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
2017 Annual Data Report
Bethesda, Maryland
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PHOTOGRAPHY BY
Cade Martin and Rebecca Drobis

SPECIAL ACKNOWLEDGMENTS
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Bruce Marshall
Albert Faro
Aliza Fink
Deena Loeffler
Alexander Elbert
Thomas O’Neil
Tucker Rush
Samar Rizvi
August 2018

Dear Friends and Colleagues:

It is a pleasure to share the 2017 Patient Registry Annual Data Report with you. The Cystic Fibrosis Foundation Patient Registry remains a very important resource to the CF community, contributing to clinical trial design, “real world” research including safety and effectiveness studies of newly approved therapies, and quality improvement. Timely Registry data entry provides an opportunity for delivering more useful patient summaries, population management, and clinical trial eligibility reports at the point of care. We are seeing a decrease in the average number of days between a clinic visit and data entry. Some centers are now entering data within a week of clinic visits. We encourage all care centers to revisit and improve their processes for Registry data entry to maximize the value of Registry reports.

Many thanks to each and every one of you who contribute to the success of the Registry — most notably, 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. We hope that you feel a sense of pride as you read through this report. It would not be possible without your vital contributions.

This is a truly exciting time in CF, with advances in health care delivery and new therapeutics with transformative potential. Approximately 15,000 people with CF in the U.S. are now eligible for treatment with a CFTR modulator. Together, we will continue to track these and other important developments in the Registry.

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

Bruce C. Marshall, M.D.
Senior Vice President of Clinical Affairs
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 120 CF Foundation-accredited care centers.

Inclusion 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 year, or were born, diagnosed, or died in the reporting year. The reporting year includes all data reported as of Dec. 31, 2017.

Data from individuals who have received a lung transplant 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 for the figure. Figures titled in gray reflect patient-level data that include individuals who are post-transplant. Figures titled in purple reflect patient-level data that do not include individuals who are post-transplant. Figures titled in blue present data on center-level variation and include only those centers reporting on 10 or more eligible individuals. Exceptions to this are figures showing center-level variation for infants, people with a G551D mutation, people with cystic fibrosis-related diabetes (CFRD), and people who had a pulmonary exacerbation. For these figures, centers reporting on five or more eligible individuals are included.

Exclusion Criteria

Data from individuals with a diagnosis of CF transmembrane conductance regulator (CFTR)-related metabolic syndrome (CRMS); CF screen positive, inconclusive diagnosis (CFSPID); or CFTR-related disorder are excluded from all figures except for the figure on new diagnoses in the reporting year.

Data from individuals who have received a lung transplant are excluded from any chapters not specified above in the inclusion criteria. In the past, data from individuals who received a lung transplant were included in most chapters of this report. This impacted reporting of highly prevalent complications in the post-transplant population, such as CFRD and osteoporosis. This year, exclusion of data from individuals who received a lung transplant has led to a lower prevalence of these complications as compared to previous years. We plan to implement case report forms that are specific for individuals who have received a lung transplant and will provide more detailed reports on this segment of the population in future reports.

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, 2002–2017

<table>
<thead>
<tr>
<th>Demographics</th>
<th>2002</th>
<th>2007</th>
<th>2012</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>People with CF (n)</td>
<td>22,976</td>
<td>24,477</td>
<td>27,607</td>
<td>29,326</td>
<td>29,887</td>
</tr>
<tr>
<td>Newly diagnosed individuals (n)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1,019</td>
<td>1,023</td>
<td>1,027</td>
<td>915</td>
<td>880</td>
</tr>
<tr>
<td>Detected by newborn screening (%)</td>
<td>14.1</td>
<td>34.2</td>
<td>62.8</td>
<td>65.0</td>
<td>58.4</td>
</tr>
<tr>
<td>Mean age at diagnosis for all people with CF (years)</td>
<td>3.2</td>
<td>3.4</td>
<td>3.7</td>
<td>3.9</td>
<td>4.0</td>
</tr>
<tr>
<td>Median age at diagnosis for all people with CF (months)</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Mean age (years)</td>
<td>17.2</td>
<td>18.5</td>
<td>19.8</td>
<td>21.2</td>
<td>21.7</td>
</tr>
<tr>
<td>Median age (years)</td>
<td>15.2</td>
<td>16.5</td>
<td>17.6</td>
<td>18.9</td>
<td>19.3</td>
</tr>
<tr>
<td>Adults ≥ 18 years (%)</td>
<td>40.0</td>
<td>45.0</td>
<td>48.9</td>
<td>52.5</td>
<td>53.5</td>
</tr>
<tr>
<td>Race (not mutually exclusive)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White (%)</td>
<td>95.3</td>
<td>94.9</td>
<td>94.1</td>
<td>93.7</td>
<td>93.6</td>
</tr>
<tr>
<td>African American (%)</td>
<td>3.9</td>
<td>4.1</td>
<td>4.5</td>
<td>4.6</td>
<td>4.6</td>
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<tr>
<td>Other race (%)</td>
<td>1.6</td>
<td>2.3</td>
<td>3.0</td>
<td>3.5</td>
<td>3.6</td>
</tr>
<tr>
<td>Hispanic (any race) (%)</td>
<td>5.6</td>
<td>6.2</td>
<td>7.6</td>
<td>8.5</td>
<td>8.7</td>
</tr>
<tr>
<td>Males (%)</td>
<td>52.8</td>
<td>51.9</td>
<td>51.7</td>
<td>51.5</td>
<td>51.6</td>
</tr>
<tr>
<td><strong>Mortality</strong>&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total deaths (n)</td>
<td>426</td>
<td>400</td>
<td>425</td>
<td>377</td>
<td>380</td>
</tr>
<tr>
<td>Annual mortality rate (per 100) (%)</td>
<td>1.9</td>
<td>1.6</td>
<td>1.5</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td>Predicted median survival (five-year increments)</td>
<td>32.7</td>
<td>37.3</td>
<td>38.3</td>
<td>42.4</td>
<td>43.6</td>
</tr>
<tr>
<td>95% confidence interval (five-year increments)</td>
<td>32.1 - 33.6</td>
<td>36.2 - 38.6</td>
<td>37.1 - 39.8</td>
<td>41.5 - 43.8</td>
<td>42.2 - 44.8</td>
</tr>
<tr>
<td>Median age at death (years)</td>
<td>26.8</td>
<td>27.3</td>
<td>28.6</td>
<td>30.2</td>
<td>30.6</td>
</tr>
<tr>
<td><strong>GI/Nutrition</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI percentile in individuals 2 to 19 years (median)</td>
<td>43.0</td>
<td>48.4</td>
<td>52.6</td>
<td>55.9</td>
<td>57.1</td>
</tr>
<tr>
<td>Weight &lt; 10th CDC percentile (%)</td>
<td>23.1</td>
<td>17.0</td>
<td>13.5</td>
<td>10.9</td>
<td>10.4</td>
</tr>
<tr>
<td>Height &lt; 5th CDC percentile (%)</td>
<td>15.9</td>
<td>13.2</td>
<td>11.0</td>
<td>9.9</td>
<td>9.7</td>
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<tr>
<td>BMI in individuals 20 to 40 years (median)</td>
<td>21.0</td>
<td>21.4</td>
<td>21.8</td>
<td>22.2</td>
<td>22.2</td>
</tr>
<tr>
<td>Pancreatic enzyme replacement therapy (%)</td>
<td>91.7</td>
<td>86.8</td>
<td>87.2</td>
<td>86.3</td>
<td>85.7</td>
</tr>
<tr>
<td>Supplemental feeding - tube (%)</td>
<td>8.0</td>
<td>10.2</td>
<td>10.7</td>
<td>10.8</td>
<td>10.9</td>
</tr>
<tr>
<td>Supplemental feeding - oral only (%)</td>
<td>30.3</td>
<td>37.9</td>
<td>41.5</td>
<td>44.2</td>
<td>44.9</td>
</tr>
<tr>
<td><strong>Pulmonary</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FVC % predicted (mean)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>82.6</td>
<td>85.8</td>
<td>87.4</td>
<td>88.5</td>
<td>88.8</td>
</tr>
<tr>
<td>FEV&lt;sub&gt;1&lt;/sub&gt; % predicted (mean)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>71.7</td>
<td>74.6</td>
<td>76.1</td>
<td>76.9</td>
<td>77.2</td>
</tr>
<tr>
<td>FEV&lt;sub&gt;1&lt;/sub&gt;/FVC ratio (mean)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>74.2</td>
<td>74.9</td>
<td>74.5</td>
<td>74.2</td>
<td>74.1</td>
</tr>
<tr>
<td><strong>Respiratory Microbiology</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>P. aeruginosa</em> (PA) (%)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>57.9</td>
<td>54.4</td>
<td>49.8</td>
<td>46.5</td>
<td>45.7</td>
</tr>
<tr>
<td>Multidrug-resistant PA (%)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>10.8</td>
<td>9.1</td>
<td>8.8</td>
<td>8.2</td>
<td>8.2</td>
</tr>
<tr>
<td><em>B. cepacia</em> complex (%)</td>
<td>3.1</td>
<td>2.9</td>
<td>2.6</td>
<td>2.7</td>
<td>2.5</td>
</tr>
<tr>
<td><em>S. aureus</em> (SA) (%)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>56.2</td>
<td>65.7</td>
<td>69.1</td>
<td>71.1</td>
<td>70.7</td>
</tr>
<tr>
<td>Methicillin-sensitive <em>S. aureus</em> (MSSA) (%)</td>
<td>49.5</td>
<td>51.4</td>
<td>52.4</td>
<td>55.1</td>
<td>54.9</td>
</tr>
<tr>
<td>Methicillin-resistant <em>S. aureus</em> (MRSA) (%)</td>
<td>9.2</td>
<td>21.2</td>
<td>26.5</td>
<td>26.0</td>
<td>25.9</td>
</tr>
<tr>
<td><em>S. maltophilia</em> (%)</td>
<td>9.4</td>
<td>12.7</td>
<td>13.5</td>
<td>13.1</td>
<td>12.9</td>
</tr>
<tr>
<td>Mycobacterial species (%)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-</td>
<td>-</td>
<td>11.9</td>
<td>12.7</td>
<td>12.7</td>
</tr>
</tbody>
</table>

Table continues on the next page.
### Summary of the Cystic Fibrosis Foundation Patient Registry, 2002-2017

<table>
<thead>
<tr>
<th>Health Care Utilization and Pulmonary Exacerbations (PEX)(^a)</th>
<th>2002</th>
<th>2007</th>
<th>2012</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outpatient visits to CF centers reported per year (mean)</td>
<td>5.5</td>
<td>4.2</td>
<td>4.6</td>
<td>4.4</td>
<td>4.4</td>
</tr>
<tr>
<td>Treated with IV antibiotics for a pulmonary exacerbation (%)</td>
<td>-</td>
<td>36.2</td>
<td>35.7</td>
<td>34.7</td>
<td>34.5</td>
</tr>
<tr>
<td>Number of pulmonary exacerbations per year (mean)</td>
<td>-</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>Number of days of treatment for all PEX per year (mean)(^b)</td>
<td>-</td>
<td>30.5</td>
<td>28.4</td>
<td>28.9</td>
<td>28.9</td>
</tr>
<tr>
<td>Number of days of home IV treatment for all PEX per year (mean)(^b)</td>
<td>-</td>
<td>13.6</td>
<td>11.2</td>
<td>10.5</td>
<td>10.6</td>
</tr>
<tr>
<td>Number of days of hospitalization for all PEX per year (mean)(^b)</td>
<td>-</td>
<td>16.9</td>
<td>17.2</td>
<td>18.3</td>
<td>18.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pulmonary Therapies(^c)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dornase alfa (≥ 6 years) (%)</td>
<td>69.2 81.9 87.5 91.0 91.6</td>
</tr>
<tr>
<td>Inhaled tobramycin (PA+ and ≥ 6 years) (%)(^d)</td>
<td>69.8 68.6 65.5 69.6 70.5</td>
</tr>
<tr>
<td>Inhaled aztreonam (PA+ and ≥ 6 years) (%)</td>
<td>- - 38.9 43.2 43.8</td>
</tr>
<tr>
<td>Azithromycin (PA+ and ≥ 6 years) (%)(^e)</td>
<td>- 63.8 70.1 65.4 64.8</td>
</tr>
<tr>
<td>Hypertonic saline (≥ 6 years) (%)</td>
<td>- 35.4 60.3 70.6 72.1</td>
</tr>
<tr>
<td>Ivacaftor (all eligible patients in that year) (%)</td>
<td>- - 80.0 77.9 60.0</td>
</tr>
<tr>
<td>Ivacaftor/Lumacaftor (all eligible patients in that year) (%)</td>
<td>- - - 52.9 63.2</td>
</tr>
<tr>
<td>Oxygen (%)(^f)</td>
<td>6.0 10.0 10.8 10.4 11.0</td>
</tr>
<tr>
<td>Non-invasive ventilation (%)</td>
<td>- - 2.5 2.8 3.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transplants(^g)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung (all procedures) (n)</td>
<td>149 171 201 262 249</td>
</tr>
<tr>
<td>Liver (n)</td>
<td>10 15 18 20 11</td>
</tr>
<tr>
<td>Kidney (n)</td>
<td>3 5 12 8 8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lost to Follow Up(^h)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lost to follow up (per 100 patients) (%)(^i)</td>
<td>3.6 5.0 4.1 3.6 3.4</td>
</tr>
</tbody>
</table>

---

\(a\) Includes data from transplant recipients.

