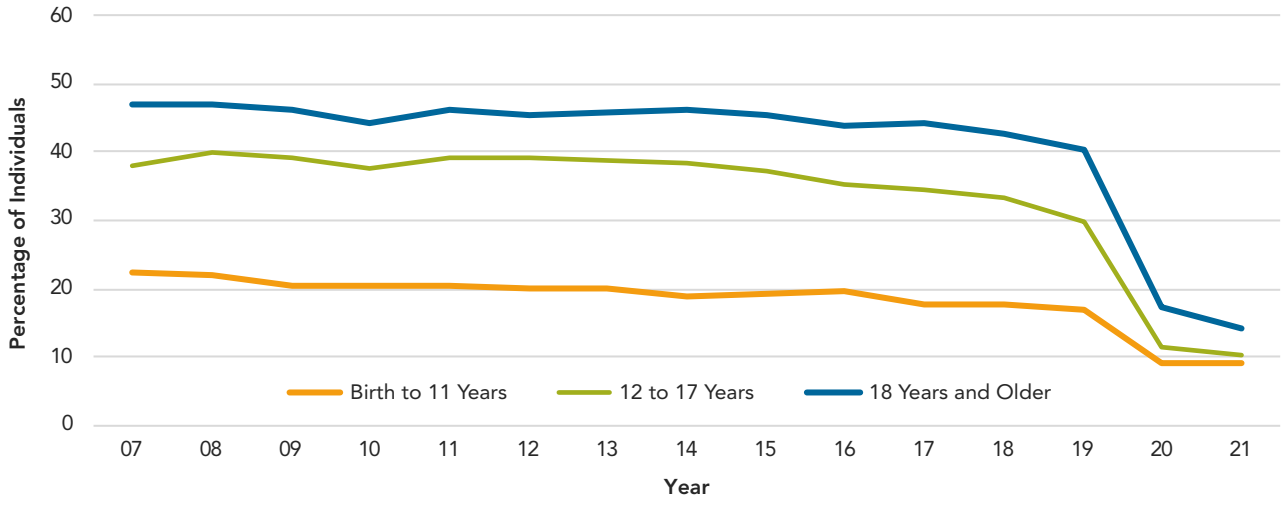
	Median	5th Percentile	95th Percentile
All Individuals 6 to 11 Years *N=4,215*	100.5	73.5	122.4
All Individuals 12 to 18 Years *N=4,689*	97.9	66.5	120.8
All Individuals 18 Years and Older *N=15,354*	79.5	35.1	112.5

Pulmonary Exacerbations

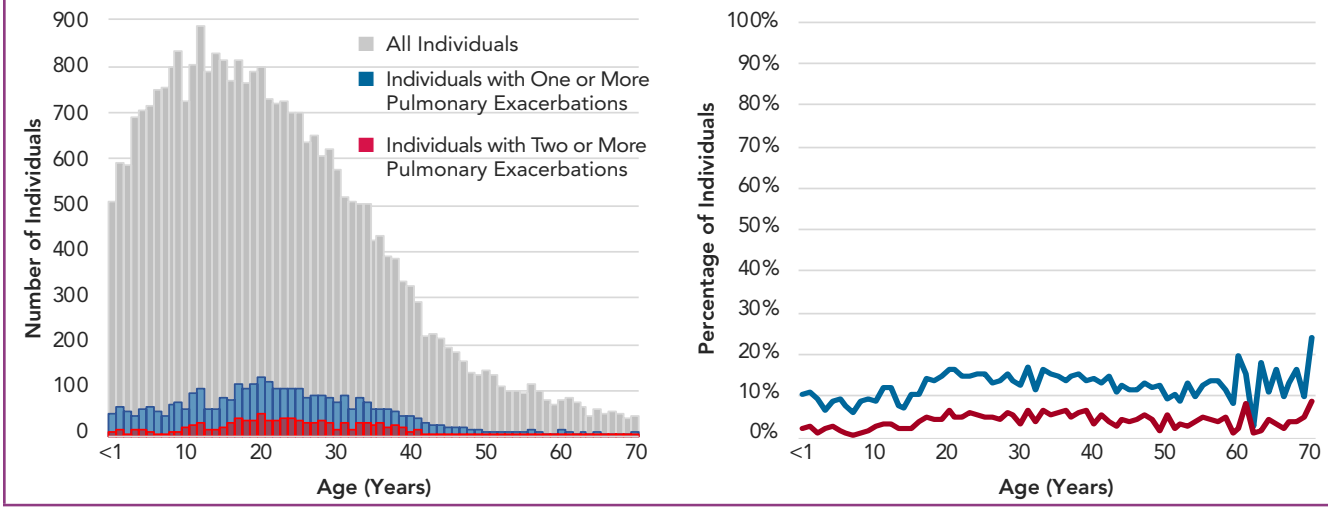
Pulmonary exacerbations, characterized by intravenous (IV) antibiotic treatment in the hospital or at home, are associated with morbidity, mortality, and decreased quality of life. They are also a major driver of health care costs. This section displays trends in the rate of pulmonary exacerbations over time and by age group. In addition, variation in exacerbation rates and treatment characteristics by CF care center is shown.

Despite notable improvements in pulmonary function and nutritional status over the years, the proportion of individuals with CF who were treated with IV antibiotics for pulmonary exacerbations remained fairly stable until recently. In 2020, a substantial decrease in the number of reported exacerbations was observed, particularly in adolescents and adults. The pandemic, with less exposure to viruses, and use of elexacaftor/tezacaftor/ivacaftor are likely contributing factors. A further modest decrease was observed in 2021.

Individuals Treated with IV Antibiotics for a Pulmonary Exacerbation, 2007–2021

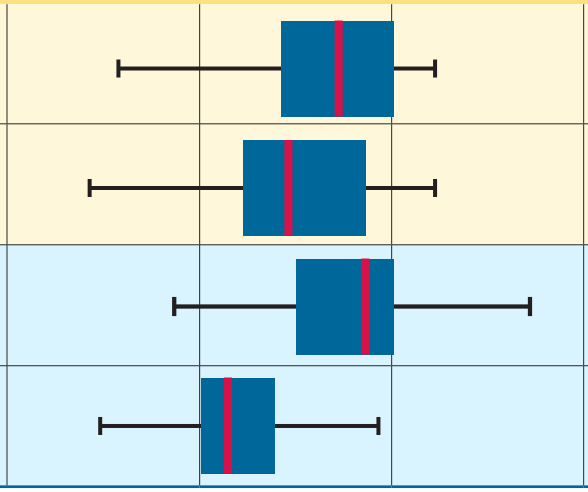


Pulmonary Exacerbations by Age in Years, 2021



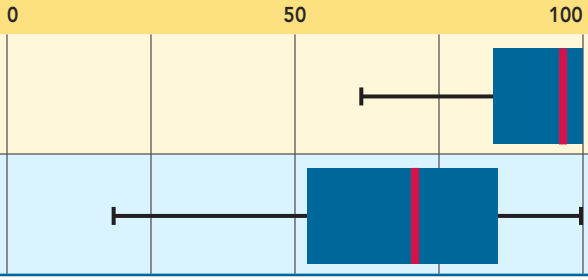
When the CF Foundation developed guidelines for the treatment of pulmonary exacerbations in 2009, little published literature or data were available upon which to base recommendations.[33] Current practice within the CF Foundation Care Center network indicates a median treatment duration of 12 to 13 days, with adults more likely to complete some of their treatment at home. Published research suggested that 10 to 14 days of treatment with intravenous antibiotics (duration based on whether there is an early response to treatment) is appropriate.[34]

Duration of Pulmonary Exacerbation Treatment in Days, by Center



	Median	Min	Max
Median Total Duration of IV Antibiotic Treatment for a Pulmonary Exacerbation in Individuals Less than 18 Years Old	12.0	4.0	15.5
Median Duration of Hospital Stay for Treatment of a Pulmonary Exacerbation in Individuals Less than 18 Years Old	10.3	3.0	15.5
Median Total Duration of IV Antibiotic Treatment for a Pulmonary Exacerbation in Individuals 18 Years and Older	13.0	6.0	19.0
Median Duration of Hospital Stay for Treatment of a Pulmonary Exacerbation in Individuals 18 Years and Older	8.0	3.3	13.5

Percentage of Total Pulmonary Exacerbation Treatment Duration in Hospital, by Center



	Median	Min	Max
Individuals Birth to 17 Years	96.4	61.8	100.0
Individuals 18 Years and Older	70.4	18.1	100.0

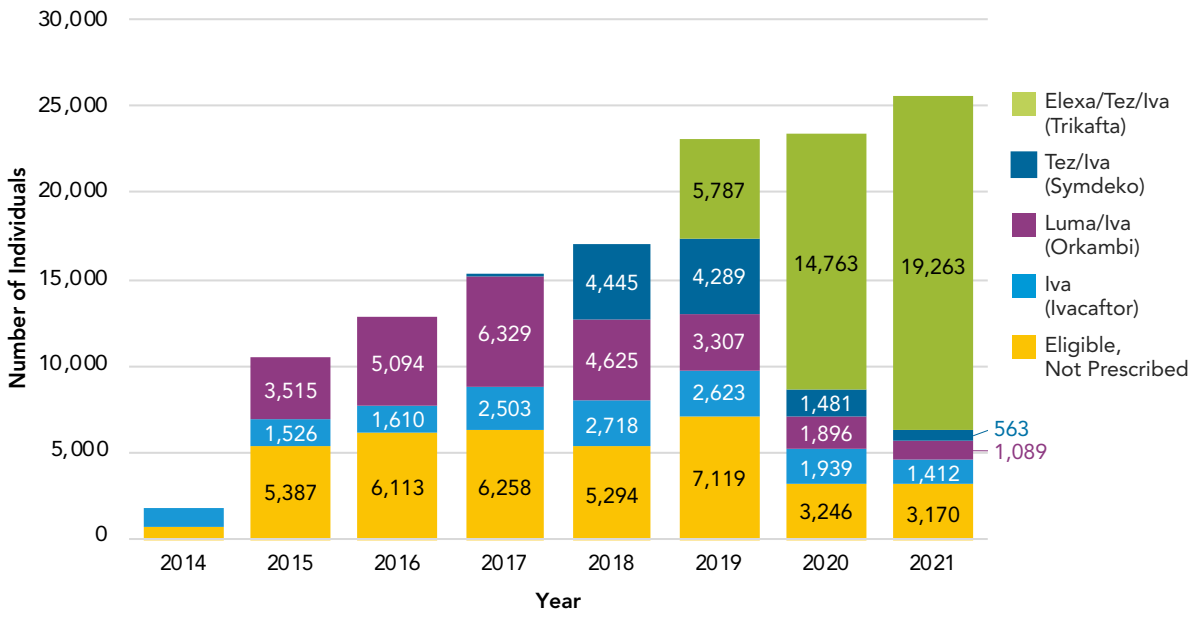
THERAPIES

CFTR Modulator Therapies

On June 9, 2021, the U.S. Food and Drug Administration (FDA) approved the use of triple-combination therapy (elexacaftor/tezacaftor/ivacaftor) for children with cystic fibrosis ages 6 through 11 who have at least one copy of the F508del mutation. The label extension made 3,954 children eligible, and 2,772 (68.8 percent) were prescribed triple-combination therapy, including 1,066 who were prescribed a CFTR modulator for the first time.

By the end of 2021, 25,497 people were eligible for CFTR modulators and 22,237 had at least one prescription reported in the Registry. Among those individuals currently eligible, 87.6 percent were prescribed a CFTR modulator as of their last encounter of 2021. As shown in the chart below, a large majority of individuals on a CFTR modulator are on elexacaftor/tezacaftor/ivacaftor. Ivacaftor, lumacaftor/ivacaftor, tezacaftor/ivacaftor, and elexacaftor/tezacaftor/ivacaftor were prescribed for 1,412, 1,089, 563, and 19,263 individuals, respectively. The number of eligible individuals who were not prescribed a CFTR modulator fell from 3,246 (13.9 percent) in 2020 to 3,170 (12.4 percent) in 2021.

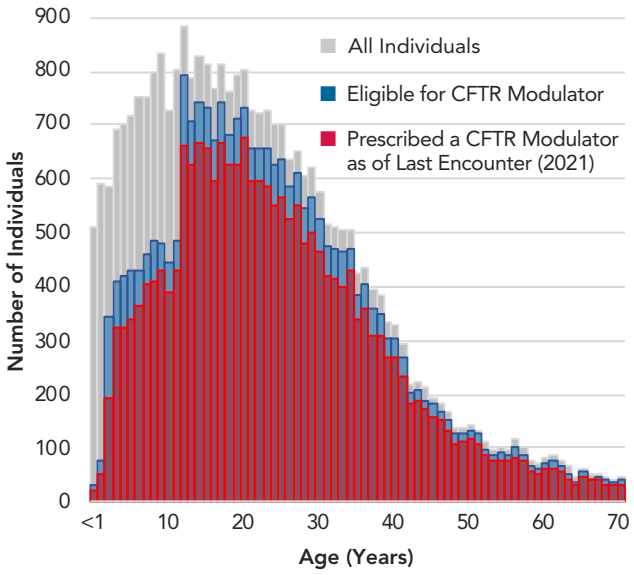
CFTR Modulators by Year, 2014–2021

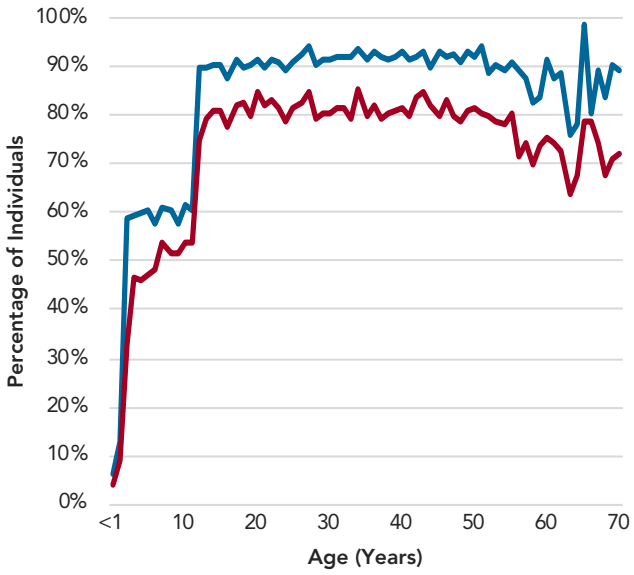


	2014	2015	2016	2017	2018	2019	2020	2021
Total Eligible	1,764	10,428	12,817	15,196	17,082	23,125	23,325	25,497
% Eligible on Modulators	60.6%	48.3%	52.3%	58.8%	69.0%	69.2%	86.1%	87.6%
Total on Modulators	1,069	5,041	6,704	8,938	11,788	16,006	20,079	22,327

The graph below shows eligibility and prescription of a CFTR modulator by age.

CFTR Modulator Use by Age, 2021





Variability across centers exists with the proportion of eligible individuals prescribed a modulator ranging from a minimum of 75.9 percent to a maximum of 100 percent. There is more variation in the prescription of modulators in the pediatric patient population.

Modulator Prescription in Eligible Individuals, by Center

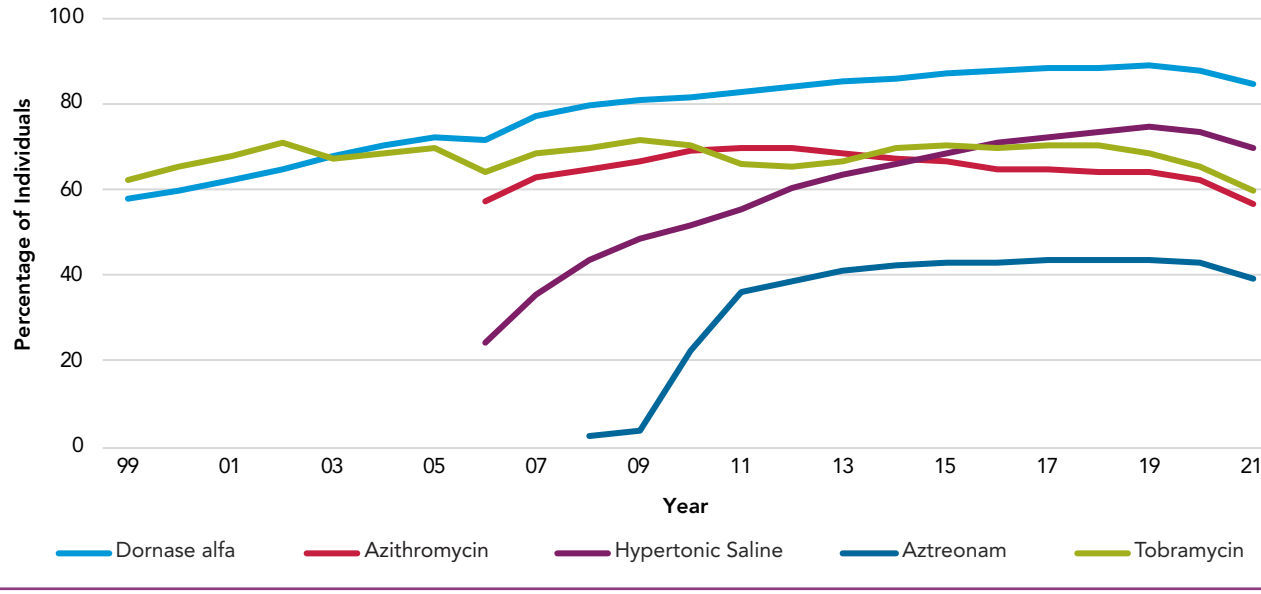
	0 — 50 — 100	Median	Min	Max
Eligible Individuals Prescribed a Modulator		91.0	75.9	100.0
Eligible Individuals Less Than 18 Years Prescribed a Modulator		85.3	60.7	100.0
Eligible Individuals 18 Years and Older Prescribed a Modulator		90.4	73.7	100.0

Pulmonary Therapies

Chronic pulmonary therapies are an important component of the treatment regimen for individuals with CF. This section provides data on uptake and trends in the prescription of pulmonary medications recommended for chronic use by the CF Foundation pulmonary guidelines committee. Data are also provided on medications that are not recommended and on those for which the committee did not find sufficient evidence to recommend for or against chronic use.[35]

The 2021 data suggests there has been a modest decrease in the prescription of many recommended therapies. It will be important to monitor this trend over time. The availability of multiple pulmonary therapies for CF is beneficial; however, this contributes to treatment complexity and overall burden for individuals with CF and their caregivers. Some people with CF who are benefiting from a CFTR modulator have discontinued one or more of their chronic therapies. Studies are underway to assess the impact of stopping these therapies.

Medication Prescription in Eligible Individuals, 1999-2021

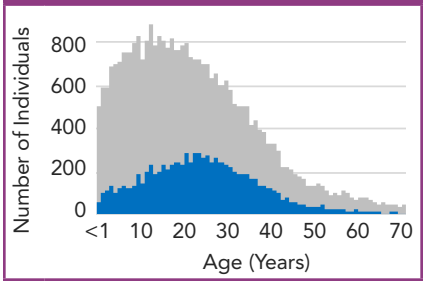


Tobramycin includes all available formulations of inhaled tobramycin. Dornase alfa, tobramycin solution for inhalation, and inhaled aztreonam were approved by the Food and Drug Administration in 1993, 1997, and 2010, respectively.

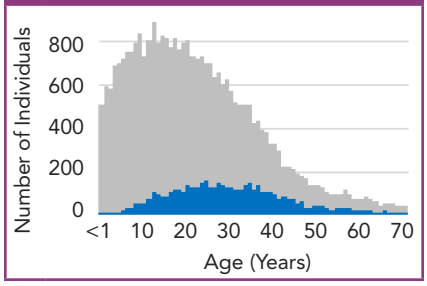
Pulmonary Medication Prescriptions by Age

There are three primary inhaled antibiotics used for treatment of *P. aeruginosa* infections. Tobramycin is used most frequently, followed by aztreonam, and then colistin. For all medications, peak use occurs during adolescence and young adulthood.

