Cystic Fibrosis

Standards of Care for British Columbia

MARCH 2018

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This document is based on a consensus of evidence and/or clinical expert opinion.

It is intended that these Standards of Care be reviewed and revised as needed by April 2020.

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Abbreviation Guide

ACMG . . . American College of Medical Genetics

AFB. . . . . Acid Fast Bacilli

BCC . . . . Burkholderia Cepacia Complex

BCCDC. . . BC Centre for Disease Control

BCCH . . . BC Children's Hospital

CBAVD . . . Congenital Bilateral Absence of the Vas Deferens

CBCCRRR . Canadian Burkholderia Cepacia Complex Research and Referral Repository

CF . . . . . Cystic Fibrosis

CFC . . . . Cystic Fibrosis Canada

CFLD . . . . Cystic Fibrosis-Related Liver Disease

CFRD. . . . Cystic Fibrosis-Related Diabetes

CFSPID. . . Cystic Fibrosis Screen Positive, Inconclusive Diagnosis [CFTR-Related Metabolic Syndrome (CRMS) in the USA]

CFTR . . . . Cystic Fibrosis Transmembrane Conductance Regulator

CKD . . . . Chronic Kidney Disease

CLAD. . . . Chronic Lung Allograft Dysfunction

CVC . . . . Central Venous Catheter

DIOS . . . . Distal Ileal (or Intestinal) Obstruction Syndrome

IRT . . . . . Immunoreactive Trypsinogen

IVAD . . . . Implanted Venous Access Device

MRP . . . . Most Responsible Physician

MRSA. . . . Methicillin-Resistant Staphylococcus Aureus

MSP . . . . Medical Services Plan

NBS . . . . Newborn Screening

NPD . . . . Nasal Potential Difference

NTM . . . . Nontuberculous Mycobacterium

PD&P . . . . Postural Drainage and Percussion

PEP. . . . . Positive Expiratory Pressure

PEx . . . . . Pulmonary Exacerbation

PICC . . . . Peripherally Inserted Central Catheter

PFT . . . . . Pulmonary Function Testing

RSV. . . . . Respiratory Syncytial Virus

VGH . . . . Vancouver General Hospital

1.0 Introduction

In the last three decades, there has been a remarkable transformation in outcomes for people with cystic fibrosis, mostly due to care being overseen by multidisciplinary teams in dedicated Cystic Fibrosis Care Clinics. Canada has been in the forefront of these developments. Survival and other metrics have placed our country amongst the international leaders in Cystic Fibrosis (CF) care.

With these positive developments, however, come challenges as we move ahead to seek even better outcomes. We work within a system that has fundamental financial constraints and one that can be fragmented organizationally and geographically. As patients age, the complexity of their disease invariably increases and this is compounded by age-related comorbidities previously not seen in people with CF. On the other end of the age spectrum, province-wide new born screening has brought additional responsibilities. Newer therapies are constantly making their way into clinical practice. For example: the CFTR modulator medications (correctors and potentiators) have daunting costs, so must be carefully and appropriately used. With the extent of care across the life span of patients, it requires a close and ongoing partnership with both the patient and their family, which is time and resource intensive. All these realities mean that innovative approaches are required to enhance our current care model.

These challenges have to be viewed in the context of the historical philosophy of the medical system specific to CF. With previous harsh survival realities, there has understandably been a focus on the younger CF patients. However, now in British Columbia (as well as in all of Canada), we have more adults than children with CF. Remarkably, we have people with CF joining the ranks of 'senior citizens'. This changing demographic is compounded by the daunting task of delivering equitable care across huge geographical distances with a broad urban and rural divide.

In collaboration with Cystic Fibrosis Canada, a system has been put in place that forms the foundation of CF Care in BC. We will use this as the basis to evolve care moving forward, modifying where necessary. There are fully accredited Pediatric and Adult Clinics (with the spectrum of healthcare providers making up the CF Team) in both Victoria and Vancouver. These clinics are charged with the primary responsibility of delivering CF care throughout the province. The level of multidisciplinary expertise required to address the full range of CF care is such that we cannot move to full-fledged CF clinics in all jurisdictions. However, our Vision is to broaden the availability of CF care throughout the province by developing partnerships with local healthcare providers and by using the latest in technology. Underpinning this Vision is the awareness that our care must firstly be patient-focused. As such, we will need to solicit an ever-greater input from our patients and their families as we plan for the future.

As we look ahead, it is necessary to develop a broad consensus, within the CF community, as to what we believe are the core principles of Cystic Fibrosis Care in BC. With funding support from the Ministry of Health, and Doctors of BC (through the Specialist Services Committee), we brought together leaders in CF Care to create this document. This document covers the spectrum of CF care while recognizing this is an overview and cannot address all issues. We have sought agreement on key aspects of care across age and geographical boundaries. With these principles in place, we will continue to work with our patients, families, and funding partners to bring about change.

2.0 Diagnosing Cystic Fibrosis

In 2016, the Cystic Fibrosis Foundation in the United States convened a panel of international experts to update the diagnostic criteria for CF.

In summary, the diagnosis of CF is based on the following criteria:[1]

- Presence of 1 or more characteristic clinical features, a history of CF in a sibling, or a positive newborn screening (NBS) test

AND

- Laboratory evidence of an abnormality in the CF transmembrane conductance regulator (CFTR) gene (2 disease causing mutations) or the CFTR protein (elevated sweat chloride, abnormal nasal potential difference test)

2.1 Sweat Testing in BC

Sweat conductivity has been approved for **screening** at clinical sites but is not acceptable for establishing a diagnosis. The Gibson-Cooke pilocarpine iontophoresis method quantifies sweat chloride. It is considered the gold standard method for confirming diagnosis of CF and should be performed if sweat conductivity is unclear (equivocal), elevated or a strong clinical suspicion for CF despite a normal result. All elevated sweat conductivity results should be followed up with a sweat chloride test. It is critical to interpret results against the ranges specific to the sweat test performed.

Sweat testing is often subject to error, particularly in younger patients. It is recommended that sweat testing be undertaken at centres which conduct a high volume of sweat tests on a weekly basis. Biochemical testing of sweat is essential in the diagnostic workup for CF. Two different sweat tests are available – sweat chloride and sweat conductivity. Determination of sweat chloride concentration is the gold standard method for CF diagnosis.

Sweat conductivity is for screening purposes only. It measures other anions in addition to chloride, such as lactate and bicarbonate. As such, the results are approximately 15 mmol/L higher than sweat chloride values. **All elevated sweat conductivity results should be followed up with a sweat chloride test.** It is critical to interpret results against the ranges specific to the sweat test performed.

Interpretation of results:

Sweat Conductivity	
≥ 80	CF likely
50-80	Equivocal
< 50	Normal range

Sweat Chloride (mmol/L)*	
≥ 60	CF confirmed
30-59	Intermediate result, needs repeating*
< 30	Normal range

* For positive sweat test results and all intermediate sweat chloride results, CF sweat testing guidelines recommend repeat testing on a separate day.

Causes of false negative and false positive sweat chloride results are known and may need to be considered when interpreting results.[2]

Sweat Chloride	Examples of causes
false negative results	technique problem milder mutations edema and hypoproteinemia
false positive results	adrenal insufficiency hypoparathyroidism hypothyroidism malnutrition nephrogenic diabetes insipidus pseudohypoaldosteronism

Repeat sweat testing is part of the diagnostic workup when patients have had a previous sweat test result from a laboratory not affiliated with a CF clinic.

Availability of sweat chloride and sweat conductivity testing in the province is tabled below. Proficiency of these laboratories is monitored by the Diagnostic Accreditation Program (DAP), College of Physicians and Surgeons of BC.

Health Authority	Testing Facility	Type of Sweat Testing
Provincial Health Services	BC Children's Hospital (BCCH)	Sweat Chloride
Fraser Health	Royal Columbian Hospital Surrey Memorial Hospital Abbotsford Regional	Sweat Chloride
Vancouver Island	Victoria General Hospital Nanaimo General Regional Hospital	Sweat Chloride
Interior	Kelowna General Hospital Royal Inland Hospital (Kamloops) Vernon Jubilee Hospital Penticton Regional Hospital Kootenay Boundary Regional Hospital (Trail)	Sweat Conductivity
Northern BC	University Hospital of Northern BC	Sweat Chloride

2.2 Diagnosing in the Pediatric Population

2.2.1 Newborn Screening

In BC and the Yukon, newborn screening (NBS) for CF began November 2009. Most new CF diagnoses are found through this method. The goal is to establish the diagnosis and initiate therapy within the first month of life, before significant morbidity and malnutrition occur. Usually, babies are asymptomatic, but some present with failure to thrive and hypoalbuminemia among other concerns (see clinical characteristics below).

Over 65 infants have been diagnosed with CF through newborn screening since the program's inception. Immunoreactive trypsinogen (IRT) is measured on a dried blood spot at 24 to 48 hours of age as part of the complete provincial panel for newborn screening. Samples with abnormally raised IRT (> 97th percentile) levels proceed to DNA testing (genotyping) to screen for CFTR mutations. (see Figure 1 and APPENDIX A). Infants with positive or inconclusive newborn screening results are contacted and counseled by the CF Newborn Screening Nurse. The initial assessment and sweat test occurs at BCCH. The exception to this are infants with 2 CF-causing mutations on NBS who live on Vancouver Island. These infants are seen by the Victoria Pediatric CF Clinic for initial assessment and sweat testing.

Note: The false negative rate for CF NBS is approximately 3%, so the clinician still needs to consider the diagnosis when a child's symptoms are consistent with CF. The clinician also needs to consider where the child was born. If born outside of British Columbia, the clinician needs to check when or if NBS occurred in that jurisdiction.

2.2.2 Clinical Features

The clinical features of CF in unscreened populations at the time of diagnosis by age are listed in the approximate order of frequency of presentation.

Clinical Features	
Children aged 0 to 2 years	**Children aged 3 to 16 years**
■ failure to thrive (FTT) ■ steatorrhea ■ recurrent chest infections ■ meconium ileus ■ rectal prolapse ■ edema/hypoproteinemia/dermatitis ■ severe pneumonia ■ salt depletion syndromes ■ prolonged newborn jaundice ■ vitamin K deficiency with bleeding	■ recurrent chest infections or 'asthma' ■ clubbing and idiopathic bronchiectasis ■ steatorrhea ■ nasal polyps and sinusitis ■ chronic intestinal obstruction ■ intussusception ■ heat exhaustion ■ hyponatremia

2.2.3 Genetic Testing

There are more than 2000 mutations in the CFTR gene, falling into classes I to VI. The most common in Caucasians is the F508del (class II), also referred to as delta F508.

In BC, genetic testing is done at BCCH. Currently, there are 139 mutations in the panel (23 from the ACMG 2004 panel plus additional mutations with a frequency of > 0.1% in the CF patient chromosome). See APPENDIX A: 'List of CFTR Mutations Assessed'

The website **cftr2.org** has useful data on mutations and their expected clinical effects in terms of disease phenotype.

Note: Non-Caucasian populations can have different mutations.

2.2.4 When the diagnosis is not clear cut[3]

A challenging aspect of NBS is the identification of infants for whom confirmatory testing remains inconclusive with regard to a CF diagnosis. All NBS-positive infants are defined as 'CF screen positive, inconclusive diagnosis' or CFSPID if any one of the following criteria is met:

- A sweat chloride value < 30 mmol/L and 2 CFTR mutations, at least 1 of which has unclear phenotypic consequences

OR

- An intermediate sweat chloride value (30-59) and 1 or no CF-causing mutations

CFSPID in the newborn screened population has been observed fairly frequently, with reports citing 1 case of CFSPID to every 3 to 5 cases of CF. Studies estimate that approximately 11% of infants with CFSPID will be diagnosed with CF within the first 3 years. This underscores the need for these infants to receive extensive genotyping and ongoing clinical monitoring in a CF centre. Currently, sweat testing is repeated every 6 months to 2 years of age then annually.

The decision to reclassify a child from CFSPID to CF should take into account the functional assessment of CFTR (sweat chloride, and possibly nasal potential difference testing if available), CFTR genetic analysis, and clinical assessment by a CF clinician.

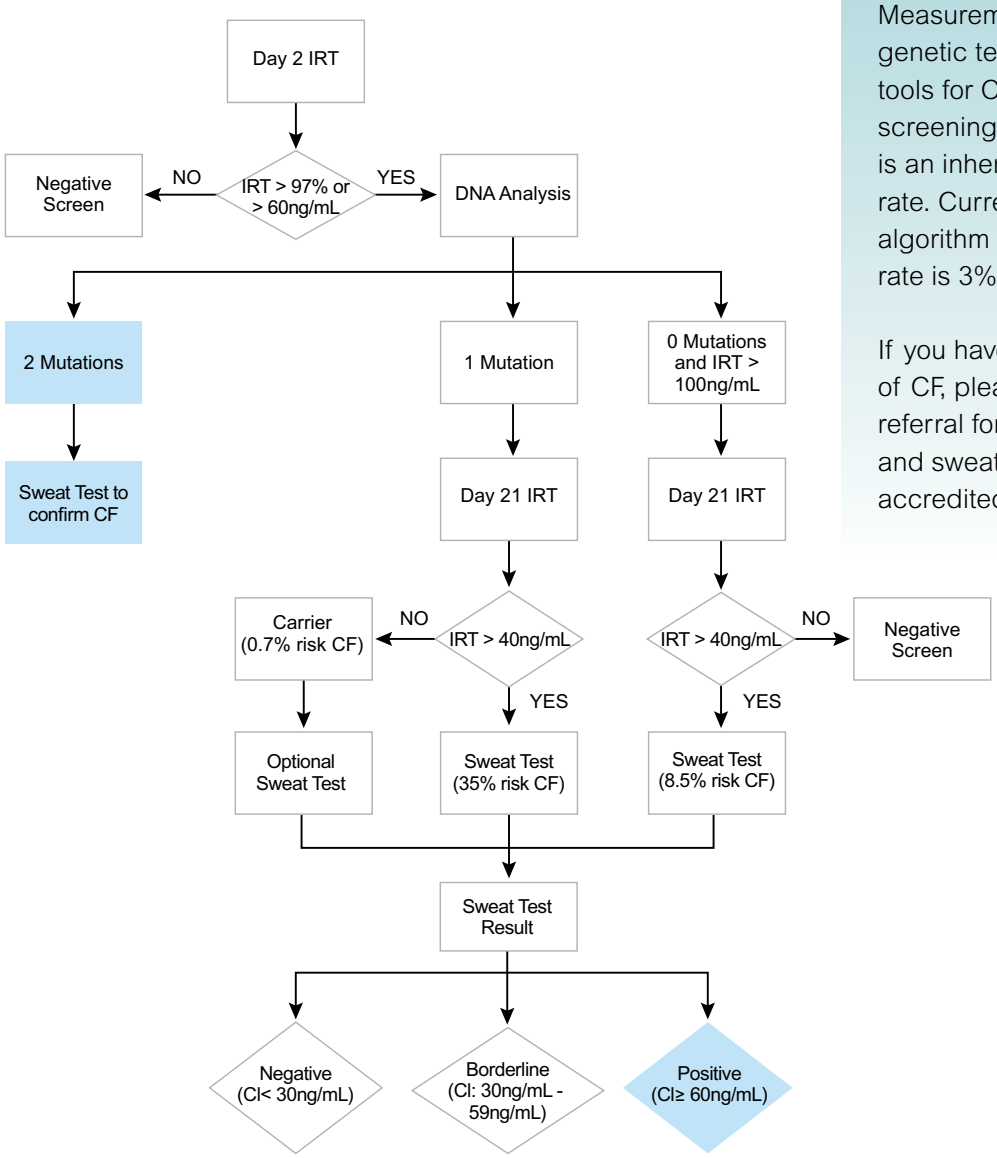
The term CFTR-related metabolic syndrome (CRMS) used in the USA is equivalent to CFSPID.