\(b\) We anticipate that additional 2017 diagnoses will be entered into the Registry in 2018.

\(c\) Pulmonary function data throughout this report reflect the use of Global Lung Initiative (GLI) equations\(^j\) for both children and adults.

\(d\) Includes PA and multidrug-resistant PA found in any culture during the year.

\(e\) Defined as resistant to all antibiotics tested in two or more classes.

\(f\) 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. This includes \(M.\) tuberculosis as well as nontuberculous mycobacteria (NTM) species.

\(h\) 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 TOBI, TOBI™ Podhaler, and Bethkis® in 2016 and 2017. In prior years, only TOBI was available.

\(l\) Individuals were considered eligible if they met the selection criteria used in the U.S. azithromycin trial.\(^2\)

\(m\) Includes continuous, nocturnal, or with exertion.

\(n\) Defined as patients seen in the previous reporting year (2016) but not the current reporting year (2017), and are not known to have died.
DEMOGRAPHICS

The Registry contains data on people with CF from 1986 to 2017. 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 2017, there were 29,887 individuals with CF in the Registry. The number of adults with CF continues to increase, while the number of children remains relatively stable. In 2017, adults were 53.5 percent of the CF population, compared with 29.8 percent in 1987.

Currently, 8.7 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. Hispanics with CF tend to be younger than the overall CF population, with a median age of 13.3 years.

Note: the decrease in the number of individuals in 2003 is due to a delay in obtaining informed consent forms before the close of the calendar year at some CF care centers.
The median age of people with CF currently in the Registry is 19.3 years. The range is from birth to 87.7 years. Despite gains in survival, the age distribution remains markedly skewed toward younger ages.

**Age Distribution of the CF Population in 2017**

![Age Distribution Graph](image-url)
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 having children of their own. About two-thirds of adults with CF are either studying or working.
Over the last ten years, there has been almost a doubling of the number of people who are married or living together and the number of people with a college degree.

The number of pregnancies among women with CF has increased steadily since the 1990s. Registry data show that 273 women with CF were pregnant in 2017. The overall pregnancy rate among women with CF has remained relatively constant, in contrast to the pregnancy rate in the general U.S. population, which has declined during this time.4
Health Insurance Information

Access to insurance coverage for specialized care and treatments is a challenge 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 2017, a majority of individuals with CF who were age 18 to 25 were covered under their parents’ health insurance plan.

### Insurance Coverage in 2017

<table>
<thead>
<tr>
<th></th>
<th>Under 18 Years</th>
<th>18 to 25 Years</th>
<th>26 Years and Older</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of individuals (n)</td>
<td>13,780</td>
<td>5,822</td>
<td>10,029</td>
<td>29,631</td>
</tr>
<tr>
<td>Health insurance policy (e.g. private insurance) (%)</td>
<td>52.2</td>
<td>64.6</td>
<td>65.5</td>
<td>59.2</td>
</tr>
<tr>
<td>Medicare/Indian Health Services (%)</td>
<td>0.6</td>
<td>5.4</td>
<td>25.8</td>
<td>10.1</td>
</tr>
<tr>
<td>Medicaid/state programs (%)</td>
<td>56.1</td>
<td>43.1</td>
<td>27.9</td>
<td>44.0</td>
</tr>
<tr>
<td>TriCare or other military health plan (%)</td>
<td>3.2</td>
<td>2.1</td>
<td>1.6</td>
<td>2.4</td>
</tr>
<tr>
<td>Other (%)</td>
<td>1.1</td>
<td>1.3</td>
<td>1.3</td>
<td>1.2</td>
</tr>
<tr>
<td>No health insurance (%)</td>
<td>0.3</td>
<td>1.3</td>
<td>0.9</td>
<td>0.7</td>
</tr>
</tbody>
</table>

*“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 2017

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Individuals who participated in a patient assistance program (%)</td>
<td>40.9</td>
</tr>
<tr>
<td>Individuals 18 to 25 years covered under parents’ insurance (%)</td>
<td>55.0</td>
</tr>
</tbody>
</table>

*“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 57.6 percent of children under age 10. Though the overall prevalence of Medicare use is low, among adults aged 30 to 35 years old, 22.7 percent report Medicare coverage. This increases to 29.0 percent among adults aged 40 to 64 years old. Individuals under age 65 who receive Medicare have met the federal criteria for disability.
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 test.

In 2017, 58.4 percent of total new diagnoses and 86.1 percent of diagnoses among those less than six months old were reported as being detected by newborn screening (NBS). There is evidence that individuals diagnosed prior to the onset of symptoms have better lung function and nutritional outcomes later in life. 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.

The implementation of a screening program is typically associated with a short-term increase in the number of newly diagnosed individuals that then tends to stabilize over time. Some of the decrease observed in 2017 is the result of a yearly issue that infants born late in the year (i.e. late 2017) were not seen at a CF care center before the close of the reporting year; therefore, their data are not yet included in the Registry. Future reports will be adjusted to include these individuals for the 2017 diagnosis year.

With the widespread use of newborn screening 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 genetic mutations. In the United States, this is referred to as CFTR-related metabolic syndrome (CRMS); other countries use the term CF screen positive, inconclusive diagnosis (CFSPID). Recently released diagnosis guidelines harmonized the criteria for CRMS/CFSPID. 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 8.3 percent of those diagnosed during the year in 2016 to 11.3 percent in 2017. 
Individuals can be diagnosed with CFTR-related disorder. This option has also 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. The percentage of CFTR-related disorder decreased from 6.1 percent of those diagnosed during the year in 2016 to 4.5 percent in 2017. Collection and analysis of data from individuals with CRMS and CFTR-related disorder will provide new and important information for these distinct populations.

In 2017, 564 newborn infants were diagnosed with CF. Of those with a known gestational age at birth, 87.6 percent were born full-term, comparable with the figure for the general U.S. population. The mean birth weight for full-term infants with CF is also about the same as for the U.S. population, suggesting that babies born with CF do not initially show nutritional deficiencies. The graph does not include the 106 infants who were born and diagnosed with CF in 2017 who did not have a gestational age recorded in the Registry (18.8 percent).

"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.
The majority of those diagnosed in their first year are asymptomatic or minimally symptomatic at time of diagnosis. Among the 13.1 percent of infants diagnosed in 2017 under age one with meconium ileus (or other intestinal obstruction), 13.8 percent had bowel perforation. Those diagnosed after age one often present with acute or persistent respiratory abnormalities.

### Symptoms Reported at CF Diagnosis

<table>
<thead>
<tr>
<th>Number of Individuals (n)</th>
<th>All Patients (%)</th>
<th>Diagnosed in 2017 (%)</th>
<th>Diagnosed in 2017 Age &lt; 1 (%)</th>
<th>Diagnosed in 2017 Age ≥ 1 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>29,887</td>
<td>880</td>
<td>611</td>
<td>269</td>
<td></td>
</tr>
</tbody>
</table>

#### Asymptomatic

- DNA analysis: 11.9/24.4/23.7/26.0
- Family history: 14.7/12.2/11.1/14.5
- Newborn (neonatal) screening: 25.1/58.4/82.0/4.8
- Prenatal screening (CVS, amniocentesis): 2.4/3.1/4.3/0.4

#### Symptomatic

- Meconium ileus/other intestinal obstruction: 17.4/9.6/13.1/1.5
- Acute or persistent respiratory abnormalities: 36.1/14.7/1.3/45.0
- CBAVD* or infertility/GUc abnormalities: 0.6/2.3/0.0/7.4
- Digital clubbing: 0.5/1.0/0.0/3.4
- Edema: 0.6/0.1/0.0/0.4
- Electrolyte imbalance: 3.0/0.5/0.2/1.1
- Failure to thrive/malnutrition: 28.1/6.9/5.1/11.2
- Liver problems: 1.1/0.7/0.2/1.9
- Nasal polyps/sinus disease: 3.5/3.4/0.2/10.8
- Rectal prolapse: 2.7/0.2/0.0/0.7
- Steatorrhea/abnormal stools/malabsorption: 21.5/4.0/2.8/6.7
- Other: 4.6/5.8/2.0/14.5

Data are not mutually exclusive. We anticipate that additional 2017 diagnoses will be entered into the Registry in 2018.

* 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 2017; the following figure includes all individuals followed in the Registry in 2017.

Age at Diagnosis of All Individuals with CF Seen in 2017

Among all individuals in the Registry in 2017, 66.6 percent were diagnosed in the first year of life.

**Diagnostic Tests**

*Sweat Chloride Testing*

Sweat chloride testing is an important diagnostic test recommended for all individuals regardless of genotype. In 2017, 89.3 percent of individuals in the Registry had a sweat chloride test result recorded. Individuals who are homozygous for F508del, the most common CF-causing genetic mutation, are less likely to have sweat chloride values in the Registry than those with other mutations. 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.

Percentage of Individuals with a Sweat Chloride Test Reported by Year of Diagnosis, 1987-2017

Some individuals diagnosed in 2017 may not have had a sweat chloride test result entered in the Registry before the close of the reporting year.
Median sweat chloride test results have remained consistent over time for individuals who are F508del homozygous. In contrast, there has been a steady decline in median sweat chloride values among individuals who are not homozygous for F508del, suggesting that more individuals with “less severe” genotypes are being entered into the Registry.

**Genotyping**

The cystic fibrosis transmembrane conductance regulator (CFTR) gene and the most prevalent CF-causing mutation (F508del) were discovered in 1989. Since then, genotyping has become a key component of the diagnostic work-up. In addition, with the introduction of CFTR modulators, genotyping all people with CF is becoming more important for research and clinical care. In 2017, 98.6 percent of individuals (n=29,469) in the Registry had been genotyped.
CFTR GENE MUTATIONS

To date, more than 1,800 mutations have been found in the CFTR gene.\textsuperscript{11} Some mutations result in virtually no CFTR function and others are associated with some residual function. To help categorize CF disease-causing mutations on the basis of their resulting functional impact, researchers have created five classes.\textsuperscript{12-14}

![One Way of Classifying CFTR Mutations](image)

This classification system is helpful for understanding the steps in the development of the CFTR protein and why mutation is associated with disease severity. However, it is increasingly being recognized that this classification schema is an oversimplification. Some mutations lead to more than one defect in CFTR function. For example, the R117H mutation results in both gating and conductance defects in CFTR. In addition, functional status has not been determined for all mutations. The issues with this classification system and the approval of CFTR modulators has initiated consideration of mutations based on theratyping, i.e. whether or not they respond to available therapies. One potential theratyping strategy would be to group all individuals with mutations that respond to a potentiator (13.0 percent), individuals with mutations that respond to a potentiator/corrector combination (44.0 percent), individuals with mutations that are currently non-responsive to available therapies (23.0 percent), and the remaining individuals (20.0 percent) who have mutations that have not yet been tested for responsiveness to therapies.

\textit{Adapted from: http://www.umd.be/CFTR/W_CFTR/gene.html}
The most common CFTR mutation is F508del: 85.8 percent of individuals in the Registry have at least one copy of this mutation. There is a substantial drop in prevalence from F508del to the next most common mutations. No other mutation is currently found in more than five percent of the population with CF.

