



Trillium
Gift of Life
Network

Clinical Handbook for Lung Transplantation

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Disclaimer: The content in this Handbook has been developed through collaborative efforts between Trillium Gift of Life Network and experts from Ontario's lung transplant programs. It is based on available literature and expert opinions at the time of development. The Handbook is not intended to be an exhaustive analysis of all lung transplant literature and practices, and may not reflect all available research and consensus from all experts. Other relevant scientific findings may have been published since completion of the Handbook and it may be superseded by an updated publication on the same topic. While every reasonable effort has been made to ensure the accuracy and validity of the information provided, TGLN and the expert contributors assume no responsibility for any errors or omissions in the content.

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List of Abbreviations

BODE	Body-mass index, degree of airflow obstruction and dyspnea, and exercise capacity
CLAD	Chronic Lung Allograft Dysfunction
COPD	Chronic Obstructive Pulmonary Disease
DAD	Discharge Abstract Database
ECFAA	Excellent Care for All Act
ED	Emergency Department
HCRS	Home Care Reporting System
LHIN	Local Health Integration Network
LOS	Length of stay
MOHLTC	Ministry of Health and Long Term Care
NACRS	National Ambulatory Care Reporting System
OAGO	Office of the Auditor General of Ontario
TGLN	Trillium Gift of Life Network
TOTAL	Trillium Organ and Tissue Allocation System

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I. Purpose

The Clinical Handbook for Lung Transplantation includes a clinical pathway and service bundles for lung transplantation, all of which have been developed in response to the *2010 Auditor General's Report on Organ and Tissue Transplantation*, the *2009 Organ and Tissue Wait Times Expert Panel Report*, and as part of the Ministry of Health and Long-Term Care's commitment to quality healthcare and better outcomes.

It aims to identify opportunities to enhance integration of services across the patient care continuum; facilitate efforts to improve existing processes within Ontario's lung transplant centres by reducing unnecessary practice variations and optimizing resource utilization; and inform policy frameworks and implementation approaches to the care of lung transplant patients in Ontario.

The Clinical Handbook includes the following tools to guide the development of policies, procedures, and processes:

1. A clinical pathway for typical lung transplant patients from the time of referral to post-transplantation. The clinical pathway outlines the general process that Ontario patients follow when moving through the transplant system.
2. Services that correspond to each stage of the patient pathway.

To foster partnership and strengthen clinician engagement, the clinical pathway and service bundles were developed using opinions from clinical experts from both Ontario transplant centres, guided by national and international evidence-based guidelines. As a result, the Clinical Handbook is a compendium of evidence-based rationale and clinical consensus on guidelines for lung transplant patients.

This document has been prepared as a tool for hospitals and individual providers to support the development of clinical patient pathways for their organizations. The Handbook is not intended to replace the professional skill and judgement of healthcare providers, nor inhibit the development of new and innovative transplant solutions.

II. Improving Quality of Care

At the forefront of Canada's health-care system is a commitment to provide the highest standard of hospital and physician services. In Ontario, the Excellent Care for All Act (ECFAA) supports this standard by creating greater public accountability, increasing the focus on quality, bringing patient satisfaction to the forefront, and basing patient care decisions on the best scientific evidence available. These dimensions of quality are supported by the following six domains:

- Improve **effectiveness** and reduce variation in clinical outcomes.
- Improve **appropriateness** by reducing practice variations and variations in volumes.
- Improve **integration** across the continuum of care.
- Improve **efficiency** by reducing unwarranted variation in resource utilization.
- Improve or maintain **access** to appropriate health services.
- Improve **patient centeredness** of health services.

Specific recommendations for the transplantation system were outlined in the *2010 Auditor General's Report on Organ and Tissue Transplantation* and the *2009 Organ and Tissue Wait Times Expert Panel Report*, both of which highlighted the need for a more efficient and equitable allocation system, improved referral practices, and more effective oversight for organ transplantation. Since then, new liver, kidney, heart and lung allocation systems have been implemented, standardized practices for referral have been introduced, and performance indicators and evaluation metrics have been developed. Such initiatives are aimed at improving both access to transplantation services by reducing geographical differences in wait times and establishing tools for patients and practitioners to ease the transplant process.