2.2.5 Follow-up and investigations for the newly diagnosed infant

Most of the children diagnosed with CF can be managed and families can be educated in an ambulatory setting. See 'Principles for Outpatient Care: Ongoing Monitoring'.

Guidelines for Management of Infant diagnosed with Cystic Fibrosis is available on the childhealthbc.ca website (last revision January 2013, revision pending 2017).

Figure 1. Newborn Screening Algorithm



Measurement of IRT and genetic testing are screening tools for CF. As with all screening programs, there is an inherent false negative rate. Currently for the BC algorithm the false negative rate is 3% to 5%.

If you have clinical suspicion of CF, please consider a referral for a CF consultation and sweat test at an accredited CF centre.

BCCH/VGH CF Clinics - Image used with permission[4]

2.3 Diagnosing in the Adult Population

The criteria for diagnosis in adults is the same as those used for infants and children (See page 3).

2.3.1 Clinical Features

Approximately 5% of people with CF in Canada are diagnosed during adulthood with 2% being diagnosed over the age of 40 (Cystic Fibrosis Canada Patient Registry, 2013). Often the diagnosis is delayed due to milder or non-classic clinical presentations and therefore a high index of clinical suspicion is required to make the diagnosis.

Cystic Fibrosis Canada website cysticfibrosis.ca

While newborn screening is expected to reduce the number of delayed adult diagnoses in future years, the number of NBS false negatives could be higher for those diagnosed as adults. Ethnic minorities are at the greatest risk of a delayed or missed diagnosis due to the low disease prevalence, low index of suspicion by physicians, and rare CFTR mutations not covered in standard mutation panels.

Not uncommonly, individuals are initially diagnosed with asthma but then have repeated chest infections, which alerts the physician to the possibility of a condition such as CF.

Other presentations during adulthood include:

- bronchiectasis
- chronic sinusitis
- acute recurrent or chronic pancreatitis of unexplained origin
- obstructive azoospermia due to congenital bilateral absence of the vas deferens (CBAVD) revealed during male infertility work-up

Most individuals diagnosed during adulthood have single-organ involvement and have normal nutritional status (e.g. pancreatic sufficient).

2.3.2 Sweat Testing

While sweat testing will help establish the diagnosis of CF in most cases, it can be less reliable in some adult-diagnosed cases. Rarely, the clinical presentation and genotyping results are consistent with CF but the sweat chloride test result is normal or equivocal/intermediate (false-negative). As a result, the diagnosis should not be excluded based on a normal sweat chloride test alone. Adults with a clinical presentation highly suggestive of CF but with a normal or intermediate initial sweat chloride result should have repeat sweat chloride testing, and standard plus extended genetic testing.

2.3.3 Genetic Testing

Rare mutations often responsible for milder CF presentations during adulthood are more likely to be missed on standard genotyping panels, and therefore identifying one or no mutations does not exclude the diagnosis. Therefore, extended genotyping (i.e. CFTR sequencing) is often required to establish a diagnosis. However, failure to find two disease-causing CF mutations following a selective or extended search still does not exclude the diagnosis of CF. In rare occasions, CF could be caused by mutations within the promoter region of the CFTR gene or in one of the introns.

Full gene sequencing should be considered with challenging diagnoses, particularly for those who are not of Northern European ancestry.

In BC, genetic testing is done at BCCH. Currently, there are 139 mutations in the panel (23 from the ACMG 2004 panel plus additional mutations with a frequency of > 0.1% in the CF patient chromosome). See APPENDIX A: 'List of CFTR Variants Assessed'

Extended CFTR analysis is performed at the University of Alberta and is often requested following initial evaluation by a CF clinic. Out-of-province laboratory requests require MSP approval for funding coverage. An application is submitted to the BC Ministry of Health (MSP) for funding.

Once approved, the following forms must be faxed to the Molecular Genetics Laboratory at BC Children's Hospital and BC Women's Hospital:[5]

- University of Alberta Testing Laboratory requisition
- Shipment for Out-of-Province Genetic Testing Form (*see page 3 of this document*)
- MSP funding approval letter

Full sequencing may become available in BC at BC Children's Hospital in the near future.

2.3.4 When the diagnosis is not clear cut[6]

Diagnostic uncertainty arises when the adult has one or more clinical features consistent with CF but the sweat chloride test is equivocal/intermediate (or even normal) with only one (or even no) disease-causing mutations identified even after extended genetic testing. These cases can either represent a CF carrier status, CFTR related disorder, a milder case of CF or 'unlikely CF'.

CFTR-related disorders include isolated CBAVD, pancreatitis, and/or bronchiectasis with associated CFTR dysfunction but not meeting diagnostic criteria for CF.

Management decisions such as frequency of follow-up, and need for medications and/or genetic counseling can differ significantly depending on the diagnostic categorization. Therefore, it is important to clarify or confirm the diagnosis to the fullest extent possible.

These challenging diagnostic cases might benefit from nasal potential difference (NPD) testing. This is potentially a more sensitive and specific marker of CFTR function than sweat chloride testing. It might lead to a more refined diagnostic categorization,7 although normal cut-off values have not yet been established. Furthermore, this test is not widely available. Currently, this method is undergoing technical refinements and standardization. It is likely to become a more integral component of the diagnostic work-up in the future. However, while NPD might improve the accuracy of diagnosis, a small number of people will still be left without a definitive diagnosis even after NPD testing.

In Canada, NPD testing is currently only available at the University of Toronto Hospital for Sick Children - http://www.sickkids.ca/Research/CSCCD/PhysiologicalResearchUnit/index.html - as it was originally used as a research tool and is very operator-dependent.

2.3.5 Follow-up and investigations for the newly diagnosed adult

Like children, most adults can be managed and educated in an ambulatory setting. Once diagnosis is established, patients should have the following investigations ordered:

Initial visit
■ Sputum culture
■ Pulmonary function testing
■ Fecal elastase
■ Bloodwork
■ CT Scan of the chest

For ongoing monitoring, see ‘Principles of Outpatient Care: Ongoing Monitoring’.

3.0 Interdisciplinary Care Team for Cystic Fibrosis

The CF clinic should have dedicated access to all described primary personnel healthcare workers. When feasible, the primary personnel caring for CF patients in the clinic and acute care settings should be the same. This helps to maintain continuity of care. If this is not feasible, clinic and acute care staff should work in close communication with each other.

3.1 Clinic Defined

To be considered an approved cystic fibrosis clinic, health centres should meet the minimum set standards and have accreditation from Cystic Fibrosis Canada (CFC). This includes adequate space to conduct the clinic, written policies for delivery of care, and clear infection control policies (based on CFC standards).

For recommended staffing levels for clinics in BC, see APPENDX B.

Additionally, it is a requirement of all clinics to regularly update the Canadian CF Registry for their site. When able, the clinic should take part in research initiatives and trials.

3.2 Primary Personnel

Living with CF provides many physical and psychological challenges for patients and their families. The centre's care team should have the expertise to not only provide adequate physical but also psychosocial care and support to meet these challenges.

Each member of the CF Team requires sufficient time, office space, and facilities to carry out their respective roles. All primary personnel (with the exception of clerical support) are expected to regularly attend local and national CF educational and conference opportunities to remain current on CF matters/ evidenced-based care; participation (e.g. through the submission of abstracts) is encouraged. There is also an expectation for primary personnel to engage in ongoing quality improvement initiatives, both individually and interdisciplinary.

3.2.1 Clinic Clerical Support

- Responsible for the administrative tasks associated with the clinic, such as completing correspondence, filing, dictation, appointment booking, and organizing charts.
- Could arrange referrals to other healthcare services, or be responsible (along with the coordinator) for preparing and submitting data to the Canadian CF Registry.

Clinic Role:

- Can vary depending on needs of the organization.

3.2.2 Medical Director

- Oversees and guides the direction of the clinic.
- Leads the team on all aspects of CF care; including current therapies, standards of care, as well as quality improvement initiatives.
- Is a leader on staff recruitment.
- Has a thorough understanding of the health care system, maintaining current knowledge on its structure, in order to develop and protect the financial support needed for CF service.
- Receives the funding supplied by Cystic Fibrosis Canada and is responsible for managing these funds, ensuring funding is applied and reported appropriately.
- Facilitates linkages between clinical experts and health system management.
- Advocates for clinic and patient needs on a local, provincial, and federal level when needed.

Clinic Role:

- Maintains all standards and responsibilities of the CF Physician.

3.2.3 Physician

- Has current knowledge of the epidemiology and pathophysiology of CF.
- Is responsible for all CF related medical decisions and referrals to subspecialties.
- Is familiar with the aetiology of respiratory and non-respiratory manifestation and complications of CF, as well as a familiarity with relevant investigations.
- Knows the indications for lung transplant.
- Familiar with CF related pharmacology, physiotherapy interventions, and nutritional requirements of patients.
- Has good interpersonal skills for routine interactions, and experience in discussing sensitive and difficult or new information (e.g. CF diagnosis; discussions around lung transplant, etc.).
- Works closely with other healthcare professionals on the CF Team to manage care.
- Regularly attends respiratory and cystic fibrosis meetings.
- Ensures job plan includes suitable time allocation for CF patients, as well as adequate time for managerial duties.

Clinic role:

- Evaluates the functional status of patients at each clinic.

- Applies their knowledge of disease management to interpret testing results and plan care.
- Uses strong interpersonal communication skills to provide education to their patients as the disease progresses.
- In collaboration with the CF Team, conducts a detailed review of patient's status and a plan of care annually.

3.2.4 Clinic Coordinator

- Manages the operationalization of the CF clinic (in conjunction with the CF Clinic Director). This role is commonly assumed by a CF nurse, but could be filled by another primary personnel CF team member.
- Provides and manages activities related to the care of CF patients and their families.
- Has expert knowledge of cystic fibrosis and experienced with the care of children and/or adults with CF.
- Acts as a link between the patients and their family with primary and community services and the hospital.
- Ensures every patient receives appropriate care for their individual needs.
- Co-ordinates multidisciplinary CF Team and patient meetings.
- Provides in-service education to healthcare professionals working with CF patients.
- Develops and moderates CF 'family information days'.
- Acts to support and advocate for the patient, including social care, counselling, and ethical issues.
- Liaises with clinical, social, educational, employment and other community agencies.
- Takes part in program development: assessing need, then develops, implements, and evaluates new practices and programs (i.e. Home IV, outreach clinics).
- Works with families to develop strategies to navigate the health care system.
- Acts as the official liaison to Cystic Fibrosis Canada: disseminating information from local chapters and national office to CF Team members.
- Works with the Medical Director, when needed, to submit the annual incentive grant application and progress reports to Cystic Fibrosis Canada.
- Manages and plans Cystic Fibrosis Canada's accreditation site visit.
- Manages rotation of undergraduate health students.

Clinic role:

- Works to ensure efficiency during the clinic.
- Works to balance the needs and time of both the staff and the patients.

3.2.5 Nurse Clinician/Clinic Nurse

- Works directly with the patient and family.
- Provides education, advocacy, and psychosocial support.
- Uses evidenced-based knowledge of cystic fibrosis and associated issues to teach patients and families.
- Develops appropriate plans of care in collaboration with the patient and family.
- Regularly attends and takes part in local and national CF conferences.
- Works with the patient and family to maximize health throughout the development spectrum and at lifetime milestones. Landmarks can include:
    - notification of screening and result diagnosis
    - first hospital admission or course of IV antibiotics
    - CFRD diagnosis
    - transition to adult care
    - reproductive issues
    - transplant
    - end of life
- Depending on the size of the clinic, is also the Clinic Coordinator or provides continuity of care when the coordinator is not available.

Clinic Role:

- Uses diagnostic and assessment skills to monitor the patient's wellbeing.
- Focuses on recognizing and monitoring changes with the patient.
- Works with patients to develop and facilitate plans of care that promote wellbeing.
- Monitors such things as:
    - physical wellbeing (lung function, sputum, GI functioning)
    - key indicators (FEV1, BMI)
    - emotional status
    - developmental stage
    - adherence to prescribed therapies

3.2.6 Dietitian

- Provides specialized nutrition care planning to optimize nutritional status.

- Experienced in the management of cystic fibrosis, including nutrition risk screening, nutritional assessment, individualized recommendations, education and working together with patients and families to support good nutrition health.
- Advises patients and caregivers of appropriate food choices and strategies to meet their nutrition needs and promote adequate growth.
- Develops specific nutrition management plans for failure to thrive, pancreatic insufficiency, micronutrient deficiency, delayed gastric emptying, reflux, constipation, and CF-related conditions such as distal intestinal obstruction syndrome, impaired glucose tolerance, CF related diabetes, and bone disease.

Clinic Role:

- Assesses the patient's nutritional status at each clinic, including review of nutritional intake, pancreatic enzyme status and absorption, management of metabolic complications, growth and nutritional status, bone mineral density, vitamin and glycemic status.
- Uses assessment findings as a framework for future care planning.
- Conducts a more thorough dietary and nutritional review (three day intake) annually.

3.2.7 Physiotherapist

- Works in collaboration with the patient and family to design a treatment plan that addresses airway clearance, exercise, and inhalation therapy within the framework of the overall treatment regime.
- Continuously modifies the treatment plan as the patient and family needs change.
- Screens for musculoskeletal concerns, such as posture, back pain and urinary incontinence.
- Provides treatment or referral to physiotherapy specialists when needed, while ensuring continuity of care.
- Focuses therapy goals on maintaining the patient's lung function at the highest level.
- Encourages establishing and maintaining normal physical capacity.
- Takes part in multidisciplinary discussions and patient/family meetings.
- Provides in-services and education to other Physiotherapists who are in contact with CF patients.
- Liaises with other professionals in community settings as required.