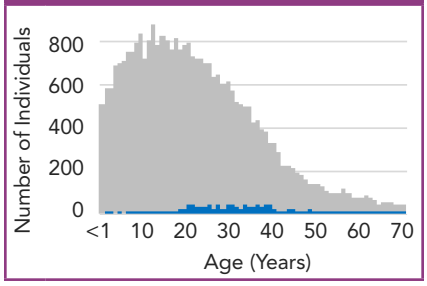
Any Tobramycin



Aztreonam

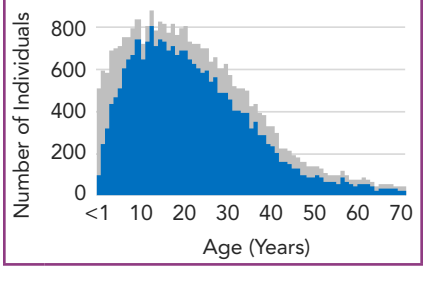


Colistin

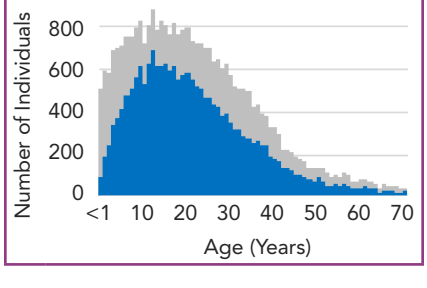


Dornase alfa and hypertonic saline are each prescribed for the majority of individuals with CF. Azithromycin is also widely used in individuals with *P. aeruginosa*, with peak use occurring at slightly older ages than for use of dornase alfa and hypertonic saline.

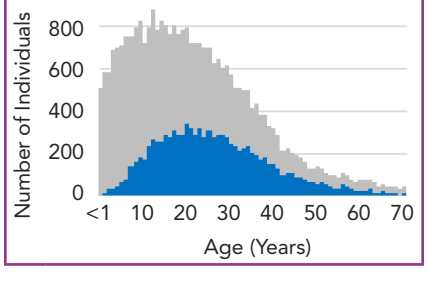
Dornase Alfa



Hypertonic Saline

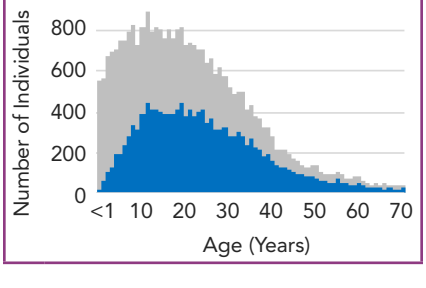


Azithromycin

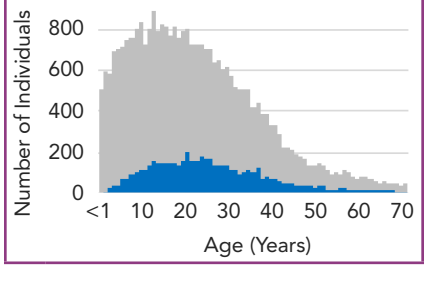


A substantial proportion of individuals with CF are prescribed inhaled corticosteroids and, to a lesser degree, leukotriene modifiers. Oral corticosteroids are used infrequently.

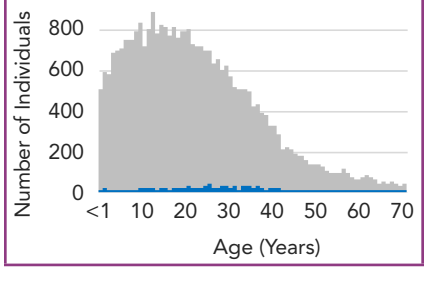
Inhaled Corticosteroids



Leukotriene Modifiers

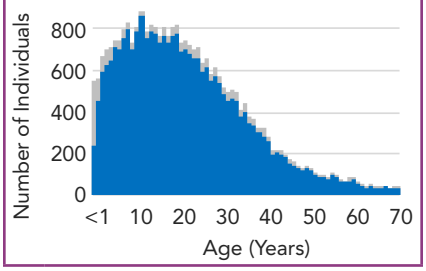


Oral Corticosteroids

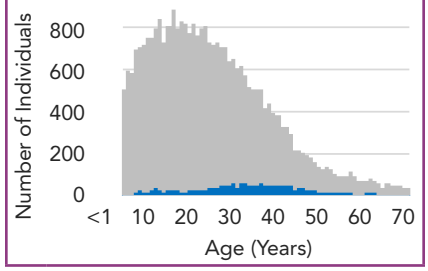


Bronchodilators are used extensively among individuals with CF. Almost all people with CF are prescribed beta agonists and a very small percentage are prescribed anticholinergics. The vast majority of those prescribed beta agonists are on short-acting formulations.

Inhaled Beta Agonists

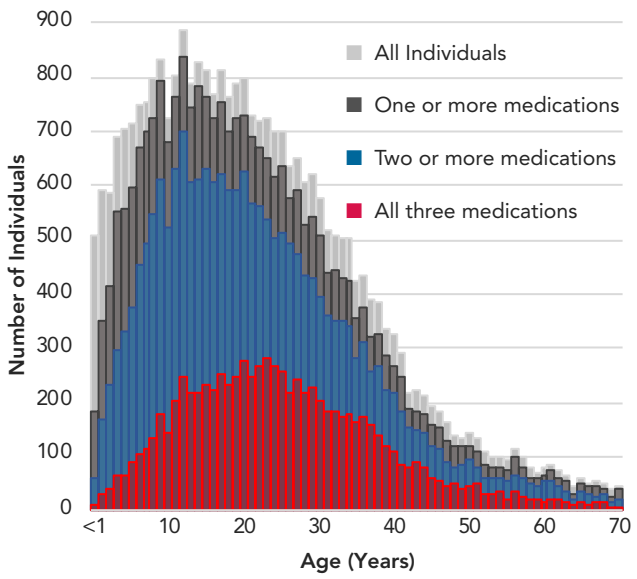


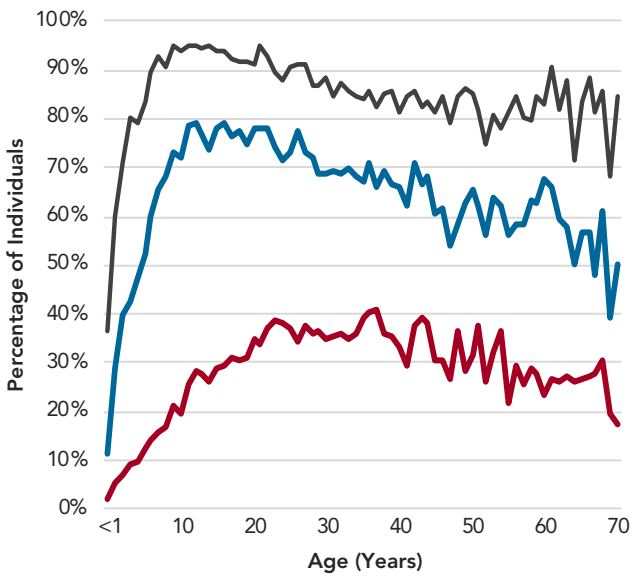
Inhaled Anticholinergics



Multiple pulmonary therapies are available for individuals with CF. Inhaled medications are effective treatments for pulmonary disease, but they require time to prepare, administer, and clean equipment after treatment. Those with *P. aeruginosa* infection or chronic infection are typically prescribed inhaled antibiotics.

Inhaled Medication Prescription by Age in Years, 2021



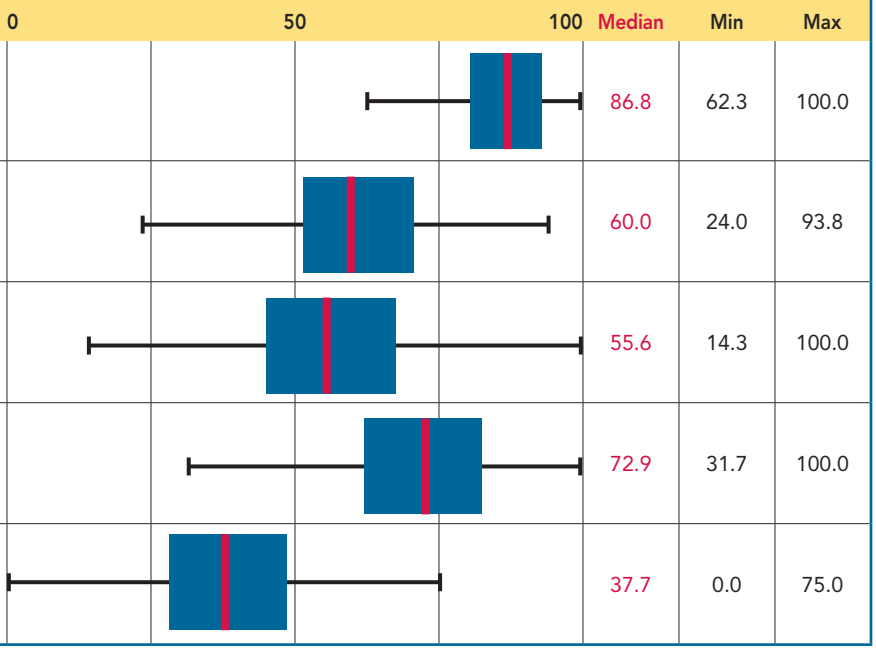


Inhaled medication use in the figure above encompasses dornase alfa, hypertonic saline, and an inhaled antibiotic.

Medications Recommended for Chronic Use

Recommended therapies are widely prescribed. However, there is considerable variation across the CF Foundation Care Center network. Some individuals with CF are using multiple inhaled antibiotics for the treatment of *P. aeruginosa* infections. CFTR modulators are discussed in a separate chapter (p. 47).

Pulmonary Therapies Recommended for Chronic Use, by Center



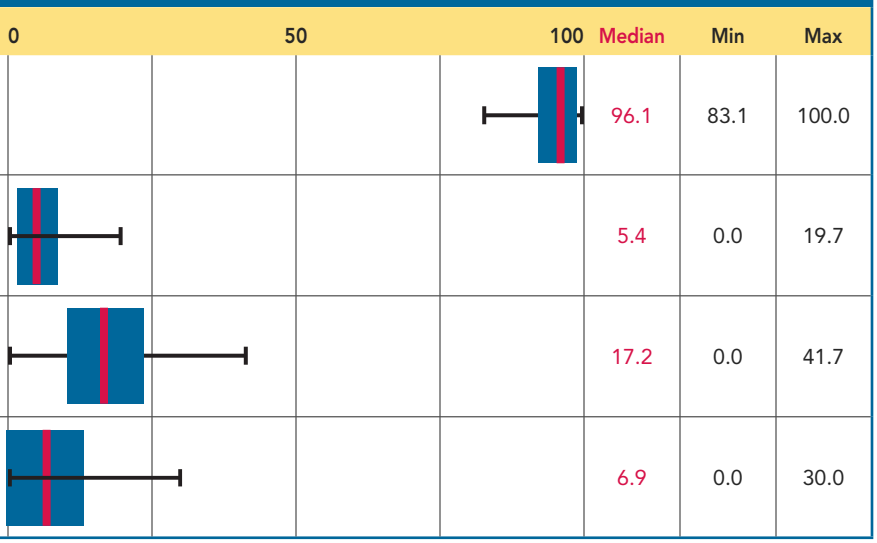
	Median	Min	Max
Dornase Alfa Prescription in Individuals 6 Years and Older	86.8	62.3	100.0
Any Inhaled Tobramycin Prescription in *P. aeruginosa*-positive Individuals 6 Years and Older	60.0	24.0	93.8
Azithromycin Prescription in Eligible *P. aeruginosa*-positive Individuals 6 Years and Older*	55.6	14.3	100.0
Hypertonic Saline Prescription in Individuals 6 Years and Older	72.9	31.7	100.0
Inhaled Aztreonam Prescription in *P. aeruginosa*-positive Individuals 6 Years and Older	37.7	0.0	75.0

**Individuals were considered eligible if they met the selection criteria used in the U.S. trial of azithromycin in individuals chronically infected with* Pseudomonas aeruginosa.[2]

Medications with Insufficient Evidence to Recommend For or Against Chronic Use

In 2013, the CF Foundation pulmonary guidelines committee determined that there was insufficient evidence to recommend for or against the chronic use of inhaled beta agonists, inhaled anticholinergics, inhaled colistin, leukotriene modifiers, and ibuprofen for adults to improve lung function, reduce exacerbations, or improve quality of life.[35] Inhaled beta agonists are used extensively, but the other medications are used infrequently. Use of colistin has decreased in recent years. Adult use of ibuprofen is less than two percent (not shown).

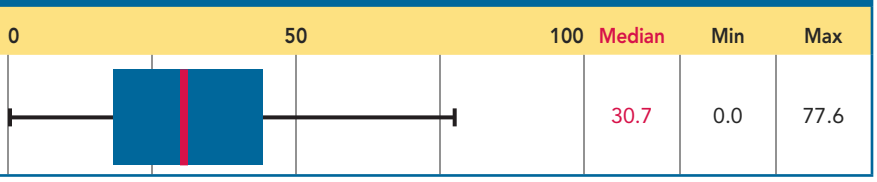
Pulmonary Therapies With Insufficient Evidence to Recommend for or Against Chronic Use, by Center



Medications Not Recommended for Chronic Use

Inhaled steroids continue to be commonly prescribed, despite the recommendation against their chronic use in the absence of asthma or allergic bronchopulmonary aspergillosis (ABPA).[36]

Pulmonary Therapies Not Recommended for Chronic Use, by Center



Medication Use in Young Children

In 2016, the CF Foundation released the first set of guidelines focusing on the preschool timeframe from ages 2 to 5.[17] Although the results of rigorous efficacy trials are not available for this age group, the guidelines recommend that dornase alfa and hypertonic saline be considered depending on individual circumstances. The chart below shows the use of medications among children ages 5 years and younger.

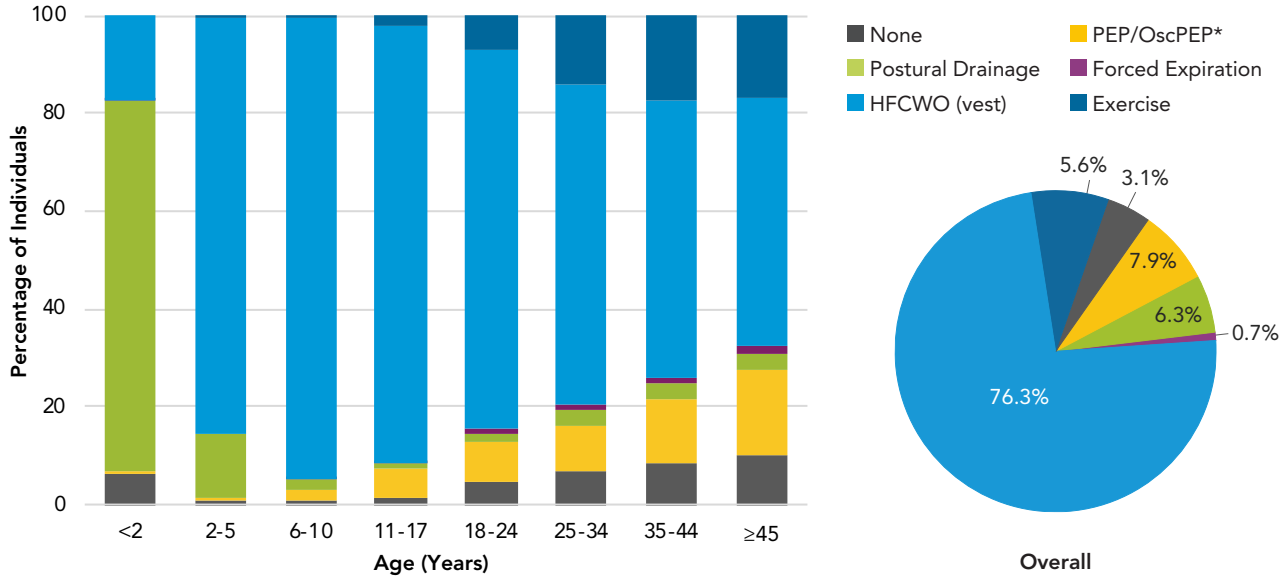
Medication Use in Individuals Under 6 Years, 2021

	Age < 3 Years (%)	Age 3 to 5 Years (%)
Number of Individuals (n)	**1,638**	**2,141**
Dornase alfa	43.6	69.2
Hypertonic saline	33.1	53.5
Inhaled bronchodilators	79.9	93.0
Inhaled corticosteroids	11.3	24.4
Inhaled tobramycin	16.8	17.6
Azithromycin	3.7	8.6
Inhaled aztreonam	1.0	2.8

Airway Clearance Techniques

The CF Foundation pulmonary guidelines recommend airway clearance for all individuals with CF.[36] A high-frequency chest wall oscillation (HFCWO) vest is the most widely used airway clearance technique in persons with CF after infancy. The small percentage using no airway clearance or substituting exercise for airway clearance has grown in the last couple years.

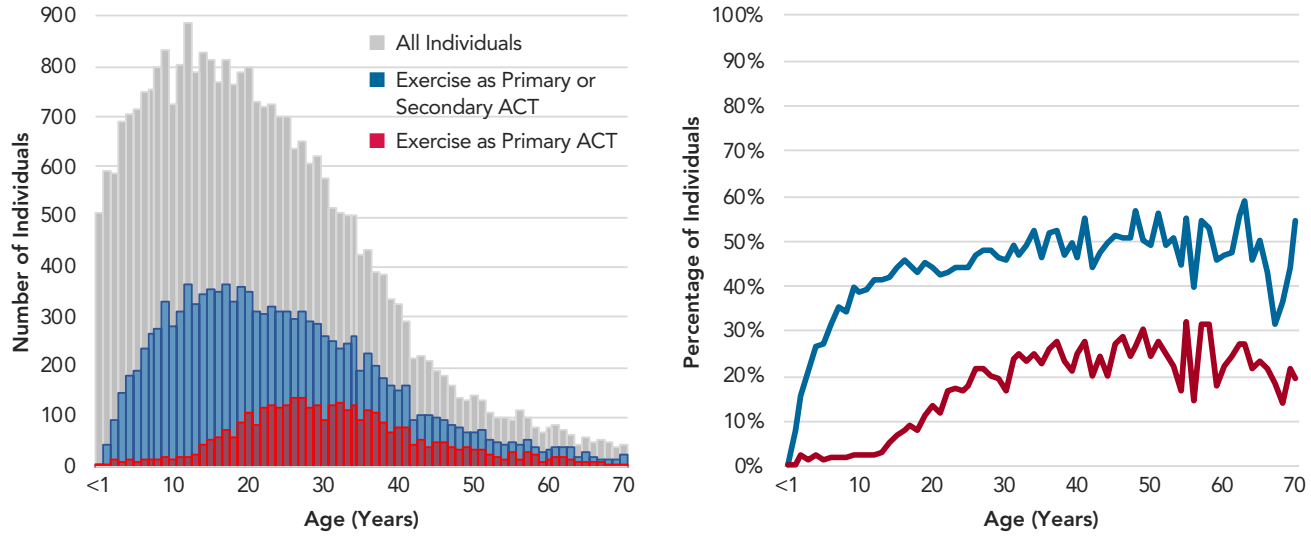
Primary Airway Clearance Techniques by Age and Overall, 2021



**Positive Expiratory Pressure (PEP)/Oscillating Positive Expiratory Pressure (OscPEP)*

The CF Foundation pulmonary guidelines recommend aerobic exercise as an adjunct therapy for airway clearance and for its additional benefits to overall health.[36] Many individuals with CF report exercising in addition to their primary method of airway clearance, with 33.6 percent of children and 46.9 percent of adults using exercise as one of their methods of airway clearance.

Exercise as an Airway Clearance Technique (ACT) by Age in Years, 2021

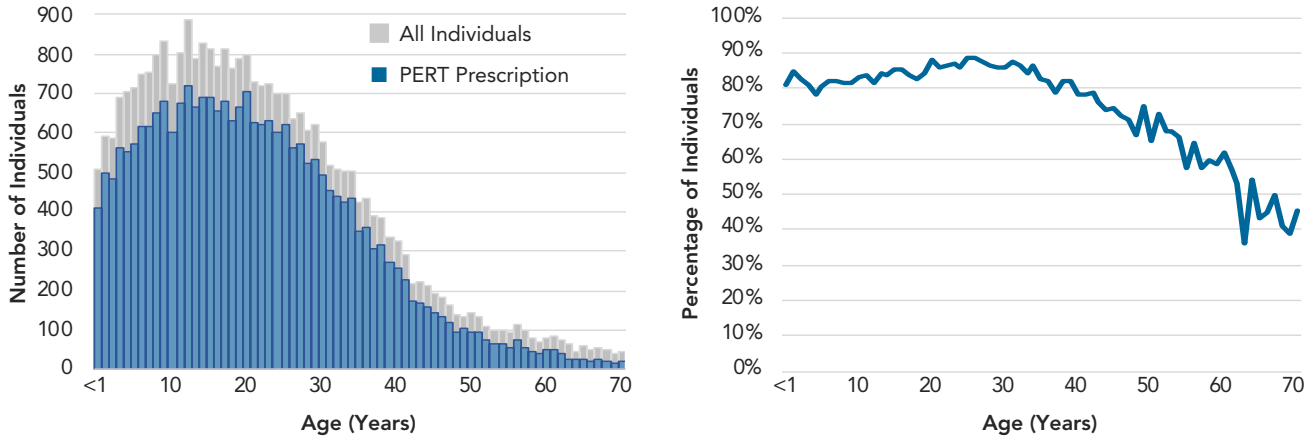


Gastrointestinal (GI) Therapies

The CF Foundation infant clinical care guidelines recommend that pancreatic enzyme replacement therapy (PERT) be started for all infants with two CFTR variants associated with pancreatic insufficiency, a fecal elastase value below 200 µg/g of stool, and/or signs of malabsorption.[27] In addition to pancreatic insufficiency, there is increasing attention on other GI manifestations of CF including Gastroesophageal Reflux Disease (GERD) and CF liver disease.