<table>
<thead>
<tr>
<th>CFTR Mutation</th>
<th>Mutation Class</th>
<th>Number of Individuals</th>
<th>Percent of All People with CF</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F508del</strong></td>
<td>2</td>
<td>25,276</td>
<td>85.8</td>
</tr>
<tr>
<td><strong>G542X</strong></td>
<td>1</td>
<td>1,352</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>G551D</strong></td>
<td>3</td>
<td>1,320</td>
<td>4.5</td>
</tr>
<tr>
<td><strong>R117H</strong></td>
<td>4</td>
<td>867</td>
<td>2.9</td>
</tr>
<tr>
<td><strong>N1303K</strong></td>
<td>2</td>
<td>709</td>
<td>2.4</td>
</tr>
<tr>
<td><strong>W1282X</strong></td>
<td>1</td>
<td>669</td>
<td>2.3</td>
</tr>
<tr>
<td><strong>R553X</strong></td>
<td>1</td>
<td>541</td>
<td>1.8</td>
</tr>
<tr>
<td><strong>3849+10kbC&gt;T</strong></td>
<td>5</td>
<td>515</td>
<td>1.7</td>
</tr>
<tr>
<td><strong>621+1G&gt;T</strong></td>
<td>1</td>
<td>476</td>
<td>1.6</td>
</tr>
<tr>
<td><strong>1717-1G&gt;A</strong></td>
<td>1</td>
<td>469</td>
<td>1.6</td>
</tr>
<tr>
<td><strong>2789+5G&gt;A</strong></td>
<td>5</td>
<td>410</td>
<td>1.4</td>
</tr>
<tr>
<td><strong>3120+1G&gt;A</strong></td>
<td>1</td>
<td>327</td>
<td>1.1</td>
</tr>
<tr>
<td><strong>D1152H</strong></td>
<td>4</td>
<td>271</td>
<td>0.9</td>
</tr>
<tr>
<td><strong>5T</strong></td>
<td>5</td>
<td>237</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>I507del</strong></td>
<td>2</td>
<td>234</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>R1162X</strong></td>
<td>1</td>
<td>224</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>1898+1G&gt;A</strong></td>
<td>1</td>
<td>213</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>3659delC</strong></td>
<td>1</td>
<td>207</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>2184insA</strong></td>
<td>1</td>
<td>196</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>G85E</strong></td>
<td>2</td>
<td>192</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>R347P</strong></td>
<td>4</td>
<td>177</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>3272-26A&gt;G</strong></td>
<td>5</td>
<td>176</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>A455E</strong></td>
<td>5</td>
<td>170</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>L206W</strong></td>
<td>4</td>
<td>170</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>R334W</strong></td>
<td>4</td>
<td>164</td>
<td>0.6</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>F508del Mutation</th>
<th>Percent of All People with CF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homozygous F508del</td>
<td>45.3</td>
</tr>
<tr>
<td>Heterozygous F508del</td>
<td>40.9</td>
</tr>
<tr>
<td>Neither F508del or Unknown</td>
<td>13.7</td>
</tr>
</tbody>
</table>
Among less common mutations, the number of individuals with an R117H mutation has increased over the years. Among those genotyped in 1993, less than one percent had an R117H mutation, compared with almost four percent of those genotyped in 2017. This may be due to the inclusion of R117H in newborn screening algorithms. Of note, 99 (11.4 percent) of the 865 individuals with an R117H mutation had a sweat chloride value less than 30 mmol/L.

The clinical significance of the R117H mutation 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.\textsuperscript{15,16} Unfortunately, the Registry has incomplete information on the poly-T tract status for the majority of individuals (66.0 percent) who are reported as having a diagnosis of CF and an R117H mutation. Of the 312 individuals with poly-T tract status recorded in the Registry, 115 (36.9 percent) are classified as having 5T.
While the theratyping classification is being developed, we will continue to provide data in the report by mutation class categories. The majority of children and young adults with CF have genotypes comprised of mutations in classes I-III. The number and proportion of individuals in this group decreases in older ages. Conversely, we see a greater number of individuals with genotypes with class IV-V mutations who are under age 10, and those of older ages. This is likely due to the implementation of NBS and survivor bias, respectively. More information about survivor bias and how alleles are grouped into classes is provided in the Technical Supplement on cff.org.

Individuals in the class I-III group are younger and are more likely to be prescribed pancreatic enzyme replacement therapies (PERT) than individuals with a mutation in the class IV-V group (97.5 percent of individuals in the class I-III group and 36.1 percent in the class IV-V group are taking PERT).
In relation to disease severity, higher sweat test values are observed among individuals in classes I-III than in classes IV-V.

### Sweat Chloride Value (mmol/L), by Mutation Class Group

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>30</th>
<th>60</th>
<th>90</th>
<th>120</th>
<th>150 Median</th>
<th>5th Percentile</th>
<th>95th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mutation Class I-III</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>102.0</td>
<td>79.0</td>
<td>127.0</td>
</tr>
<tr>
<td>N=18,060</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mutation Class IV-V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>71.0</td>
<td>27.0</td>
<td>113.0</td>
</tr>
<tr>
<td>N=3,056</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genotyped But Not</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>93.0</td>
<td>42.0</td>
<td>123.0</td>
</tr>
<tr>
<td>Identified in Mutation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classes I-III or IV-V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N=4,805</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Individuals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>99.0</td>
<td>52.0</td>
<td>125.0</td>
</tr>
<tr>
<td>N=25,921</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

These charts use the highest sweat test value reported to the Registry. For some individuals, this value may reflect sweat chloride values after initiation of CFTR modulator therapy.
GUIDELINES: CARE, SCREENING, AND PREVENTION

The CF Foundation sponsors the development of clinical practice guidelines to promote high quality physical and mental health care for individuals with CF during infancy, childhood, and adulthood.17-19 Many CF care centers report four office visits, two pulmonary function tests, and at least one microbiology culture annually for the majority of their CF patients. Similarly, among children age 2 to 5, the majority have at least four visits and at least one culture.

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.20

There is significant variation by CF care center in several key screening measures, including dual-energy X-ray absorptiometry (DXA) scans for osteopenia/osteoporosis. 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 percentage of individuals who receive care that meets CF Foundation care guidelines has increased in recent years. Because individuals should be able to perform reliable pulmonary function tests (PFTs) at age six and older, we use guidelines criteria for those age seven and older to ensure that individuals were eligible to perform a reliable PFT for the entire year.

Over the past decade, the number of children and adults receiving, at a minimum, the annual recommended four office visits, four respiratory cultures, and two PFTs20,21 has steadily increased. The percentage of adults who receive care that meets guidelines criteria remains lower than that observed in children. However, the percentage of those meeting guidelines continues to rise. Currently, more than half of adults are being seen at least four times, complete two or more PFTs, and are cultured at least once during the year. While we strive for all patients to meet guideline recommendations, we acknowledge that many factors outside of the control of CF care centers may impact metrics.
The guidelines on infection prevention and control recommend that individuals with CF have quarterly respiratory cultures. In 2017, 98.5 percent of individuals received at least one culture, and 56.1 percent of individuals had four or more respiratory cultures.

The multidisciplinary care team plays an important role in CF care. Over time, there has been an increase in the number of individuals with CF who receive an annual evaluation from a respiratory/physical therapist, dietitian/nutritionist, and social worker. In 2017, 78.7 percent of individuals were evaluated by all three specialists. In addition, to support individuals’ complex treatment regimens, the Registry now reports whether patients are seen by a pharmacist in clinic. In 2017, 35.9 percent of individuals were seen by a pharmacist.
The CF Foundation recommends the inclusion of a mental health professional as part of the CF care team. Information on screening for anxiety and depression is included in the Complications section (page 71).

The Centers for Disease Control and Prevention’s Advisory Committee on Immunization Practices recommends influenza vaccination for all individuals with CF age six months and older. The influenza vaccination rate of people with CF age six months and older is 77.3 percent of the total population and 89.5 percent of those with a known vaccination status (excluding 13.7 percent with unknown status).

**Flu Vaccine Status by Age in Years, 2017** *(Stacked Bar Chart)*
The CF Foundation consensus statement on bone health and disease recommends screening all adults with CF with a DXA scan and subsequent follow-up based on the findings of the baseline scan. Annual screenings are recommended only for individuals with DXA z-scores that are lower than two standard deviations below the mean, with less frequent screening recommended for those with higher values. Therefore, in the figure below, we group five years of data.

| Percentage of Individuals with a DXA Scan in the Past Five Years, by Center |
|---|---|---|---|---|
| 0 | 50 | 100 | Median | Min | Max |
| Individuals 18 Years and Older | | | 54.2 | 0.0 | 100.0 |

Includes any DXA scans performed during 2013–2017.

CF Foundation guidelines recommend annual measurement of fat-soluble vitamins to screen for vitamin deficiency. 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. Registry data suggest that these tests are being done on the majority of 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 | | | 90.8 | 45.3 | 100.0 |
| Individuals with Liver Enzymes Measured | | | 91.2 | 30.0 | 100.0 |
Tobacco smoke and secondhand smoke exposure remain significant concerns, especially for infants and young adults. In 2017, 18.6 percent of individuals with CF reported monthly or more frequent exposure to tobacco smoke, either secondhand or as a smoker. Cigarette smoking prevalence is lower in the CF population than in the general U.S. population; 2.0 percent of adults with CF are smokers, compared with 17.5 percent in the general population in 2015. Smoke exposure was unknown for 35.1 percent of individuals with CF, who were excluded from the analyses.
Infant Care Guidelines

The CF Foundation recommends that evaluation and treatment of infants detected by newborn screening should be done at a CF Foundation-accredited care center, with the goal of an initial visit within 24–72 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. Encouragingly, 86.3 percent of infants diagnosed have their first clinic encounter, genotyping, or sweat test within 30 days of birth.

The CF Foundation infant care guidelines recommend monthly CF care center visits during the first six months of life and every 1 to 2 months in the second six months. Therefore, we expect infants with CF detected by NBS to have 9 to 12 visits in the first year of life. There is marked variation in the number of encounters for individuals in the first year of life across the CF care center network.
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.5

The chart shows data for children born in 2016 because a full year of data is available for these individuals. The median number of visits in the first year of life is nine.

The chart shows data for children born in 2016 because a full year of data is available for these individuals. The median number of cultures in the first year of life is six.
Fecal elastase testing, which provides an objective measure of pancreatic function, is recommended in the infant care guidelines. 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. We observe substantial variation in the utilization of palivizumab (respiratory syncytial virus, or RSV, prophylaxis) across the CF care center network, with a downward trend since 2008. The current American Academy of Pediatrics recommendation is that palivizumab should not be routinely used in individuals with CF. The CF Foundation infant care guidelines recommend that its use be considered for infants with CF.
MICROBIOLOGY

This section provides information on trends in CF airway pathogens over time and by age group for individuals never transplanted. Updated infection prevention and control guidelines provide current best practices for reducing exposure to CF pathogens in the health care setting and in everyday life.\textsuperscript{30}

The prevalence of \textit{Pseudomonas aeruginosa} (\textit{P. aeruginosa} or PA) continues to decrease. This may relate in part to widespread implementation of therapy to eradicate initial acquisition.\textsuperscript{22,30} Despite this, the prevalence of infection with multidrug-resistant \textit{P. aeruginosa} (MDR-PA) has remained constant.

Some of the increase in \textit{Staphylococcus aureus} (\textit{S. aureus}) may be due to improved microbiologic practices for detection and reporting of Gram-positive organisms. From 2000 to 2010, there was a significant increase in the number of individuals with CF with a positive culture for methicillin-resistant \textit{S. aureus} (MRSA). Since 2010, prevalence appears to have plateaued. The stabilization of prevalence is potentially due to increased awareness and infection prevention and control strategies.
The graph shows the proportion of individuals in various age groups who cultured positive for the bacterial species indicated during 2017.

### Culture Data for Individuals Seen in 2017

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Percent with Infection</th>
<th>Median Age in Years at First Infection</th>
<th>Distinctive Features in CF</th>
</tr>
</thead>
</table>
| P. aeruginosa                         | 44.6                   | 5.2                                    | • A leading cause of airway infection  
• Associated with a decline in lung function  
• 17.9% of strains are multidrug-resistant |
| B. cepacia complex                    | 2.4                    | 19.4                                   | • Small proportion of people with CF infected  
• Can lead to rapid deterioration  
• Multidrug-resistant |
| MRSA                                  | 25.2                   | 11.1                                   | • Prevalent among people with and without CF  
• Multidrug-resistant  
• Health care and community-associated strains |
| S. maltophilia                        | 12.6                   | 9.4                                    | • Found in water, soil, plants, animals, and hospital environments  
• Often multidrug-resistant |
| Achromobacter xylosoxidans            | 5.8                    | 13.8                                   | • Inhabits natural environment, including soil and water  
• Often multidrug-resistant |
| Non-tuberculous mycobacteria          | 12.6                   | 20.7                                   | • Found in water and soil  
• Sporadic reports of person-to-person spread  
• Treatment is rigorous and often poorly tolerated |

A note about the reporting of *Burkholderia* species: in 2017, 2.4 percent of those cultured were reported in the Registry as having had a culture positive for *Burkholderia cepacia* (*B. cepacia*) complex. Further investigation is needed on the reporting practices for these variables before figures on *B. cepacia* complex subspecies can be included in the report.