Clinic Role:

- Reviews the patient at each clinic, including respiratory signs and symptoms (cough characteristics, airway clearance technique), timing of inhalation therapy, activity level, and adherence with treatment plan.
- Monitors inhalations technique if using inhalers.
- Assesses posture and musculoskeletal development.
- Reviews cleaning of equipment for infection control with patient and family.

- Revises treatment plan accordingly.
- Provides education for new plan (either exercise or airway clearance technique) tailored to the individual with consideration for their age, disease severity, physical side effects or complications, social and domestic circumstances. (Education may need to be scheduled outside of CF clinic visit.)
- Annually conducts comprehensive evaluation, including sub-maximal exercise testing if maximal exercise testing not done in CF centre, more complete musculoskeletal/postural assessment, urinary incontinence screening, and exercise and activity level questionnaire.

3.2.8 Social Worker

- Proficient at working with children and families, and/or adults, depending on the specific clinic needs.
- Serves as an advocate for patients and families.
- Helps patients and families navigate through the health care, school and community systems.
- Has current and working knowledge of available resources.
- Provides emotional and practical support at disease stages such as:
    - CF diagnosis
    - first pseudomonas infection
    - CFRD diagnosis
    - Hospitalization
    - transition to adult care
    - transplantation
    - end of life care
- Provides expertise, social, emotional, and practical support at developmental milestones stages, including: starting daycare, starting school, awareness of being different, non-adherence, teenager with CF, first relationship, living independently, death of a friend, higher education, and parenthood.

Clinic Role:

- Reviews the patient at each visit, conducting a psychosocial assessment.
- Refers to and advocates for psychological and practical resources as required by the patient.
- Facilitates patient and family communication with the entire CF Team.
- Annually conducts an in depth psychosocial assessment, using a proven tool to determine the level of anxiety and depression (PHQ-9, GAD-7) experienced by the patient (or parent, in the case of infants).

3.2.9 Pharmacist

- Provides patient-focused pharmaceutical care, defined as the responsible provision of medication to achieve definite outcomes that improve the patients' quality of life and long-term survival.
- Manages and dispenses medications, vitamins, enzymes, and, in many cases, nutritional supplements to the CF population.
- Promotes the correct and appropriate use of medicinal products with an aim to
    - maximize clinical effectiveness of medicines
    - minimize the risk of treatment-induced adverse events
    - optimize the expenditures for pharmacological treatments borne by the provincial healthcare system and patients
- Arranges for the dispensing of medications to inpatients or outpatients as required by their health authority.
- Completes formulary applications to ensure access to special access medications.
- Identifies patient and medication risk factors.
- Prevents, detects, and reports any adverse drug reactions.
- Individualizes drug and dosage requirements.
- Educates and counsels patients and care givers on medication administration.
- Resolves issues with medication supply.
- Acts as an advisor on legal and ethical responsibilities of using medicine (sourcing, administration of unlicensed and off-label medicine).
- Attend ward rounds and CF clinic meetings.
- Networks with other CF pharmacists for advice and knowledge dissemination.
- Liaises with other pharmacists who may be in contact with the CF patient (other hospitals, in the community, and during transition of care).
- Takes part in CF research and development.

Clinic Role:

- Conducts medicine reconciliation reviews at each clinic.
- Ensures safe and effective use of medications.
- Ensures an accurate history is recorded, that medication and formulation are appropriate for the patient, that adverse drug reactions are noted, and review and counsel on adherence.
- When medicines are prescribed, ensures the prescription is unambiguous; monitors for drug interactions; and ensures patient characteristics (age, organ dysfunction) are taken into account.
- Monitors prescriptions for costs to ensure this is not a barrier for adherence.

- Takes into account the patient's wishes and lifestyle, and when required, is open to non-drug and complementary therapies.
- Annually reviews patient's medication regime to ensure they remain on the most effective formulary for their status.

3.2.10 Respiratory Therapist

- Works alongside the CF clinic team.
- Assists in caring for the respiratory needs of the CF patient.
- Has experience and knowledge of pulmonary issues and tests related to cystic fibrosis.
- Establishes a comfortable relationship, especially for the pediatric CF population, to help to alleviate the fear of performing the tests, and help ensure usable responses to testing (consistency of results is crucial).
- Recognizes warning signs when individual's lung function begins to decline and alerts the care team.
- Takes part in educational opportunities when able.

Clinic Role

- Performs all procedures and tests to establish lung function measurements, which are often done at every clinic visit, up to four times each year (helps to have the same Respiratory Therapist do all procedures and test for consistency of results).
- Conducts lung function measurement.
- Tracks patients' lung function.
- Produces longitudinal studies of patient status.

3.2.11 Psychologist

- Helps patients and families with challenges related to CF in conjunction with normal developmental tasks.
- Educated and current with psychological issues surrounding Cystic Fibrosis.
- Familiar with applying proven therapeutic techniques (cognitive/ behavioural, motivational interviewing) around adherence, self-care, impact of a chronic illness on human development, family and social life, end of life issues, and palliative care.

When special psychosocial concerns arise, a medical professional specializing in mental health should be available to the CF Clinic, and the services of a psychiatrist or psychologist will often be requested by either the clinic director, coordinator, or social worker. As patients live longer with complex health issues, the need for adequate access to a psychologist increases.

Clinic Role:

- Takes part in regular CF patient's appointments.
- Assesses and intervenes in emotional, behavioural, and psychological difficulties, using evidence-based treatments where indicated.
- Works in collaboration with the CF Team, and when required, making referrals when appropriate (Psychiatry).

3.3 Supporting Personnel (depending on the size of the clinic)

3.3.1 Clinical Nurse Specialist (Practice Leader)

- Is an advanced practice nurse.
- Provides clinical expertise in an aspect of cystic fibrosis care (newborn care, CFRD, research).
- Provides education and support to the patient and family around their speciality, within the context of Cystic Fibrosis.
- In most cases, is employed in larger clinics, where patient population justifies role specification. Role title can vary with each health authority.

Clinic Role:

- Mirrors the clinic role of the nurse clinician, within the context of their speciality.

3.3.2 Nurse Practitioner

- Practices autonomously and interdependently within the context of an interdisciplinary healthcare team, making referrals to physicians and others as appropriate.
- Responsible and accountable for the comprehensive assessment of patients including diagnosis.
- Has current knowledge of the epidemiology and pathophysiology of CF.
- Familiar with CF related pharmacology, physiotherapy interventions, and nutritional requirements of patients.
- Initiates treatment, including health care management, therapeutic interventions, and prescribes medications in accordance with the statutory and regulatory standards, limits and conditions, policy and guidelines.
- Provides professional guidance to other health professionals.
- Has good interpersonal skills.
- Works closely with other healthcare professionals on the CF Team to manage care.

Clinic Role

- Varies with each health authority.

3.3.4 Psychiatrist

- Accessible to CF clinic when needed.
- Provides care when psychological intervention proves ineffective for a patient, or when a patient has an acute mental health exacerbation.
- Has all the described knowledge and techniques required by a CF psychologist, along with education and experience in medical treatments related to mental health.

Clinic Role

- Same as psychologist, providing appropriate medicinal intervention when needed.

3.3.5 Spiritual Health Practitioner

- Can offer spiritual support and guidance for patients and families at any time it is needed.
- Has working knowledge of psychosocial, developmental, and physical manifestations of chronic disease.
- Ordained or has appropriate ecclesiastical endorsement.
- Has extensive knowledge of spiritual health and/or pastoral counselling and its application with chronic disease.
- Has a thorough knowledge of ethics related to various theologies and faith backgrounds.

Clinic Role

- Varies depending to the individual's needs.
- Provides care that aligns with the patient's cultural beliefs and values.
- Supports patients and families of all faiths and spiritual practices.
- Works closely with the patient and CF Team, when the need arises.

4.0 Principles for Outpatient Care

- Treatment should be coordinated by a multi-disciplinary team in specialized Cystic Fibrosis centres.
- Most patients should be reviewed at least four times per year.
- Access to the specialist CF multidisciplinary team should be available at all clinics.
- Monitoring of disease should include appropriate tests undertaken at timely intervals, whether by an annual review process or spaced throughout the year.
- CF centres should have access to appropriate specialists and services.
- Adequate policies, facilities, and procedures should be in place to comply with, and promote, infection control guidelines.
- Ambulatory (outpatient) care is the primary goal throughout the lifespan of all CF patients.
- Patient and family centered care should be practised.

4.1 Specialized Cystic Fibrosis Centres

CF patients should be cared for in a CF clinic that has been accredited by Cystic Fibrosis Canada. Such accreditation infers that certain standards are in place. To achieve accreditation and maintain competency, clinics need at least 20 CF patients.[8]

Shared Care: Role of family physician and/or pediatrician:

- The involvement of a general practitioner/family physician is required for all patients.
- The involvement of a general pediatrician should be encouraged for infants and children.
- GP's/ FP's/ Pediatricians must be able to access advice from the CF Team, and collaboration is essential in optimising care.

For more on the staffing of CF Centres, see APPENDIX B and C.

4.2 Follow-up care

4.2.1 Clinic visits

Frequency of clinic reviews depends on whether the patient has a classical cystic fibrosis diagnosis or cystic fibrosis screen-positive, inconclusive diagnosis (CFSPID).

Frequency of clinic visits	Classical CF	CFSPID
Newly diagnosed infant	See weekly for first month, then monthly until age 1 year	See at diagnosis, 3 months, 6 months, and 1 year
1 to 17 years	Review every 3 months, depending on severity of disease	See every 6 months until school age, then annually
≥ 18 years	Review every 3 months, depending on severity of disease and need	See annually, depending on need

All CF clinic visits should have a multidisciplinary post-clinic discussion to review each patient once test results have been finalized. It is also recommended to have a pre-clinic multidisciplinary huddle to briefly review that day's list of CF patients.

4.2.2 Outreach clinics

Where possible, regular outreach clinics should be held to lessen the burden on those patients/families who travel great distances to attend CF clinic appointments.

Outreach clinics include members of the CF Team (CF specialist, nurse, dietitian, physiotherapist, and social worker when feasible) travelling to an established medical facility closer to the patient's home, and seeing CF patients in a 'pared down' type of clinic visit.

The local medical facility used for holding outreach clinics must allow for adequate CF infection control measures. It must also have access to a radiology department, pulmonary function testing, and a microbiology laboratory that can process a panel of CF respiratory cultures. Where a microbiology laboratory cannot handle CF respiratory cultures, they may be transported back to the CF clinic laboratory.

Consideration should be given to promoting relationships with local healthcare professionals who look after CF patients in their communities, and providing CF mentorship/education.

4.2.3 Telehealth

Telehealth can be utilized as an adjunct to regular CF clinic reviews for CF children and adults. Telehealth does not replace foundation of care for CF (i.e. CF specialist and multidisciplinary review).

4.3 Specialist CF interdisciplinary team

Outpatient clinic visits should include consultation with members of the CF Team as needed. The full interdisciplinary CF Team should be present and available at all outpatient CF clinics. (Refer to 'Primary Personnel' in the section 'Interdisciplinary Care Team for Cystic Fibrosis').

4.4 Ongoing monitoring

4.4.1 From 0 to 2 Years

Test	@ Diagnosis	@ 2-3 months	@ 6 months	Every 1 to 2 months until age 1 Year	@ Age 1 Year
Stool for Elastase	X		X		X
Stool for Fat Globules	X				
Urine for electrolytes	X			X	
Cough Swab	X	X	X	X	X
Bloodwork	X		X		X
CXR		X			X
Measure BMI, weight, length & head circumference at every clinic	X	X	X	X	X

4.4.2 From 2 Years and older

Test	Start @ Age 2 yrs	Start @ Age 6 yrs	Start @ Age 10 yrs	Comments
Growth				
Children: At every visit, measure weight and height, and calculate BMI Adults: At every visit, measure weight and calculate BMI	X			
Radiology				
CXR every 6 months	X			
CT Scan	Only if clinically indicated			
Liver Ultrasound annually		X		Stop at age 18 years if no CF-related liver disease established.

Test	Start @ Age 2 yrs	Start @ Age 6 yrs	Start @ Age 10 yrs	Comments
Microbiology				
Cough Swab or Sputum C&S at every clinic	X			
Sputum for NTM annually & with respiratory exacerbations	X			Must be able to produce sputum
Bronchoscopy	Only if clinically indicated			
Lung Function				
Spirometry at every clinic		X		Must be able to follow spirometry instructions
Plethysmography annually			X	
LCI				Not routinely available at this time.
Exercise Test annually			X	
Bloodwork annually				
ABPA (CBC + Diff, IgE, RAST for Aspergillus; Aspergillus precipitins IgE)	X			
Liver (CBC, AST, ALT, GGT, Alk Phos, PT, INR, Bili conj & unconj, Amylase, Alb)	X			
Infection (C-Reactive Protein, Anti-pseudomonal antibodies*)	X			*May not be available at every CF centre
General Chemistry (Na, Cl, K, BUN, Cr, IgG, IgM,	X			
Nutrition (Ca, Mg, Glucose Random, Phos, Iron, Ferritin, Selenium, Zinc, Triglycerides, Cholesterol, Vit A, Vit D, Vit E)	X			
Coagulation Studies				If Cystic Fibrosis-Related Diabetes diagnosed (CFRD)

Test	Start @ Age 2 yrs	Start @ Age 6 yrs	Start @ Age 10 yrs	Comments
Endocrine				
Oral Glucose Tolerance Test annually			X	Start annual tests earlier if clinical suspicion Stop if insulin started
Bone Densitometry (scan) every 1-3 years, or annually if abnormal			X	Do at earlier age if patient is at risk
Other				
Measure BP at every visit.	X			Only if: taking oral steroids and/or Orkambi CFRD CKD and/or post-transplant
Urine electrolytes annually	X			Stop at age 18 yrs.
Eye Exam annually				If CFRD
Urine Protein/Creatinine annually				If CFRD
HbA1C every 3 months				If CFRD

Other Checks	Comments
Annually conduct full assessment of respiratory therapy equipment	Include cleaning protocols

4.4.3 Additional testing for transplant patients

	Comments
Colonoscopy Post-transplant: Start 1 year post transplant. Non-transplant: Start at age 40.	Post-transplant: Repeat every 5 yrs. if Normal. Non-transplant: Repeat every 5-10 yrs.
Refer to Dermatology for skin cancer screening	Post-transplant only: Do annually

4.5 Appropriate specialists and specialty services

CF Centres should have access to the following specialists and specialty services.*

Specialists	Specialty Services
Adolescent Health	B. cepacia complex Repository
Allergy	Interventional Radiology
Endocrinology	Microbiology Laboratory with ability to test for full panel of CF respiratory pathogens
ENT	Nuclear Medicine
Gastroenterology	Outpatient Day Unit (or similar)
Genetic Counselling	Pulmonary Function Lab
Infectious Diseases	Radiology
Medical Genetics	Sweat Testing facility (by accredited method)
Microbiology	Home IV Therapy Program
Ophthalmology	
Pain Specialist	
Palliative Care	
Psychology	
Psychiatry	
Rheumatology	
Transplant	

*This is not an inclusive list

4.6 Adequate policies, facilities, and procedures for infection control

This principle is described in detail in section titled 'Standards for Cystic Fibrosis Infection Control'.