Overall, a large proportion of individuals of all ages are prescribed PERT. The decrease in the proportion of older individuals with CF prescribed PERT is most likely due to pancreatic sufficient individuals (thus not on PERT) surviving longer.

Pancreatic Enzyme Replacement Therapy (PERT) Prescription by Age in Years, 2021



For individuals aged 2 years and older, the recommended upper limit for enzyme dosing is 2,500 lipase units/kg/meal and a total of 10,000 lipase units/kg/day.[24] The mean dose of lipase units/kg/meal for individuals 2 to 19 years is 1,954, and for individuals 20 years and older, the mean dose is 1,780, suggesting that children and adults on average are not exceeding the maximum recommended dose of PERT.

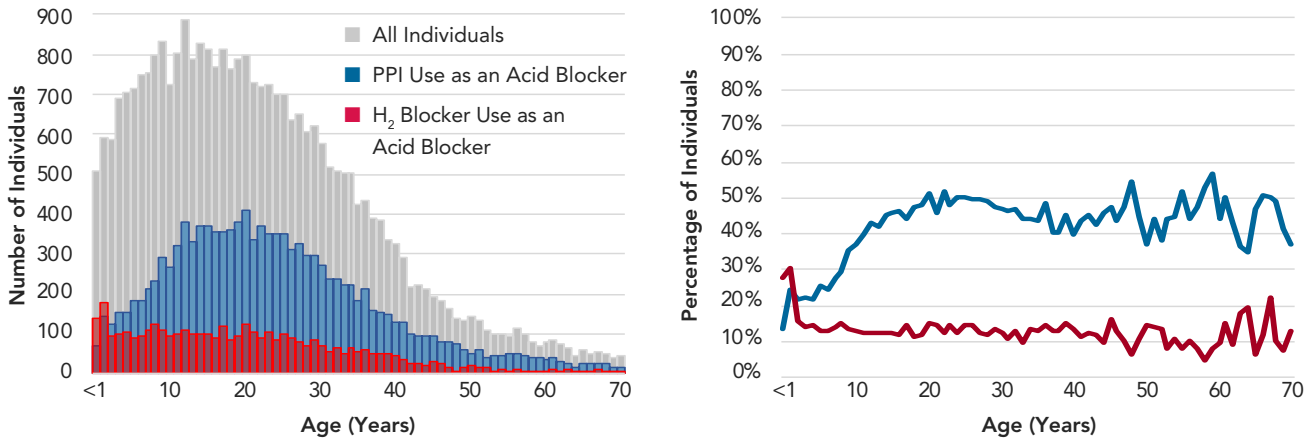
Infants with evidence of pancreatic insufficiency are recommended to receive 2,000 to 5,000 units of lipase total per feeding with adjustments as the infant grows.[7] Registry data show that the mean highest weight-based dose of lipase among children younger than 2 years was 1,678 units/kg/meal.

For infants with CF younger than 2 years, the infant clinical care guidelines recommend assessment of pancreatic functional status by measurement of fecal elastase.[27] Data on fecal elastase test results have been collected in the Registry since 2010, with an increased number of individuals undergoing fecal elastase testing. About 80.0 percent of infants born in 2021 were tested and have a fecal elastase value, an increase from 70.9 percent reported for infants born in 2020. Almost all individuals with a known fecal elastase value of less than 200 µg/g of stool were prescribed PERT. Approximately 33.5 percent of individuals with fecal elastase values greater than or equal to 200 µg/g of stool were also prescribed PERT based on clinical assessment.

Pancreatic Enzyme Use by Fecal Elastase Value in Infants Under 24 Months, 2021		
Pancreatic Enzyme Replacement Therapy	Fecal Elastase Value <200	Fecal Elastase Value ≥ 200
On PERT	864	81
Not on PERT	17	161

Acid blockers are commonly prescribed for people with CF to treat gastroesophageal reflux disease (GERD) and/or to decrease the acidity of the stomach to increase the effectiveness of PERT. Overall, proton pump inhibitors (PPIs) are prescribed more often (41.1 percent of individuals) than H_2 blockers (13.6 percent of individuals). H_2 blockers are used more frequently in younger individuals. Use of PPIs increases until age 20 and overall is prescribed to 46.6 percent of individuals 20 years and older.

PPI and H_2 Blocker Use by Age in Years, 2021



In 2021, 88.4 percent of individuals age 2 to 19 and 76.9 percent of individuals age 20 and older were prescribed CF-specific vitamins, including vitamins A, D, E, and K. With regards to liver manifestations of CF, 12.3 percent of individuals were prescribed ursodeoxycholic acid, which is most commonly prescribed to those with abnormal liver function tests or suspected CF liver disease.

COMPLICATIONS

Recognition and management of the multi-organ system health issues associated with CF is important for maintaining an individual's health and quality of life. Complications of CF can affect many different aspects of health; they can be the direct result of the malfunction or deficiency of the CFTR protein or a downstream effect of the disease or its treatment. The prevalence of some non-pulmonary CF complications is higher among individuals who received a lung transplant than among individuals who have never had a lung transplant.

CFRD remains an important and highly prevalent complication that greatly impacts quality of life and is associated with increased morbidity and mortality. As the population ages, a larger proportion of individuals are reporting complications typically seen in older adults, including bone and joint disease and sinus disease. Furthermore, along with the implementation of mental health screening guidelines,[18] an increase in the reporting of anxiety and depression has been observed, particularly in children and adolescents. In 2021, anxiety disorder and depression were reported in 13.4 percent and 10.2 percent, respectively, in individuals with CF less than 18 years of age as compared to 5.4 percent and 3.6 percent in 2020.

Complications of CF, 2021

	Age < 18 (%)	Age ≥ 18 (%)	All (%)
Number of Individuals (n)	**13,360**	**17,096**	**30,456**
Percent with no complications	26.0	4.1	13.7
Percent with complications not reported[A]	1.3	3.2	2.4
Cystic Fibrosis-Related Diabetes			
Cystic fibrosis-related diabetes (CFRD)[B]	5.0	29.2	18.6
Hepatobiliary			
Gallstones[C]	0.1	0.2	0.2
Gallstones, requiring surgery/procedure[C]	0.1	0.3	0.2
Liver disease, cirrhosis[D]	1.8	4.1	3.1
Liver disease, non-cirrhosis[C]	3.4	3.2	3.3
Acute hepatitis[C]	0.1	0.1	0.1
Hepatic steatosis	0.5	0.9	0.7
Liver disease, other[C]	1.4	1.7	1.5
Bone/Joints			
Arthritis/arthropathy	0.2	5.8	3.3
Bone fracture[C]	0.2	0.2	0.2
Osteopenia	1.0	18.0	10.5
Osteoporosis	0.3	7.5	4.3
Pulmonary			
Allergic bronchopulmonary aspergillosis (ABPA)	1.8	7.0	4.7
Asthma	25.9	34.8	30.8
Hemoptysis	0.3	2.8	1.7
Hemoptysis, massive[C]	*<0.1*	*0.3*	*0.2*
Pneumothorax requiring chest tube[C]	<0.1	0.2	0.1

Table continues on the next page

Complications of CF, 2021 *continued*			
GI	**Age < 18 (%)**	**Age ≥ 18 (%)**	**All (%)**
Distal intestinal obstruction syndrome (DIOS)[C]	1.7	1.8	1.8
Fibrosing colonopathy/colonic stricture[C]	<0.1	<0.1	<0.1
Gastroesophageal reflux disease (GERD)	30.0	42.2	36.8
GI bleed requiring hospitalization (non-variceal)[C]	<0.1	<0.1	<0.1
History of intestinal or colon surgery	5.2	2.7	3.8
Pancreatitis[C]	0.5	1.1	0.9
Peptic ulcer disease[C]	<0.1	<0.1	<0.1
Rectal prolapse[C]	0.5	0.1	0.3
Mental Health[E]			
Anxiety disorder	13.4	28.0	24.7
Depression	10.2	29.6	25.2
Other Complications			
Cancer confirmed by histology[C]	0.0	0.3	0.2
Hearing loss	1.3	3.8	2.7
Hypertension	0.5	7.2	4.2
Kidney stones[C]	0.1	1.2	0.7
Nasal polyps requiring surgery[C]	1.4	0.9	1.1
Renal failure requiring dialysis[F]	<0.1	0.1	0.1
Sinus disease	18.7	52.1	37.3

[A] *Individuals for whom the complications case report form was not completed were considered to not have any complications, as in previous years.*

[B] *See table on page 64 for secondary complications.*

[C] *At the end of 2015, the data entry for complications was revised such that acute complications would no longer carry forward from one encounter to the next. We hypothesize that this impacted the number of reported acute complications in subsequent years.*

[D] *See table below for secondary complications.*

[E] *Percentages for mental health disorders include individuals age 12 and older at the end of the reporting year. In years prior to 2021, reporting included all individuals.*

[F] *Cause other than CFRD.*

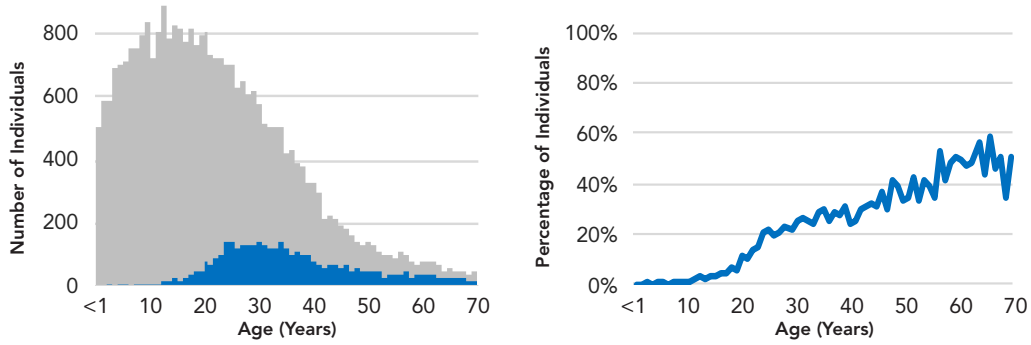
The table below highlights the prevalence of clinical manifestations of portal hypertension among individuals with cirrhosis.

Complications of Cirrhosis, 2021 (n=924)			
	Age < 18 (%)	**Age ≥ 18 (%)**	**All (%)**
Number of Individuals (n)	**241**	**683**	**924**
Esophageal varices	18.3	24.3	22.7
Gastric varices	8.3	4.7	5.6
GI bleed related to varices	2.1	2.9	2.7
Splenomegaly	39.4	33.7	35.2
Hypersplenism	12.0	11.7	11.8
Encephalopathy	0.8	2.0	1.7
Ascites	3.7	7.0	6.2

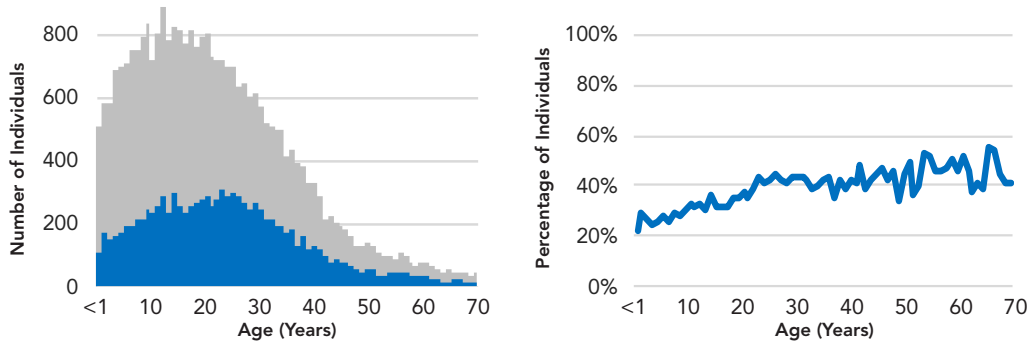
CF Complications by Age

Reported complications differ in their distribution by age. Some are relatively stable over time while others increase with age. The prevalence of bone disease and GERD is higher in the older age groups. The prevalence of asthma peaks during adolescence and then decreases among adults, while the prevalence of sinus disease increases in adolescence and in young adults and remains high through the older ages. The prevalence of CFRD is higher in adolescence and adulthood. ABPA and DIOS are less common overall but occur in all age groups.

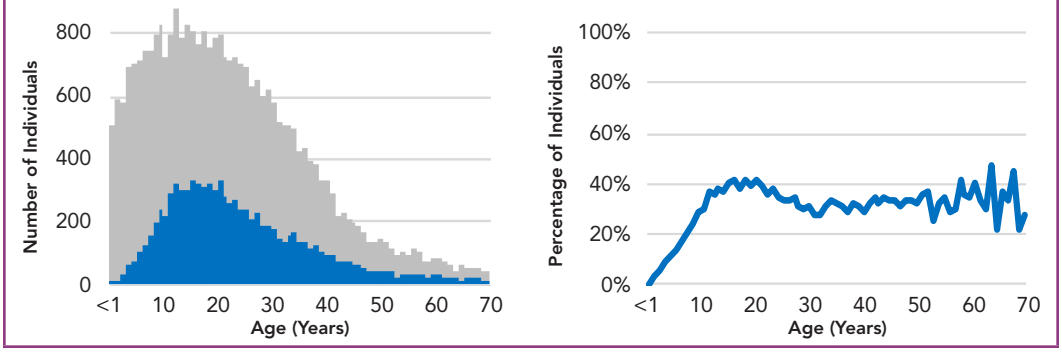
Bone Disease (Osteopenia, Osteoporosis, or Bone Fracture)



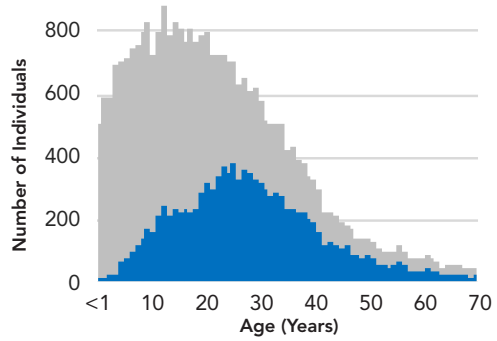
Gastroesophageal Reflux Disease (GERD)

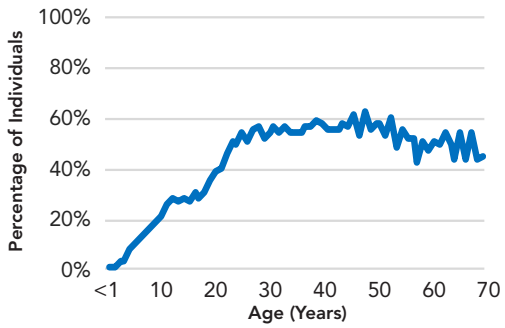


Asthma

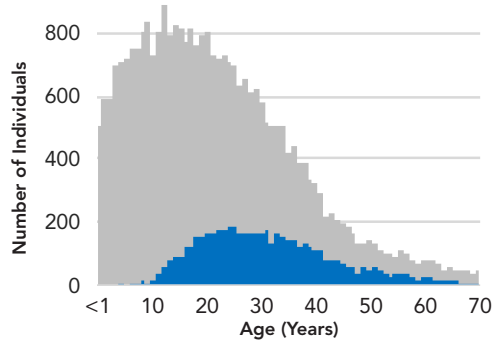


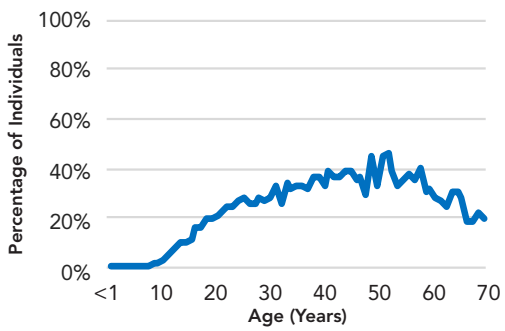
Sinus Disease



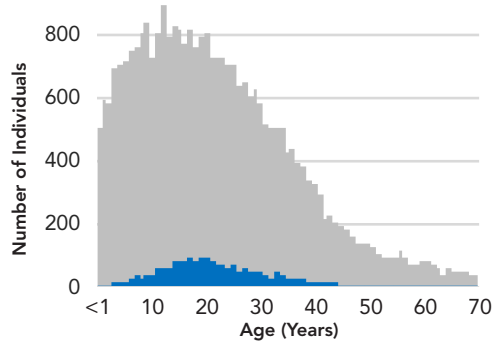


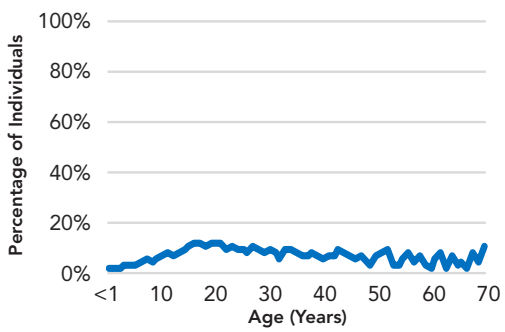
Cystic Fibrosis-Related Diabetes (CFRD)



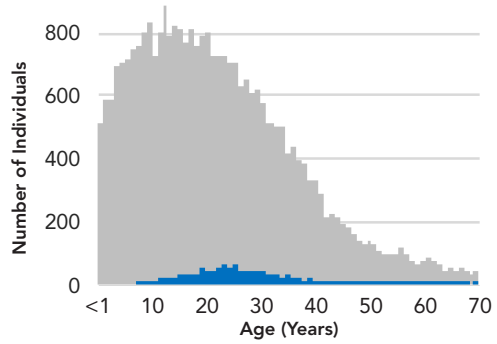


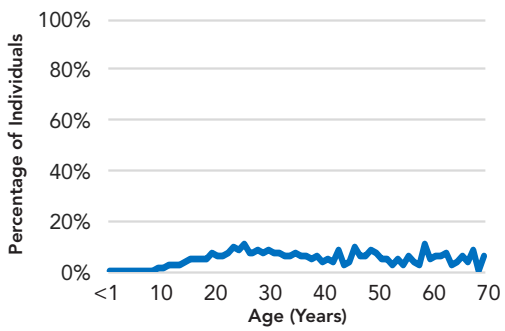
Liver Disease (All Types)





Allergic Bronchopulmonary Aspergillosis (ABPA)