The table below displays prevalence of the key respiratory microorganisms in 2017 along with median age at first positive culture for the species.
**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 (47.0 percent had a positive culture in 1997 compared with 27.5 percent in 2017). Many individuals with CF now transition to adult care without *P. aeruginosa* in their respiratory tract.

Rates of MDR-PA infection are greatest in older adolescents and adults with CF. This finding likely reflects cumulative exposure to antibiotics. The clinical significance of this drug resistance is unclear. Among the individuals with CF who had at least one bacterial culture in 2017, 8.2 percent were reported to have MDR-PA. Among the individuals with CF with a *P. aeruginosa* infection in 2017, 17.9 percent were reported to have MDR-PA.

A classification system known as the Leeds criteria is used to categorize individuals on the basis of *P. aeruginosa* infection status. The Leeds criteria categories are “never having a positive *P. aeruginosa* culture,” “free of a positive *P. aeruginosa* culture in the past 12 months,” “intermittent infection” (less than 50 percent of their cultures in the past year were positive for *P. aeruginosa*), and “chronic infection” (more than 50 percent of their cultures in the past year were positive for *P. aeruginosa*).
**Staphylococcus aureus**

*S. aureus* is currently the most common microorganism reported among individuals with CF. Overall, more than half of individuals had at least one culture positive for methicillin-sensitive *S. aureus* (MSSA) in 2017. This chart shows that the highest prevalence of MRSA occurs in individuals between the ages of 10 and 30, while MSSA peaks among those younger than 10.
Nontuberculous Mycobacteria

Prevalence of nontuberculous mycobacteria (NTM) infections is increasing in the general population. Since 2010, the Registry has collected more robust information on mycobacterial cultures and NTM infections.

The CF Foundation/European Cystic Fibrosis Society Guidelines Committee recommends that individuals with CF who are able to expectorate be cultured for NTM infections annually. Individuals should also be screened before and six months after beginning azithromycin and annually thereafter. The data show improvement in screening rates over time, but wide variation by CF care center persists in these measures.

### Percentage of Individuals with a Mycobacterial Culture, by Center

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>50</th>
<th>Median</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individuals Who Produced a Sputum Sample During the Year</td>
<td>76.8</td>
<td></td>
<td></td>
<td>0.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Individuals Taking a Chronic Macrolide Who Produced a Sputum Sample During the Year</td>
<td>84.7</td>
<td></td>
<td></td>
<td>4.5</td>
<td>100.0</td>
</tr>
</tbody>
</table>

A throat swab is insufficient for a mycobacterial culture, so a patient must be able to produce sputum in order for this culture to be performed. A majority (79.4 percent) of the individuals who produced a sputum culture for a bacterial culture also had a mycobacterial culture performed during the year.
Of the 15,041 individuals who had a mycobacterial culture performed in 2017, 1,903 (12.7 percent) had a mycobacterial species isolated one or more times. The relative proportion of *M. abscessus* isolated in 2017 is higher than reported more than a decade ago in a CF Foundation-supported multicenter prevalence study.\(^{34}\)

Data are not mutually exclusive. Some individuals had more than one species isolated in 2017.

<table>
<thead>
<tr>
<th>Mycobacterial Species Isolated in 2017</th>
<th>Number of Individuals</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>M. avium complex</em> (MAC)</td>
<td>966</td>
</tr>
<tr>
<td><em>M. abscessus</em>/<em>M. chelonae</em></td>
<td>782</td>
</tr>
<tr>
<td><em>M. gordonae</em></td>
<td>58</td>
</tr>
<tr>
<td><em>M. fortuitum</em></td>
<td>24</td>
</tr>
<tr>
<td><em>M. tuberculosis</em></td>
<td>13</td>
</tr>
<tr>
<td><em>M. kansasii</em></td>
<td>11</td>
</tr>
</tbody>
</table>

*Data are not mutually exclusive. Some individuals had more than one species isolated in 2017.*
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 for individuals never transplanted. Overall, improvements in nutritional metrics are observed for all ages. Recent CF Foundation evidence-informed guidelines recommend enteral tube feeding as a means to improve age-dependent anthropometrics and nutrition in individuals with CF who are unable to consume adequate nutrition to meet nutritional goals.35

Goals for CF Foundation weight-for-length and BMI percentile in children are based on CDC growth curves. However, the CDC and the American Academy of Pediatrics recommend the use of World Health Organization (WHO) growth curves, which are more frequently utilized in children less than 24 months of age.36 WHO growth curves are used to report the data below.

![Median WHO Nutritional Outcome Percentiles for Infants Under 24 Months, 1997–2017](image)
The charts below show the population-level variation in infants for WHO weight-for-length, weight percentile, and length percentiles in three groups: all individuals, those in mutation classes I-III (typically considered more severe mutations), and those in classes IV-V. All three groups show a median weight-for-length value well above the 50th percentile; however, individuals in the I-III group have lower weight and substantially lower length percentiles than individuals in the IV-V group.

### All Individuals, WHO Nutritional Outcomes for Infants Under 24 Months

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>50</th>
<th>100</th>
<th>Median</th>
<th>5th Percentile</th>
<th>95th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight-for-Length</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N=1,759</td>
<td></td>
<td></td>
<td></td>
<td>64.8</td>
<td>15.9</td>
<td>96.6</td>
</tr>
<tr>
<td>Weight Percentile</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N=1,765</td>
<td></td>
<td></td>
<td></td>
<td>44.1</td>
<td>2.8</td>
<td>92.3</td>
</tr>
<tr>
<td>Length Percentile</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N=1,764</td>
<td></td>
<td></td>
<td></td>
<td>30.5</td>
<td>1.0</td>
<td>87.9</td>
</tr>
</tbody>
</table>

### Mutation Class I-III, WHO Nutritional Outcomes for Infants Under 24 Months

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>50</th>
<th>100</th>
<th>Median</th>
<th>5th Percentile</th>
<th>95th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight-for-Length</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N=1,184</td>
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<td></td>
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<td>63.7</td>
<td>15.2</td>
<td>96.1</td>
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<tr>
<td>Weight Percentile</td>
<td></td>
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<tr>
<td>N=1,189</td>
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<td>41.8</td>
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<td>91.8</td>
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<td>Length Percentile</td>
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<tr>
<td>N=1,186</td>
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<td>29.5</td>
<td>1.0</td>
<td>86.7</td>
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</tbody>
</table>

### Mutation Class IV-V, WHO Nutritional Outcomes for Infants Under 24 Months

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>50</th>
<th>100</th>
<th>Median</th>
<th>5th Percentile</th>
<th>95th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight-for-Length</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>N=213</td>
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<td></td>
<td></td>
<td>65.8</td>
<td>16.8</td>
<td>97.8</td>
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<td>Weight Percentile</td>
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<tr>
<td>N=213</td>
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<td></td>
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<td>51.4</td>
<td>5.2</td>
<td>92.5</td>
</tr>
<tr>
<td>Length Percentile</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N=214</td>
<td></td>
<td></td>
<td></td>
<td>35.5</td>
<td>1.9</td>
<td>90.5</td>
</tr>
</tbody>
</table>
The goal established by the CF Foundation nutrition guidelines for children age 2 to 19 years is a BMI percentile at or above 50 using CDC growth curves.\textsuperscript{25} The median BMI percentile is above the 50th percentile for this age group regardless of mutation class. Children in the IV-V group have higher BMI percentiles than those in the I-III group.

### All Individuals, CDC Nutritional Outcomes for Individuals 2 to 19 Years

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>50</th>
<th>100</th>
<th>Median</th>
<th>5th Percentile</th>
<th>95th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI Percentile</td>
<td>57.3</td>
<td>10.3</td>
<td>94.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight Percentile</td>
<td>46.7</td>
<td>4.0</td>
<td>93.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height Percentile</td>
<td>37.9</td>
<td>2.3</td>
<td>91.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Mutation Class I-III, CDC Nutritional Outcomes for Individuals 2 to 19 Years

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>50</th>
<th>100</th>
<th>Median</th>
<th>5th Percentile</th>
<th>95th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI Percentile</td>
<td>55.9</td>
<td>10.1</td>
<td>92.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight Percentile</td>
<td>44.6</td>
<td>3.6</td>
<td>90.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height Percentile</td>
<td>35.5</td>
<td>2.1</td>
<td>89.4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Mutation Class IV-V, CDC Nutritional Outcomes for Individuals 2 to 19 Years

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>50</th>
<th>100</th>
<th>Median</th>
<th>5th Percentile</th>
<th>95th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI Percentile</td>
<td>66.4</td>
<td>12.7</td>
<td>98.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight Percentile</td>
<td>61.0</td>
<td>9.2</td>
<td>97.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height Percentile</td>
<td>51.6</td>
<td>5.2</td>
<td>94.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Successive birth cohorts show improved weight and height percentiles, most notably in the youngest cohorts. Multiple factors may contribute to improvements in the youngest cohorts, including implementation of NBS with early intervention.\textsuperscript{37,38}

**Median CDC Weight Percentile, by Age and Birth Cohort in 2017**

![Median CDC Weight Percentile](image1)

**Median CDC Height Percentile, by Age and Birth Cohort in 2017**

![Median CDC Height Percentile](image2)
The BMI goal established by the CF Foundation nutrition guidelines is at or above 22 for females and 23 for males age 20 years and older. Among individuals in the class I-III group, median BMI is below the goal, whereas individuals in the class IV-V group have a median BMI above the goal. Considerable variation in BMI exists within each mutation class, with significant overlap between individuals in the I-III group and the IV-V group. Of note, 30.4 percent of those in the IV-V group are overweight (BMI of 25 to 29.9), and 21.1 percent are obese (BMI of 30+).

**BMI Value for Adults 20 Years and Older, by Mutation Class Group**

<table>
<thead>
<tr>
<th>Mutation Class Group</th>
<th>Median</th>
<th>5th Percentile</th>
<th>95th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Individuals N=12,390</td>
<td>22.7</td>
<td>17.9</td>
<td>31.6</td>
</tr>
<tr>
<td>Mutation Class I-III N=8,543</td>
<td>22.3</td>
<td>17.8</td>
<td>29.1</td>
</tr>
<tr>
<td>Mutation Class IV-V N=1,723</td>
<td>25.2</td>
<td>19.0</td>
<td>36.8</td>
</tr>
</tbody>
</table>

Significant progress in nutritional outcomes continues for all people with CF. Aging of the CF population and a greater number of late diagnoses with genotypes associated with milder disease may be contributing to the trend in adult nutritional outcomes shown below.
Infant Feeding

The majority of 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.5

### Form of Feeding by Age in 2017

<table>
<thead>
<tr>
<th>Age Category</th>
<th>Breast Milk</th>
<th>Breast Milk Plus Formula</th>
<th>Formula Exclusively</th>
<th>Other Food</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth to 3 Months</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>4 to 6 Months</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>7 to 12 Months</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>13 to 24 Months</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>400</td>
</tr>
</tbody>
</table>

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 FUNCTION

Pulmonary function is an important clinical indicator of the health of individuals with CF. This section provides information on trends in pulmonary function by age for individuals who have never had an organ transplant, as well as variations in pulmonary function across CF care centers and by mutation class groups. Pulmonary function is measured using the FEV₁ percent predicted and calculated using the Global Lung Initiative (GLI) reference equations.¹

Successive birth cohorts show improved pulmonary function across all ages, for individuals who are old enough to perform reliable pulmonary function testing. The majority of those age 18 now have an FEV₁ percent predicted greater than or equal to 70.

FEV₁ percent predicted is steadily improving and currently is above 90 percent predicted into early adolescence.

The GLI reference equations allow for the calculations of FEV₁ percent predicted for children age three and older. However, the validity and generalizability of the data for children aged 3 to 5 in the Registry were investigated and found to be insufficient. Further details are available in the Technical Supplement on cff.org.
The proportion of people with CF age 18 who are in the normal/mild lung disease category (FEV₁ ≥70 percent predicted) has increased from 34.6 percent in 1987 to 76.0 percent in 2017. The proportion in the severe lung disease category (FEV₁ <40 percent predicted) has decreased from 31.7 percent in 1987 to 4.0 percent in 2017.