With regard to outpatient care, in order to meet Cystic Fibrosis Canada-approved infection control guidelines, outpatient clinics must have an adequate number of exam rooms and a centralized conference room for staff. Portable spirometry equipment is recommended.

4.7 Patient and family centered care

Patient- and family-centered care is a partnership approach to health care decision making. It recognizes the vital role that patients and families play in their health and wellbeing.

Examples of patient-centred practices in a CF centre:

- Honouring patient and family choices in decision making
- Collaborating with CF patients and families on new program initiatives
- Creating a Patient or Family Advisory Council

Patient-centred also means adjusting the care plan as the patient grows and develops. Below shows how the care plan needs to be adjusted as the child gets older.

Approximate age of child	3 months (after NBS diagnosis of CF)	5 yrs	6 yrs	12 yrs	18 yrs
Annual depression and anxiety screening		PARENTS	CHILD and PARENT		
School plan for CF needs Chronic Health Designation					
Change from Postural Drainage and Percussion (PD&P) to Positive Expiratory Pressure (PEP) mask					
Start adolescent transition plan					
Educate on reproductive health					
Initiate transfer from pediatric to adult clinic					

4.8 Additional care recommendations

4.8.1 24/7 access

CF patients should have 24/7 access to a specialist with experience in CF care.

4.8.2 Canadian CF Registry

CF centres should approach all CF patients/caregivers about enrollment in the Canadian CF Registry.

CF centres must update the Registry data yearly.

4.8.3 Quality improvement

Formal training in the quality improvement process is recommended for the CF Team. All members of the CF Team should engage in ongoing quality improvement projects.

4.8.4 Administrative requirements

CF centres should have in place systems and processes for charting, team meetings, strategies for missed appointments, etc.

4.8.5 Immunizations

CF patients should receive all recommended immunizations as per BCCDC Immunization Schedule. In addition, CF patients are eligible for additional protection against influenza and Strep pneumoniae (APPENDIX D: SAMPLE Immunization Schedule for Cystic Fibrosis Patients form).

5.0 Principles for Inpatient Care

Inpatient care is fundamental to CF care.

5.1 Rationale for admission

5.1.1 Respiratory

- **CF Pulmonary Exacerbation (PEx)**

Lung disease remains the most important driver of mortality (estimated as primary cause of death in >80% of cases) and morbidity for individuals with CF. Of the various respiratory complications, pulmonary exacerbations (PEx) account for the majority of CF hospitalizations.

No widely accepted definition of an exacerbation exists, but operationally, a PEx is a significant and sustained change from baseline in respiratory symptoms, pulmonary physiological measures, or chest radiology deemed by a CF clinician as needing important changes in therapy. Most often these are considered to be infectious in origin, either from higher levels of chronic infecting organisms or from a new organism. The decision to hospitalize is individualized and generally means the need for IV antibiotics along with other therapies. When Home IV therapy is an option, factors to consider before deciding to admit include: severity of the illness, tolerance of proposed medications, severity of co-morbidities, and the ability of the individual (or caregiver) to take on the responsibility.

> Further studies are underway to address optimal duration of therapy and could alter the standards of care for IV antibiotic duration in the future.

Currently the standard of care is to complete approximately 2 weeks of IV antibiotics. Hospitalization is often for the full duration of this treatment. If there is a good response to in-hospital treatment, the length of stay could be shorter with changing to Home IV or stepping down to oral therapy. Conversely, some patients need longer hospital stays for respiratory treatment, ranging from a few extra days to indefinite stay while waiting lung transplantation.

- **Acute Viral Illness**

The acquisition of viruses such as Respiratory Syncytial Virus (RSV) (in infants), and influenza (in all ages) might cause acute respiratory symptoms which on occasion can be severe enough to require inpatient management. In additional to treatment of acute respiratory symptoms, monitoring for secondary bacterial infection should be undertaken.

- **Hemoptysis (large volume)**

Hemoptysis is a relatively common complication of CF, often a consequence of bronchiectasis with its associated increased bronchial arterial blood flow. Other factors can contribute such as a coagulopathy due to vitamin K deficiency. Frequently, the volume is modest and can be managed

conservatively. On occasion, it can be substantial and require hospitalization with possible Interventional Radiology for bronchial artery embolization.

- **Pneumothorax**

  Spontaneous pneumothorax occurs in ~ 5% of CF patients. Independently, this is a marker of an adverse long-term prognosis.

  While a pneumothorax can occur following trauma or on occasion be iatrogenic, most are spontaneous. The physiological impact on the patient depends both on the size of the pneumothorax and the underlying cardiopulmonary status. While small pneumothoraces with reasonable preservation of lung volume can be managed as an outpatient, in most instances hospitalization is required.

  The decision as to whether a chest tube is needed (and if so, what type of tube is appropriate) is made on an individual basis. The duration of chest tube placement is most dependent on the presence or absence of an air leak (bronchopleural fistula). At times, a pneumothorax can precipitate a CF exacerbation and the need for antibiotic therapy. In the uncommon situation of an air leak not closing, thoracic surgical intervention might be needed.

- **Upper Respiratory Tract**

  CF patients commonly have a noticeable symptomatic chronic rhinosinusitis. Acute sinusitis can be severe enough to need hospitalization for comprehensive therapy. Sinus surgery can be required with hospitalization pre- and postoperatively.

- **Other pulmonary causes**

  On occasion, hospitalization could be needed to start therapy for problematic subacute to chronic pulmonary infections (e.g. mycobacterium abscessus).

5.1.2 Gastroenterology

- **Distal Ileal Obstruction Syndrome (DIOS)**

  Patients with CF are predisposed to gut dysmotility. In DIOS, a partial or complete small bowel obstruction with dried fecal material occurs where the distal small bowel (ileum) joins the ascending colon. Risk factors include meconium ileus presentation as an infant and a previous history of DIOS. Hospitalization is often required to:

  - ensure this is the correct diagnosis
  - facilitate appropriate therapy (aggressive osmotic laxatives is the basis of treatment)
  - monitor metabolic status
  - have general surgical evaluation in more severe instances

- **Pancreatitis**

  Patients who are pancreatic sufficient are at risk of acute pancreatitis. In the subset of CF patients who develop this complication, it is often recurrent. When it occurs and is more severe, hospitalization is necessary for appropriate investigations to confirm this diagnosis, to properly manage pain, and to intervene appropriately for fluid and electrolyte resuscitation.

- **Other GI admission causes**

  Malnutrition is common in people with CF. At times, enteral feeding by gastrostomy or jejunostomy tube is required. Patients are usually hospitalized to in order to place tubes and initiate feeds. Uncommonly, Total Parenteral Nutrition is needed and initiated in hospital.

  Cystic fibrosis patients are at a higher risk of cholelithiasis and possibly appendicitis.

  Bowel obstruction secondary to adhesions can occur in those CF patients who have had previous GI surgery (e.g. for meconium ileus). Rarely, bowel intussusception can occur and lead to bowel obstruction.

  GI patients are at a higher risk (compared to age and sex matched controls) for a number of GI malignancies.

  A small proportion of CF patients have advanced liver disease. Patients might need to be hospitalized due to complications (e.g. ascites, esophageal varices, and encephalopathy).

  CF patients can also be hospitalized for elective procedures such as the insertion of a venous access device or for laparoscopic cholecystectomy surgery.

5.1.3 Other reasons for hospitalization

- Ante- and Post-natal care
- Uncontrolled cystic fibrosis-related diabetes
- Psychosocial or Psychiatric Issues
- Initiation of non-invasive ventilation

5.2 CF Specialized Care Centre vs local or regional hospital care

While shared care is encouraged in many facets of CF care, it is recognized that certain aspects of this care are best facilitated by direct involvement of the CF Team. This is especially the case for the more serious issues that lead to hospitalization, or when unsure as to whether hospitalization is appropriate or not. Such decisions should be made individually and on the basis of dialogue between the local or regional most responsible physician (MRP) and the appropriate CF Physician. For some individuals, any

hospitalization should be at a CF Centre (either direct admission or transfer admission) whereas others could be cared for in a local hospital with input from the CF Team.

The following describes situations where hospitalization in a CF Specialized Care Centre is recommended.

5.2.1 Large volume hemoptysis

- Any hemoptysis of large volume (e.g. > 200 mL) or repetitive in sub-massive amounts.
- Allows for intervention when necessary including bronchial artery embolization and coordination of other aspects of CF respiratory care.

5.2.2 Non- or limited-response to initial local hospital care

- Patient not responding to initial care, might have a broader differential diagnosis to consider, and/or needs access to investigations and therapies not available locally.
- Expertise of the CF Team needed.

5.2.3 Severe respiratory distress or respiratory failure

- Needed investigations and therapies not available locally.
- Expertise of the CF Team needed for care and relevant issues such as transplantation appropriateness and end-of-life care.

5.2.4 Patients activated for transplantation

- Require specialized care due to advance nature of the disease.
- CF Team's detailed knowledge of the individual needed as part of frequent collaborations with the Transplant Team.

5.3 Hospital facilities

It is necessary to have readily available beds, equipment, and services suitable for the core delivery of care to CF patients. These include:

- Fully accredited tertiary institution
- A multidisciplinary CF Team on staff and available
- CF unit, either stand alone or embedded in adult or pediatric tertiary acute care hospital under subspecialty care (usually Respirology)
- CF unit with CF nursing care knowledge and expertise (including adhering to appropriate infection control principles)

- Single hospital rooms used whenever possible (exceptions to be agreed upon by the CF Team).
- Adequate space for medical equipment necessary for care
- Space for parents of children with CF, and for family/care givers of adults with CF
- Space and equipment for exercise/rehabilitation
- Space and equipment for additional food storage and food preparation recommended by CF dietitian
- Hospital Infection Control policies in place and all staff aware of CF Infection control guidelines
- Space and facilities for students to study, and when necessary to work

Always avoid cohorting with other CF patients.

5.4 Admission policies

5.4.1 Single hospital rooms

Single hospital rooms are to be used in most instances (avoid cohorting two CF patients in a common room, except for siblings).

Consider separate nursing staff and units for specific organisms (e.g. Burkholderia Cepacia Complex (BCC), M. abscessus).

5.4.2 Urgent admissions

For urgent admissions, the preferred route is direct to inpatient bed.

If admitted through the emergency department, target the admission to an inpatient bed in less than 24 hours.

5.4.3 Non-urgent admissions

The goal for an available inpatient bed should be within 2-3 days.

Admission should be arranged for between 0800 and 1700 hours.

CF Team to notify the admitting physician of the need to admit and to provide appropriate documentation.

5.4.4 CF nursing units

Use nursing units with CF expertise whenever possible.

5.4.5 Selected admission diagnoses

Only use non-CF unit specialty service for select admission diagnoses (e.g. surgical unit for planned surgery).

5.4.6 Emergency Department visits

Emergency Department staff to notify CF Team of all patients arriving in emergency regardless of reason for visit.

5.4.7 Initiation of therapy

All patients should receive timely initiation of therapy after arrival to hospital (target IV antibiotics < 6 hrs).

5.4.8 Self-administration of medications

CF patients (age-appropriate) should be allowed to self-administer medications that they have previously been taking routinely (oral and nebulized). Specific medications are decided in discussions with medical, nursing, and pharmacy. Medications will adhere to individual hospital regulations.

This policy can improve efficiency of care, foster independence, and self-learning.

5.4.9 In-hospital or inter-hospital transfers

Whenever CF patients are transferred to another hospital or another service in the same hospital, the CF service is notified regardless of the medical issue.

5.4.10 Elective procedures

If an elective procedure is planned, the CF service should be made aware and should have the opportunity to discuss care plans related to the procedure.

5.4.11 Organ transplant

For patients post organ transplant or those awaiting organ transplantation, the appropriate section of BC Transplant should be notified.

5.5 Hospital care team

The goal is to have health professionals with CF expertise provide care to CF inpatients.

5.5.1 CF Physician

- Have direct patient visits a minimum of twice weekly. Residents/Fellows should have daily direct patient visits and liaise daily with the CF Physician.
- If the CF Physician is not the MRP, be readily available for patient care discussions.
- If the MRP is not a CF Specialist, needs to have expertise in key CF issues (usually Pediatrician or Adult Respirologist).
- Take part in multidisciplinary patient rounds 1-2 times a week.

5.5.2 CF Nurse

- Have direct patient contact soon after admission to aid in identifying CF patient care needs. Frequency of inpatient contact is determined by patient needs after the initial inpatient visit.
- Liaise with inpatient nursing staff regarding CF protocols such as infection control, isolation, etc.
- Help with discharge planning and arranging follow-up with the CF clinic.
- Take part in multidisciplinary patient rounds 1-2 times a week.

5.5.3 Physiotherapist

- In coordination with the CF Physiotherapist, assess and plan a treatment strategy within 24 hours of admission.
- Assessment and treatment to include:
    - assessing patient's airway clearance technique and adjust technique as needed
    - coordinating the giving of inhalation medications and airway clearance with nursing staff
    - arranging for patient to attend the inpatient gym at least 3 times a week or for patient to go outside for activities
- Take part in multidisciplinary patient rounds 1-2 times a week.

5.5.4 CF Dietitian

- Assess and arrange for the appropriate nutritional needs of the CF inpatient within 24 hours of admission, including constructing specialized diet plans.
- Monitor the CF patient's nutritional status. Frequency of inpatient contact is determined by patient needs after the initial inpatient visit.
- Work with the patient and family to create appropriate dietary habits that optimize nutritional health.

- Get more involved in care of CF inpatients with special needs such as
    - enteral and IV parenteral feeds
    - indwelling feeding tubes such as a PEG or Jejunostomy
    - diabetes
    - Crohn's disease
- Take part in multidisciplinary patient rounds 1-2 times a week.