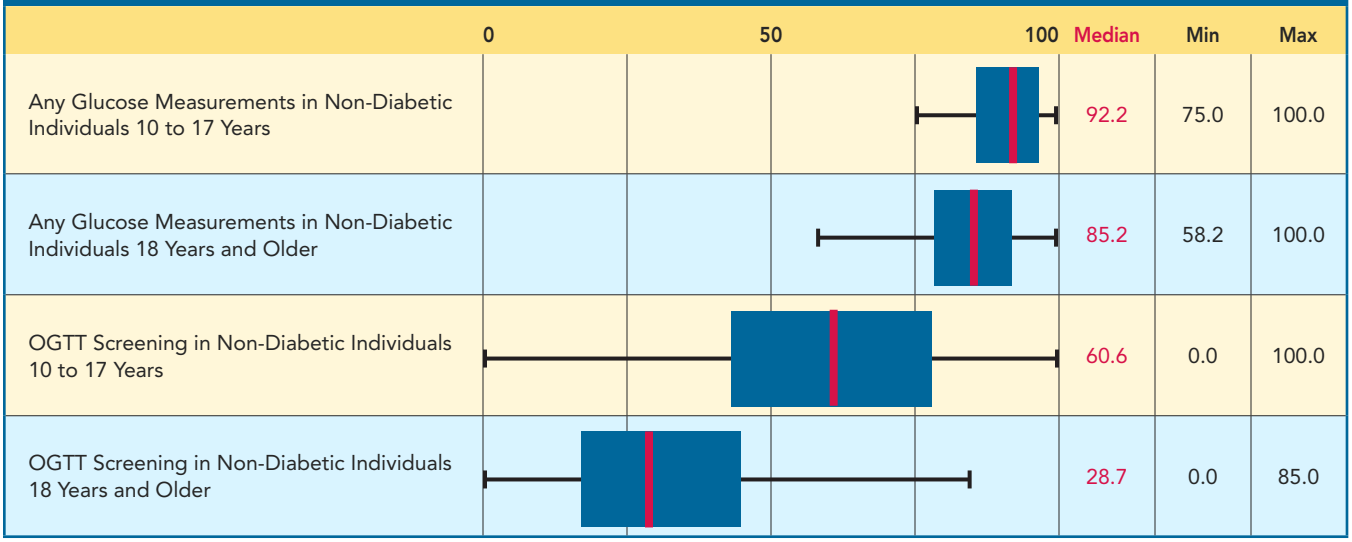


Cystic Fibrosis-Related Diabetes (CFRD)

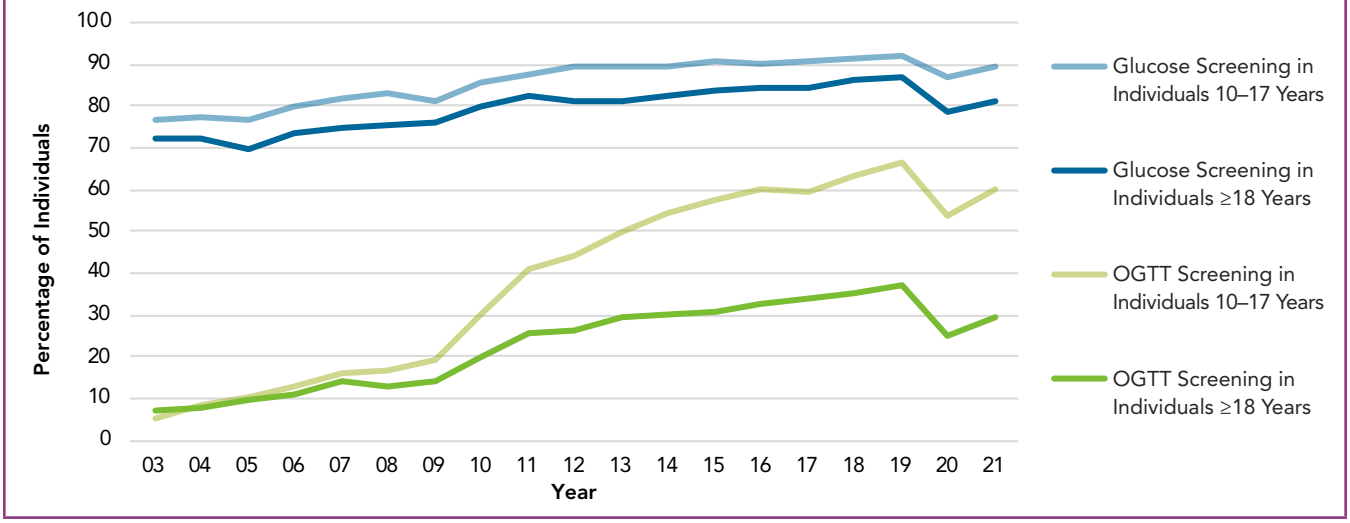
CFRD is an important complication of CF and is associated with weight loss, lung function decline, and increased mortality.[37] Early diagnosis and treatment may minimize the impact of CFRD. The CF Foundation/American Diabetes Association clinical practice guidelines for CFRD recommend screening all individuals annually, starting at age 10, with an oral glucose tolerance test (OGTT).[37]

Blood glucose testing is routinely performed at most CF care centers. The recommended OGTT is used less frequently, and substantial variation exists across CF care centers. It is encouraging to note that rates of screening adolescents for CFRD using the OGTT continue to increase (with the exception of 2020) since the CF Foundation clinical care guidelines for CFRD were published in 2010,[37] while screening of adults lags behind.

Percentage of Non-Diabetic Individuals Receiving Glucose Testing, by Center

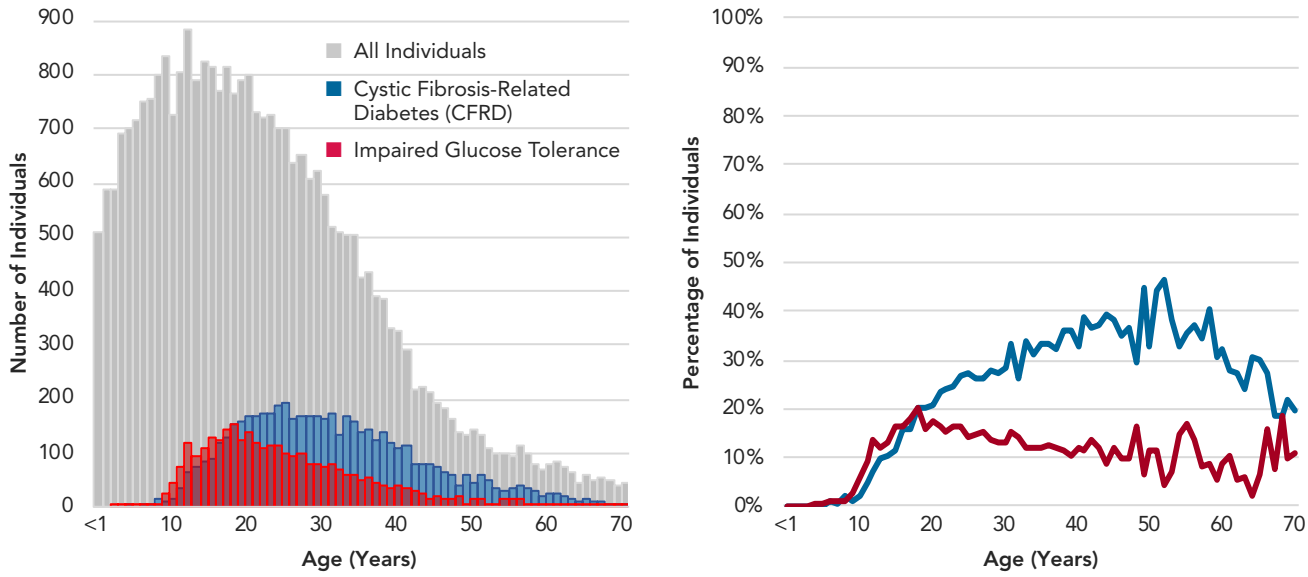


Blood Glucose and OGTT Screening for Individuals without CFRD, 2003–2021



Prevalence of CFRD is higher among adults as compared to children with CF. Impaired glucose tolerance is most prevalent in adolescence; these individuals are at increased risk for developing CFRD and may benefit from increased monitoring.

CFRD and Impaired Glucose Tolerance by Age in Years, 2021



The vast majority of individuals who were diagnosed with CFRD are noted in the Registry as being treated with insulin, as recommended in the CF Foundation CFRD clinical care guidelines.[37]

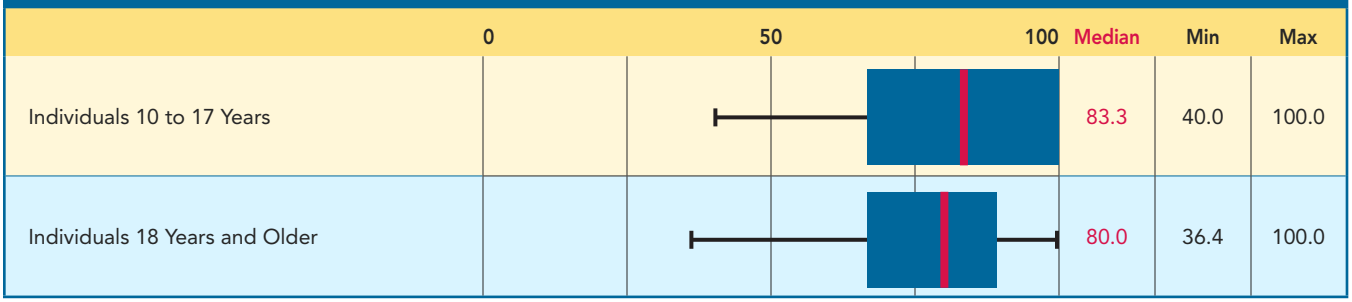
CFRD Treatment in 2021

	Percentage of People with CFRD on Treatment
Dietary change	23.6
Oral hypoglycemic agents	3.6
Intermittent insulin (with illness, steroids, etc.)	4.5
Chronic insulin	69.4
No treatment noted in reporting year	15.4

The data are not mutually exclusive and represent CFRD treatment at any point during the year.

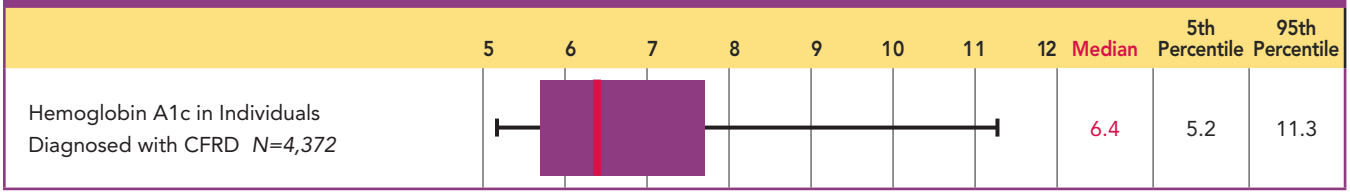
The clinical practice guidelines recommend regular hemoglobin A1c (HbA1c) measurements for individuals with CFRD.[37] Although there is variation by CF care centers in the percentage of individuals with CFRD with one or more HbA1c measurements during the year, the majority of centers test most of their patients at least annually.

Percentage of Individuals with CFRD with One or More Hemoglobin A1c Measurement, by Center



The goal established by the CF Foundation guidelines for CFRD is an HbA1c less than 7.0 percent for individuals with CFRD.[37] More than half of individuals with CFRD are meeting this guideline.

Hemoglobin A1c Lab Values Reported, 2021



Rates of secondary complications of CFRD, including retinopathy, microalbuminuria, kidney disease, and neuropathy remain low. Episodes of severe hypoglycemia can be dangerous in individuals with CFRD. In 2021, they occurred more in adults compared to children (4.8 percent vs. 3.8 percent). As the CF population continues to age, adult CF care providers should continue to screen individuals for these complications, as recommended by the CF Foundation clinical care guidelines for CFRD.[38]

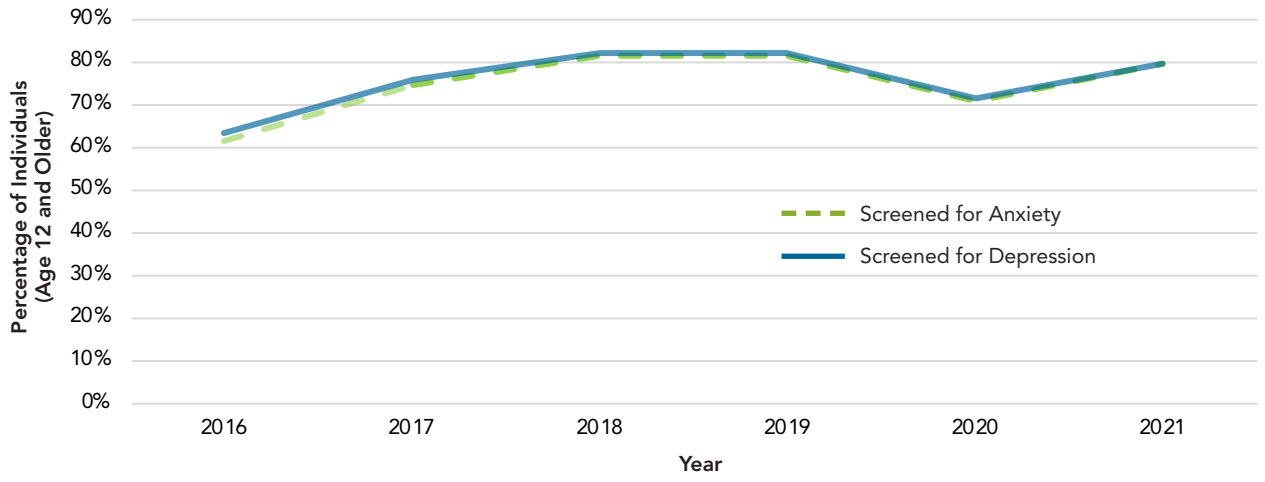
Complications of CFRD in 2021

	Age < 18 (%)	Age ≥ 18 (%)	All (%)
Number of Individuals (n)	**665**	**4,996**	**5,661**
Retinopathy	0.0	1.0	0.9
Microalbuminuria	0.0	1.2	1.1
Chronic renal insufficiency	0.0	1.9	1.7
Chronic renal failure requiring dialysis	0.0	0.2	0.1
Peripheral neuropathy	0.2	1.5	1.3
Any episodes of severe hypoglycemia	3.8	4.8	4.7

Depression and Anxiety

Addressing the mental health of all individuals with CF is critical to maintaining their overall health and quality of life. In 2015, the CF Foundation and the European CF Society published guidelines on screening and treatment for depression and anxiety among individuals with CF and caregivers of children with CF.[18] These guidelines recommend annual screenings for all individuals with CF who are age 12 and older, as well as caregivers of children with CF. The graph below shows recovery of screening rates for anxiety and depression in 2021 to near pre-pandemic levels.

Depression and Anxiety Screening for Individuals 12 Years Old and Older, 2016–2021



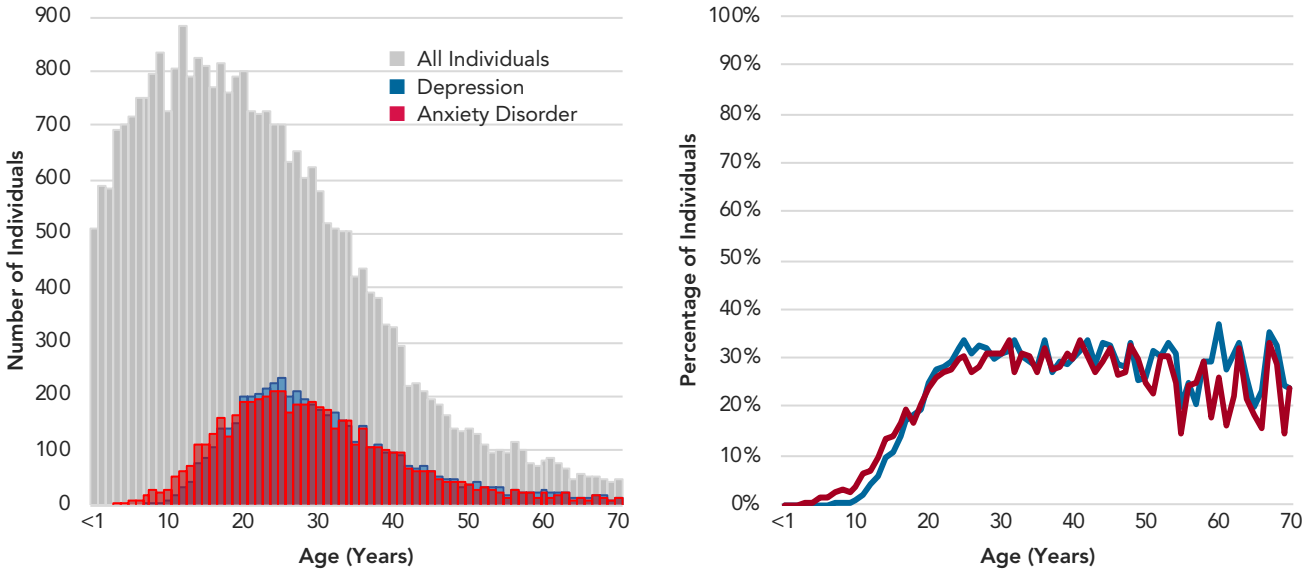
No significant differences are observed between screening rates for adolescents and adults. Of note, wide variation in screening across the CF Care Center network remains.

Percentage of Individuals with Mental Health Screening, by Center

	0 — 50 — 100	Median	Min	Max
Depression Screening Performed in Individuals 12 to 17 Years		83.3	45.5	100.0
Depression Screening Performed in Individuals 18 Years and Older		87.2	48.0	100.0
Anxiety Screening Performed in Individuals 12 to 17 Years		83.3	48.5	100.0
Anxiety Screening Performed in Individuals 18 Years and Older		86.3	49.0	100.0

Prevalence of both anxiety and depression increases through adolescence and early adulthood, then remains high at older ages. There is substantial overlap and many individuals experience both anxiety and depression. Among individuals who report anxiety or depression, 47.1 percent report both conditions.

Depression and Anxiety by Age in Years, 2021



TRANSPLANTATION

Historically, many transplant procedures in individuals with CF are lung transplants, but other types of transplants are performed as well. Lung transplantation remains an option for some individuals with severe lung disease. The number of lung transplant procedures for individuals with CF fluctuates yearly and there was an overall upward trend until 2020 when a marked decrease occurred and continued in 2021.

In 2021, there were 1,849 individuals in the Registry who were reported to have ever received a lung, kidney, heart, or liver transplant.

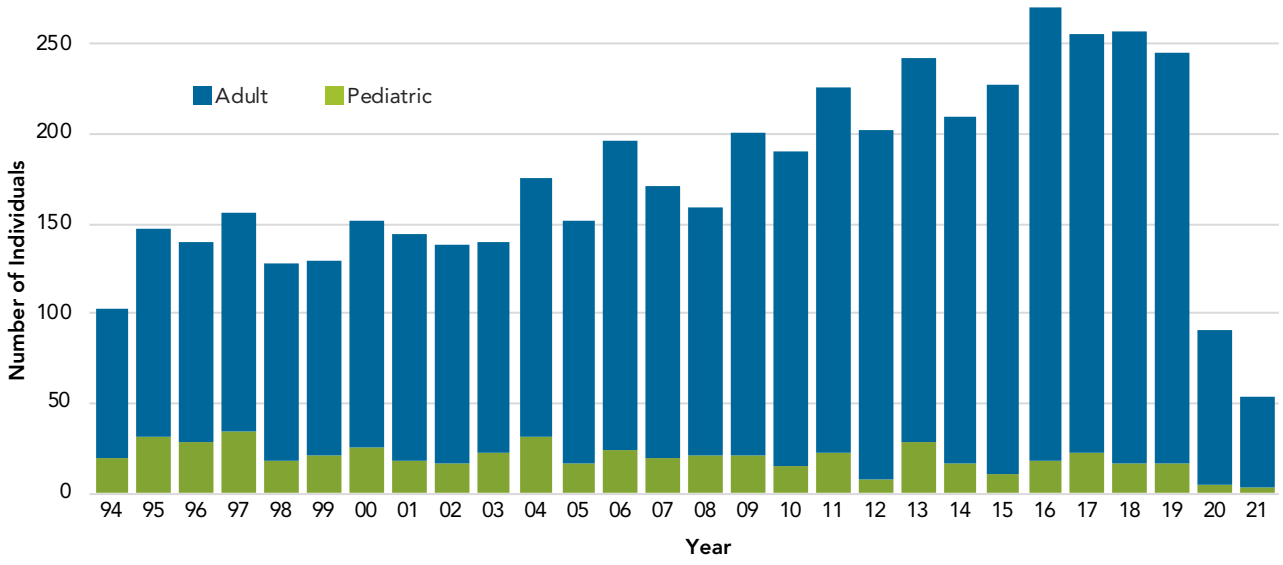
Transplant Status of People with CF in 2021 (All Organs)

	Number of Individuals
Accepted, on waiting list	33
Evaluated, rejected	83
Received transplant this year	87
Received transplant in a prior year	1,762

Lung Transplantation

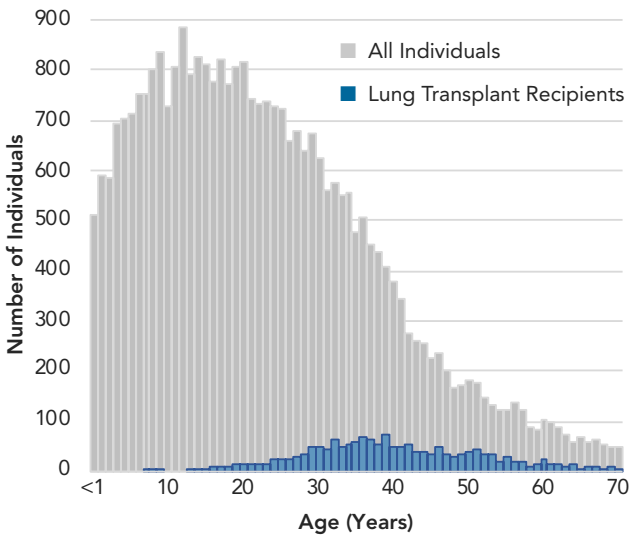
There were 1,645 individuals who have ever reported having a lung transplant in the Registry in 2021. A total of 54 individuals with CF were reported as receiving a lung transplant in 2021, as compared to 2,524 total lung transplants (for any underlying cause) reported by United Network for Organ Sharing.[38] From the early 1990's to 2019, there was a steady increase in the number of lung transplants per year reported among individuals with CF. The number of lung transplants reported to the Registry in 2020 and 2021 was far lower than the number reported in 2019. This stands in contrast to the modest decrease in the overall number of lung transplants performed in the United States over the same time frame. The decrease in CF lung transplants coincides with the availability of elexacaftor/tezacaftor/ivacaftor for individuals with CF.