It is important to point out that spirometry is not a sensitive measure of early lung disease in CF. With that caveat in mind, the vast majority of children have normal or “mild” impairment in pulmonary function. This proportion decreases until age 45, when the population has nearly equal proportions of individuals with mild, moderate, and severe lung disease.
Variation in Pulmonary Function by Mutation Class

A majority of people with CF are in the class I-III group of mutations (70.4 percent of those genotyped), and the clinical outcomes of this group drive national averages. Median lung function is lower among individuals in the I-III group than in individuals in the IV-V group (6.6 percent lower in children and 9.1 percent lower in adults). However, there is considerable variation among individuals within each mutation class group and substantial overlap between the two groups.

| FEV1 Percent Predicted for Individuals 6 to 17 Years, by Mutation Class Group |
|----------------|--------|--------|--------|--------|--------|--------|--------|
|                | 0      | 25     | 50     | 75     | 100    | 125    | Median | 5th Percentile | 95th Percentile |
| All Individuals|        |        |        |        |        |        | 93.8   | 58.1     | 117.3    |
| N=9,208        |        |        |        |        |        |        |        |          |          |
| Mutation Class I-III |   |        |        |        |        |        | 92.8   | 56.2     | 116.2    |
| N=6,695        |        |        |        |        |        |        |        |          |          |
| Mutation Class IV-V |   |        |        |        |        |        | 99.4   | 73.0     | 120.7    |
| N=917          |        |        |        |        |        |        |        |          |          |

| FEV1 Percent Predicted for Individuals 18 Years and Older, by Mutation Class Group |
|----------------|--------|--------|--------|--------|--------|--------|--------|
|                | 0      | 25     | 50     | 75     | 100    | 125    | Median | 5th Percentile | 95th Percentile |
| All Individuals|        |        |        |        |        |        | 68.8   | 28.3     | 105.0    |
| N=13,918       |        |        |        |        |        |        |        |          |          |
| Mutation Class I-III |   |        |        |        |        |        | 66.9   | 27.6     | 103.2    |
| N=9,750        |        |        |        |        |        |        |        |          |          |
| Mutation Class IV-V |   |        |        |        |        |        | 76.0   | 33.5     | 109.5    |
| N=1,837        |        |        |        |        |        |        |        |          |          |
PULMONARY AND NUTRITIONAL OUTCOMES

Pulmonary and nutritional outcomes are two key measures of CF health. These metrics are the primary focus of quality improvement work within the CF care center network. The data show that for all people with CF, pulmonary function and nutrition status are related, and improvements in one metric are associated with improvements in the other.

Pulmonary and nutritional goals\textsuperscript{25} are as follows:

- For children, FEV\textsubscript{1} percent predicted greater than or equal to 100, and BMI percentile meeting or exceeding the 50th percentile.
- For adults, FEV\textsubscript{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\textsubscript{1} Percent Predicted vs. BMI Percentile for Children 6 to 19 Years in 2017**

![Graph showing FEV\textsubscript{1} Percent Predicted vs. BMI Percentile for Children 6 to 19 Years in 2017](image)

---

**FEV\textsubscript{1} Percent Predicted vs. BMI Value for Adults 20 to 40 Years in 2017**

![Graph showing FEV\textsubscript{1} Percent Predicted vs. BMI Value for Adults 20 to 40 Years in 2017](image)
The figures below on the left show median BMI percentile and FEV₁ percent predicted values for each center in 2017. The figures on the right show how median values for all centers have improved over the last 30 years.
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 among individuals who never had an organ transplant, as well as variation in exacerbation rates and treatment characteristics by CF care center. Despite notable improvements in pulmonary function and nutritional status over the years, there has not been a marked change in the proportion of individuals with CF who are treated with IV antibiotics for pulmonary exacerbations. This suggests that clinicians are more aggressively prescribing IV antibiotics to healthier individuals.

Individuals with CF who are between ages 15 and 30 are more likely than those in other age groups to experience a pulmonary exacerbation during the year.
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. Current practice within the CF Foundation care center network indicates a median treatment duration of about two weeks, with adults more likely to complete some of their treatment at home. Further research is underway to develop evidence for best practices in the treatment of pulmonary exacerbations.

### Duration of Pulmonary Exacerbation Treatment in Days, by Center

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>Median</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median Total Duration of IV Antibiotic Treatment for a Pulmonary Exacerbation in Individuals Less than 18 Years</td>
<td></td>
<td></td>
<td></td>
<td>13.0</td>
<td>5.9</td>
<td>19.5</td>
</tr>
<tr>
<td>Median Duration of Hospital Stay for Treatment of a Pulmonary Exacerbation in Individuals Less than 18 Years</td>
<td></td>
<td></td>
<td></td>
<td>9.3</td>
<td>3.0</td>
<td>14.5</td>
</tr>
<tr>
<td>Median Total Duration of IV Antibiotic Treatment for a Pulmonary Exacerbation in Individuals 18 Years and Older</td>
<td></td>
<td></td>
<td></td>
<td>14.0</td>
<td>8.0</td>
<td>23.3</td>
</tr>
<tr>
<td>Median Duration of Hospital Stay for Treatment of a Pulmonary Exacerbation in Individuals 18 Years and Older</td>
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<td></td>
<td></td>
<td>8.0</td>
<td>2.0</td>
<td>15.0</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>50</th>
<th>100</th>
<th>Median</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individuals Less than 18 Years</td>
<td></td>
<td></td>
<td></td>
<td>84.0</td>
<td>13.6</td>
<td>100.0</td>
</tr>
<tr>
<td>Individuals 18 Years and Older</td>
<td></td>
<td></td>
<td></td>
<td>63.2</td>
<td>14.6</td>
<td>100.0</td>
</tr>
</tbody>
</table>
THERAPIES

Gastrointestinal (GI) Therapies

The CF Foundation infant clinical care guidelines recommend that pancreatic enzyme replacement therapies (PERT) be started for all infants with two CFTR mutations associated with pancreatic insufficiency, a fecal elastase value below 200 μg/g of stool, and/or signs of malabsorption.\(^5\)

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 individuals with milder disease surviving longer and removing post-transplant individuals from the analysis.

For individuals age two 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.\(^26\) The mean dose of lipase units/kg/meal for individuals 2 to 19 years is 1,935 and for individuals 20 years and older, the mean dose is 1,783.

Infants with evidence of pancreatic insufficiency are recommended to receive 2,000 to 5,000 lipase units per feeding (total lipase dose), with adjustments as the infant grows.\(^7\) Registry data show that the mean highest dose of lipase among children younger than two years is 1,653 units/kg/meal.

For infants with CF younger than two years, the infant clinical care guidelines recommend assessment of pancreatic functional status by measurement of fecal elastase.\(^5\) 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 65 percent of infants were tested in 2017. Among individuals under two years old with a clinic visit in 2017, 35.1 percent did not have a fecal elastase value reported, and of those individuals, 89.4 percent were prescribed PERT. Almost all individuals with a known fecal elastase value of less than 200 μg/g of stool were prescribed PERT. Approximately 23 percent of individuals with fecal elastase values greater than 200 μg/g of stool were also prescribed PERT.
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 (48.5 percent of individuals) than H₂ blockers (17.5 percent of individuals). H₂ blockers are used more frequently in younger individuals and their use tapers among older individuals. Use of PPIs increases with age until age 20 and then is prescribed to 55.7 percent of individuals age 20 and older.

In 2017, 91.8 percent of individuals age 2 to 19 and 81.3 percent of individuals age 20 and older were prescribed CF-specific vitamins, including vitamins A, D, E, and K. Additionally, 12.8 percent of individuals are prescribed ursodeoxycholic acid, which is most commonly prescribed to those with abnormal liver function tests or suspected CF liver disease.
Pulmonary Therapies

Chronic pulmonary therapies are a major 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 for individuals never transplanted. 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.41

Many of the CF therapies are used by between 60 to 80 percent of the eligible population. The use of most therapies has increased over time. In recent years, additional formulations of inhaled tobramycin have become available, and they are included in the chart below. Dornase alfa, which is recommended for all individuals with CF, is used by the vast majority of people and its use continues to rise. Use of chronic inhaled antibiotics seems to have plateaued. The availability of multiple pulmonary therapies for CF is beneficial; however, this also contributes to treatment complexity and overall burden on individuals with CF and their caregivers.

Medication Prescription in Eligible Individuals, 1997-2017

Tobramycin includes all available formulations of inhaled tobramycin. Dornase alfa was approved by the FDA in 1994.
**Pulmonary Medication Prescriptions by Age**

There are three classes of inhaled antibiotics for treatment of \textit{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.

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

A substantial proportion of individuals with CF are prescribed inhaled corticosteroids and, to a lesser degree, leukotriene modifiers. Oral corticosteroids are used infrequently.
Bronchodilators are used extensively among individuals with CF. Almost all people with CF are prescribed beta agonists, except for a very small percentage who are prescribed anticholinergics. The vast majority of those prescribed beta agonists are on short-acting formulations.

Multiple pulmonary therapies are available for individuals with CF. Inhaled medications are effective treatments for pulmonary disease, and they require time to prepare, administer, and clean equipment after treatment. All people with CF are eligible for dornase alfa and hypertonic saline prescriptions. Those with \( P. \) aeruginosa infection or colonization are typically prescribed inhaled antibiotics. Almost all individuals are prescribed at least one inhaled medication, and over half of those age 15 and older are prescribed two or more of these therapies.

Inhaled Medication Prescription by Age in Years, 2017

Inhaled medication includes dornase alfa, hypertonic saline, and inhaled antibiotic. Inhaled antibiotic use includes the use of tobramycin, aztreonam, colistin, or other aminoglycosides.
Medications Recommended For Chronic Use

Recommended therapies are widely prescribed, with the exception of ibuprofen; however, there is considerable variation across the CF Foundation care center network. Increasingly, individuals with CF are using multiple inhaled antibiotics for the treatment of *P. aeruginosa* infections. CFTR modulators are discussed in a separate chapter (p. 59).

Pulmonary Therapies Recommended for Chronic Use, by Center

<table>
<thead>
<tr>
<th>Therapy</th>
<th>0</th>
<th>50</th>
<th>100 Median</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dornase Alfa Prescription in Individuals 6 Years and Older</td>
<td></td>
<td></td>
<td>91.0</td>
<td>37.8</td>
<td>100.0</td>
</tr>
<tr>
<td>Any Inhaled Tobramycin Prescription in <em>P. aeruginosa</em>-positive Individuals 6 Years and Older</td>
<td></td>
<td></td>
<td>70.6</td>
<td>38.9</td>
<td>100.0</td>
</tr>
<tr>
<td>Azithromycin Prescription in Eligible <em>P. aeruginosa</em>-positive Individuals 6 Years and Older*</td>
<td></td>
<td></td>
<td>66.0</td>
<td>0.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Hypertonic Saline Prescription in Individuals 6 Years and Older</td>
<td></td>
<td></td>
<td>74.1</td>
<td>8.3</td>
<td>100.0</td>
</tr>
<tr>
<td>Ibuprofen Prescription in Individuals 6 to 17 Years with FEV1 Greater than 60 Percent Predicted</td>
<td></td>
<td></td>
<td>0.0</td>
<td>0.0</td>
<td>70.8</td>
</tr>
<tr>
<td>Inhaled Aztreonam Prescription in <em>P. aeruginosa</em>-positive Individuals 6 Years and Older</td>
<td></td>
<td></td>
<td>42.9</td>
<td>0.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*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.*
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. Use of colistin has decreased in recent years. Inhaled beta agonists are used extensively, but the other medications are used infrequently. Ibuprofen use in adults is used very rarely, in less than two percent of adults.

<table>
<thead>
<tr>
<th>Pulmonary Therapies with Insufficient Evidence to Recommend For or Against Chronic Use, by Center</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inhaled Beta Agonist Prescription in Individuals 2 Years and Older</strong></td>
</tr>
<tr>
<td><strong>Inhaled Anticholinergic Prescription in Individuals 2 Years and Older</strong></td>
</tr>
<tr>
<td><strong>Leukotriene Modifier Prescription in Individuals 2 Years and Older</strong></td>
</tr>
<tr>
<td><strong>Inhaled Colistin Prescription in Individuals 6 Years and Older with P. aeruginosa</strong></td>
</tr>
</tbody>
</table>

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).

<table>
<thead>
<tr>
<th>Pulmonary Therapies Not Recommended for Chronic Use, by Center</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inhaled Steroid Prescription in Individuals 6 Years and Older Without Asthma or ABPA</strong></td>
</tr>
</tbody>
</table>
**Medication Use in Young Children**

The CF Foundation recently released the first set of guidelines focusing on the preschool timeframe from ages 2 to 5.\textsuperscript{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 selectively offered on the basis of individual circumstances. The chart below shows the use of medications among children younger than age six.