5.5.5 CF Social Worker

- Have direct patient contact soon after admission to address any psychosocial or financial concerns of the CF patient and family needs. Frequency of inpatient contact is determined by patient needs after the initial inpatient visit.
- Take part in multidisciplinary patient rounds 1-2 times a week.

5.5.6 Pharmacist

- Not all CF clinics have a Pharmacist attached to the clinic. However, each hospital has a Pharmacy responsible for dispensing all the drugs, vitamins, enzymes, and, in many cases, nutritional supplements, to the CF population. Wherever available the service of a Pharmacist should be utilized. They are knowledgeable about CF drugs, other drug therapies, and drug interactions. They can also provide information about provincial drug coverage programs and how financial coverage can be obtained.

5.6 Access to other key hospital services

5.6.1 IV Services

CF Patients will generally require IV access during their admission.

- **Peripheral Intravenous**

  To be placed by IV Team with the option for topical anesthesia when appropriate. Often these are a short-term option while waiting for central venous catheter placement. In selected individuals, a peripheral IV might be adequate for IV access needs while in the hospital.

- **Peripherally Inserted Central Catheter (PICC)**

  These are commonly utilized for IV access in CF patients. In adults, they are usually placed by experienced technicians at the bedside using ultrasound guidance. When necessary, as well as in the pediatric population, they can be placed by Interventional Radiology services. Sedation may be used when deemed medically appropriate.

Standard protocols are used for placement. Position can be confirmed with imaging before using, depending on hospital policies.

When needed, the goal is to have in place within 48 hrs of admission.

- **Central Venous Catheter**

  An option for central line insertion should exist (usually internal jugular given a higher pneumothorax risk for the subclavian approach). This is usually performed by trained medical staff employing ultrasound guidance.

- **Implanted Venous Access Device (IVAD)**

  For patients with pre-existing IVAD, this represents the preferred access choice with the goal of initiating use as soon as possible. Access is the responsibility of the designated IV Team using standardized protocols.

5.6.2 Interventional Radiology (IR) - Vascular

A number of procedures offered by this service are relevant to CF patients. These include IV access when additional expertise is required.

IR at all sites caring for CF patients should have competence in bronchial artery embolization when necessary for management of hemoptysis. This service should be available 24 hours a day.

Other services that may be provided by IR include ultrasound-guided thoracentesis and chest tube placement (if not performed by Respirology), feeding tube placement, portovenous hepatic shunt insertion, and IVAD insertion and troubleshooting.

5.6.3 Gastroenterology/General Surgery with CF expertise

GI complications are relatively common in admitted CF patients. Special expertise is required to manage these complications when they arise. While diagnosis and management of DIOS might be led by the CF Team, it requires GI and General Surgery backup. Other examples of complications include CF liver disease, pancreatitis, cholelithiasis, and cholecystitis, and upper and lower GI bleeding.

5.6.4 Endocrinology

Dysglycemia and overt diabetes (CFRD) are very common in CF, occurring in up to 40% of CF adults. It can manifest or be more difficult to manage during hospitalization. Given the unique aspects of CFRD, ideally access to endocrinologists with expertise in CFRD should be available and utilized when appropriate. This should also include specialized diabetes education services that can bridge to outpatient diabetes care.

5.6.5 Psychiatry/Psychology

Mood and anxiety disorders are estimated to have a prevalence of ~40% in CF patients. These conditions can be negatively impacted during hospitalization. The hospital setting can provide an opportunity to diagnose or intervene in these conditions. Ideally, healthcare professionals in these areas who also offer outpatient CF consultation should be available for continuity reasons. If this is not possible, these services in conjunction with the CF Team should ensure the appropriate flow of information to those involved in longitudinal care.

5.6.6 Pain Services

It is common for CF patients to have pain related to the admitting diagnosis or to have pre-existing pain. In many instances, the responsibility for managing the pain falls to the Most Responsible Physician. In more complicated scenarios, both Acute and Chronic Pain Services should be available, and optimally, a process to seamlessly transition the patient to outpatient care when appropriate.

5.6.7 Ear, Nose, Throat (ENT)

Sinus involvement is a very common feature of CF. Acute or chronic rhinosinusitis can either be a reason for hospitalization or contribute to the illness during admission. This condition can have unique aspects (such as the infecting organisms). An ENT Specialist with experience in CF sinus disease is optimal for the management of these patients. This can require access to equipment that is not necessarily available in general ENT practice.

5.6.8 Obstetrics/Gynecology

Pregnancy and delivery often proceeds uneventfully in CF. However, complications can occur. Obstetricians who have experience with CF patients and high risk obstetric care services should be available. When these services are not at a CF designated facility, close collaboration should occur pre-, peri-, and post-delivery.

Relatively few gynaecologic problems needing hospitalization are specific to CF. However, for those CF patients admitted with gynaecologic problems, specialty expertise should be available.

5.6.9 Intensive Care/Critical Care Services

For those instances where a CF patient's condition requires critical care, appropriate facilities must be immediately available. This includes invasive and non-invasive ventilation, dialysis, and circulatory support. While acknowledging that care in these areas is usually directed by critical care teams, CF Team input should be ensured.

5.6.10 Palliative Care Services

End of life care is a recognized part of the spectrum of CF. CF Teams are uniquely positioned to provide this care. However, there are instances where special expertise is beneficial and should be available to CF patients and their family/caregivers. This might include transfer to beds where the Palliative Care Team assume primary responsibility. It is recognized that Palliative Care expertise can be very helpful at times other than in the final stages of the disease.

5.6.11 Other services

Other services to be mentioned for availability beyond those in any full-service hospital include CF knowledgeable Thoracic Surgeons, Infectious Disease Specialists, Microbiologists, and Geneticists.

5.7 Inpatient infection control

See 'Standards for Cystic Fibrosis Infection Control'.

Core components of care

Who	What	When
Clinical / Nursing	Weight	on admission minimum twice weekly
	Vital signs (BP, HR, respiratory rate, temperature, oximetry)	minimum BID
	Clinical status overall charted	minimum once a shift
Laboratory	Chemistry/Hematology CBC, Liver Function Tests , creatinine, GFR, Calcium, Phosphate, albumin, CRP, Magnesium	on admission
	CBC, Creat, GFR, CRP	twice weekly
	additional testing e.g. aminoglycoside levels	PRN
	Glucometer / blood glucose	Fasting and 2hr post prandial for first 48 hrs and on Day 8 of hospitalization (For all CFRD or dysglycemia: QID glucometer testing)
Microbiology	Sputum samples with CF Micro lab expertise identification of CF relevant pathogens (protocols)	at minimum: at admission at treatment completion
	Mycobacterium, pathogenic fungi	generally at least at admission

Who	What	When
Pulmonary Function Testing	Spirometry	minimum of once weekly generally at discharge
	Full PFT	when appropriate
	Arterial blood gases	when appropriate
Radiology	Routine CXR	on admission generally at discharge (or completion of treatment)
	CT chest	when appropriate
	Other imaging (e.g. abdominal plain films or CT, ultrasound, MR imaging)	when appropriate
Other	Echocardiography Angiography Bronchoscopy	when appropriate

5.8 Pharmacy/Drug Formulary

In addition to their usual daily home medications (see APPENDIX E for a list of commonly used ambulatory CF medications), CF patients will often be prescribed additional medications while hospitalized (most commonly, IV antibiotics). Access to all standard CF medications is required. It is expected that the majority will be on the hospital formulary. In-stock medications should include those commonly needed for conditions that lead a CF patient to be hospitalized, such as antibiotics (including some ones unusual outside of CF care - colymycin for example). A process should be in place to quickly access supplies from other sources if necessary.

For those medications not on the formulary and necessary for continuation of CF treatment, patients can bring their own medications or allow (through policy) for the medications to be brought in from an outside pharmacy.

Standard pharmacy practices are expected such as recording and updating adverse medication reactions, and medication reconciliation on admission.

Pharmacists should be involved in appropriate monitoring of medications (e.g. aminoglycoside levels) and in discussions about drug interactions with the admitting physician.

5.9 Space and equipment for exercise/ rehabilitation

Exercise is an essential part of CF treatment. Thus, it is important for the CF patient to have access to an exercise space within the hospital. An exercise gym with cardiopulmonary equipment available is ideal, including an interactive video console for children.

Infection control policies must be followed at all times with only single patient use and equipment wiped down after each use. For patients colonized with or infected with Burkholderia cepacia complex, multi-resistant Achromobacter, multi-resistant or epidemic strains of Pseudomonas and Mycobacteria abscessus, exercise space should be used at the end of the day and the unit terminally cleaned after use. If this is not possible, then exercise equipment could be brought to the patient's room.

5.10 Home Intravenous Therapy

Parenteral antibiotics can be offered in both the hospital and in the home environment. For some people, Home IV Therapy with antibiotics could prevent hospitalization. For other people, it could allow the person to be discharged sooner to complete the course of therapy at home.

There are a number of reasons that might favor Home IV Therapy:

- generally preferred familiarity and nutrition options available at home
- less disruption to the person's usual activities
- opportunity for more involvement of a family member or friend
- possibly fewer concerns around pathogen transmission

Countering these positives are a number of possible downsides:

- The medication regimen used is often complex requiring multiple drugs with varying administration frequencies.
- Optimal safety requires appropriate clinical and laboratory monitoring which can be a challenge in the home setting.
- Early detection of adverse effects or a blunted response to treatment may not occur.
- IV access problems can lead to interruption of dosing and potentially increase the risks of site infection.
- Other key aspects of treatment beyond IV antibiotics may be more consistently achieved in hospital, such as airway clearance.
- Linking with other specialists and Allied Health professionals may be fostered by hospitalization.
- Sometimes the person can get more of a 'rest' in hospital, allowing the person to focus completely on their treatment regimen.

Recognizing these arguments for and against, studies have shown comparable outcomes for highly selected patients comparing home vs hospital treatments for pulmonary exacerbations.

5.10.1 First-time Home IV Therapy

Patients should be admitted to hospital to stabilize/improve their clinical status on the full treatment regimen before being considered for Home IV Therapy.

Home IV Program must be consulted so they can provide comprehensive training focused on caring for the IV site and how to give the medications correctly.

Criteria for Home IV Therapy
An adequate IV access (generally PICC if the patient does not have an IVAD).
Patient and/or caregiver is capable of safely delivering medications, regularly monitoring both the IV and their health status, and detecting concerns.
The medications are safe for Home IV Therapy, and there is a suitable supply of medication (as determined by the hospital ro appointed pharmacy).

After meeting these criteria and deemed appropriate by the CF Team, Home IV, and Pharmacy formal orders can then proceed.

In BC, Home IV Therapy is the responsibility of the patient's home community health services and not all communities have an established Home IV program. The appropriate regional program must be contacted and be agreeable to the discharge plan. Currently, there is no standardized protocol for Home IV Therapy, and rules and policies differ across health authorities.

Routine blood work monitoring can vary but should include minimum twice a week:

- drug levels (when appropriate, e.g. aminoglycosides)
- blood counts
- renal function

CF Team should always be copied on blood results and informed of important clinical issues.

Necessary Before Discharge
Home IV Program training completed
Primary Physician identified to be responsible for the patient's Home IV Therapy
Healthcare professional/service identified to review blood results and respond to care issues
Medications supply confirmed
Ongoing monitoring regimens established including follow-up plan with CF Team
infusion pumps (and type) available
Community Home IV Therapy Team have adequate lead time

At the end of the Home IV Therapy, the patient should be seen in a CF clinic for a clinical, radiographic, lung function, and microbiologic review.

5.10.2 Previous experience/certification with Home IV Therapy

In most instances, the duration of Home IV Therapy should be more than 5 days to justify accessing the often oversubscribed Home Care services.

The Home IV Therapy Team should review the patient's ability (certification) and provide refresher training as needed.

All criteria and other parameters should be fulfilled as those listed in 'First-time Home IV Therapy'.

6.0 Standards for Cystic Fibrosis Infection Control

Although Cystic Fibrosis (CF) is a multisystem disease, the majority of morbidity comes from chronic lung disease. The build-up of thick mucus in the lungs leads to a vicious cycle of infection and inflammation ultimately leading to progressive lung damage and death. We know that the bronchiectatic airways in CF become colonized with various pathogens and that some of these pathogens are associated with more rapid pulmonary deterioration than others (example: mucoid Pseudomonas aeruginosa, MRSA, Burkholderia, etc.). We also know that many of these pathogens are transmitted by contact and/or droplet routes. With that in mind, infection control is an extremely important aspect of routine CF care.

The mucous of all CF patients should be considered infected with pathogens potentially harmful to other CF patients, even if prior sputum cultures are unremarkable. Healthcare workers should take appropriate precautions to prevent patient-to-patient transmission of these pathogens. As well, CF patients should be educated so they can avoid passing potentially harmful pathogens between each other, either directly or indirectly.

The Cystic Fibrosis Foundation published an extensive Infection Prevention and Control Guideline for Cystic Fibrosis in 2013.[9] This guideline was accepted and circulated to all CF clinics by Cystic Fibrosis Canada.

6.1 General recommendations

It is generally advised that education be provided, when appropriate, to family, friends, teachers, employers, and coworkers about why infection prevention and control guidelines are needed. Because infection prevention and control involves isolation of the CF patient, education should include the possible psychological impact of being isolated and strategies to limit the impact.

CF care teams should collaborate with their institutional infection prevention and control teams to implement recommendations from the latest CF guidelines and develop standardized protocols for cleaning and disinfecting rooms/items used for CF care and assessment.

All CF patients should be considered to have respiratory pathogens that are potentially transmissible, even if prior sputum cultures did not demonstrate any pathogens.

The following are **general recommendations** for both inpatient and outpatient care to reduce the risk of transmission of respiratory pathogens.

For more information on infection prevention and control for CF patients, see the CF Canada website: www.cysticfibrosis.ca/about-cf/living-with-cystic-fibrosis/infection-prevention-and-control

6.1.1 Healthcare personnel

- All healthcare personnel caring for people with CF should receive education regarding infection prevention and control for CF.
- All healthcare personnel should have up-to-date vaccinations against measles, mumps, rubella, varicella, pertussis, influenza, hepatitis B.
- All healthcare personnel should implement 'contact precautions' (gloves, gowns before entry and removal on exit) when caring for CF patients, regardless of respiratory tract cultures.
- Whenever possible, health care personnel should avoid cross-coverage for multiple patients with CF.
- Routine use of respiratory masks is **not** recommended **but** appropriate respiratory precautions should be taken as per CDC guidelines (e.g.: airborne precautions for suspected influenza, RSV, etc.).
- Proper hand hygiene should be performed before and after direct contact with all CF patients (either antimicrobial soap or alcohol-based hand sanitizer). Hand hygiene is also recommended for contact with equipment used near a CF patient during assessment.
- Alcohol-based hand sanitizer should be available in all patient rooms, Pulmonary Function Testing laboratories, patient care and testing areas, and all areas accessible to patients and families.
- Stethoscopes should be cleaned before and after use on each patient according to their institutions infection prevention and control policy. If a stethoscope remains in a patient's room and is dedicated to that patient, then cleaning is not required.