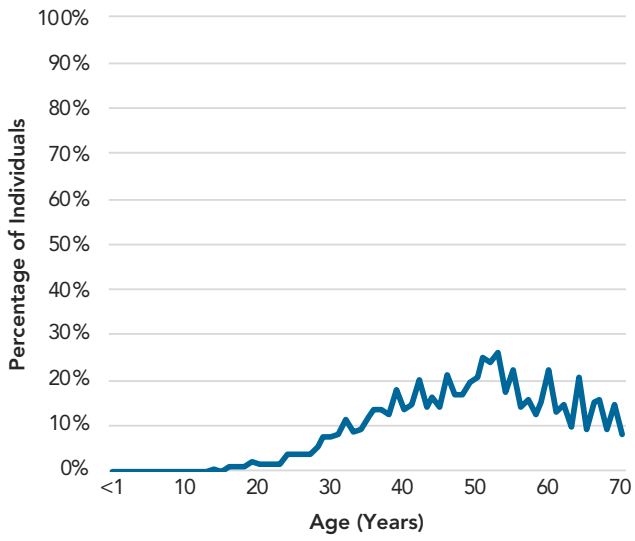
Number of Individuals Receiving a Lung Transplant, 1994-2021



Overall, lung transplant recipients are 5.1 percent of all individuals with CF included in the Registry; the majority are age 30 years and older.

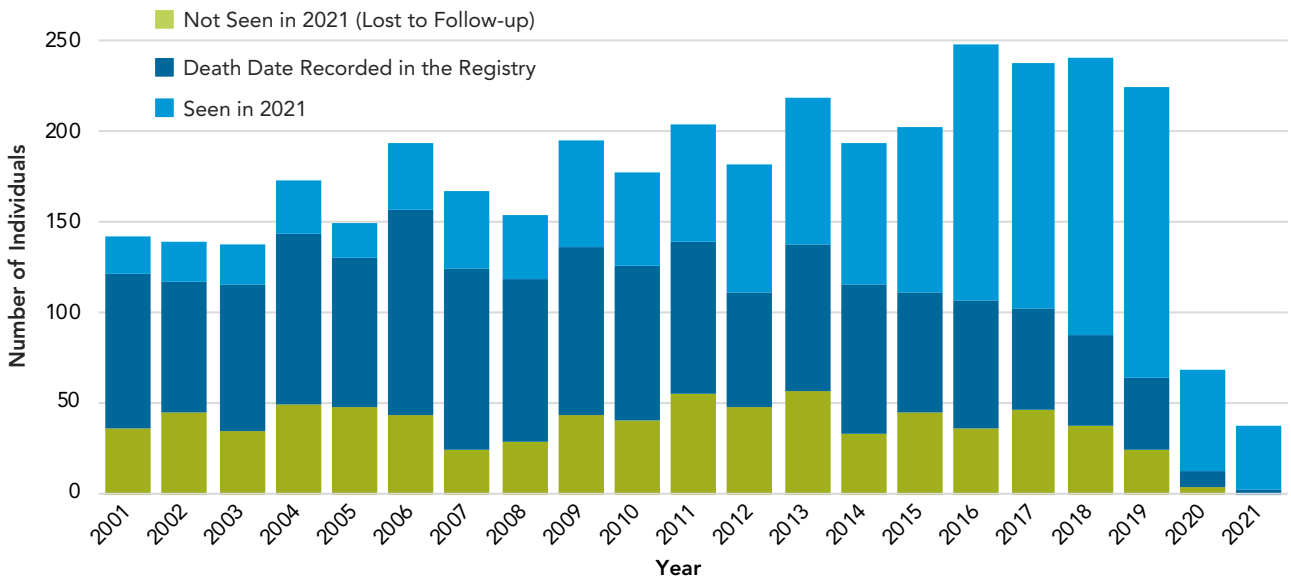
Lung Transplant Distribution in People with CF Seen in 2021





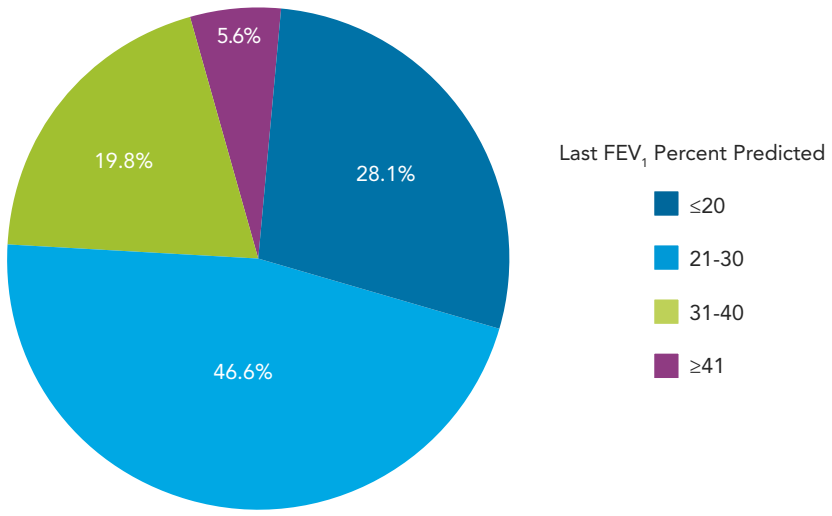
While most CF care occurs within CF Foundation-accredited care centers, transplant and post-transplant care typically occurs at transplant centers. Some of these individuals are lost to follow-up in the Registry. Optimal care for CF transplant recipients should include periodic follow-up at a CF Foundation-accredited Care Center.

Status of Lung Transplant Recipients by Year of Transplant, 2001-2021



The last documented FEV_1 percent predicted prior to lung transplant demonstrates that the majority of individuals have FEV_1 percent predicted values less than 30 percent with 28.1 percent having FEV_1 percent predicted values less than 20 percent. The data underscore the severity of disease at the time of transplant and the potential benefit of earlier conversations about lung transplantation.[39]

Last FEV_1 Percent Predicted Prior to Lung Transplant, 2019-2021 (N=324)



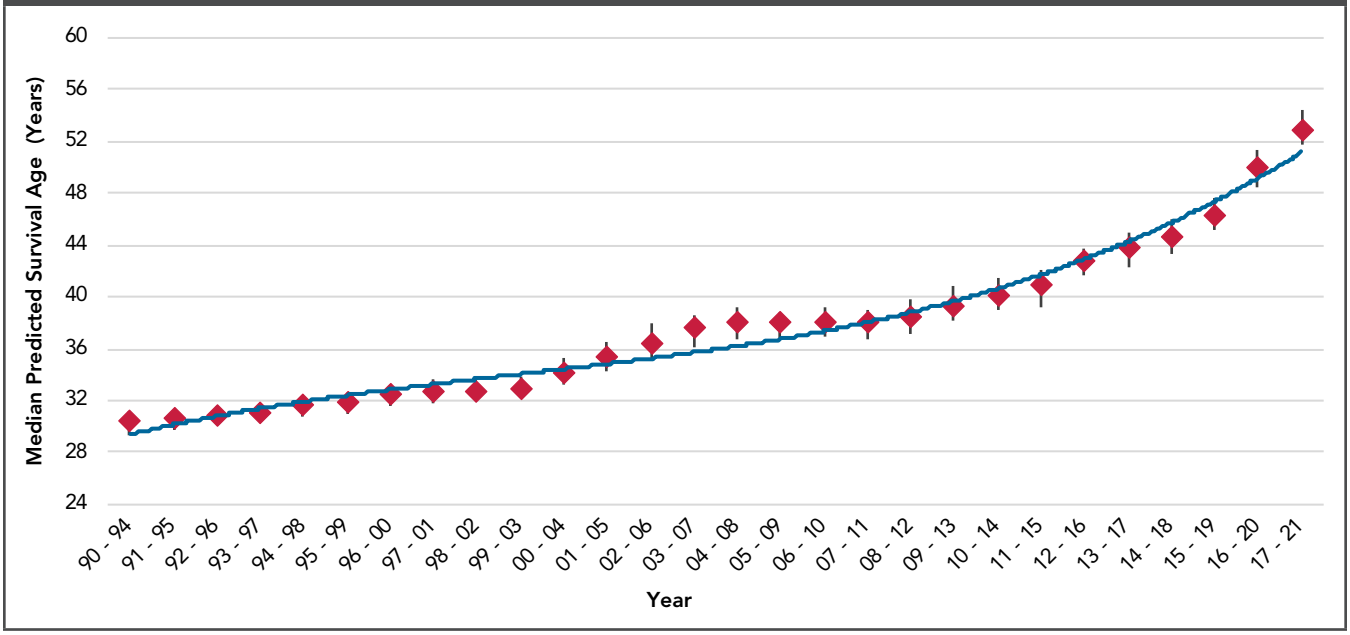
SURVIVAL

There have been substantial improvements in the survival of people with CF over the last few decades. There are several different metrics to describe the survival of people living with CF in the United States. Definitions for these metrics are provided in the Technical Supplement, available on cff.org. All individuals with CF, including lung transplant recipients, are included in the calculations below.

Median Predicted Survival

The median predicted survival age in of an individual born with CF in 2021 was 65.6 years (95 percent confidence interval: 59.2 - 71.1 years). Given the instability of annual survival estimates due to the relatively low number of deaths in any given year, the data are more accurate when grouped into five-year increments. The following graph shows gains in median predicted survival from 1990 to 2021 in five-year increments.* For individuals born between 2017 and 2021, the median predicted survival age was 53.1 years (95 percent confidence interval: 51.6 - 54.7 years). This means that half of individuals born from 2017 to 2021 are predicted to live beyond 53.1 years of age. This prediction assumes no further improvement in mortality rate and, thus, does not take into account the potential impact of CFTR modulators on younger CF patients and other improvements in clinical care.

Median Predicted Survival Age, 1990–2021 In Five Year Increments

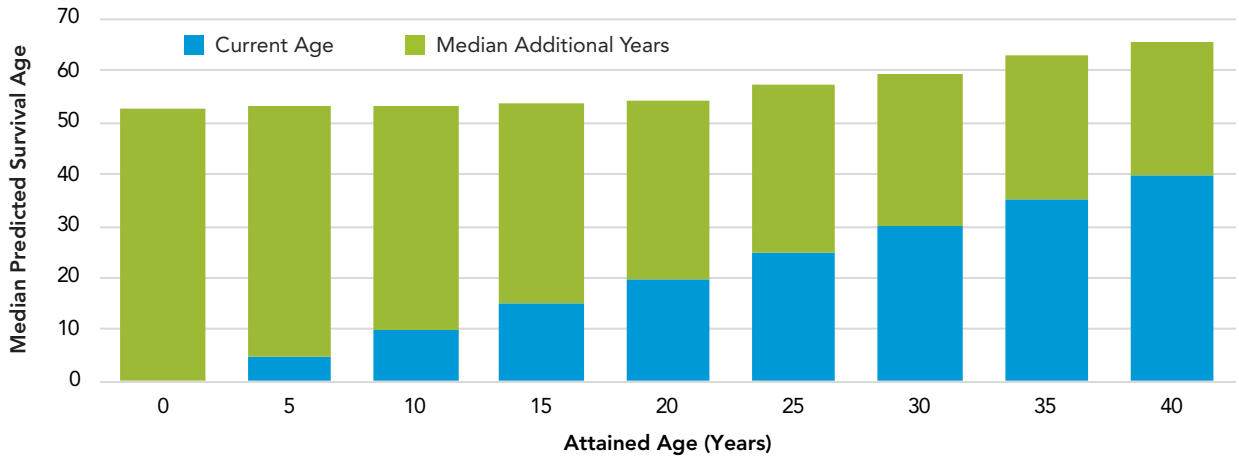


**Using the currently recommended method for calculating median predicted survival. For more information about the methodology, please see the Technical Supplement available at cff.org.*

Median Conditional Predicted Survival

Median conditional predicted survival at specific ages is another metric to help understand changes in survival over time. This metric reflects the population-based median for all individuals of a specific attained age and does not take individual characteristics into consideration. The figure ends at age 40 because the numbers at older ages are currently too small to accurately predict survival. This metric does not take into account the potential impact of CFTR modulators and other improvements in clinical care.

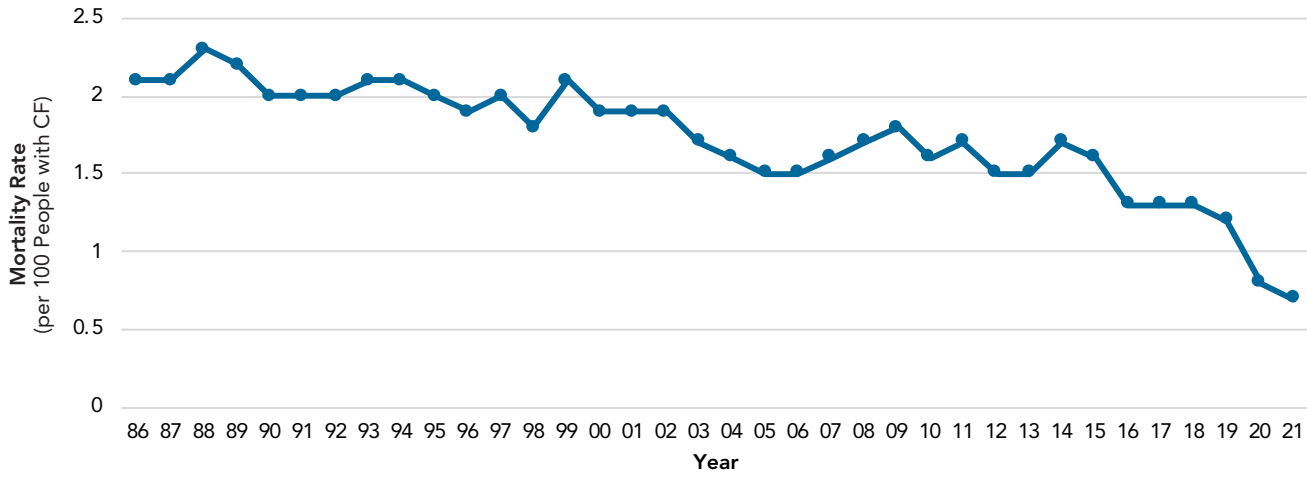
Median Conditional Predicted Survival Based on Attained Age, 2017-2021



Mortality Rate

The mortality rate in 2021 was 0.7 deaths per 100 individuals with CF in the Registry. There has been a steady decrease in the mortality rate over the last 30 years. This is encouraging and has resulted with an increase in the median age of individuals in the Registry from 12.5 years in 1991 to 21.4 years in 2021.

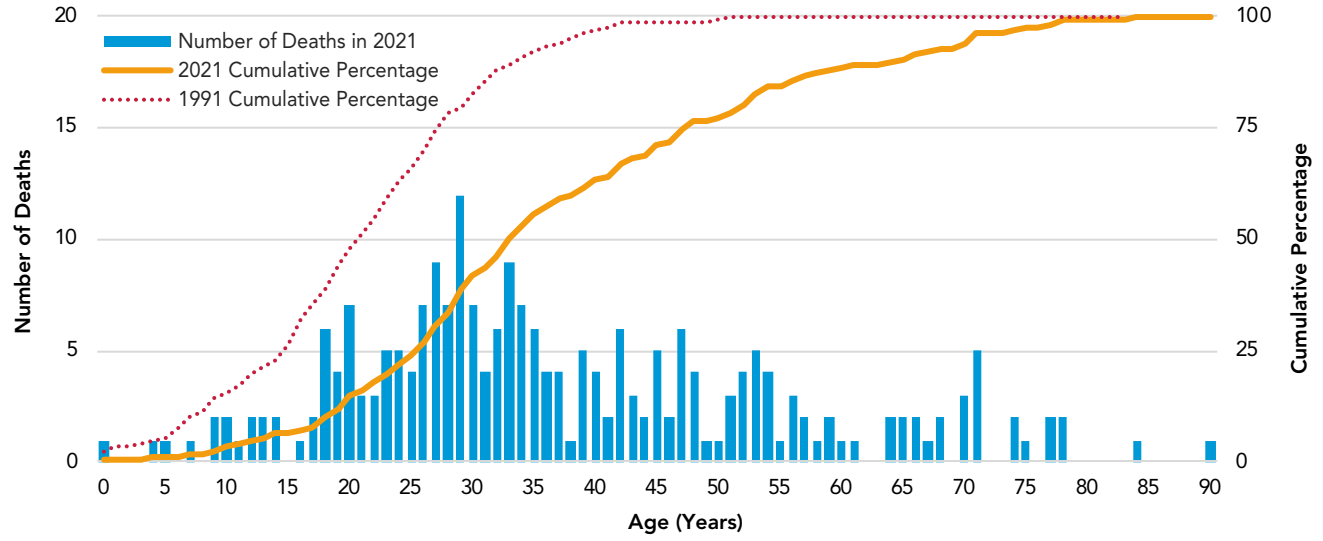
Annual Mortality Rate (per 100 people with CF), 1986-2021



Median Age at Death

The median age at death was 33.9 years for the 232 people with CF who were reported to have died in 2021. About 11 percent of deaths occurred before 20 years of age. A comparison of the cumulative percentage for age at death between 1991 and 2021 shows a substantial shift of the curve toward the right with a larger proportion of deaths occurring at older ages. The median age at death reflects the age distribution of deaths in 2021 and cannot be used to predict survival of the entire population.

Age at Death in 2021 (with 1991 Cumulative Percentage for Comparison)



Causes of Death

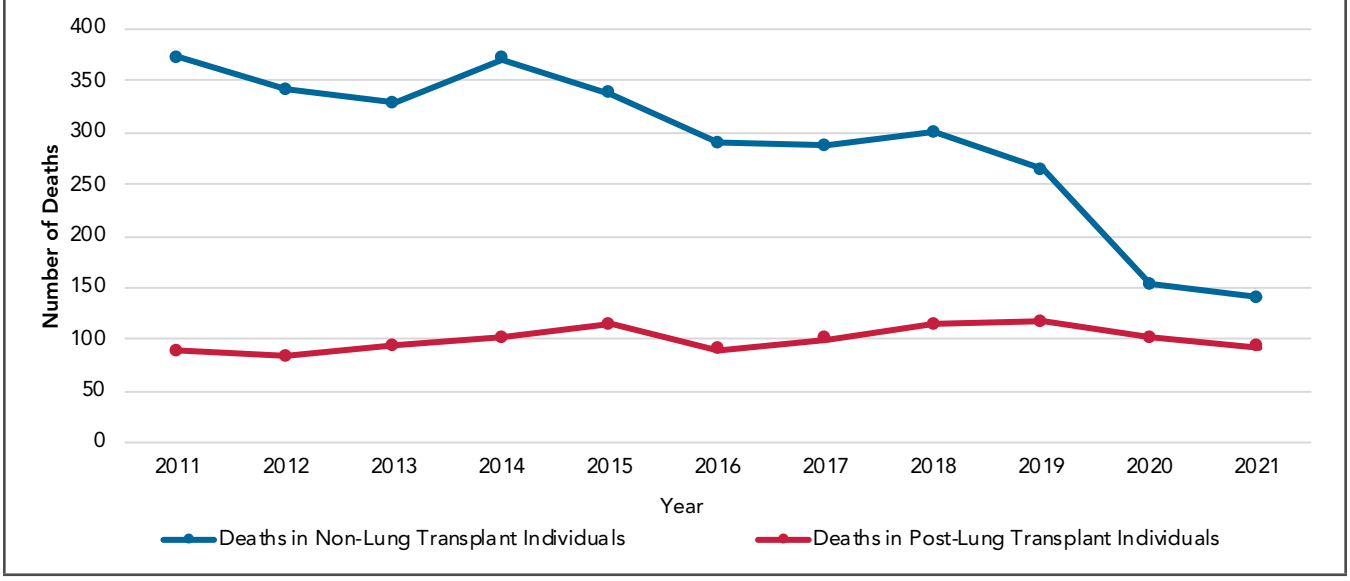
Among the 232 deaths in 2021, the primary causes were respiratory/cardiorespiratory and transplant-related, similar to previous years. Of these, 42.2 percent of deaths occurred in people who were F508del homozygotes, reflecting their distribution in the Registry. Although 5.1 percent of people in the Registry are post-transplant, 95 of the 232 deaths (40.9 percent) occurred in transplant recipients. Note that the primary cause of death for these individuals was not always categorized as transplant-related. COVID-19 was a contributing factor in eight deaths.