<table>
<thead>
<tr>
<th>Medication Use in Individuals Under 6 Years, 2017</th>
<th>Age &lt; 3 Years (%)</th>
<th>Age 3 to 5 Years (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Individuals (n)</td>
<td>1,922</td>
<td>2,305</td>
</tr>
<tr>
<td>Dornase alfa</td>
<td>44.2</td>
<td>71.4</td>
</tr>
<tr>
<td>Hypertonic saline</td>
<td>28.3</td>
<td>46.9</td>
</tr>
<tr>
<td>Inhaled bronchodilators</td>
<td>80.6</td>
<td>93.4</td>
</tr>
<tr>
<td>Inhaled corticosteroids</td>
<td>17.3</td>
<td>29.9</td>
</tr>
<tr>
<td>Inhaled tobramycin</td>
<td>14.8</td>
<td>18.1</td>
</tr>
<tr>
<td>Azithromycin</td>
<td>4.1</td>
<td>8.9</td>
</tr>
<tr>
<td>Inhaled aztreonam</td>
<td>1.7</td>
<td>3.7</td>
</tr>
</tbody>
</table>
Airway Clearance Techniques

The CF Foundation pulmonary guidelines recommend airway clearance for all individuals with CF. A high-frequency chest wall oscillation (HFCWO) vest is the most widely used airway clearance technique in persons with CF after infancy.

The CF Foundation pulmonary guidelines recommend aerobic exercise as an adjunct therapy for airway clearance and for its additional benefits to overall health. Many individuals with CF report exercising in addition to their primary method of airway clearance, with 34.5 percent of children and 49.6 percent of adults identifying exercise as one of their methods of airway clearance.
CFTR Modulator Therapies

Ivacaftor

In 2012, the U.S. Food and Drug Administration approved ivacaftor for individuals with at least one G551D mutation ages six and older. Since then, there have been label extensions to other mutations and to younger individuals. In 2017, ivacaftor was approved for individuals two years and older with 23 residual function mutations and five additional splice mutations.

Timeline of Ivacaftor Eligibility

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 2012</td>
<td>Ivacaftor approved for those 6 years and older with the G551D mutation</td>
</tr>
<tr>
<td>February 2014</td>
<td>Ivacaftor approved for those 6 years and older with the additional gating S549N, G1244E, G178R, S549R, S1251N, G551S, G1349D, and S1255P mutations</td>
</tr>
<tr>
<td>December 2014</td>
<td>Ivacaftor approved for those 6 years and older with the R117H mutation</td>
</tr>
<tr>
<td>March 2015</td>
<td>Ivacaftor approved for those 2 to 5 years with a previously approved mutation</td>
</tr>
<tr>
<td>May 2017</td>
<td>Ivacaftor approved for those 2 years and older with 23 residual function mutations*</td>
</tr>
<tr>
<td>August 2017</td>
<td>Ivacaftor approved for those 2 years and older with the additional splice 3849+10kbC-&gt;T, 2789+5G-&gt;A, 3272-26A-&gt;G, 711+3A-&gt;G, EB31X mutations</td>
</tr>
</tbody>
</table>


As eligibility for ivacaftor increases, the number of individuals prescribed the medication continues to increase; yet, the proportion of eligible individuals prescribed the medication has decreased. Prescription rates appear to differ by mutation with lower prescription rates observed among individuals with an R117H mutation as compared to individuals with a G551D mutation. Wider variation exists across centers in the number of individuals prescribed ivacaftor among children as compared to adults.
The box and whisker plots below show variation across the CF care center network with regard to the number of individuals prescribed ivacaftor therapy.

### Ivacaftor Prescription in Individuals with an Eligible Mutation, by Center

<table>
<thead>
<tr>
<th>Age Group</th>
<th>0</th>
<th>50</th>
<th>100</th>
<th>Median</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eligible Individuals 2 Years and Older</td>
<td>57.8</td>
<td>0.0</td>
<td>100.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eligible Individuals 2 to 17 Years</td>
<td>57.1</td>
<td>0.0</td>
<td>100.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eligible Individuals 18 Years and Older</td>
<td>60.0</td>
<td>0.0</td>
<td>100.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Ivacaftor/Lumacaftor**

In 2017, ivacaftor/lumacaftor was prescribed for 63.2 percent of the eligible population of individuals age six and older who are homozygous for the F508del mutation (66.3 percent of those age 6 to 17 and 61.1 percent of those age 18 and older). Since ivacaftor/lumacaftor was approved, there have been steady increases each year in the number of individuals prescribed the therapy, with 52.5 percent of individuals receiving a prescription in 2016. There does not appear to be substantial variation in the proportion of eligible individuals receiving a prescription for ivacaftor/lumacaftor across age groups or lung function.
The box and whisker plots below show variation across the CF care center network with regard to the number of individuals prescribed ivacaftor/lumacaftor therapy.

### Ivacaftor/Lumacaftor Prescription in F508del Homozygous Individuals 6 and Older by FEV₁, 2017

<table>
<thead>
<tr>
<th></th>
<th>Number Eligible</th>
<th>On Ivacaftor/Lumacaftor</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>10,734</td>
<td>6,747</td>
<td>62.9</td>
</tr>
<tr>
<td>FEV₁, Less than 40% Predicted</td>
<td>1,077</td>
<td>592</td>
<td>55.0</td>
</tr>
<tr>
<td>FEV₁, 40% to 69% Predicted</td>
<td>2,751</td>
<td>1,806</td>
<td>65.6</td>
</tr>
<tr>
<td>FEV₁, 70% to 89% Predicted</td>
<td>3,108</td>
<td>2,049</td>
<td>65.9</td>
</tr>
<tr>
<td>FEV₁, 90% Predicted or Higher</td>
<td>3,550</td>
<td>2,226</td>
<td>62.7</td>
</tr>
<tr>
<td>FEV₁, Unknown in 2017</td>
<td>248</td>
<td>74</td>
<td>29.8</td>
</tr>
</tbody>
</table>

### Ivacaftor/Lumacaftor Prescription in F508del Homozygous Individuals, by Center

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>50</th>
<th>100 Median</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>F508del Homozygous Individuals 6 Years and Older</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F508del Homozygous Individuals 6 to 17 Years</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F508del Homozygous Individuals 18 Years and Older</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
COMPLICATIONS

Management of complications secondary to CF is important for maintaining an individual’s health and quality of life. Complications of CF can affect many different organ systems; 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 more common among individuals post-transplant than among individuals who have never had a transplant. As a result of removing individuals who had a transplant from the analyses, rates of some complications, e.g. CFRD and osteoporosis, are lower this year than reported previously.

Cystic fibrosis-related diabetes (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 recent publication and implementation of mental health screening guidelines, an increase in the reporting of anxiety and depression has been observed.

<table>
<thead>
<tr>
<th>Complications of CF, 2017</th>
<th>Age &lt; 18 (%)</th>
<th>Age ≥ 18 (%)</th>
<th>All (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Individuals (n)</td>
<td>13,831</td>
<td>14,508</td>
<td>28,339</td>
</tr>
<tr>
<td>Percent with no complications</td>
<td>24.2</td>
<td>4.6</td>
<td>14.2</td>
</tr>
<tr>
<td>Percent with complications not reported</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Cystic Fibrosis-Related Diabetes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cystic fibrosis-related diabetes (CFRD)</td>
<td>5.3</td>
<td>31.0</td>
<td>18.5</td>
</tr>
<tr>
<td>Hepatobiliary</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gall stones</td>
<td>0.1</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>Gall stones, requiring surgery/procedure</td>
<td>0.1</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>Liver disease, cirrhosis</td>
<td>2.4</td>
<td>3.8</td>
<td>3.1</td>
</tr>
<tr>
<td>Liver disease, non-cirrhosis</td>
<td>3.4</td>
<td>3.7</td>
<td>3.5</td>
</tr>
<tr>
<td>Acute hepatitis</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Hepatic steatosis</td>
<td>0.6</td>
<td>0.7</td>
<td>0.6</td>
</tr>
<tr>
<td>Liver disease, other</td>
<td>1.9</td>
<td>1.7</td>
<td>1.8</td>
</tr>
<tr>
<td>Bone/Joints</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arthritis/arthropathy</td>
<td>0.5</td>
<td>6.2</td>
<td>3.4</td>
</tr>
<tr>
<td>Bone fracture</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Osteopenia</td>
<td>1.4</td>
<td>19.0</td>
<td>10.4</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>0.5</td>
<td>7.0</td>
<td>3.8</td>
</tr>
<tr>
<td>Pulmonary</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allergic bronchopulmonary aspergillosis (ABPA)</td>
<td>2.6</td>
<td>7.5</td>
<td>5.1</td>
</tr>
<tr>
<td>Asthma</td>
<td>30.5</td>
<td>33.4</td>
<td>32.0</td>
</tr>
<tr>
<td>Hemoptysis</td>
<td>0.8</td>
<td>5.9</td>
<td>3.4</td>
</tr>
<tr>
<td>Hemoptysis, massive</td>
<td>&lt;0.1</td>
<td>0.7</td>
<td>0.4</td>
</tr>
<tr>
<td>Pneumothorax requiring chest tube</td>
<td>0.1</td>
<td>0.4</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Table continues on the next page
### Complications of CF, 2017 continued

<table>
<thead>
<tr>
<th>GI</th>
<th>Age &lt; 18 (%)</th>
<th>Age ≥ 18 (%)</th>
<th>All (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distal intestinal obstruction syndrome (DIOS)¹</td>
<td>2.0</td>
<td>2.6</td>
<td>2.3</td>
</tr>
<tr>
<td>Fibrosing colonopathy/colonic stricture²</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Gastroesophageal reflux disease (GERD)</td>
<td>36.1</td>
<td>39.6</td>
<td>37.9</td>
</tr>
<tr>
<td>GI bleed requiring hospitalization (non-variceal)²</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>History of intestinal or colon surgery</td>
<td>3.6</td>
<td>1.5</td>
<td>2.6</td>
</tr>
<tr>
<td>Pancreatitis³</td>
<td>0.5</td>
<td>1.6</td>
<td>1.0</td>
</tr>
<tr>
<td>Peptic ulcer disease³</td>
<td>&lt;0.1</td>
<td>0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Rectal prolapse³</td>
<td>0.5</td>
<td>0.1</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Mental Health</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anxiety disorder</td>
<td>4.1</td>
<td>20.6</td>
<td>12.5</td>
</tr>
<tr>
<td>Depression</td>
<td>3.6</td>
<td>26.8</td>
<td>15.5</td>
</tr>
<tr>
<td><strong>Other Complications</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cancer confirmed by histology³</td>
<td>0.0</td>
<td>0.5</td>
<td>0.2</td>
</tr>
<tr>
<td>Hearing loss</td>
<td>1.3</td>
<td>3.1</td>
<td>2.2</td>
</tr>
<tr>
<td>Hypertension</td>
<td>0.4</td>
<td>5.7</td>
<td>3.1</td>
</tr>
<tr>
<td>Kidney stones³</td>
<td>0.2</td>
<td>1.3</td>
<td>0.8</td>
</tr>
<tr>
<td>Nasal polyps requiring surgery³</td>
<td>1.9</td>
<td>1.5</td>
<td>1.7</td>
</tr>
<tr>
<td>Renal failure requiring dialysis³</td>
<td>&lt;0.1</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Sinus disease</td>
<td>22.7</td>
<td>53.8</td>
<td>38.6</td>
</tr>
</tbody>
</table>

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 70 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 is the reason for the decrease in the observed number of reported acute complications, most notably DIOS.