Further improvements to quality can be achieved by maximizing system effectiveness. Given the significant economic costs of lung transplantation and subsequent re-hospitalizations, as well as the desire to further improve outcomes and quality of life, it is imperative that every effort is taken to maximise quality throughout the patient care continuum.

In its report, the Expert Panel specifically raised the concern that Ontario does not have standard best practice guidelines for the pre- and post-care of transplant patients, stating that such guidelines are important since they would identify the care that transplant centres and the local community should provide. The Panel recommended:

- Ontario's transplantation community compile and/or develop pre- and post-care best practice standards and guidelines by organ, and ensure that healthcare providers use these standards and guidelines to inform their care.
- Trillium Gift of Life Network and the transplantation community establish a system to monitor the use of best practice standards and guidelines for adult and paediatric organ transplantation, and the outcomes of these procedures [1].

These recommendations align with the Excellent Care for All Act (ECFAA) with its increased emphasis on continuous quality improvement supported by evidence informed best practices and standards of care.

The clinical pathway and corresponding services set out in this handbook and the steps taken to monitor their implementation and outcomes are intended to improve the appropriateness and efficiency of transplant care by reducing unnecessary practice variations, optimizing resource utilization, and enhancing integration across the patient care continuum.

Clinical Pathways and Practice Guidelines

Clinical pathways are tools used to manage quality in healthcare by standardizing processes. The objectives are to reduce unnecessary variations in practice, improve interdisciplinary cooperation, integrate care, and ultimately, improve clinical outcomes. They are especially useful in complex care systems, such as lung transplant, where care may be delivered by multiple providers at multiple sites over an extended period. Lung transplant referrals require a minimum set of tests and consultations to be completed. Patients may receive testing as outpatients at referring centres or in the hospital as inpatients depending on the severity of their condition. Transplant centres review referrals and may liaise with referring centres to complete additional tests as necessary before scheduling patients for a transplant assessment. During the transplant assessment process, patients are provided with transplant-specific education and transplant specialists determine whether patients are eligible to be wait listed. While on the wait list, patients receive ongoing assessments by the transplant centre, which require blood testing and laboratory work, often performed by community healthcare providers.

Once a patient is matched with a potential donor lung(s), if not already an inpatient, he/she is admitted and cared for by the transplant centre before, during, and immediately following their transplant surgery. Once transplanted, recipients receive ongoing care from a variety of providers including lung transplant specialists, healthcare professionals (e.g. nurse coordinators, physiotherapists), respirologists, family physicians, and other medical practitioners based on their needs. The involvement of multiple providers creates considerable opportunity for variations in practice and resource utilization as the patient moves through the pathway.

The success of practice guidelines and clinical pathways has been documented in a variety of areas. For example, in the treatment of community-acquired pneumonia across nineteen teaching and community hospitals in Canada, implementation of a clinical pathway reduced the use of institutional resources without causing adverse effects on the well-being of patients [2]. Other individual clinical pathways, for stroke management, inguinal hernia repair, laparoscopic surgery, pancreaticoduodenectomy, and the management of fractured femoral necks, have been shown to reduce length of stay and total costs of acute hospital admission while maintaining quality of care, improving patient outcomes, interdisciplinary co-operation and staff satisfaction [3].

A systematic review of published literature and analysis of twenty-seven studies involving 11,398 participants found that patients managed according to clinical pathways encountered a reduction in in-hospital complications. Furthermore, the review presented evidence of decreased lengths of stay and reductions in hospital costs when clinical pathways were implemented [3]. More generally, reviews of best practice clinical guideline dissemination and implementation strategies have shown that in the majority of

cases, improvements in care are observed [4]. In one study of 59 clinical guidelines, the authors concluded that “guidelines improve clinical practice and achieve health gains when introduced in the context of rigorous evaluations” [5].