6.1.2 Ambulatory (Outpatient) setting

- All newly diagnosed patients and/or families should receive education regarding infection prevention and control.
- CF clinics should either stagger patient visits or place patients into individual exam rooms immediately upon arrival to the clinic. CF patients should not be placed into a common waiting room prior to assessment.
- CF patients should wear a surgical mask upon entering the facility and when outside their clinic room but still within the facility. Masks are not necessary for patient once inside their clinic exam room, or pulmonary function testing room, if applicable.
- Recreational items (such as toys, computers, and books) should not be shared among rooms or patients. If shared, items should be cleaned properly after use. Patients should bring their own recreational items to clinic.
- Portable spirometry equipment is recommended. If not available, Pulmonary Function Testing is ideally performed in a laboratory with either negative pressure or HEPA filtration. Alternatively, a 30-minute elapsed time between CF patients is also acceptable.
- Exam rooms should be cleaned and disinfected between patients by cleaning staff wearing appropriate personal protective equipment according to institutional infection prevention and control policies.

6.1.3 Hospital (Inpatient) setting

- CF patients should be placed into single-person rooms for the duration of their care (including a private bathroom, toilet, and shower). People with CF who live in the same household can share a common room.
- Rooms should provide adequate space for personal protective equipment (gowns, gloves, and masks) at the point of entry.
- CF patients should wear a surgical mask when outside their room in the healthcare facility. Masks do not need to be worn inside the patient room.
- CF patients should perform hand hygiene upon entering and leaving their room.
- CF patients should not visit activity rooms or other areas where they could be exposed to other patients (such as the patient lounge, play room, school room, computer kiosk, resource centre, etc.)
- CF patients should avoid contact with other CF patients on the wards. If this is not possible, a distance of at least 6 feet between patients is advised.
- All respiratory interventions (airway clearance, aerosol therapy, sputum collection, and spirometry) should be performed inside the patient's room.
- All medical equipment and devices should be cleaned and reprocessed according to the Canadian Standards Association and the BC Ministry of Health's 'Best Practice Guidelines for the Cleaning, Disinfection, and Sterilization of Critical and Semi-critical Medical Devices in BC Health Authorities' (2011).

Devices used for respiratory therapy (e.g. nebulizers), diagnostic evaluation (spirometers), or treatment (e.g. medication vials) can be reservoirs or vehicles of transmission.

- Every CF patient should have dedicated airway clearance devices (e.g. flutter, acapella, or PEP device) for the duration of their hospital stay. On discharge, either discard or clean and reprocess devices as per standards. Ideally, reusable nebulizer equipment should be cleaned, disinfected, rinsed, and dried away from the room sink after each use.

6.1.4 Community Settings

- For outdoor events, CF patients should maintain at least 6 feet distance between each other and avoid communal activities with each other.
- For indoor events, it is advised that only 1 CF patient attend to prevent the spread of pathogens. Suggest webcasts and teleconferencing as alternatives.
- Everyone with CF and anyone in close contact with them should have their immunizations updated regularly according to the recommended BCCDC Immunization Schedule for their age, unless medically contra-indicated.

6.1.5 Microbiology Considerations

- CF patients who are acid fast bacilli (AFB) smear positive for the first time should be placed in airborne precautions (negative pressure room) in both inpatient and outpatient settings until Mycobacterium tuberculosis infection has been excluded.
- CF patients infected with nontuberculous Mycobacterium (NTM) do not require airborne precautions.
- Ideally, all CF patients infected with the following should be placed on a separate unit away from other CF patients: Burkholderia cepacia complex, multi-drug resistant Achromobacter, multi-drug resistant or epidemic strains of Pseudomonas and Mycobacterium abscessus.
- Annual samples of CF isolates should be sent to the Canadian Burkholderia Cepacia Complex Research and Referral Repository (CBCCRRR) to screen for Burkholderia species.
- Healthcare personnel caring for CF patients do not require routine screening for MRSA.
- CF patients infected with MRSA should not be restricted from taking part in community-based activities (work, sports, school) as long as the CF patient performs appropriate hand and respiratory hygiene.

CBCCRRR is located at the University of British Columbia. This service is free of charge. Referral forms can be found here: cupic.bcchr.ca/research/cbccrrr.html

6.2 Conclusion

The above recommendations are simply a primer for infection control in CF care. The most recent, comprehensive recommendations from the 2013 CF Foundation Infection and Prevention Control Guideline are available for detailed consultation and advice.

Ultimately, adherence to strict infection control protocols is a difficult task. To overcome the challenges involved in promoting consistent implementation, it is critical to acknowledge the potential psychosocial and medical impact that these recommendations can have on CF patients, their families, and the healthcare team.

The full document can be reviewed here: www.jstor.org/stable/10.1086/676882

7.0 Cystic Fibrosis and Organ Transplantation in BC

For those with CF and the most advanced forms of organ dysfunction, transplantation can improve the quality and length of life. The two most commonly transplanted organs are the lungs and the liver. Kidney, heart, and pancreas transplants are much less frequent in those with CF. The focus here is mainly on double lung transplantation as it is by far the most common transplant procedure in those with CF. The second most common is liver transplantation. Combined liver and lung transplants have been carried out in those with severe disease in both organs. In a few situations, a pancreas transplant has been done with the liver or the lungs.

Deciding to have an organ transplant is a significant decision that requires serious consideration. Organ transplantation is a major surgical procedure which, in itself, includes a certain level of risk. Transplantation requires a life-long commitment to the maintenance of a rigid post-transplant regimen. While some CF medications may no longer be needed, others will be added to prevent rejection of the new organ and to deal with other post-transplant problems. In many ways, organ transplantation means trading one set of medical issues and complications for another. It is important that individuals and their families have a good understanding of the trade-offs involved in organ transplantation.

Fortunately, there is a lot of information available to help patients and their families who are considering organ transplantation.

- Cystic Fibrosis Canada has information on transplantation on their website (www.cysticfibrosis.ca). They have produced a useful decision aid for those wanting information about lung transplantation as well for those actively considering the procedure.
- BC Transplant coordinates all organ transplants for BC residents and has information available on their website (www.transplant.bc.ca).
- CF Clinics, especially those serving adult populations, have significant experience helping patients and their families with the transplantation process.

On the Cystic Fibrosis Canada site, select the tab 'About CF', then 'Living with Cystic Fibrosis'. The decision aid is available at decisionaid.ohri.ca/decaids.html.

7.1 Lung Transplantation

For those with the most advance forms of CF lung disease, lung transplantation can offer significant improvement in both the quality and duration of life. Both lungs are always transplanted in CF, to reduce the risk of infection spreading from the CF lung to the transplanted lung. It must be remembered, however, that lung transplantation is not a cure for CF. Even though the donated lungs do not contain the CF gene, they are prone to other complications such as rejection and infection.

Also, the lung transplant does not affect or improve the other organ systems affected by CF, such as the pancreas and sinuses. Life-time follow-up and treatment by both the Transplant Team and CF Team is needed.

7.1.1 BC Lung Transplant Program

The BC Lung Transplant Program is one of four in Canada and is based at Vancouver General Hospital (VGH). The number of lung transplants performed in BC has been increasing steadily (Figure 2). CF is now the third most common diagnosis for which lung transplantation is performed (Figure 3). The BC Lung Transplant Program takes part in the Canadian Blood Services Lung Transplant Group. This group has developed common criteria for recipient selection and transplant processes as well as common data collection. Over the past decade, survival post-transplant has improved significantly. Individuals who have undergone lung transplantation within the last 10 years have a 1 year survival of 90%, a 5 year survival of 60%, and a 10 year survival of 50% (Figure 4). Overall, survival post-lung transplant is the same for those transplanted in BC as it is for those transplanted in the rest of Canada (Figure 5).

Figure 2

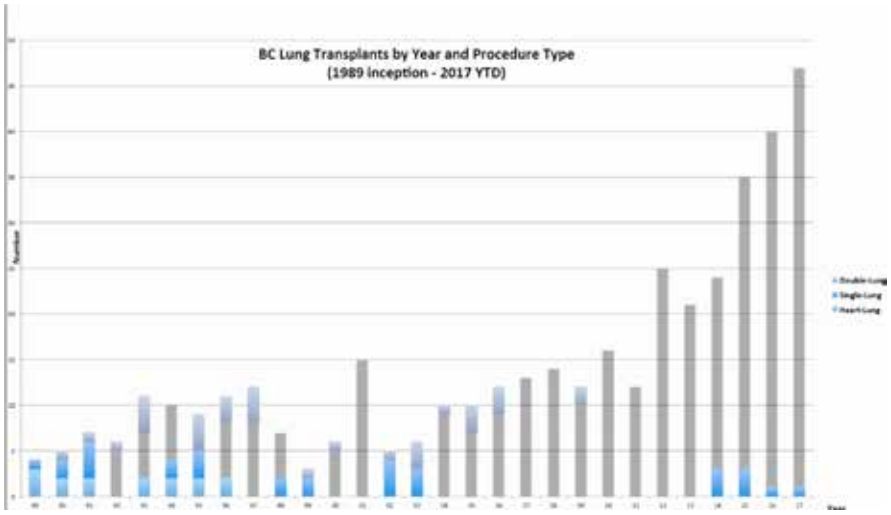
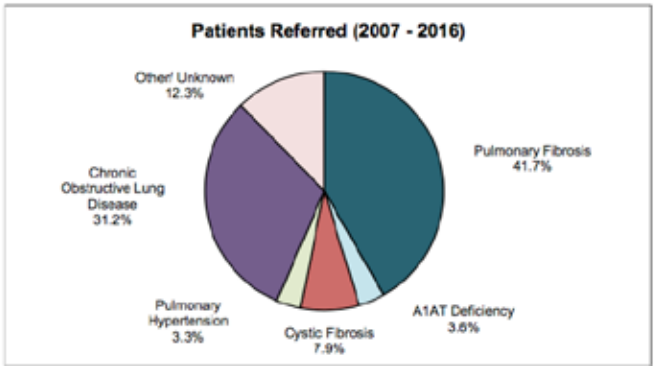


Figure 3



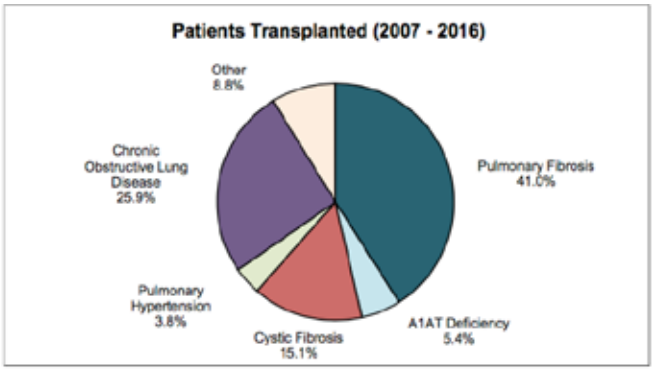


Figure 4

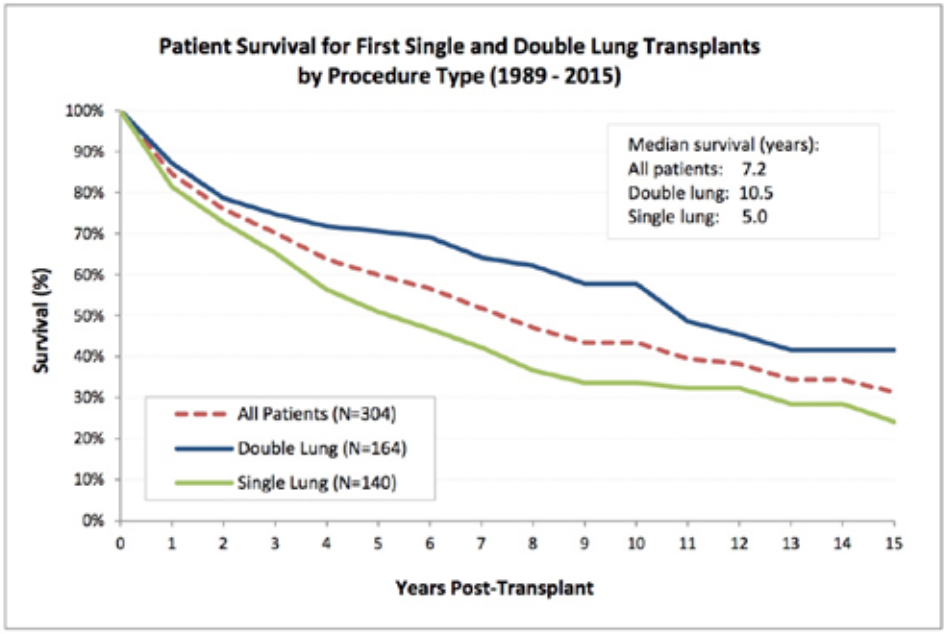
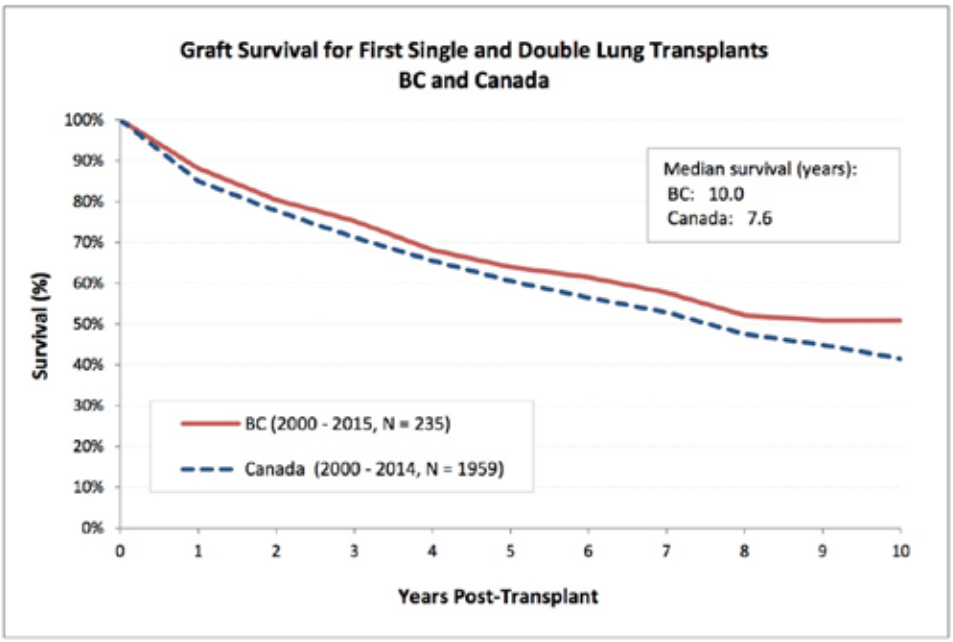


Figure 5



Figures 2 to 5 Courtesy of BC Transplant

7.1.2 Referral process

The work-up, referral process, and wait-time for transplantation can take 18 months so it is best to consider referral earlier rather than later. Waiting times for transplantation tend to be longer in smaller individuals (less lungs available) and those with type O blood group (more recipients waiting).