D. See table below for secondary complications.

E. Cause other than CFRD.

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

### Complications of Cirrhosis, 2017 (n=881)

<table>
<thead>
<tr>
<th></th>
<th>All (%)</th>
<th>Age &lt; 18 (%)</th>
<th>Age ≥ 18 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of Individuals (n)</strong></td>
<td>881</td>
<td>332</td>
<td>549</td>
</tr>
<tr>
<td>Esophageal varices</td>
<td>21.3</td>
<td>20.5</td>
<td>21.9</td>
</tr>
<tr>
<td>Gastric varices</td>
<td>4.1</td>
<td>4.8</td>
<td>3.6</td>
</tr>
<tr>
<td>GI bleed related to varices</td>
<td>2.0</td>
<td>1.5</td>
<td>2.4</td>
</tr>
<tr>
<td>Splenomegaly</td>
<td>32.9</td>
<td>41.0</td>
<td>28.1</td>
</tr>
<tr>
<td>Hypersplenism</td>
<td>11.2</td>
<td>13.6</td>
<td>9.8</td>
</tr>
<tr>
<td>Encephalopathy</td>
<td>1.1</td>
<td>0.3</td>
<td>1.6</td>
</tr>
<tr>
<td>Ascites</td>
<td>4.7</td>
<td>3.3</td>
<td>5.5</td>
</tr>
</tbody>
</table>
CF Complications by Age, 2017

Reported complications differ in their distribution by age. Some are relatively stable over ages while others increase with age. The prevalence of bone disease and GERD is higher among older age groups. The prevalence of asthma peaks during adolescence and then decreases among adults while the prevalence of sinus disease and depression increases in adolescence and in young adults and then remains high through the older ages. The prevalence of CFRD is higher in adolescence and adulthood. ABPA and DIOS are less prevalent and appear across all age groups. Liver disease is more prevalent in children.
CF Complications by Mutation Class

The table below displays complications by mutation class groups. For more information about mutation classes and groups, see page 18. Many complications do not differ between mutation classes. CFRD, liver disease, and DIOS are more prevalent among individuals in mutation class I-III, typically associated with more severe disease. In contrast, pancreatitis is more common among individuals in mutation class IV-V. It is interesting to note that the prevalence of anxiety and depression does not differ by mutation class.

<table>
<thead>
<tr>
<th>Complications of CF in 2017, by Mutation Class Group</th>
<th>Mutation Class I-III (%)</th>
<th>Mutation Class IV-V (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Individuals (n)</td>
<td>19,712</td>
<td>3,394</td>
</tr>
<tr>
<td>Percent with no complications</td>
<td>11.8</td>
<td>21.6</td>
</tr>
<tr>
<td>Percent with complications not reporteda</td>
<td>0.9</td>
<td>1.9</td>
</tr>
<tr>
<td>Cystic Fibrosis-Related Diabetes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cystic fibrosis-related diabetes (CFRD)b</td>
<td>22.2</td>
<td>5.7</td>
</tr>
<tr>
<td>Hepatobiliary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gall stonesc</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Gall stones, requiring surgery/procedurec</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Liver disease, cirrhosisd</td>
<td>3.8</td>
<td>0.5</td>
</tr>
<tr>
<td>Liver disease, non-cirrhosisc</td>
<td>4.1</td>
<td>1.0</td>
</tr>
<tr>
<td>Acute hepatitisc</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Hepatic steatosis</td>
<td>0.8</td>
<td>0.2</td>
</tr>
<tr>
<td>Liver disease, otherc</td>
<td>2.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Bone/Joints</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arthritis/arthropathy</td>
<td>3.4</td>
<td>3.7</td>
</tr>
<tr>
<td>Bone fracturec</td>
<td>0.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Osteopenia</td>
<td>10.6</td>
<td>10.1</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>3.7</td>
<td>4.4</td>
</tr>
<tr>
<td>Pulmonary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allergic bronchopulmonary aspergillosis (ABPA)</td>
<td>5.4</td>
<td>3.9</td>
</tr>
<tr>
<td>Asthma</td>
<td>32.9</td>
<td>29.1</td>
</tr>
<tr>
<td>Hemoptysis</td>
<td>3.6</td>
<td>2.6</td>
</tr>
<tr>
<td>Hemoptysis, massivec</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Pneumothorax requiring chest tubec</td>
<td>0.3</td>
<td>0.1</td>
</tr>
<tr>
<td>GI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distal intestinal obstruction syndrome (DIOS)c</td>
<td>2.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Fibrosing colonopathy/colonic stricturec</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Gastroesophageal reflux disease (GERD)</td>
<td>40.8</td>
<td>28.2</td>
</tr>
<tr>
<td>GI bleed requiring hospitalization (non-variceal)c</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>History of intestinal or colon surgery</td>
<td>3.0</td>
<td>0.6</td>
</tr>
<tr>
<td>Pancreatitisc</td>
<td>0.2</td>
<td>4.4</td>
</tr>
<tr>
<td>Peptic ulcer diseasec</td>
<td>0.1</td>
<td>0.0</td>
</tr>
<tr>
<td>Rectal prolapsec</td>
<td>0.3</td>
<td>&lt;0.1</td>
</tr>
</tbody>
</table>

Table continues on the next page
### Complications of CF in 2017, by Mutation Class Group

<table>
<thead>
<tr>
<th>Mental Health</th>
<th>Mutation Class I-III (%)</th>
<th>Mutation Class IV-V (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety disorder</td>
<td>12.7</td>
<td>12.1</td>
</tr>
<tr>
<td>Depression</td>
<td>15.9</td>
<td>14.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other Complications</th>
<th>Mutation Class I-III (%)</th>
<th>Mutation Class IV-V (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancer confirmed by histology</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Hearing loss</td>
<td>2.1</td>
<td>2.5</td>
</tr>
<tr>
<td>Hypertension</td>
<td>2.7</td>
<td>5.1</td>
</tr>
<tr>
<td>Kidney stones</td>
<td>0.9</td>
<td>0.4</td>
</tr>
<tr>
<td>Nasal polyps requiring surgery</td>
<td>1.8</td>
<td>1.1</td>
</tr>
<tr>
<td>Renal failure requiring dialysis</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Sinus disease</td>
<td>39.1</td>
<td>39.8</td>
</tr>
</tbody>
</table>

---

| **A** | Individuals who did not have a complications case report form recorded were considered to not have any complications, as in previous years.  
**B** | See table on page 70 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 is the reason for the decrease in the observed number of reported acute complications, most notably DIOS.  
**D** | See table on page 63 for secondary complications.  
**E** | Cause other than CFRD. |
Cystic Fibrosis-Related Diabetes (CFRD)

CFRD is associated with weight loss, lung function decline, and increased mortality. 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).

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 continues to increase since the CF Foundation clinical care guidelines for CFRD were published in 2010, with use among adults increasing more slowly.

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

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>50</th>
<th>100</th>
<th>Median</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any Glucose Measurements in Non-Diabetic Individuals 10 to 17 Years</td>
<td></td>
<td></td>
<td></td>
<td>92.9</td>
<td>28.6</td>
<td>100.0</td>
</tr>
<tr>
<td>Any Glucose Measurements in Non-Diabetic Individuals 18 Years and Older</td>
<td></td>
<td></td>
<td></td>
<td>87.7</td>
<td>31.8</td>
<td>100.0</td>
</tr>
<tr>
<td>OGTT Screening in Non-Diabetic Individuals 10 to 17 Years</td>
<td></td>
<td></td>
<td></td>
<td>61.7</td>
<td>0.0</td>
<td>100.0</td>
</tr>
<tr>
<td>OGTT Screening in Non-Diabetic Individuals 18 Years and Older</td>
<td></td>
<td></td>
<td></td>
<td>29.1</td>
<td>0.0</td>
<td>93.3</td>
</tr>
</tbody>
</table>

### Blood Glucose and OGTT Screening for Individuals without CFRD, 2000–2017

- **Glucose Screening in Individuals 10–17**
- **Glucose Screening in Individuals ≥18**
- **OGTT Screening in Individuals 10–17**
- **OGTT Screening in Individuals ≥18**
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.

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.43

<table>
<thead>
<tr>
<th>CFRD Treatment in 2017</th>
<th>Percent of People with CFRD on Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dietary change</td>
<td>21.5</td>
</tr>
<tr>
<td>Oral hypoglycemic agents</td>
<td>4.2</td>
</tr>
<tr>
<td>Intermittent insulin (with illness, steroids, etc.)</td>
<td>5.1</td>
</tr>
<tr>
<td>Chronic insulin</td>
<td>73.6</td>
</tr>
<tr>
<td>No treatment noted in reporting year</td>
<td>13.3</td>
</tr>
</tbody>
</table>

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.\(^{43}\) Variation by CF care centers in the percentage of individuals with CFRD with one or more HbA1c measurements during the year shows that a majority of centers test their patients at least annually.

<table>
<thead>
<tr>
<th>Complications of CFRD in 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of Individuals (n)</strong></td>
</tr>
<tr>
<td>-------------------------------</td>
</tr>
<tr>
<td>Retinopathy</td>
</tr>
<tr>
<td>Microalbuminuria</td>
</tr>
<tr>
<td>Chronic renal insufficiency</td>
</tr>
<tr>
<td>Chronic renal failure requiring dialysis</td>
</tr>
<tr>
<td>Peripheral neuropathy</td>
</tr>
<tr>
<td>Any episodes of severe hypoglycemia</td>
</tr>
</tbody>
</table>

Rates of secondary complications of CFRD, including retinopathy, microalbuminuria, kidney disease, and neuropathy remain low. 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.\(^{43}\)
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. These guidelines recommend annual screenings for all individuals with CF who are age 12 and older, as well as caregivers of children with CF.

There continues to be a steady increase in the number of adolescents and adults receiving a screening for depression or anxiety.

Of note, there is currently wide variation in screening across the CF care center network. Data on caregiver screening are not included in the Registry at this time.

### Depression and Anxiety Screening Comparison (2016 to 2017)

<table>
<thead>
<tr>
<th>Year</th>
<th>Depression 12 to 17</th>
<th>Depression 18+</th>
<th>Anxiety 12 to 17</th>
<th>Anxiety 18+</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>57.0%</td>
<td>69.0%</td>
<td>57.0%</td>
<td>67.2%</td>
</tr>
<tr>
<td>2017</td>
<td>61.2%</td>
<td>75.1%</td>
<td>53.2%</td>
<td>73.9%</td>
</tr>
</tbody>
</table>

### Table: Percentage of Individuals with Mental Health Screening, by Center

<table>
<thead>
<tr>
<th>Screening Type</th>
<th>0</th>
<th>50</th>
<th>Median</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression Screening Performed in Individuals 12 to 17 Years</td>
<td></td>
<td></td>
<td>80.6</td>
<td>0.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Depression Screening Performed in Individuals 18 Years and Older</td>
<td></td>
<td></td>
<td>85.4</td>
<td>0.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Anxiety Screening Performed in Individuals 12 to 17 Years</td>
<td></td>
<td></td>
<td>80.6</td>
<td>0.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Anxiety Screening Performed in Individuals 18 Years and Older</td>
<td></td>
<td></td>
<td>84.8</td>
<td>0.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Prevalence of both anxiety and depression increase through adolescence and early adulthood, then remain high at older ages. There is substantial overlap in individuals who report both anxiety and depression; among individuals who report anxiety or depression, 40.2 percent report both conditions.
TRANSPANTATION

Lung transplantation remains an option for some individuals with severe lung disease. The number of lung transplant procedures for individuals with CF fluctuates yearly, with an overall upward trend.

In 2017, there were 1,712 individuals in the Registry who were reported to have ever received a lung, kidney, heart, or liver transplant.

<table>
<thead>
<tr>
<th>Transplant Status of People with CF in 2017 (All Organs)</th>
<th>Number of Individuals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accepted, on waiting list</td>
<td>146</td>
</tr>
<tr>
<td>Evaluated, rejected</td>
<td>127</td>
</tr>
<tr>
<td>Received transplant this year</td>
<td>264</td>
</tr>
<tr>
<td>Received transplant in a prior year</td>
<td>1,448</td>
</tr>
</tbody>
</table>

Lung Transplantation

There were 1,548 post-transplant individuals in the Registry in 2017, including 250 individuals who were reported to have received a lung transplant in 2017. The number of CF lung transplants reported to the Registry is slightly lower this year, despite an overall increase in lung transplants in 2017 (2,449) compared to 2016 (2,327) as reported by UNOS. Overall, 9.3 percent of CF transplants performed in 2017 were among individuals younger than age 18.
Overall, lung transplant recipients are a relatively small proportion of individuals included in the Registry; the majority are age 30 years and older.

While most CF care occurs within CF Foundation-accredited care centers, transplant and post-transplant care typically occurs at transplant centers. Therefore, 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.
SURVIVAL

Over time, there have been substantial improvements in the survival of people with CF. We used a number of metrics to describe the survival of people living with CF in the United States. Definitions for these metrics are provided in the Technical Supplement that can be found on cff.org.

Median Predicted Survival

In 2017, the median predicted survival age of those born in 2017 was 46.2 years (95 percent confidence interval: 43.8-50.0 years). Given the instability of annual survival estimates due to the relatively low number of deaths in a given year, we group the data into five year increments. The graph below shows gains in median predicted survival from 1986 to 2017 in five year increments.* Between 2013 to 2017, the median predicted survival age was 43.6 years (95 percent confidence interval: 42.2-44.8 years). This means that half of individuals born from 2013 to 2017 are predicted to live beyond 43.6 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 and other improvements in clinical care.