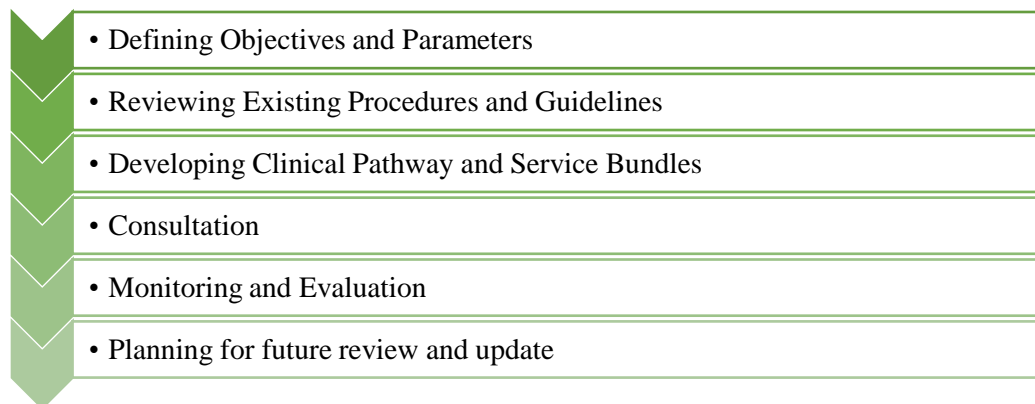
Ultimately, clinical guidelines can improve the experience of patients as they navigate through the transplant process by facilitating integrated care plans along the continuum. With the goal of optimizing care at all stages of the patient continuum, it is intended that this Clinical Handbook will facilitate efforts to improve existing processes in the care of lung transplant patients in Ontario.

III. Methods

In developing the Clinical Handbook, Trillium Gift of Life Network and the Provincial Heart and Lung Working Group took a quality-driven approach for translating evidence into action. The overarching aim was to produce a *quality-driven, evidence-based* clinical pathway and service bundles using an *efficient* and *transparent* methodology for *action-ready* recommendations with *multi-disciplinary applicability* [6]:

- **Quality-driven** means placing quality improvement at the forefront of clinical pathway and service bundle development, using current best evidence and multidisciplinary consensus to prioritize recommendations. Selection of key action statements is driven by opportunities to promote best practices, reduce unnecessary variations in care, and minimize inappropriate care or resource utilization.
- **Evidence-based** means supporting all decisions with the best available research evidence identified through systematic literature review and expert consensus.
- **Efficient** clinical pathway and service bundles make maximum use of available resources to create a timely product, moving from conception to publication within a reasonable timeframe.
- **Transparent methodology** is explicit, reproducible, and applied consistently so guideline users can link recommendations to the corresponding level of evidence, benefit-harm-cost relationship, and the roles of values and patient preferences in decision making.
- **Action-ready** recommendations tell providers what to do, to whom, under what specific circumstance, using unambiguous language that facilitates implementation and measurement.
- **Multi-disciplinary** validity and applicability means that all stakeholders (e.g., primary care, specialists, allied health, nursing, consumers) are part of the development and implementation processes.

To achieve these goals the following systematic process was used:



The following sections describe each of these steps in further detail.

Defining Objectives and Parameters

Objectives

In defining the objectives for developing a clinical pathway and service bundles, the Working Group was guided by the following key question:

How can Ontario's transplant system provide the best quality of care to achieve the best possible outcomes for lung transplant patients?

The Working Group agreed that the Clinical Handbook was an opportunity to develop and implement best practice guidelines throughout the transplant patient continuum, and determined that it must answer the following questions:

- **Who** should be defined as the patient population(s)?
- **What** practices and services should be employed in the treatment of transplant patients?
- **Where** can transplant patients expect to receive their treatment?
- **When** in their continuum of care can transplant patients expect to receive certain aspects of their care?

These guiding questions ensured that the patients' best interests remained at the center of the development of the clinical pathway and service bundles.

Parameters

From the outset, the Working Group identified the clinical population as being all patients in Ontario who are potentially eligible to receive a lung transplant. Because of differences in service needs, separate clinical bundles were created for adult and paediatric patients. This decision followed consultation with paediatric specialists and is due in part to anatomical, physiological, and psychological differences between children and adults, and because the common causes of lung disease in children are often different than those in adults.