BC residents can be referred to one of the other Canadian lung transplant programs (usually Toronto or Edmonton) if they require specific expertise not available in BC. Reasons for referral could also include the recipients age (e.g. less than 12 years) or extremes of body size. Also, colonization of the lungs with highly resistant bacteria or other micro-organisms might require referral to another program to ensure the best possible patient outcome.

Out-of-Province referrals are co-ordinated by the BC Transplant Team with assistance from the CF Team. Medical expenses for out-of-province transplant are covered by the BC Ministry of Health. Travel and living expenses are not covered for adults, however, non-medical expenses for **pediatric patients** are covered by The David Foster Foundation, a non-profit, charitable organization (davidfosterfoundation.com). Acceptance by an out-of-province transplant program requires the patient to move and live close to the transplant center before the transplant. The patient's CF care would be arranged at the out-of-province CF clinic by their local CF Team. On return to BC, the patient's transplant care is provided by the Vancouver Lung Transplant Program. Their local CF Team resumes the patient's CF care.

In general, referral for lung transplant assessment should be considered when the likelihood of dying within the next 2-3 years is assessed to be greater than 50%. While this prediction is difficult to make with great accuracy, the CF Team considers these factors:

- FEV1 <30% predicted or a recent more rapid decline in lung function
- the need for supplemental oxygen
- more frequent pulmonary exacerbations or difficult to control bleeding from the lungs
- recurrent air leaks (pneumothorax) from the lungs
- the presence of drug resistant organisms in the lungs
- inability to maintain adequate nutritional status and conditioning

Once the decision has been made to proceed with the lung transplant assessment, the CF Physician refers the patient to the Pre-Lung Transplant Clinic at Vancouver Hospital. The CF Team works with the Transplant Team to co-ordinate the tests needed prior to transplant assessment.

7.1.3 Pre-transplant assessment

The assessment is done at VGH by the Transplant Team. It can involve several visits, some of these might be done using a telehealth connection in the local hospital. Most required tests can be done in the patient's community.

The assessment process includes careful evaluation for both medical and psychological suitability and may include review by those with expertise in respirology, nursing, psychology, transplant surgery, pharmacology, social work, nutrition, anesthesiology, and physiotherapy. All immunizations should be up to date. Once all of the evaluations have been completed, each case is discussed at a multidisciplinary conference to determine the appropriate option.

Once the decision is made to proceed with lung transplantation, the patient is 'activated'. Some patients could be deemed to be 'too healthy' for immediate activation. These individuals continue to receive their usual CF care and are reassessed periodically by the Transplant Team. If their health status changes in a way that indicates transplantation is now appropriate, they can be quickly activated onto the transplant list.

7.1.4 Transplantation

'Activated' patients usually return to their home communities to await the call. However, if the patient lives more than 3 hours by air from Vancouver, they might need to move to a less remote location. Patients are reassessed every 3-4 months by the Transplant Team.

Exercise is very important both pre- and post-transplant. Once activated for transplant, an ongoing exercise program is essential and an expectation for all patients awaiting transplant. Optimal physical conditioning before transplant can shorten the recovery time post-transplant. The CF Team helps organize a suitable fitness program. Post-transplant exercise rehabilitation is essential to achieve the maximum benefit from the new lungs.

The actual transplant procedure takes place at VGH. The average stay in the Intensive Care Unit after transplant is 2 to 4 days and the average stay in the hospital is 2 to 4 weeks. After discharge, the patient has to live near the VGH for approximately 3 months to allow for frequent visits to the post-transplant clinic.

Once fully recovered from the transplant procedure, individuals can return to their local community. They are followed periodically by the Transplant Clinic as well as by their local health care providers and CF Team.

7.1.5 Post-organ transplant complications

While there are many potential post-transplant complications, the most important are related to infections due to the drugs needed to suppress the immune system and prevent rejection of the transplanted organs. Rejection can be acute, usually in the first year post-transplant or chronic. Chronic rejection, also called bronchiolitis obliterans syndrome or chronic lung allograft dysfunction (CLAD), usually occurs over several years. There are good prevention options as well as treatments for all of these complications, making strict adherence to post-transplant care critical.

As part of the assessment process, the BC Transplant Team reviews in detail the post-transplant treatment regime as well as the surgical and other potential complications. This is augmented with post-transplant support from the CF Team.

7.2 Liver Transplantation

Like the lung, liver transplantation can offer significant benefits to those with severe CF related liver disease (CFLD). Fortunately, only about 5% of those with evidence of CFLD go on to cirrhosis and liver transplantation.

Choosing the optimal time for liver transplantation remains a difficult problem but the trend has been to consider the option before severe liver decompensation develops. Most people with CF who are referred for liver transplantation have either progressive liver failure or intractable variceal bleeding (bleeding from the esophagus or stomach). Survival post-liver transplantation is as good if not slightly better than after lung transplantation. Liver transplant in CF can result in weight gain and improvement in lung function post-transplant.

All liver transplant assessments are co-ordinated through the Liver Transplant Clinic at VGH. A standardized scoring system is used to help guide the timing of transplantation. The referral, assessment, and waiting list processes are similar to those described for lung transplant. Surgery is also done at VGH.

Liver transplant in the younger pediatric age group can be referred out of Province through a process similar to the out-of-province referrals for lung transplant.

Once the liver transplant has been completed and the patient has stabilized, they will return to their home community with follow-up from both the Liver Transplant Clinic and their CF Team.

Appendix

A. List of CFTR Variants Assessed

List of CFTR Variants Assessed with MiSeqDX Cystic Fibrosis 139-Variant Assay[10]

Legacy Nomenclature	HGVS nomenclature	
	cDNA	Protein
M1V	c.1A>G	p.Mel1Val
CFTRdele2,3	c.54-5940_273+10250del21kb	-
Q39X	c.115C>T	p.Gln39*
E60X	c.178G>T	p.Glu60*
P67L	c.200C>T	p.Pro67Leu
R75X	c.223C>T	p.Arg75*
G85E	c.254G>A	p.Gly85Glu
394delTT	c.262_263delTT	p.Leu88Ilefs*22
405+1G>A	c.273+1G>A	-
406-1G>A	c.274-1G>A	-
E92X	c.274G>T	p.Glu92*
E92K	c.274G>A	p.Glu92Lys
Q98X	c.292C>T	p.Gln98*
457TAT>G	c325_327delTATinsG	p.Tyr109Glyfs*4
D110H	c.328G>C	p.Asp110His
R117C	c.349C>T	p.Arg117Cys
R117H	c.350G>A	p.Arg117His
Y122X	c.366T>A	p.Tyr122*
574delA	c.422delA	p.Ile148Leufs*5
621+1G>T	c.489+1G>T	-
663delT	c.531delT	p.Ile177Metfs*12
G178R	c.532G>A	p.Gly178Arg
711+1G>T	c.579+1G>T	-
711+3A>G	c.579+3A>G	-
711+5G>A	c.579+5G>A	-
712-1G>T	c.580-1G>T	-
H199Y	c.595C>T	p.His199Tyr
P205S	c.613C>T	p.Pro205Ser
L206W	c.617T>G	p.Leu206Trp
Q220X	c.658C>T	p.Gln220*
852del22	c.720_741del	p.Gly241Glufs*13

Legacy Nomenclature	HGVS nomenclature	
	cDNA	Protein
1078delT	c.948delT	p.Phe316Leufs*12
G330X	c.988G>T	p.Gly330*
R334W	c.1000C>T	p.Arg334Trp
I336K	c.1007T>A	p.Ile336Lys
T338I	c.1013C>T	p.Thr338Ile
S341P	c.1021T>C	p.Ser341Pro
1154insTC	c.1022_1023insTC	p.Phe342Hisfs*28
R347H	c.1040G>A	p.Arg347His
R347P	c.1040G>C	p.Arg347Pro
R352Q	c.1055G>A	p.Arg352Gln
1213delT	c.1081delT	p.Trp361Glyfs*8
1248+1G>A	c.1116+1G>A	-
1259insA	c.1127_1128insA	p.Gln378Alafs*4
W401X	c.1202G>A	p.Trp401*
W401X	c.1203G>A	p.Trp401*
1341+1G>A	c.1209+1G>A	-
1461ins4	c.1329_1330insAGAT	p.Ile444Argfs*3
A455E	c.1364C>A	p.Ala455Glu
1525-1G>A	c.1393-1G>A	-
S466X	c.1397C>A	p.Ser466*
S466X	c.1397C>G	p.Ser466*
L467P	c.1400T>C	p.Leu467Pro
1548delG	c.1418delG	p.Gly473Glufs*54
S489X	c.1466C>A	p.Ser489*
S492F	c.1475C>T	p.Ser492Phe
Q493X	c.1477C>T	p.Gln493*
1507del	c.1519_1521delATC	p.Ile507del
F508del	c.1521_1523delCTT	p.Phe508del
1677delTA	c.1545_1546delTA	p.Tyr515*
V520F	c.1558G>T	p.Val520Phe
Q525X	c.1573C>T	p.Gln525*
1717-8G>A	c.1585-8G>A	-
1717-1G>A	c.1585-1G>A	-
G542X	c.1624G>T	p.Gly542*
S549R	c.1645A>C	p.Ser549Arg
S549N	c.1646G>A	p.Ser549Asn
S549R	c.1647T>G	p.Ser549Arg

Legacy Nomenclature	HGVS nomenclature	
	cDNA	Protein
G551D	c.1652G>A	p.Gly551Asp
Q552X	c.1654C>T	p.Gln552*
R553X	c.1657C>T	p.Arg553*
A559T	c.1675G>A	p.Ala559Thr
R560T	c.1679G>C	p.Arg560Thr
R560K	c.1679G>A	p.Arg560Lys
1181+1.6kbA>G	c.1679+1.6kbA>G	-
1812-1G>A	c.1680-1G>A	-
E585X	c.1753G>T	p.Glu585*
1898+1G>A	c.1766+1G>A	-
1898+3A>G	c.1766+3A>G	-
2143delT	c.2012delT	p.Leu671*
2183AA>G	c.2051_2052delAAinsG	p.Lys684Serfs*38
2184delA	c.2052delA	p.Lys684Asnfs*38
2184insA	c.2052_2053insA	p.Gln685Thrfs*4
R709X	c.2125C>T	p.Arg709*
K710X	c.2128A>T	p.Lys710*
2307insA	c.2175_2176insA	p.Glu736Argfs*4
L732X	c.2195T>G	p.Leu732*
2347delG	c.2215delG	p.Val739Tyrfs*16
R764X	c.2290C>T	p.Arg764*
2585delT	c.2453delT	p.Leu818Trpfs*3
E822X	c.2464G>T	p.Glu822
2622+1G>A	c.2490+1G>A	-
E831X	c.2491G>T	p.Glu831*
W846X	c.2537G>A	p.Trp846*
R851X	c.2551C>T	p.Arg851*
2711delT	c.2583delT	p.Phe861Leufs*3
2789+5G>A	c.2657+5G>A	-
Q890X	c.2668C>T	p.Gln890*
L927P	c.2780T>C	p.Leu927Pro
S945L	c.2834C>T	p.Ser945Leu
3007delG	c.2875delG	p.Ala959Hisfs*9
G970R	C2908G>C	p.Gly970Arg
3120G>A	c.2988G>A	-
3120+1G>A	c.2988+1G>A	-
3121-1G>A	c.2989-1G>A	-

Legacy Nomenclature	HGVS nomenclature	
	cDNA	Protein
3272-26A>G	c.3140-26A>G	-
L1065P	c.314T>C	p.Leu1065Pro
R1066C	c.3196C>T	p.Arg1066Cys
R1066H	c.3197G>A	p.Arg1066His
L1077P	c.3203T>C	p.Leu1077Pro
W1089X	c.3266G>A	p.Trp1089*
Y1092X	c.3276C>A	P.Tyr1092*
Y1092X	c.3276C>G	p.Tyr1092*
M1101K	c.3302T>A	p.Met1101Lys
E1104X	c.3310G>T	p.Glu1104*
R1158X	c.3472C>T	p.Arg1158*
R1162X	c.3484C>T	p.Arg1162*
3659delC	c.3528delC	p.Lys1177Serfs*15
S1196X	c.3587C>G	p.Ser1196*
W1204X	c.3611G>A	p.Trp1204*
W1204X	c.3612G>A	p.Trp1204*
3791delC	c.3659delC	p.Thr1220Lysfs*8
3849+10kbC>T	c.3717+12191C>T	-
G1244E	c.3731G>A	p.Gly1244Glu
3876delA	c.3744delA	p.Lys1250Argfs*9
S1251N	c.3752G>A	p.Ser1251Asn
3905insT	c.3773_3774insT	p.Leu1258Phefs*7
W1282X	c.3846G>A	p.Trp1282*
4005+1G>A	c.3873+1G>A	-
4016insT	c.3884_3885insT	p.Ser1297Phefs*5
N1303K	c.3909C>G	p.Asn1303Lys
Q1313X	c.3937C>T	p.Gln1313*
4209TGTT>AA	c.4077_4808delTGTTinsAA	-
CFTRdele22,23	c.3963-78_4242+577del	-
4382delA	c.4251delA	p.Glu1418Argfs*14
-	polyTG/polyT	-
I506V	c.1516A>G	p.Ile506Val
I507V	c.1519A>G	p.Ile507Val
F508C	c.1523T>G	p.Phe508Cys

Reference sequence accession number: NM_000492.3; HGVS nomenclature version 2.0.

B. Recommended Staffing for British Columbia Cystic Fibrosis Clinics

Cystic Fibrosis is a life-long disease process. When examining the management of CF, care planning is largely the same for both the pediatric and adult patients. This means that staffing needs for each clinic type will closely parallel each other. Outlined standards for treatment and full-time equivalent (FTE) will remain the same. Because patients live longer into adulthood, adult centres are responsible for most end of life care.