Primary Cause of Death in 2021

Cause	Number of Individuals	Percentage
Respiratory/cardiorespiratory	103	44.4
Transplant-related	47	20.3
Other	40	17.2
Unknown	29	12.5
Liver Disease/Liver Failure	6	2.6
Suicide or Drug Overdose	7	3.0

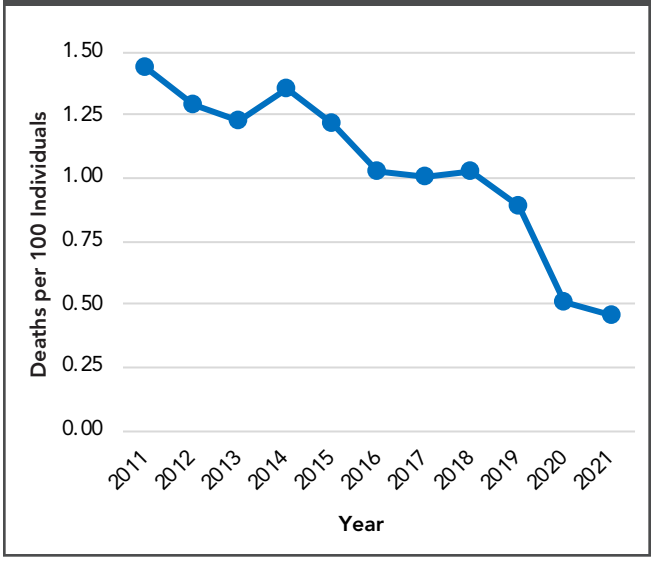
The graph below shows the number of deaths of lung transplant recipients and non-transplanted individuals with CF.

Number of Deaths by Lung Transplant Status, 2011-2021

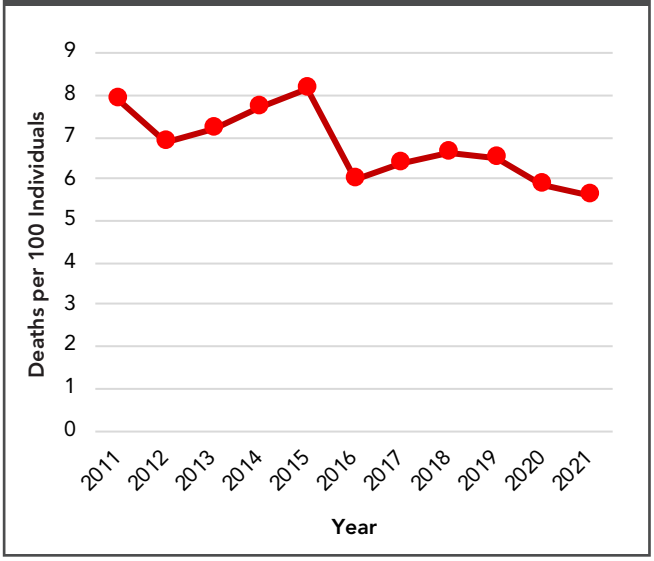


Despite the stable number of deaths in transplant recipients the increasing number of transplant recipients reported to the Registry in previous years contributes to a decrease in mortality rate for both groups of patients. It is important to note that not all CF lung transplant recipients return to a CF Foundation accredited program for care and missing data may impact these findings.

Mortality Rate (per 100 Non-lung transplant individuals)



Mortality Rate (per 100 Post-lung transplant individuals)



2021 Cystic Fibrosis Foundation Patient Registry Questionnaire

DEMOGRAPHIC DATA

Demographics

CFF Patient Number: _____
Last Name: _____
Last Name at Birth (if different): _____
First Name: _____
Middle Name: _____
Last 4 digits of SSN: _____
Date of Birth: (MM/DD/YYYY)
State of Birth: _____
Gender: ○ Male ○ Female
Current Zip: _____
Is patient residing in the US permanently?
○ Yes ○ No
Emergency Phone: _____
Email: _____

Race/Ethnicity Information

Race:
○ White
○ Black or African American
○ American Indian or Alaska Native
○ Asian
○ Native Hawaiian or Other Pacific Islander
○ Some other race
○ Two or more races
If two or more races, specify Mixed Race components:
☐ White
☐ Black or African American
☐ American Indian or Alaska Native
☐ Asian
☐ Native Hawaiian or Other Pacific Islander

Is the Patient of Hispanic Origin?
○ Yes ○ No ○ Unknown

Death Information

Date of Death: (MM/DD/YYYY)

Check if date of death is approximate: ☐

Primary Cause of death:
○ Respiratory/cardiorespiratory
○ Liver Disease/Liver Failure
○ Trauma
○ Suicide
○ Transplant related: Bronchiolitis obliterans
○ Transplant related: Other
○ Drug Overdose
○ Other
○ Unknown

Additional Information

Additional Information: _____

CF DIAGNOSIS

History of patient diagnosis*

Date of Diagnosis: (MM/DD/YYYY)
Date is an approximation: ☐

Diagnosis:
○ Cystic Fibrosis
○ CFTR-related metabolic syndrome
○ CFTR-related disorder
○ CF, CRMS and CFTR-related disorder all ruled out

Patient was diagnosed with CF after false negative result by newborn screening:
○ Yes ○ No ○ Unknown

Diagnosis Suggested by the following:
☐ Acute or persistent respiratory abnormalities
☐ CBAVD (absent vas deferens) or related abnormalities
☐ Digital clubbing
☐ DNA Analysis
☐ Edema
☐ Electrolyte imbalance
☐ Elevated immunoreactive trypsinogen (IRT) at CF newborn screening
☐ Failure to thrive/malnutrition
☐ Family history
☐ Infertility/GU abnormalities
☐ Less than 2 identified disease causing mutations
☐ Liver problems
☐ Meconium ileus/other intestinal obstruction (provide details below)
○ meconium ileus with perforation
○ meconium ileus without perforation
Other neonatal bowel obstruction: _____
☐ Nasal polyps/sinus disease
☐ Newborn (neonatal) screening
☐ Non-diagnostic sweat chloride value(<60 mmol/L)
☐ Pancreatitis (not explained by other etiologies)
☐ Persistent respiratory colonization/infection with a typical CF pathogen(s) (e.g., Pseudomonas aeruginosa)
☐ Prenatal screening (CVS, amnio)
☐ Pulmonary mycobacterial infection
☐ Rectal prolapsed
☐ Repeat Normal Sweat Testing
☐ Steatorrhea/abnormal stools/malabsorption
☐ Transepithelial potential differences
☐ Other, specify: _____
☐ Unknown

Date & value of documented positive quantitative pilocarpine iontophoresis sweat test (Chloride)*

Date of Test: MM/DD/YY
Value (mmol/L): _____
Quantity Not Sufficient: ☐

If sweat test value <=60, CF diagnosis was suggested by:

☐ DNA Analysis/genotyping
☐ Transepithelial potential differences
☐ Clinical presentation (pancreatic fxn tests, Microbiology, etc.)
☐ Unknown

Key:
FORM NAME
○ radio buttons (select one option only)
☐ check box (multiple selections allowed)

*repeated entries can be recorded
[ ] indicates values calculated by the registry

2021 Cystic Fibrosis Foundation Patient Registry Questionnaire

Parents' Information *(information not required for patients 21 years of age and older)*
Not available: ☐
Mother height: _____ ○ cm ○ inches
Father height: _____ ○ cm ○ inches

Birth Measurements
Baby delivered:
○ Full term (>= 37 weeks gestational age)
○ Premature (< 37 weeks gestational age)
○ Unknown

Specify gestational age(only if premature):_____
Birth length: _____ ○ cm ○ inches
Birth weight:_____ ○ kg ○ lb

Genotype Information
For a list of mutation options, please contact reghelp@cff.org
Has this patient been genotyped? ___ Yes ___ No
Date: (MM/DD/YYYY) Date is an approximation: ☐

Select Mutation 1: _____ Other genotype: _____
Poly T tract: ○ 5T ○ 7T ○ 9T ○ not 5T ○ Unknown
Poly TG repeats: ○ 9 ○ 10 ○11 ○12 ○13
○ Other/unknown/not done

Select Mutation 2: _____ Other genotype: _____
Poly T tract: ○ 5T ○ 7T ○ 9T ○ not 5T ○ Unknown
Poly TG repeats: ○ 9 ○ 10 ○11 ○12 ○13
○ Other/unknown/not done

Select Mutation 3: _____ Other genotype: _____

Additional information about genotype not captured above:_____

ENCOUNTER DATA

Vital Signs/Encounter Start

Encounter date: (MM/DD/YYYY)
Location: ○ Clinic ○ Hospital ○ By Phone
○ By Phone/Computer with Video ○ Other
Height : _____ ○ cm ○ inches
[Height Percentile _____]
Weight : _____ ○ kg ○ lb
[Weight Percentile _____]
[BMI value: _____]
[BMI Percentile: _____]
[Weight for Length percentile: _____]

Exacerbation Assessment
Were there crackles (rales) on physical exam at this visit?
○ Yes ○ No ○ Physical exam data not available

What was your assessment regarding pulmonary exacerbation at this visit?
○ Absent
○ Mild exacerbation
○ Moderate exacerbation
○ Severe exacerbation
○ Don't know/unable to answer

Was a follow up visit scheduled?
○ Yes ○ No ○ Unknown
If Yes, indicate when:*
○ In less than 2 weeks
○ 2-4 weeks
○ 5-6 weeks
○ 7 weeks or later

If you determined that an exacerbation was present, please select the treatment course prescribed to treat the exacerbation:
☐ Increased airway clearance, exercise, and/or bronchodilators
☐ Oral NON-quinolone antibiotic (e.g. azithromycin, Bactrim, Augmentin, etc.)
☐ Oral quinolone antibiotic (e.g. ciprofloxacin (Cipro), levofloxacin)
☐ Inhaled antibiotic
☐ Inhaled antibiotic PLUS Oral NON-quinolone antibiotic
☐ Inhaled antibiotic PLUS an oral quinolone antibiotic
☐ None of the above
If none of the above, the specify:_____
(Note: if you elected to treat with hospital or home IV antibiotics, please start a care episode and enter the requested data.)

Consultations with Care Team Members
☐ Patient consulted with a Social Worker at this visit
☐ Patient was seen by a Dietitian/Nutritionist at this visit
☐ Patient was seen by a Physical therapist at this visit
☐ Patient was seen by a Respiratory therapist at this visit
☐ Patient consulted with a Pharmacist at this visit
☐ Patient was seen by a Mental Health Coordinator at this visit

Other
Record any additional information about this encounter:
Custom field 1:_____
Custom field 2:_____
Custom field 3: _____

Microbiology

Bacterial Culture
Bacterial culture done? ☐
Date of Culture: (MM/DD/YYYY)
Type of Specimen:
○ sputum ○ induced sputum
○ throat/nasal ○ bronchoscopy

Culture Results:
○ Microorganisms ○ Normal flora
○ No growth/sterile culture

Staphylococcus aureus: ☐
○ MRSA (methicillin resistant Staph aureus)
○ MSSA (methicillin sensitive Staph aureus)

Key:
FORM NAME
○ radio buttons (select one option only)
☐ check box (multiple selections allowed)

*repeated entries can be recorded
[ ] indicates values calculated by the registry

2021 Cystic Fibrosis Foundation Patient Registry Questionnaire

Haemophilius influenzae (any species): ☐

Pseudomonas aeruginosa: ☐
☐ mucoid ☐ non mucoid ☐ mucoid status unknown

Susceptibility Testing *(Please use the most resistant PA strain. If multiple PA strains are resistant to the same number of classes of antibiotics then use the following schema: Beta lactams> Quinolones>Aminoglycosides).*

Resistant to All Aminoglycosides Tested (e.g., tobramycin, gentamicin, amikacin):
○ Yes ○ No ○Testing not done

Resistant to All Quinolones Tested (e.g., ciprofloxacin, levofloxacin, moxifloxacin):
○ Yes ○ No ○ Testing not done

Resistant to All Beta Lactams Tested (e.g., ceftazidime, imipenem, meropenem, piperacillin/tazobactam (Zosyn), ticarcillin/clavulanic acid (Timentin), aztreonam):
○Yes ○ No ○ Testing not done

Burkholderia species: ☐
☐ B. gladioli
☐ B. cenocepacia
☐ B. multivorans
☐ Burkholderia – other
☐ B. cepacia ☐ B. stabilis ☐ B. vietnamiensis
☐ B. dolosa ☐ B. anthina ☐ B. ambifaria
☐ B. pyrrocinia ☐ B. ubonensis ☐ B. arboris
☐ B. latens ☐ B. lata ☐ B. metallica
☐ B. seminalis ☐ B. contaminans
☐ B. diffusa ☐ B. pseudomallei

Was the identification of the Burkholderia species confirmed at the CFF reference lab? ○ Yes ○ No ○ Unknown

Other microorganisms:
☐ Alcaligenes (Achromobacter) xylosoxidans
☐ Stenotrophomonas (Xanthomonas)/Maltophilia
☐ Other types:
☐ Acinetobacter baumannii ☐ Acinetobacter species -other*
☐ Agrobacterium species ☐ Bordetella species
☐ Brevundimonas species ☐ Chryseobacterium species
☐ Cupriadidus metallidurans ☐ Cupriavidus pauculus
☐ Cupriavidus respiraculi ☐ Delftia acidivordans
☐ Delftia species - other* ☐ Enterobacter species
☐ Exophilia dermatitidis ☐ Herbaspirillum frisingense
☐ Herbaspirillum seropedicae ☐ Inquilinus limosus
☐ Klebsiella pneumoniae ☐ Klebsiella species - other*
☐ Ochrobacterum species ☐ Pandoraea apista
☐ Pandoraea norimbergensis ☐ Pandoraea pulmonicola
☐ Pandoraea sputorum ☐ Pandoraea species - other*
☐ Pseudomonas mendocina
☐ Pseudomonas pseudoalcaligenes
☐ Pseudomonas putida ☐ Pseudomonas stutzeri
☐ Pseudomonas species - other*
☐ Ralstonia insidiosa ☐ Ralstonia pickettii
☐ Ralstonia species - other* ☐ Serratia marcescens
☐ Streptococcus milleri

Key:
FORM NAME
○ radio buttons (select one option only)
☐ check box (multiple selections allowed)

Fungal/Yeast:
☐ Aspergillus (any species) ☐ Candida (any species)
☐ Scedosporium species

Other bacterial or fungal species: ☐
Specify: _____

Mycobacterial culture
Was Mycobacterial culture done? ☐
Date of Culture: (MM/DD/YYYY)

Type of Specimen:
○ sputum ○ induced sputum ○ bronchoscopy

AFB Smear:
○ Positive ○ Negative ○ Not done

Culture Results:
○ Microorganisms
○ Normal flora
○ No growth/sterile culture

Mycobacterial Species:
☐ Mycobacterial tuberculosis
☐ Mycobacterium abscessus/chelonae
☐ Mycobacterium avium complex (MAC)
☐ Mycobacterium fortuitum group
☐ Mycobacterium gordonae
☐ Mycobacterium kansasii
☐ Mycobacterium marinum
☐ Mycobacterium terrae
☐ Other
Specify: _____
Please note: The option Mycobacterium avium complex (MAC) includes M. avium subsp. Avium, M. avium subsp. Hominissuis, M. avium subsp paratuberculosis, and M. intracellulare.

Medications

Not on Medications
This patient is not on any of the pulmonary medications below: ☐

Pulmonary Medications
Antibiotics – inhaled and/or oral
Tobramycin Based Medications

Tobramycin solution for inhalation (i.e. TOBI): ☐
Frequency: ○ 300 mg BID alternate month schedule
○ 300 mg BID continuous
○ Other regimen (different dose or freq)
○ Eradication
○ PRN/As needed
Tobi Podhaler (Tobramycin Inhalation Powder): ☐
Frequency: ○ Four 28mg capsules BID alternate month
○ Other regimen (different dose or freq)
○ Eradication
○ PRN/As needed

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2021 Cystic Fibrosis Foundation Patient Registry Questionnaire

Bethkis: ☐
Frequency: ○ 300 mg BID alternate month
○ Other regimen (different dose or freq)
○ Eradication
○ PRN/As needed

Other inhaled aminoglycoside (e.g. gentamcin, amikacin, or tobramycin preparation): ☐
Frequency: ○ Alternate Month
○ Continuous
○ Other regimen (different dose or freq)
○ Eradication
○ PRN/As needed

Colistin: ☐
Frequency: ○ Alternate Month
○ Continuous
○ Other regimen (different dose or freq)
○ Eradication
○ PRN/As needed

Aztreonam – Inhaled: ☐
Frequency: ○ 75 mg TID Alternate Month Schedule
○ 75 mg TID Continuous
○ Other Regimen
○ Eradication
○ PRN/As needed

Other inhaled antibiotics: ☐
Comments:_____

Oral macrolide antibiotic: ☐
☐ azithromycin (Zithromax)
☐ clarithromycin (Biaxin)

Other oral antibiotic: ☐
☐ Quinolone (Cipro, Levaquin, gatifloxacin, etc.)
☐ Cephalosporin (cephalexin, Keflex, cefixime, etc.)
☐ Sulfa (Bactrim, Septra, etc.)
☐ Amoxicillin (Augmentin, etc.)
☐ Tetracycline (doxycycline, Vibramycin, minocycline, etc.)
☐ Other

CFTR Modulators
Ivacaftor Monotherapy (i.e. Kalydeco): ☐
Frequency: ○ 50 mg BID
○ 75 mg BID
○ 150mg BID
○ Other Regimen (different dose or freq)
Ivacaftor/Lumacaftor Combination Therapy (i.e. Orkambi): ☐
Frequency: ○ Full dose BID
○ Half dose BID
○ Other Regimen (different dose or freq)
Tezacaftor/Ivacaftor Combination Therapy): ☐
Frequency: ○ Full dose BID
○ Half dose BID
○ Other Regimen (different dose or freq)
Key:
FORM NAME
○ radio buttons (select one option only)
☐ check box (multiple selections allowed)

Elexacaftor/Tezacaftor/Ivacaftor Triple Combination Therapy: ☐
Frequency: ○ Full dose BID
○ Half dose BID
○ Other Regimen (different dose or freq)

Other Medications
Dornase alfa (i.e. Pulmozyme): ☐
Frequency: ○ 2.5 mg QD
○ 2.5 mg BID
○ Other regimen (different dose or frequency)
○ PRN/As needed

Bronchitol (Mannitol): ☐
Frequency: ○ 400 mg BID
○ Other regimen (different dose or frequency)

Acetylcysteine or Mucomist: ☐
High-dose ibuprofen (e.g. 25-30 mg/kg): ☐
Total (mg/dose): _____
Hypertonic saline: ☐
Concentration (%):○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10
Frequency: ○ QD ○ BID ○ Other
○ PRN/As needed

Bronchodilators (oral):
☐ Beta agonist (e.g. Proventil Repetabs, Volmax, etc.)
☐ Theophylline product (e.g. Theodur, Slo-bid, Uniphyl)

Bronchodilators (inhaled)
☐ Short acting beta agonist (e.g. albuterol, Proventil, Ventolin, Xopenex, etc.)
☐ Long acting beta agonist (e.g. salmeterol, Serevent, Foradil, Brovana, etc.)
☐ Short acting anticholinergic (e.g. ipratroprium, Atrovent)
☐ Long acting anticholinergic (e.g. tiotroprium, Spiriva, etc.)
☐ Combination beta agonist and anticholinergic (e.g. Combivent, DuoNeb, etc.)