*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 that considers an individual’s current age. 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 number at older ages are currently too small to accurately predict survival. As for median predicted survival, this metric assumes no further improvement in mortality rate.

Mortality Rate

The mortality rate in 2017 was 1.3 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, given that the median age of individuals in the Registry has increased from 11.7 years in 1987 to 19.3 years in 2017.

Annual Mortality Rate (per 100 people with CF), 1986-2017

![Annual Mortality Rate Chart]

- Median Conditional Predicted Survival Based on Attained Age, 2013-2017
- Mortality Rate
Median Age at Death

The median age at death was 30.7 years for the 380 people with CF who were reported to have died in 2017. About 15 percent of deaths occurred before 20 years of age. Comparing the cumulative percentage for age at death between 1987 and 2017 shows a substantial shift of the curve toward the right and a less steep curve, indicating that deaths are occurring at older ages and are spread across a wider age range. The median age at death reflects the current situation and cannot be used to predict survival of the entire population.

Causes of Death

Among the 380 deaths in 2017, the primary causes were respiratory/cardiorespiratory and organ transplant-related, similar to previous years. Of these, 47.6 percent of deaths occurred in people who were F508del homozygotes, reflecting their distribution in the Registry. While 5.3 percent of people in the Registry are post-transplant, 104 deaths (27.4 percent) occurred in transplant recipients. Note that the primary cause of death for these individuals was not always categorized as transplant-related.

<table>
<thead>
<tr>
<th>Primary Cause of Death in 2017</th>
<th>Number of Individuals</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory/cardiorespiratory</td>
<td>239</td>
<td>62.9</td>
</tr>
<tr>
<td>Transplant-related</td>
<td>61</td>
<td>16.1</td>
</tr>
<tr>
<td>Other</td>
<td>38</td>
<td>10.0</td>
</tr>
<tr>
<td>Unknown</td>
<td>24</td>
<td>6.3</td>
</tr>
<tr>
<td>Liver Disease/Liver Failure</td>
<td>13</td>
<td>3.4</td>
</tr>
<tr>
<td>Suicide or Trauma</td>
<td>5</td>
<td>1.3</td>
</tr>
</tbody>
</table>
2017 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 ☐ Unknown
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
☐ 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: ☐ ☐ ☐ ☐ ☐ ☐ ☐
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

*repeated entries can be recorded
[ ] indicates values calculated by the registry
### 2017 Cystic Fibrosis Foundation Patient Registry Questionnaire

**Parents’ Information** *(information not required for patients 21 years of age and older)*

Not available: ☐

- Mother height: _____ cm  o inches
- Father height: _____ cm  o 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  o inches
- Birth weight: _____ kg  o 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: ___________

<table>
<thead>
<tr>
<th>Poly T tract:</th>
<th>Poly TG repeats:</th>
</tr>
</thead>
<tbody>
<tr>
<td>5T</td>
<td>9</td>
</tr>
<tr>
<td>7T</td>
<td>10</td>
</tr>
<tr>
<td>9T</td>
<td>11</td>
</tr>
<tr>
<td>not 5T</td>
<td>12</td>
</tr>
<tr>
<td>Unknown</td>
<td>13</td>
</tr>
</tbody>
</table>

Select Mutation 2: ________  Other genotype: ___________

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, Home IV
  - Non-clinic start date: (MM/DD/YYYY)
  - Non-clinic end date: (MM/DD/YYYY)

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<thead>
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<th>cm</th>
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<tbody>
<tr>
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<tr>
<th>[BMI value: ]</th>
<th>[BMI Percentile: ]</th>
<th>[Weight for Length percentile: ]</th>
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</thead>
</table>

**Exacerbation Assessment**

What was your assessment regarding pulmonary exacerbation at this visit?

- Absent
- Mild exacerbation
- Moderate exacerbation
- Severe exacerbation

Key:

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

- Don’t know/unable to answer

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

**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)

<table>
<thead>
<tr>
<th>Type of Specimen:</th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>spurtum</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>throat/nasal</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>induced sputum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bronchospopy</td>
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<td></td>
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</tbody>
</table>

**Culture Results:**

- Microorganisms  ○ Normal flora
- No growth/sterile culture

**Staphylococcus aureus:** ☐

<table>
<thead>
<tr>
<th>MRSA (methicillin resistant Staph aureus)</th>
<th>MSSA (methicillin sensitive Staph aureus)</th>
</tr>
</thead>
<tbody>
<tr>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

**Haemophilus influenzae (any species):** ☐

**Pseudomonas aeruginosa:** ☐

- mucoid  ○ non mucoid  ○ mucoid status unknown

---

*repeated entries can be recorded

[ ] indicates values calculated by the registry
2017 Cystic Fibrosis Foundation Patient Registry Questionnaire

**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. vietnamensis
- [ ] B. dolosa
- [ ] B. anthina
- [ ] B. ambifaria
- [ ] B. pyruvina
- [ ] 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
  - [ ] Agrobacterium species
  - [ ] Brevundimonas species
  - [ ] Cupriavidus metallidurans
  - [ ] Cupriavidus respiraculi
  - [ ] Deftia species - other*
  - [ ] Enterobacter species
  - [ ] Exophila dermatitidis
  - [ ] Herbaspirillum frisingense
  - [ ] Herbaspirillum seropedicae
  - [ ] Klebsiella pneumoniae
  - [ ] Klebsiella species - other*
  - [ ] Ochrobacterium species
  - [ ] Pandoraea norimbergensis
  - [ ] Pandoraea sputorum
  - [ ] Pseudomonas mendocina
  - [ ] Pseudomonas putida
  - [ ] Pseudomonas stutzeri
  - [ ] Raistonia insidiosa
  - [ ] Raistonia pickettii
  - [ ] Raistonia species - other*
  - [ ] Serratia marcescens
  - [ ] Streptococcus milleri

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

Tobi Podhaler (Tobramycin Inhalation Powder): ☐

Frequency: ☐ Four 28mg capsules BID alternate month
- ☐ Other regimen (different dose or freq)
- ☐ Eradication

Bithikis: ☐

Frequency: ☐ 300 mg BID alternate month
- ☐ Other regimen (different dose or freq)
- ☐ Eradication

Other inhaled aminoglycoside (e.g. gentamcin, amikacin, or tobramycin preparation): ☐

Frequency: ☐ Alternate Month

Key:
- [ ] radio buttons (select one option only)
- [ ] check box (multiple selections allowed)

*repeated entries can be recorded

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### 2017 Cystic Fibrosis Foundation Patient Registry Questionnaire

- **Continuous**
- **Other regimen (different dose or freq)**
- **Eradication**

#### Colistin: □
- **Frequency:**
  - Alternate Month
  - Continuous
  - Other regimen (different dose or freq)
  - Eradication

#### Aztreonam – Inhaled: □
- **Frequency:**
  - 75 mg TID Alternate Month Schedule
  - 75 mg TID Continuous
  - Other Regimen
  - Eradication

#### 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.)
- **Cephalosporin** (cephalexin, Keflex, cefixime, 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 (Orkambi)
    - 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)

#### Other Medications
- **Dornase alfa** (i.e. Pulmozyme): □
  - **Frequency:**
    - 2.5 mg QD
    - 2.5 mg BID
    - Other regimen (different dose or frequency)
- **Acetylcysteine or Mucomist**: □
  - **High-dose ibuprofen** (e.g. 25-30 mg/kg): □
  - **Total (mg/dose):** ______

#### Key:
- **FORM NAME**
  - □ radio buttons (select one option only)
  - □ check box (multiple selections allowed)

- **Hypertonic saline:** □
  - **Concentration (%):** 3 4 5 6 7 8 9 10
  - **Frequency:** QD BID Other

- **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. ipratropium, Atrovent)
  - □ Long acting anticholinergic (e.g. ipratropium, Spiriva, etc.)
  - □ Combination beta agonist and anticholinergic (e.g. Combivent, DuoNeb, etc.)

- **Corticosteroids:**
  - □ Oral (e.g. prednisone)
  - □ Inhaled (e.g. fluticasone, Flovent, budesonide, Pulmicort, etc.)
  - □ Inhaled in combination with a bronchodilator (e.g. Advair, Symbicort)

- **Other:**
  - □ Leukotriene modifiers (e.g. montelukast, Singular, zafirlukast, Acolate, zileuton, Zyro, etc.)
  - □ Mast cell stabilizers (e.g. cromolyn, Intal, nedocromil, Tiade, etc.)
  - □ Antifungals (e.g. itraconazole, Sporanox) Note: exclude topical agents for skin conditions and agents used for oral thrush

- **Drug Intolerance/Allergies:**
  - □ Domase 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)

#### GI/Nutrition/Endocrine Medications

**This Patient is on enzyme medications:** Yes No

For all enzymes, *capsules per largest meal* options are:

- 0.5 □ 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:_____

*repeated entries can be recorded

[ ] indicates values calculated by the registry
### 2017 Cystic Fibrosis Foundation Patient Registry Questionnaire

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<th>Enzyme</th>
<th>Number of capsules per largest meal of the day</th>
<th>Number of capsules per largest meal of the day</th>
<th>Number of capsules per largest meal of the day</th>
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</table>

#### Pulmonary

**Pulmonary Function Tests (PFTs)**

Unable to Perform test: ☐

Reason why PFTs have not been done: ___________

**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 FEV1 percentile (ages 6-21): __________**

#### GI/Nutrition

*repeated entries can be recorded

[ ] indicates values calculated by the registry
## 2017 Cystic Fibrosis Foundation Patient Registry Questionnaire

### 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)

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
- 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

**Key:**
- ○ radio buttons (select one option only)
- □ check box (multiple selections allowed)

- Encephalopathy
- Liver disease, non-cirrhosis
- Acute Liver Failure (No underlying liver disease, ALT>3X ULN, INR>2.0, not responsive to vitamin K)
- Hepatic Steatosis
- 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
- Hemosplasmosis

Please specify selection of hemoptysis:
- Hemosplasmosis, massive
- Hemosplasmosis, other
- Pneumothorax requiring chest tube

#### GI
- 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

#### 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
*Repeated entries can be recorded
[ ] indicates values calculated by the registry
## 2017 Cystic Fibrosis Foundation Patient Registry Questionnaire

### 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: __________

### Glucose Test
- Random blood glucose (mg/dL): __________
- Fasting blood glucose (mg/dL): __________

### 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: __________

### 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

### CARE EPISODE

#### Care Episode Segment*
- Start date: (MM/DD/YYYY)
- End date: (MM/DD/YYYY)
- Location: Hospital, Home IV
- Key: 
  - FORM NAME
    - radio buttons (select one option only)
    - check box (multiple selections allowed)

### 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: No

- 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: No
- 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, pm
  - No
  - Unknown

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

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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  

**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 patient smoke 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  

**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:  

**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 ophthalmologist in this reporting year?  
- Yes  
- No  
- Unknown  

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

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  
- Heart/lung  
- Kidney  
- Other  

Number this year:  
- Date of last transplant:  

Specify transplant type:  

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### 2017 Cystic Fibrosis Foundation Patient Registry Questionnaire

**Were there post transplant complications?**
- [ ] Bronchiolitis obliterans syndrome
- [ ] Lympho-proliferative disorder
- [ ] Other
  - Specify other complication: __________

**Clinical Trials**
- [ ] Has this patient participated in any interventional (drug) studies?
  - [ ] Yes
  - [ ] No
  - [ ] Unknown

**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:**
- [ ] Full time employment
- [ ] Part Time
- [ ] Full time homemaker
- [ ] Unemployed
- [ ] Student
- [ ] Disabled
- [ ] Retired
- [ ] Unknown

**Pregnancy**
- [ ] Was patient pregnant during the reporting year?
  - [ ] Yes
  - [ ] No
  - [ ] Unknown

- [ ] If Yes, indicate outcome:
  - [ ] Live Birth

**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:**
- [ ] Full time employment
- [ ] Part Time
- [ ] Full time homemaker
- [ ] Unemployed
- [ ] Student
- [ ] Disabled
- [ ] Retired
- [ ] Unknown

**Pregnancy**
- [ ] Was patient pregnant during the reporting year?
  - [ ] Yes
  - [ ] No
  - [ ] Unknown

- [ ] If Yes, indicate outcome:
  - [ ] Live Birth

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- 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

**Other**
Please use this field to record any additional information about this patient: ________________________
REFERENCES