CF Physician

CF Clinic	Staffing FTEs										
Number of Patients	Medical Director	Physician	Clinic Co-ordinator	Nurse Clinician	Nurse Specialist	Dietitian	Physiother-apist	Social worker	Pharmacist	Respiratory Therapist	Psycholo-gist
20	0.1	0.3	0.5			0.2	0.5	0.25	0.15	0.2	0.2
20 - 40	0.2	0.6	1			0.4	1	0.5	0.3	0.4	0.4
40 - 60	0.3	0.9	1	0.5		0.6	1.5	0.75	0.45	0.6	0.6
60-80	0.4	1.2	1	1		0.8	2	1	0.6	0.8	0.8
80 - 100	0.5	1.5	1	1	1.5	1	2.5	1.25	0.75	1	1
100- 140	0.6	1.8	1	1	1	1.2	3	1.5	0.9	1.2	1.2
140 - 180	0.7	2.1	1	1.5	1	1.4	3.5	1.75	1.05	1.4	1.4
180 - 220	0.8	2.4	1	2	1	1.8	4	2	1	1.6	1.6
220 - 260	0.9	2.7	1	2.5	1	2.2	4.5	2.25	1	1.8	1.8

Notes:

- In cases where the CF Director and the CF physician are the same, FTE should be combined.
- Nurse Practitioner FTE would be born out of recommended nursing or physician FTE, depending on scope for particular clinic.
- In the absence of a Clinical Nurse Specialist, or if Clinic Coordinator role is not a RN, FTE from that column should be added to Nurse Clinician/Clinic Nurse.

C. How Recommended Staffing for BC Cystic Fibrosis Clinics was Calculated

Staffing levels were calculated through use of the *Health Human Resource Guidelines: Minimum Staffing Standards for CF Healthcare Teams* set by Cystic Fibrosis Canada in 2011 and use of *Standards for the Clinical Care of Children and Adults with Cystic Fibrosis in the UK (2011)*. Respective professionals from all BC CF Clinics were polled on the set standards from these two documents. Results were collated for BC standards.

FTE's for patients was set through BC clinic's responses, Cystic Fibrosis Canada minimum recommendations, and UK guidelines. Where conflicts existed, FTE's were extrapolated from the UK standards, as these are the most referenced standards in use. Respective Clinic professionals were then re-polled for responses. Recommended staffing levels were then agreed on by BC CF Clinic Directors.

FTE equivalents were set at 20 patient intervals for the first 100 patients, and then increased by 40 patient intervals thereafter. This reflects the significance of increased workload with smaller patient populations; these gains are lessened at higher patient concentrations. It is felt by the directors that patient populations less than 20 do not necessarily justify a multidisciplinary clinic.

FTE equivalents were developed to reflect time needed for professionals in clinic, outside of clinic, and for administrative duties. Annual leave coverage must also be accounted for.

Currently, efforts to determine a more detailed workload picture for CF clinics in British Columbia are being made. This may result in further modification of staffing full time equivalents.

Comparison of Recommended Staffing for CF Clinics:
BC CF Clinic Directors; CF Canada; and CF Trust UK Guidelines

CF Physician	FTEs						
Number of Patients	Recommended Staff		Cystic Fibrosis Canada		UK Guidelines		
	Medical Director	Physician	Medical Director	Physician	Pediatric	Adult	Fellow
20	0.1	0.3	0.18	0.02			
21 - 40	0.2	0.6					
41 - 60	0.3	0.9					
61 - 80	0.4	1.2	0.29 (21-75)	0.25 (21-75)	0.8 (75)	0.8 (75)	0.5 (75)
81 - 100	0.5	1.5					
101 - 140	0.6	1.8					
141 - 180	0.7	2.1	0.63 (76-150)	0.61 (76-150)	1.5 (150)	1.5 (150)	1.0 (150)

CF Physician	FTEs						
Number of Patients	Recommended Staff		Cystic Fibrosis Canada		UK Guidelines		
	Medical Director	Physician	Medical Director	Physician	Pediatric	Adult	Fellow
181 - 220	0.8	2.4	0.5 (150-249)	1.67 (150-249)			
221 - 260	0.9	2.7	1.0 (250+)	2.83 (250+)	2.5 (250)	2.5 (250)	1.0 (250)

Nursing	FTEs					
Number of Patients	Recommended Staffing			Cystic Fibrosis Canada	UK Guidelines	
	Clinic Coordinator	Nurse Clinician	Nurse Specialist		Pediatric	Adult
20	0.5			0.4 (20)		
21 - 40	1.0					
41 - 60	1.0	0.5				
61 - 80	1.0	1.0		0.78 (21-75)	2.0 (75)	2.0 (75)
81 - 100	1.0	1.0	1.5			
101 - 140	1.0	1.0	1.0			
141 - 181	1.0	1.5	1.0	1.53 (76-150)	3.0 (150)	3.0 (150)
181 - 220	1.0	2.0	1.0	2.5 (151-249)		
221 - 260	1.0	2.5	1.0	3.17 (250+)	4.0 (250)	5.0 (250)

Dietary	FTEs			
Number of Patients	Recommended Staffing	Cystic Fibrosis Canada	UK Guidelines	
	Dietitian		Pediatric	Adult
20	0.2	0.15 (20)		
21 - 40	0.4			
41 - 60	0.6			
61 - 80	0.8	0.28 (21-75)	0.5 (75)	0.5 (75)
81 - 100	1			
101 - 140	1.2	0.59 (76-150)		
141 - 181	1.4		(150) 1.0	1.0 (150)
181 - 220	1.8	1.0 (151-249)		
221 - 260	2.2	1.6 (250+)	1.5 (250)	2.0 (250)

Physiotherapy	FTEs			
Number of Patients	Recommended Staffing	Cystic Fibrosis Canada	UK Guidelines	
	Physiotherapist		Pediatric	Adult
20	0.5	0.15 (20)		
21 - 40	1.0			
41 - 60	1.5			
61 - 80	2.0	0.3 (21-75)	2.0 (75)	2.0 (75)
81 - 100	2.5			
101 - 140	3.0	0.59 (76-150)		
141 - 181	3.5			
181 - 220	4.0	1.15 (151-249)	3.0 (150)	3.0 (150)
221 - 260	4.5	1.83 (250+)	4.0 (250)	5.0 (250)

Social Work	FTEs			
Number of Patients	Recommended Staffing	Cystic Fibrosis Canada	UK Guidelines	
	Social worker		Pediatric	Adult
20	0.25	0.15 (20)		
21 - 40	0.5			
41 - 60	0.75			
61 - 80	1.0	0.3 (21-75)	0.5 (75)	0.5 (75)
81 - 100	1.25			
101 - 140	1.5			
141 - 181	1.75	0.53 (75-150)	1.0 (150)	1.0 (150)
181 - 220	2.0	1.5 (151-249)		
221 - 260	2.25	1.33 (250+)	1.0 (250)	2.0 (250)

Pharmacy	FTEs			
Number of Patients	Recommended Staffing	Cystic Fibrosis Canada	UK Guidelines	
	Pharmacist		Pediatric	Adult
20	0.15	0.12 (20)		
21 - 40	0.3			
41 - 60	0.45			
61 - 80	0.6	0.17 (21-75)	0.5 (75)	0.5 (75)
81 - 100	0.75			
101 - 140	0.9			
141 - 181	1.05	0.31 (76-150)	1.0 (150)	1.0 (150)
181 - 220	1.0	0.88 (151-249)		
221 - 260	1.0	0.73 (250+)	1.0 (250)	1.0 (250)

Respiratory Therapy	FTEs			
Number of Patients	Recommended Staffing	Cystic Fibrosis Canada	UK Guidelines	
	Respiratory Therapist		Pediatric	Adult
20	0.2	None specified		
21 - 40	0.4			
41 - 60	0.6			
61 - 80	0.8		0.3 (75)	0.5 (75)
81 - 100	1.0			
101 - 140	1.2			
141 - 181	1.4		0.5 (150)	1.0 (150)
181 - 220	1.6			
221 - 260	1.8		1.0 (250)	(2.0 (250)

Psychology	FTEs			
Number of Patients	Recommended Staffing	Cystic Fibrosis Canada	UK Guidelines	
	Psychologist		Pediatric	Adult
20	0.2	None Specified		
21 - 40	0.4			
41 - 60	0.6			
61 - 80	0.8		0.5 (75)	0.5 (75)
81 - 100	1.0			
101 - 140	1.2			
141 - 181	1.4		1.0 (150)	1.0 (150)
181 - 220	1.6			
221 - 260	1.8		1.5 (250)	2.0 (250)

D. SAMPLE Immunization Schedule for Cystic Fibrosis Patients

Child's name _____ Date of birth _____
(First Name) (Last Name) (yyyy/mm/dd)

Child's Personal Health Number _____

After giving immunizations:
Please fax a copy of this record to the Cystic Fibrosis Clinic 604-875-2349

Vaccine[A]	Doses required	Date of dose					Series completed Yes/No
		1st dose	2nd dose	3rd dose	4th dose	5th dose	
DTaP-HB-IPV-Hib *Infanrix hexa®*	3 doses	2 months	4 Months	6 months			
DTaP-IPV-Hib *Infanrix®-IPV/Hib Pediacel®*	1 dose				18 months		
DTaP-IPV *Quadracel® Infanrix®-IPV*	1 dose					4-6 years	
Pneumococcal conjugate 13 *Prevnar® 13*	4 doses[B]	2 months	4 months	6 months	12 months		
Meningococcal C conjugate *Neisvac-c®*	2 doses	2 months	12 months				
Rotavirus *Rotarix®*	2 doses	2 months	4 months				
MMR *MMR II® Priorix®*	2 doses	12 months	4-6 years[C]				
Varicella *Varilrix® Varivax® III*	2 doses	12 months	4-6 years[D]				
Pneumococcal Polysaccharide[E] *Pneumovax® 23*	1 dose at least 8 weeks after last dose of PCV13	> 2 years					

Note:
Annual influenza vaccine is recommended and provided free.
Hepatitis A vaccine is recommended and provided free to Aboriginal children.

A Abbreviations: D—Diphtheria, T—Tetanus, aP—Pertussis, HB—Hepatitis B, IPV—Polio, HIB—*Haemophilus influenzae* type B, MMR—measles, mumps and rubella

B Children with CF under one year should be immunized according to the high risk schedule (@ 2, 4, 6, and 12 months).

C Second dose of MMR and Varicella may be given as MMRV.

D Second dose of MMR and Varicella may be given as MMRV.

E Pneumococcal polysaccharide vaccine is not part of the routine childhood schedule but is recommended for CF patients.

E. SAMPLE of Common Ambulatory Cystic Fibrosis Medications:

Medications for Nutrition	Dosage Instructions
Pancreatic Enzymes ■ Give capsules by mouth immediately before eating meals TID, and before snacks BID-TID	500 - 2500 units lipase/kg/meal; Max 10,000units lipase/kg/day. For infants, open capsules and mix beads with 2 - 5 mL apple sauce
MVW Complete Formulation ■ Give by mouth, BID (for pancreatic insufficient pts.)	
Multivitamin (any brand) ■ Give by mouth, OD or BID (for pancreatic sufficient pts)	
Vitamin D ■ Give by mouth OD	Maximum: ■ 2000 iu/day for 0 - 12 mos; ■ 4000 iu/day for 1 - 10 yrs; ■ 10,000 iu/day for ≥10 yrs.
Calcium	
Iron	
Medications for Gastrointestinal Tract	**Dosage Instructions**
Ranitidine ■ Give by mouth, BID	4 - 10 mg/kg/day
Proton Pump Inhibitor (PPI) ■ Give by mouth either OD or BID	e.g. Omeprazole, Tecta
Domperidone ■ Give by mouth TID or QID (before meals and at bedtime)	1.2 - 2.4 mg/kg/day; Maximum 60 mg/day
Bethanacol ■ Give by mouth TID or QID (before meals and at bedtime)	0.1 - 0.2 mg/kg/day
Ursodiol ■ Give by mouth BID to TID	20 - 30 mg/kg/day
Polyethylene glycol (PEGG) 3350 Give OD or PRN	
Medications for Inhalation	**Dosage Instructions**
Salbutamol Nebulized Solution ■ Give by nebulizer pre-physiotherapy, BID to TID	2.5 - 5 mg/dose
Salbutamol MDI ■ Give by MDI with aerochamber pre-physiotherapy or PRN	100 mcg/puff or 200 mcg/puff
7% Hypertonic Saline 4 mL ■ Give by nebulizer BID to TID, pre-physiotherapy	Mix with Salbutamol Nebulized Solution or give after Salbutamol MDI

Medications for Inhalation	Dosage Instructions
Dornase Alfa ■ Give by nebulizer OD or BID, post-physiotherapy	2.5 mg/dose
Corticosteriod drug of choice ■ Give by nebulizer BID, post-physiotherapy	
Medications for Pseudomonas Infection/Management	**Dosage Instructions**
Ciprofloxacin ■ Give by mouth BID to TID	30 - 40 mg/kg/day 750 mg/dose for adults
Colistimethate ■ Give by nebulizer BID, post-physiotherapy	100 - 150 mg/dose
Tobramycin (TOBI®) ■ Give by nebulizer BID, post-physiotherapy	300 mg/dose
Tobramycin (TOBI Podhaler) ■ Give by podhaler BID, post-physiotherapy	112 mg (4 capsules)
Aztreonam lysine ■ Give by nebulizer TID, post-physiotherapy	75 mg/dose
Medications for Nasal Administration	**Dosage Instructions**
Mometasone nasal spray ■ Give spray in each nostril OD or BID, or PRN.	50 mcg/spray
Medications for Fungal Infection	Dosage Instructions
Voriconazole ■ Give by mouth BID	
Prednisone ■ Give by mouth OD or BID	0.5 - 2 mg/kg/day

Antibiotics	Dosage Instructions	
	Pediatric	Adult
Septra (Cotrimoxazole) TMP/SMX	12 mg TMP/kg/day up to maximum 320 mg TMP/dose, BID	2 DS (Double Strength) tabs, BID
Cephalexin	100 mg/kg/day up to maximum 1000 mg/dose, QID	1 gm, QID
Ciprofloxacin	30 - 40 mg/kg/day up to maximum 750 mg/dose, BID	750 mg, TID
Amoxiclav	80 - 100 mg amoxicillin/ kg/ day, BID or TID	
Cloxacillin	150 mg/kg/day up to 2000 mg/ dose	2 gm, QID
Doxycycline	*Used only in select circumstances	200 mg, OD
Levofloxacin	*Used only in select circumstances	750 mg, OD
Linezolid	*Used only in select circumstances	600 mg, BID
Minocycline	*Used only in select circumstances	100 mg, BID

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