Corticosteriods:
☐ Oral (e.g. prednisone)
Types:
☐ Prednisone
☐ Methylprednisolone (Medrol)
☐ Dexamethasone
☐ Other
Total (mg/dose): _____
Frequency:
☐ Short Term Less Than Two Weeks
☐ Chronic, Low Dose
☐ Chronic, High Dose
☐ Other
☐ Inhaled (e.g. fluticasone, Flovent, budesonide, Pulmicort, etc.)
☐ Inhaled in combination with a bronchodilator (e.g. Advair, Symbicort)

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Other:

☐ Leukotriene modifiers (e.g. montelukast, Singulair, zafirlukast, Accolate, zileuton, Zyflo, etc.)
☐ Mast cell stabilizers (e.g. cromolyn, Intal, nedocromil, Tilade, etc.)
☐ Antifungals (e.g. itraconazole, Sporanox) Note: exclude topical agents for skin conditions and agents used for oral thrush)

Drug Intolerance/Allergies:

☐ Dornase alfa (i.e. Pulmozyme)
☐ TOBI or other aminoglycoside
☐ Aztreonam
☐ Colistin
☐ Macrolide antibiotics
☐ High-dose ibuprofen
☐ Hypertonic saline
☐ Ivacaftor (i.e. Kalydeco)
☐ Ivacaftor Lumacaftor (i.e. Orkambi)
☐ Tezacaftor/Ivacaftor (i.e. Symdeko)
☐ Elexacaftor/Tezacaftor/Ivacaftor (i.e. Trikafta)

GI/Nutrition/Endrocrine Medications

This Patient is on enzyme medications: ○ Yes ○ No

For all enzymes, "capsules per largest meal" options are:
○ .5 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10 ○ 10+
"Total capsules per day" is a numeric free text field.

Enzymes

Creon

Creon 1203: ☐
Number of capsules per largest meal of the day:____
Total capsules per day:____
Creon 1206: ☐
Number of capsules per largest meal of the day:____
Total capsules per day:____
Creon 1212: ☐
Number of capsules per largest meal of the day:____
Total capsules per day:____
Creon 1224: ☐
Number of capsules per largest meal of the day:____
Total capsules per day:____
Creon 1236: ☐
Number of capsules per largest meal of the day:____
Total capsules per day:____

Pancreaze

Pancreaze MT4: ☐
Number of capsules per largest meal of the day:____
Total capsules per day:____
Pancreaze MT10: ☐
Number of capsules per largest meal of the day:____
Total capsules per day:____
Pancreaze MT16: ☐
Number of capsules per largest meal of the day:____
Total capsules per day:____
Pancreaze MT20: ☐
Number of capsules per largest meal of the day:____
Total capsules per day:____

Ultresa

Ultresa 14: ☐
Number of capsules per largest meal of the day:____
Total capsules per day:____
Ultresa 20: ☐
Number of capsules per largest meal of the day:____
Total capsules per day:____
Ultresa 23: ☐
Number of capsules per largest meal of the day: ____
Total capsules per day: ____

Pertzye (Pancrecarb)

Pertzye 4000: ☐
Number of capsules per largest meal of the day: ____
Total capsules per day: ____
Pertzye 8000: ☐
Number of capsules per largest meal of the day: ____
Total capsules per day: ____
Pertzye 16000: ☐
Number of capsules per largest meal of the day: ____
Total capsules per day: ____
Pertzye 24000: ☐
Number of capsules per largest meal of the day: ____
Total capsules per day: ____

Zenpep

Zenpep 3: ☐
Number of capsules per largest meal of the day: ____
Total capsules per day: ____
Zenpep 5: ☐
Number of capsules per largest meal of the day: ____
Total capsules per day: ____
Zenpep 10: ☐
Number of capsules per largest meal of the day: ____
Total capsules per day: ____
Zenpep 15: ☐
Number of capsules per largest meal of the day: ____
Total capsules per day: ____
Zenpep 20: ☐
Number of capsules per largest meal of the day: ____
Total capsules per day: ____
Zenpep 25: ☐
Number of capsules per largest meal of the day: ____
Total capsules per day: ____
Zenpep 40: ☐
Number of capsules per largest meal of the day: ____
Total capsules per day: ____

Viokace

Viokace 10: ☐
Number of capsules per largest meal of the day: ____
Total capsules per day: ____
Viokace 20: ☐
Number of capsules per largest meal of the day:____
Total capsules per day: ____

Key:

FORM NAME
○ radio buttons (select one option only)
☐ check box (multiple selections allowed)

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Other Enzymes
Please specify if other enzymes: _____

Acid Blocker
Acid Blocker (Daily use. Check all that apply since last visit):
☐ H2 Blocker (e.g. Zantac, Pepcid, etc.)
☐ Proton Pump Inhibitor (e.g. Prilosec, Nexium, etc.)
☐ Unknown

GI other
Ursodeoxycholic acid: ☐

Pulmonary

Pulmonary Function Tests (PFTs)
Unable to Perform test: ☐
Reason why PFTs have not been done: _____
Was pulmonary testing done in PFT lab that adheres to ATS standards? ○ Yes ○ No ○ Unknown

FVC measure (L): _____
[Predicted value:_____]
[Reference equation:_____]
[% Predicted:_____]
[Relative change since previous measurement:_____]
[Days since last measured:____]
FEV1 measure (L): _____
[Predicted value:_____]
[Reference equation:_____]
[% Predicted:_____]
[Relative change since previous measurement:_____]
[Days since last measured:____]
FEF25-75 measure (L/sec): _____
[Predicted value:_____]
[Reference equation:_____]
[% Predicted:_____]
[CF Specific FEV 1 percentile (ages 6-21):]

GI/Nutrition

Assessment of Oral Intake: ○ Done ○ Not done
Is patient currently receiving supplemental feeding?
○ Yes ○ No ○Unknown
Feeding:
☐ oral supplementation (Scandishakes, Pediasure, Instant Breakfast, etc.)
☐ nasogastric tube (NG)
☐ gastrostomy tube/button (G-Tube)
☐ jejunal tube (J-tube)
☐ total parenteral nutrition (TPN)

If using a tube (NG, G-tube or J-tube), was the patient recommended to use pancreatic enzymes with supplemental feedings?
☐ No enzymes recommended with tube feeding
☐ Yes enzymes mixed into the formula
☐ Yes, enzymes administered directly through the tube (i.e. not into the formula)
☐ Yes, enzymes taken by mouth prior to, during and/or after the feeding
☐ Yes, formula infused through Relizorb (enzyme cartridge)
☐ Other

CF specific vitamins (i.e. with additional vitamins A, D, E, and K): ○ Yes ○ No

Infants under 2 years of age
Salt supplementation: ○ Yes ○ No

Select type of feeding:
○ Breast milk ○ Breast milk plus formula
○ Formula exclusively ○ Other food
○ Unknown

If receiving any formula feeding, select type of formula and caloric density:
○ Cow's milk ○ Soy milk
○ Predigested ○ Other

Caloric Density:
○ 20 cal/oz ○ 22 cal/oz
○ 24 cal/oz ○ 27 cal/oz
○ 30 cal/oz ○ Other, specify:_____

Complications

Patient does not have any complications: ☐

Diabetes Status
○ Impaired Glucose Tolerance (FBG < 126, 2-h PG 140-199)
○ CFRD with or without fasting hyperglycemia
○ Type 1 Diabetes
○ Type 2 Diabetes
CFRD secondary complications:
☐ Retinopathy
☐ Microalbuminuria
☐ Chronic renal insufficiency
☐ Chronic renal failure requiring dialysis
☐ Peripheral neuropathy

Hepatobiliary
☐ Gall stones
☐ Gall stones, requiring surgery/procedure
☐ Liver disease, cirrhosis
Please specify complications related to cirrhosis:
☐ Esophageal varices
☐ Gastric varices
☐ GI bleed related to varices
☐ Splenomegaly
☐ Hypersplenism (i.e., WBC <3.0 or platelets <100,000)
☐ Ascites
☐ Encephalopathy
☐ Liver disease, non- cirrhosis
☐ Acute Liver Failure (No underlying liver disease, ALT>3X ULN, INR>2, not responsive to vitamin K)
☐ Hepatic Steatosis

Key:
FORM NAME
○ radio buttons (select one option only)
☐ check box (multiple selections allowed)

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☐ Liver disease, other: _____

Acute Hepatitis (ALT > 5X ULN and duration of illness < 6 months) ☐
☐ Infectious (Hepatitis A,B,C,EBV,CMV or other known infectious cause)
☐ Non-infectious (Autoimmune, Drug Induced, Alcohol or other known cause)
☐ Unknown

Bone/Joints
☐ Arthritis/Arthropathy
☐ Bone fracture
☐ Osteopenia
☐ Osteoporosis

Pulmonary
☐ Allergic Bronchial Pulmonary Aspergillosis (ABPA)
☐ Asthma
☐ Hemoptysis
Please specify selection of hemoptysis:
☐ Hemoptysis, massive
☐ Hemoptysis, other
☐ Pneumothorax requiring chest tube

GI
☐ Chronic constipation
☐ Distal intestinal obstruction syndrome (DIOS, Meconium ileus equiv.)
☐ Fibrosing colonopathy/colonic stricture (report incidence only)
☐ GERD (Gastro-Esophageal Reflux Disease)
☐ GI Bleed req hosp non variceal
☐ History of intestinal or colon surgery
☐ Pancreatitis
☐ Peptic ulcer disease
☐ Rectal prolapse
☐ C. diff. colitis

Other Complications
☐ Absence of Vas Deferens
☐ Anxiety Disorder
☐ Cancer confirmed by histology
☐ Depression
☐ Hearing loss
☐ Hypertension
☐ Kidney Stones
☐ Nasal polyps requiring surgery
☐ Renal failure requiring dialysis (cause other than CFRD)
☐ Sinus Disease (symptomatic)

Complications not listed above
Enter additional complications: _____

Lab

Blood counts
WBC count x1,000/microL(typical clinical value: 3.0 to 30.0): _____

Platelet Count x1,000/microL(typical clinical value: 100 to 500):_____
Hemoglobin (grams per deciliter):_____

Serum Creatinine
Serum Creatinine Level (mg/dL): _____

Liver Function Tests (LFTs)
Alanine Aminotransferase (ALT or SGPT), IU/L: _____
GGTP (gamma glutamyl transpeptidase), IU/L: _____
Aspartate Aminotransferase (AST), IU/L: _____
Alkaline phosphatase (ALP), IU/L: _____
Total Bilirubin, mg/dL: _____
Albumin, g/dL: _____

Glucose Test
Random blood glucose (mg/dL):_____
Fasting blood glucose (mg/dL):_____

If OGTT performed:
OGTT Fasting glucose level (mg/dL):_____
1 hour (mg/dL)(not required):_____
2 hour (mg/dL):_____

Hemoglobin A1C (Hgb A1C)
Hgb A1C value, %:_____

Fecal Elastase
Fecal Elastase Value (microg/g of stool):_____

Act/Exercise

Primary Airway Clearance Technique (ACT)
○ Positive Expiratory Pressure (PEP)
○ Postural drainage with clapping (CPT)
○ Forced expiratory techniques (e.g. autogenic drainage, huff cough, active cycle breathing)
○ Oscillating PEP (e.g. Flutter, acapella, IPV)
○ High frequency chest wall oscillation (e.g. Vest)
○ Exercise
○ None
○ Other
Specify if other technique:_____
☐ Please check if patient is using this technique PRN as As needed

Secondary Airway Clearance Technique (ACT)
☐ Positive Expiratory Pressure (PEP)
☐ Postural drainage with clapping (CPT)
☐ Forced expiratory techniques (e.g. autogenic drainage, huff cough, active cycle breathing)
☐ Oscillating PEP (e.g. Flutter, acapella, IPV)
☐ High frequency chest wall oscillation (e.g. Vest)
☐ Exercise
☐ PRN/As Needed

CARE EPISODE

Key:
FORM NAME
○ radio buttons (select one option only)
☐ check box (multiple selections allowed)

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Care Episode Segment*
Start date: (MM/DD/YYYY)
End date: (MM/DD/YYYY)
Location: ○ Hospital ○ Home IV
Reasons:
☐ Pulmonary Exacerbation
☐ Pulmonary Complication Other than exacerbation
☐ GI Complications
☐ Transplant related
☐ Sinus infection
☐ Non-transplant surgery
☐ NTM Pulmonary Infection
☐ Other
Please specify reason: _____

Care Episode Measurements
At the beginning of Care Episode:
FVC (L):_____
FEV1 (L):_____
FEF25-75 (L):_____
Height: _____ ○ cm ○ inches
Weight: _____ ○ kg ○ lb
Date recorded: (MM/DD/YYYY)
Check if data were impossible to measure: ☐

At the end of Care Episode:
FVC (L):_____
FEV1 (L):_____
FEF25-75 (L):_____
Height: _____ ○ cm ○ inches
Weight: _____ ○ kg ○ lb
Date recorded: (MM/DD/YYYY)
Check if data were impossible to measure: ☐

Comments:_____

ANNUAL REVIEW
Annual Review Year: (YYYY)

Patient Statistics
Number of Encounters recorded by Center: [ ]
Number of Encounters recorded by other Care Centers: [ ]
[Number of Care Episodes recorded by Care Center: [ ]
Number of Care Episodes recorded by Other Care Centers: [ ]

Demographics Update
Current Zip: _____
Patient is: [alive or dead]

Pulmonary
Did this patient use oxygen therapy during the reporting year?
○ Yes, Continuously
○ Yes, Nocturnal and/or with exertion
○ Yes, During exacerbation
○ Yes, prn
○ No
○ Unknown

Did this patient use non-invasive ventilation during the reporting year (i.e., assisted breathing, BiPap, CPAP, etc)
○ Yes ○ No ○ Unknown

Was a Chest X Ray performed during the reporting year?
○ Yes ○ No ○ Unknown

Did the patient receive an influenza vaccination this season (Sept through Jan)?
○ Yes ○ No ○ Unknown

Covid-19 Vaccination
Did the patient receive a Covid-19 vaccination this year?
○ Yes (Please complete Covid-19 Vaccination form)
○ No
○ Unknown
Specify why vaccination wasn't done:
○ Ineligible by Age
○ Allergic
○ Patient refused vaccination
○ Other
Specify other reasons why vaccination wasn't done: _____

Mycobacterial Culture
[According to the encounters a Mycobacterial culture has been performed during this reporting year: ○ Yes ○ No]
Please check to confirm the above is correct: ☐
Was treatment INITIATED for a pulmonary mycobacterial infection during this reporting year?
○ Yes ○ No ○ Unknown

Was an IgE screening for ABPA performed in this reporting year? ○ Yes ○ No ○ Unknown

Did this patientsmoke cigarettes during the reporting year?
○ No
○ Occasionally
○ Yes, Regularly, less than 1 ppd
○ Yes, Regularly, 1 ppd or more
○ Declined to answer
○ Not Known
○ Not Applicable

Does anyone in the patient's household smoke cigarettes?
○ Yes ○ No ○ Unknown

During the reporting year, how often was this patient exposed to secondhand smoke?
○ Daily
○ Several Times Per Week
○ Several Times Per Month or less
○ Never
○ Declined to answer
○ Not Known

CFTR Modulators

Key:
FORM NAME
○ radio buttons (select one option only)
☐ check box (multiple selections allowed)

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Was Elexacaftor/Tezacaftor/Ivacaftor Triple Combination Therapy initiated during the reporting year?
○ Yes ○ No ○ Unknown

Approximate date patient started taking this drug:
(MM/DD/YYYY)

Liver

[According to the encounters data liver function tests were done in this reporting year ○ Yes ○ No]

Please check to confirm that information about liver function tests above is correct. If it is incorrect, please return to the encounter forms and enter correct information into the lab section of the encounter form: ☐

Eye

Was any eye exam performed to check for cataracts in this reporting year?
○ Yes ○ No ○ Unknown

Growth and Nutrition

Fat soluble vitamin levels measured?
○ Yes ○ No ○ Unknown

Has this patient been on growth hormone in the reporting year? ○ Yes ○ No ○ Unknown

Was a DEXA scan for bone density performed in the reporting year? Please enter findings of osteoporosis or osteopenia into the complications section of last patient encounter. ○ Yes ○ No ○ Unknown

Results of DEXA Scan:
○ Normal ○ Osteopenia
○ Osteoporosis ○ Other
○ Unknown

Diabetes Status

Status from recent encounter [does or does not] indicate CFRD.
○ Normal Glucose Metabolism (includes normal, random, fasting, or OGTT)
○ Impaired Glucose Tolerance (FBG < 126, 2-h PG 140-199)
○ CFRD with or without fasting hyperglycemia (2-h PG >= 200)
○ Type 1 Diabetes
○ Type 2 Diabetes

Was a retinal eye exam performed by an opthalmologist in this reporting year? ○ Yes ○ No ○ Unknown

Was a spot urine sent for albumin/creatinine ratio in this reporting year? ○ Yes ○ No ○ Unknown

If positive findings, please update CFRD secondary complications in the most recent encounter of the patient.

Was the patient prescribed treatment for CFRD?
○ Yes ○ No

Select all that apply:
☐ Dietary change
☐ Oral hypoglycemic agents
☐ Intermittent insulin (with illness, steroids, etc.)
☐ Chronic insulin

Did the patient experience any episodes of severe hypoglycemia (became unconscious or required help to resolve) during the reporting year?
○ Yes ○ No ○ Unknown

Transplantation

What is the transplantation status of the patient currently? If the patient had transplantation in previous years please select or keep "Had transplantation" option.
○ Not pertinent
○ Accepted, on waiting list
○ Evaluated, final decision pending
○ Evaluated, rejected
○ Had transplantation

Transplant
☐ Lung: Bilateral
Number this year:__ Date of last transplant: (MM/DD/YYYY)
☐ Heart/lung
Number this year:__ Date of last transplant: (MM/DD/YYYY)
☐ Lung: Lobar/Cadaveric
Number this year:__ Date of last transplant: (MM/DD/YYYY)
☐ Lung: Lobar/living donor
Number this year:__ Date of last transplant: (MM/DD/YYYY)
☐ Liver
Number this year:__ Date of last transplant: (MM/DD/YYYY)
☐ Kidney
Number this year:__ Date of last transplant: (MM/DD/YYYY)
☐ Other
Number this year:__ Date of last transplant: (MM/DD/YYYY)
Specify transplant type: _____

Were there post transplant complications? ☐
Select those that apply:
☐ Bronchiolitis obliterans syndrome
☐ Lympho-proliferative disorder
☐ Other
Specify other complication: _____

Colorectal Cancer Screening/Surveillance

Did the patient undergo a colonoscopy (screening or surveillance during the reporting year?
○ Yes ○ No ○ Unknown

What were the results of the colonoscopy?
○ Normal
○ Colorectal Cancer
○ Adenomatous polyps
○ Indeterminate results (e.g. inadequate preparation)

Clinical Trials

Has this patient participated in any interventional (drug) studies?
○ Yes ○ No ○ Unknown

Has this patient participated in any observational studies?
○ Yes ○ No ○ Unknown

Key:
FORM NAME
○ radio buttons (select one option only)
☐ check box (multiple selections allowed)

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2021 Cystic Fibrosis Foundation Patient Registry Questionnaire

Health Insurance Coverage

It is important for us to have accurate numbers of patients who have specific types of coverage:

☐ Health Insurance Policy (e.g. Private Insurance)
☐ Medicare
☐ Medicaid
☐ State special needs program, e.g., BCMH, CCS, CRS, GHPP, etc.
☐ TriCare or other military health plan
☐ Indian Health Service
☐ Other
Specify if other insurance:_____

Patient has no health insurance: ☐

Was patient covered under parent's health insurance plan?
○ Yes ○ No ○ Unknown

Did patient receive free medicine or co-pay/deductible assistance from a Patient Assistance Program?
○ Yes ○ No ○ Unknown

Socio-economic Status

Education of Patient:
○ Less than High School
○ High School diploma or equivalent
○ Some College
○ College Graduate
○ Masters/Doctoral level degree
○ Unknown/Not applicable

Education of father of patient:
○ Less than High School
○ High School diploma or equivalent
○ Some College
○ College Graduate
○ Masters/Doctoral level degree
○ Unknown/Not applicable

Education of mother of patient:
○ Less than High School
○ High School diploma or equivalent
○ Some College
○ College Graduate
○ Masters/Doctoral level degree
○ Unknown/Not applicable

Education of spouse of patient:
○ Less than High School
○ High School diploma or equivalent
○ Some College
○ College Graduate
○ Masters/Doctoral level degree
○ Unknown/Not applicable

What was the total combined income of the household before taxes where the patient resided for the majority of the reporting year?
○ <$10,000 ○ $10,000 to $19,999
○ $20,000 to $29,999 ○ $30,000 to $39,999
○ $40,000 to $49,999 ○ $50,000 to $59,999
○ $60,000 to $69,999 ○ $70,000 to $79,999
○ $80,000 to $89,999 ○ >$90,000
○ Unknown or Prefer not to Answer

How many people currently live in the patient's household (including the patient)?
○ 1 ○ 2 ○ 3 ○ 4
○ 5 ○ 6 ○ 7 ○ 8
○ 9 ○ 10 ○ 11 ○ 12 or more
○ Unknown

Mental Health

Was the patient screened for symptoms of classic depression using Patient Health Questionnaire (PHQ-9) or other valid depression screening tools?
○ Yes ○ No ○ Unknown

Was the patient screened for the anxiety disorder using Generalized Anxiety Disorder Tool (GAD-7 or similar)?
○ Yes ○ No ○ Unknown

Age 18 and Older

Marital Status:
○ Single (never married)
○ Living Together
○ Married
○ Separated
○ Divorced
○ Widowed
○ Unknown

Employment:
☐ Part Time
☐ Full time homemaker
☐ Full time employment
☐ Unemployed
☐ Student
☐ Disabled
☐ Retired
☐ Unknown

Pregnancy

Was patient pregnant during the reporting year?
○ Yes ○ No ○ Unknown

If Yes, indicate outcome:
○ Live Birth
○ Still Birth
○ Spontaneous Abortion
○ Therapeutic Abortion
○ Undelivered
○ Unknown

Age 2 and Younger

Did the patient attend day care during this reporting year?
○ Yes ○ No ○ Unknown

Did the family receive genetic counseling this reporting year?
○ Yes ○ No ○ Unknown

Was the patient given palivizumab (Synagis) this season (Sept through January)?
○ Yes ○ No ○ Unknown

Key:
FORM NAME
○ radio buttons (select one option only)
☐ check box (multiple selections allowed)

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2021 Cystic Fibrosis Foundation Patient Registry Questionnaire

Other
Please use this field to record any additional information about this patient: _____

ALD INITIATION

Date patient flagged for ALD: (MM/DD/YYYY)
Select all reasons for flagging ALD:
☐ FEV1pp<40% when stable
☐ Referred for lung transplantation evaluation
☐ Respiratory failure (requiring ICU admission)
☐ Hypercarbia
☐ Daytime supplemental oxygen at rest
☐ Pulmonary Hypertension
☐ Six-minute walk distance <400m
☐ Rapid rate of FEV1 decline
☐ Supplemental oxygen requirement with exercise or sleep
☐ Pneumothorax (recurrent and/or persistent)
☐ Massive Hemoptysis (>240 ml)
☐ Other
Specify other reasons for including patient: _____

ALD ANNUAL

Interventions

Review Year:

Thoracic Procedure(s)
Did patient have a thoracic procedure during the reporting year?
○ Yes ○ No ○ Unknown

Thoracic procedure type(s):
☐ Lung resection
☐ Thoracotomy
☐ Video thoracotomy
☐ Tube thoracotomy
☐ Pleurodesis

Pleurodesis side:
○ Unilateral ○ Bilateral ○ Unknown

Other Interventions
Was patient enrolled in pulmonary rehabilitation during the reporting year?
○ Yes ○ No ○ Unknown
Was the patient seen by a palliative care specialist during the reporting year?
○ Yes ○ No ○ Unknown

Specify type(s) of palliative care services:
☐ Documented advance care planning conversation
☐ Documentation of an advance directive
☐ Referral to palliative care specialist
☐ Referral to hospice

Embolization For Hemoptysis
Embolization Date (if performed): (MM/DD/YYYY)

ICU Admissions
Was patient admitted to ICU this year?
○ Yes ○ No ○ Unknown

Date of admission to ICU: (MM/DD/YYYY)
Date of discharge from ICU: (MM/DD/YYYY)
Primary reason for admission:
○ Post-surgical procedure with observation
○ Respiratory failure
○ Hemoptysis
○ Pneumothorax
○ Shock
○ Densensitization for antibiotics
○ Other
○ Unknown

Intubation
Was patient intubated?
○ Yes ○ No ○ Unknown
Date of intubation: (MM/DD/YYYY)
Date of extubation: (MM/DD/YYYY)
Was a tracheostomy performed?
○ Yes ○ No ○ Unknown

ECMO/Novalung
Was patient placed on ECMO/Novalung?
○ Yes ○ No ○ Unknown
Date ECMO/Novalung started: (MM/DD/YYYY)
Date ECMO/Novalung ended: (MM/DD/YYYY)
Cannulation strategy used:
○ VV-Single Cannula
○ Code 2VV-Double Cannula
○ Veno-Arterial
○ Veno-Arterial-Venous
○ Unknown
Was ECMO/Novalung used in combination with ventilator?
○ Yes ○ No ○ Unknown

Labs/Tests

Echocardiogram
Was ECHO performed during the reporting year?
○ Yes ○ No ○ Unknown
Date of last echocardiogram: (MM/DD/YYYY)
Could PA pressure be estimated?
○ Yes ○ No ○ Unknown
Estimated RVSP or PASP, mmHg: _____
Tricuspid annular plane systolic excursion, mm: _____

Right Heart Catheterization (RHC)
Was Right Heart Catheterization (RHC) done during the reporting year?
○ Yes ○ No ○ Unknown
Date of last RHC: (MM/DD/YYYY)
Mean PA pressure from RHC, mmHg: _____
Systemic systolic pressure, mmHg: _____

Key:
FORM NAME
○ radio buttons (select one option only)
☐ check box (multiple selections allowed)

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2021 Cystic Fibrosis Foundation Patient Registry Questionnaire

Systemic diastolic pressure, mmHg: _____
Heart Rate: _____
PA systolic pressure, mmH: _____
PA diastolic pressure, mmHg: _____
Pulmonary capillary wedge pressure (PCW), mmHg: _____
Cardiac Index (L/min/m2): _____

Six Minute Walk

Date of six-minute walk test: (MM/DD/YYYY)
Six minute walk distance, m: _____
Was supplemental oxygen titrated?
○ Yes ○ No ○ Unknown

Blood Gas Analysis

Date of blood gas analysis: (MM/DD/YYYY)
Blood source:
○ Venous ○ Arterial
Type of blood gas analysis:
○ Stable blood gas
○ Worst blood gas in a year
○ Last blood gas prior to discharge
Blood pH: _____
PaO2, mm Hg: _____
PaCO2, mm Hg: _____

Transplant Consideration and Referral

Transplant Consideration

Was transplant discussed with patient at the care program in the reporting year?
○ Yes ○ No ○ Unknown

Transplant Referral And Evaluation

Was patient referred to a transplant program in the reporting year?
○ Yes ○ No ○ Unknown
If patient was not referred for transplant, select reasons:
☐ Patient stable
☐ Patient declined to pursue
☐ Substance misuse (alcohol, marijuana, illicit drugs etc.)
☐ Chronic opioid use
☐ Smoking tobacco
☐ Inadequate medical insurance
☐ Limited social support
☐ Adherence issues
☐ Poor nutritional status
☐ Microbiological reasons
☐ Mental health
☐ Uncontrolled diabetes
☐ Physical inactivity/deconditioning
☐ Other
Specify other reasons for not referring: _____
Date patient referred for transplant: (MM/DD/YYYY)
State of primary transplant program:
Primary transplant program:

○ AL
  ○ University of Alabama Hospital
○ AZ
  ○ Banner University Medical Center – Tucson
○ CA
  ○ Mayo Clinic Hospital
  ○ St Joseph's Hospital and Medical Center
  ○ Cedars-Sinai Medical Center
  ○ Childrens Hospital Los Angeles
  ○ Keck Hospital of USC
  ○ Lucile Salter Packard Children's Hospital at Stanford
  ○ Stanford Health Care
  ○ University of California San Diego Medical Center
  ○ University of California San Francisco Medical Center
  ○ University of California at Los Angeles Medical Center
○ CO
  ○ University of Colorado Hospital/Health Science Center
○ FL
  ○ Florida Hospital Medical Center
  ○ Jackson Memorial Hospital University of Miami School of Medicine
  ○ Mayo Clinic Florida
  ○ Tampa General Hospital
  ○ UF Health Shands Hospital
○ GA
  ○ Emory University Hospital
○ IA
  ○ University of Iowa Hospitals and Clinics Transplant Programs
○ IL
  ○ Advocate Christ Medical Center
  ○ Loyola University Medical Center
  ○ Northwestern Memorial Hospital
  ○ University of Chicago Medical Center
○ IN
  ○ Indiana University Health
○ KY
  ○ Jewish Hospital
  ○ University of Kentucky Medical Center
○ LA
  ○ Ochsner Foundation Hospital
○ MA
  ○ Boston Children's Hospital
  ○ Brigham and Women's Hospital
  ○ Massachusetts General Hospital
○ MD
  ○ Johns Hopkins Hospital
  ○ University of Maryland Medical System
○ MI
  ○ Henry Ford Hospital
  ○ Spectrum Health
  ○ University of Michigan Medical Center
○ MN
  ○ Saint Marys Hospital (Mayo Clinic)
  ○ University of Minnesota Medical Center, Fairview
○ MO
  ○ Barnes-Jewish Hospital
  ○ St Louis Children's Hospital at Washington University Medical Center
○ NC
  ○ Duke University Hospital
  ○ University of North Carolina Hospitals
○ NE
  ○ The Nebraska Medical Center
○ NJ

Key:
FORM NAME
○ radio buttons (select one option only)
☐ check box (multiple selections allowed)

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2021 Cystic Fibrosis Foundation Patient Registry Questionnaire

○ Newark Beth Israel Medical Center

○ NY
- ○ Mount Sinai Medical Center
- ○ NY Presbyterian Hospital/Columbia Univ Medical Center

○ OH
- ○ Children's Hospital Medical Center
- ○ Nationwide Children's Hospital
- ○ Ohio State University Medical Center
- ○ The Cleveland Clinic Foundation
- ○ University Hospitals of Cleveland

○ OK
- ○ Integris Baptist Medical Center

○ PA
- ○ Allegheny General Hospital
- ○ Children's Hospital of Pennsylvania
- ○ Children's Hospital of Pittsburgh of UPMC
- ○ Hospital of the University of Pennsylvania
- ○ Temple University Hospital
- ○ University of Pittsburgh Medical Center

○ SC
- ○ Medical University of South Carolina

○ TN
- ○ Baptist Memorial Hospital
- ○ Vanderbilt University Medical Center and Nashville VA Medical Center

○ TX
- ○ Baylor University Medical Center
- ○ CHI St. Luke's Health Baylor College of Medicine Medical Center
- ○ Houston Methodist Hospital
- ○ Memorial Hermann Hospital, University of Texas at Houston
- ○ Scott and White Memorial Hospital
- ○ Texas Children's Hospital
- ○ UT Southwestern Medical Center/William P Clements Jr University Hospital
- ○ University Hospital, University of Texas Health Science Center
- ○ University of Texas Medical Branch at Galveston

○ UT
- ○ University of Utah Medical Center

○ VA
- ○ Inova Fairfax Hospital
- ○ University of Virginia Health Sciences Center

○ WA
- ○ University of Washington Medical Center

○ WI
- ○ Aurora St. Luke's Medical Center
- ○ Froedtert Memoria Lutheran Hospital
- ○ University of Wisconsin Hospital and Clinics

Was patient evaluated for transplant at primary transplant program?
○ Yes ○ No ○ Unknown

If patient evaluated for transplant at primary transplant program, specify outcome:
○ Listed
○ Delisted
○ Denied
○ Pt declined to pursue
○ Unknown

Date listed for transplant: (MM/DD/YYYY)

Was the patient removed from the transplant waitlist in the reporting year? ○ Yes ○ No ○ Unknown

Key:

FORM NAME

○ radio buttons (select one option only)
☐ check box (multiple selections allowed)

Select all reasons for delisting:
☐ Condition improved
☐ Patient declined transplant
☐ Too sick to transplant
☐ Died
☐ Other

Other reasons for delisting: _____

If transplant deferred, specify reason:
☐ Patient stable
☐ Additional testing necessary
☐ Poor nutritional status
☐ Limited social support
☐ Financial hardship
☐ Substance misuse
☐ Other

Other reason(s) for transplant deferral: _____

If patient was denied for transplant, specify reason:
☐ Too sick
☐ Microbiological reasons
☐ Limited social support
☐ Substance misuse
☐ Malignancy
☐ Poor nutritional status
☐ Renal disease
☐ Liver disease
☐ Financial hardship
☐ Other, specify

Other reasons patient denied for transplant: _____

Was pt referred to another program for second opinion?
○ Yes ○ No ○ Unknown

State of second transplant program:

Second transplant program:

○ AL
- ○ University of Alabama Hospital

○ AZ
- ○ Banner University Medical Center – Tucson
- ○ Mayo Clinic Hospital
- ○ St Joseph's Hospital and Medical Center

○ CA
- ○ Cedars-Sinai Medical Center
- ○ Childrens Hospital Los Angeles
- ○ Keck Hospital of USC
- ○ Lucile Salter Packard Children's Hospital at Stanford
- ○ Stanford Health Care
- ○ University of California San Diego Medical Center
- ○ University of California San Francisco Medical Center
- ○ University of California at Los Angeles Medical Center

○ CO
- ○ University of Colorado Hospital/Health Science Center

○ FL
- ○ Florida Hospital Medical Center
- ○ Jackson Memorial Hospital University of Miami School of Medicine
- ○ Mayo Clinic Florida

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2021 Cystic Fibrosis Foundation Patient Registry Questionnaire

○ Tampa General Hospital
○ UF Health Shands Hospital

○ GA
○ Emory University Hospital

○ IA
○ University of Iowa Hospitals and Clinics Transplant Programs

○ IL
○ Advocate Christ Medical Center
○ Loyola University Medical Center
○ Northwestern Memorial Hospital
○ University of Chicago Medical Center

○ IN
○ Indiana University Health

○ KY
○ Jewish Hospital
○ University of Kentucky Medical Center

○ LA
○ Ochsner Foundation Hospital

○ MA
○ Boston Children's Hospital
○ Brigham and Women's Hospital
○ Massachusetts General Hospital

○ MD
○ Johns Hopkins Hospital
○ University of Maryland Medical System

○ MI
○ Henry Ford Hospital
○ Spectrum Health
○ University of Michigan Medical Center

○ MN
○ Saint Marys Hospital (Mayo Clinic)
○ University of Minnesota Medical Center, Fairview

○ MO
○ Barnes-Jewish Hospital
○ St Louis Children's Hospital at Washington University Medical Center

○ NC
○ Duke University Hospital
○ University of North Carolina Hospitals

○ NE
○ The Nebraska Medical Center

○ NJ
○ Newark Beth Israel Medical Center

○ NY
○ Mount Sinai Medical Center
○ NY Presbyterian Hospital/Columbia Univ Medical Center

○ OH
○ Children's Hospital Medical Center
○ Nationwide Children's Hospital
○ Ohio State University Medical Center
○ The Cleveland Clinic Foundation
○ University Hospitals of Cleveland

○ OK
○ Integris Baptist Medical Center

○ PA
○ Allegheny General Hospital
○ Children's Hospital of Pennsylvania
○ Children's Hospital of Pittsburgh of UPMC
○ Hospital of the University of Pennsylvania
○ Temple University Hospital
○ University of Pittsburgh Medical Center

○ SC
○ Medical University of South Carolina

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○ CHI St. Luke's Health Baylor College of Medicine Medical Center
○ Houston Methodist Hospital
○ Memorial Hermann Hospital, University of Texas at Houston
○ Scott and White Memorial Hospital
○ Texas Children's Hospital
○ UT Southwestern Medical Center/William P Clements Jr University Hospital
○ University Hospital, University of Texas Health Science Center
○ University of Texas Medical Branch at Galveston

○ UT
○ University of Utah Medical Center

○ VA
○ Inova Fairfax Hospital
○ University of Virginia Health Sciences Center

○ WA
○ University of Washington Medical Center

○ WI
○ Aurora St. Luke's Medical Center
○ Froedtert Memoria Lutheran Hospital
○ University of Wisconsin Hospital and Clinics

If patient evaluated for transplant at second program, specify outcome:
○ Listed
○ Delisted
○ Denied
○ Pt declined to pursue
○ Unknown

COVID-19

Covid-19 Event

Was patient tested for Covid-19?
○ Yes, testing was done
○ No testing was done, but there were strong reasons to suspect Covid-19

Non-Testing Reasons for Suspecting/Treating COVID-19:
☐ Known contact with Sars-cov-2 carrier
☐ X-Ray or CT scan imaging
☐ Patient has symptomatology consistent with COVID-19
☐ Other

Other reasons to suspect Covid-19: _____

Testing

Select all applicable reasons for testing:
☐ Pre-admission/procedure
☐ Known contact with Sars-cov-2 carrier
☐ Patient has symptomatology consistent with COVID-19
☐ Other reasons for testing

Other reasons for testing: _____

Testing date: (MM/DD/YYYY)
Type of specimen:
○ Nasopharyngeal swab (PCR test)
○ Saliva (PCR test)
○ Serology (antibody test)

Key:
FORM NAME
○ radio buttons (select one option only)
☐ check box (multiple selections allowed)

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2021 Cystic Fibrosis Foundation Patient Registry Questionnaire

○ Nasopharyngeal swab (antigen test)
Testing Result:
○ Positive ○ Negative ○ Inconclusive
Test Comments: _____

Please describe confirmed or suspected event:
Did patient have any symptoms related to COVID-19 at presentation?
○ Yes, symptomatic
○ No, patient was asymptomatic
Date of first symptoms: (MM/DD/YYYY)
Signs and Symptoms at manifestation:
☐ Cough, different from CF
☐ New shortness of breath or difficulty breathing
☐ Chills
☐ Fever (>=38C)
☐ Headache
☐ Muscle pain
☐ New loss of taste or smell
☐ Repeated shaking with chills
☐ Other
Other symptoms, not included above: _____

Treatment
Where was the patient treated for Covid-19 symptoms?
☐ Self-quarantine at home
☐ Admitted to hospital
☐ Other
Specify other treatment location: _____
Date admitted to hospital: (MM/DD/YYYY)
Make sure to create a care episode if a patient was hospitalized.

Was patient admitted to ICU?
○ Yes ○ No
Was patient on supplemental oxygen?
○ Yes ○ No
Did the patient require non-invasive respiratory support (CPAP, biPAP; High-flow)?
○ Yes ○ No
Did the patient require mechanical ventilation?
○ Yes ○ No
Did the patient require ECMO support?
○ Yes ○ No
Did the patient require treatment therapies?
○ Yes ○ No ○ Unknown
Specify if the following therapies were used to treat the patient:
☐ Antiviral therapy
☐ Antibiotics
☐ Systemic steroids
☐ Immune modulators
☐ Other
Other Therapies: _____

Complications/Co-morbidities
COVID-19 associated complications/comorbidities (e.g. stroke, secondary infection): _____

Please be sure to enter or update patient data in the appropriate tabs of an encounter form (e.g. complications, labs). For any data entry questions, contact reghelp@cff.org.

Follow-up
Has patient recovered?
○ Yes
○ Currently Hospitalized
○ Currently in ICU
○ Currently in domestic quarantine
○ Deceased
○ Unknown

Date of recovery (i.e. end of symptoms OR negative COVID-19 test): (MM/DD/YYYY)

COVID-19 Vaccination

Covid-19 Vaccination
Please enter the date of first vaccination shot, even if it is approx.: (MM/DD/YYYY)
Please enter the date of second vaccination shot, if known and required: (MM/DD/YYYY)
The patient received a vaccine developed by:
○ Pfizer
○ Moderna
○ AstraZeneca
○ Novavax
○ Johnson&Johnson
○ Other or Unknown
Specify other vaccine manufacturer, if known: _____

Key:
FORM NAME
○ radio buttons (select one option only)
☐ check box (multiple selections allowed)
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NOTES

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