To ensure a seamless transition between different stages of the transplant process, the Clinical Handbook encompasses a patient's full continuum of care, beginning from the time of referral to a transplant program and continuing through transplantation and long-term, post-transplant management. In most cases, once a patient is referred and placed on the provincial wait list, the patient remains in the transplant care continuum until end of life.

These parameters guided the development of the Clinical Handbook to ensure that full and proper consideration was given to all patient populations throughout their transplant continuum of care.

Reviewing Existing Procedures and Guidelines

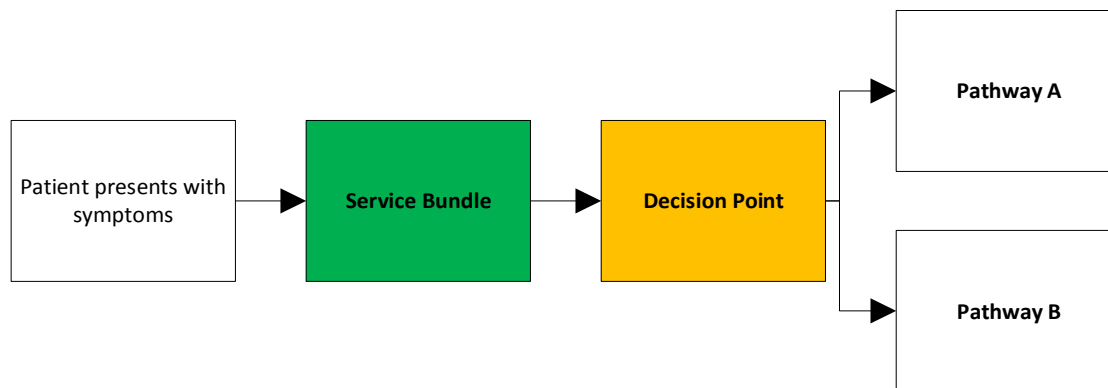
The Clinical Handbook contains a set of recommended practices reviewed and agreed upon by the Working Group and through wider consultation with the transplant community. In keeping with ECFAA's commitment to evidence-based care, considerable attention has been paid to ensure that the practices recommended here are supported by the best available evidence. A review was carried out of existing practices at the Toronto Lung Transplant Program and the Hospital for Sick Children, as well as published national and international clinical guidelines currently utilized in the management of lung transplant patients. A detailed review of the following was conducted:

- Standard Operating Procedures from each of Ontario's lung transplant programs
- Clinical guidelines from the following organizations:
 - The International Society for Heart & Lung Transplantation (ISHLT) Guidelines (2014 Update) - A consensus document for the selection of lung transplant candidates
 - CHEST (2012) - Monitoring of Nonsteroidal Immunosuppressive Drugs in Patients With Lung Disease and Lung Transplant Recipients: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines
 - American Society of Transplantation (2006) - Executive Summary on Paediatric Lung Transplantation
 - Practical Guidelines: Lung Transplantation in Patients with Cystic Fibrosis (2014)

The analysis was used to determine what services and procedures were carried out during a patient's care continuum at each of Ontario's lung transplant centers. A full list of services was then compiled and compared with the clinical guidelines to determine if they could be considered best practice.

Developing Clinical Pathway and Service Bundles

The clinical pathway model is structured around the parameters defined for the episode of care. The model describes the pathway of each patient case, from their initial presentation with symptoms warranting consideration of a transplant through the subsequent components of care that they receive. The pathway presents the critical decision points and phases of treatment within the continuum of care. Decision points provide patient-specific criteria for whether a particular case proceeds down one branch of the pathway or another. Once patients move down a particular branch, they then receive a set of recommended practices that are clustered together as a bundle. Service bundles represent the major phases of care that patients receive during the transplant process. Figure 1 provides an illustrative example of a service bundle and assessment point:



Through the development of the clinical pathway, the Working Group identified five service bundles corresponding to the key stages in the patient care continuum:

1. **Pre-Transplant before Listing: Referral and Transplant Assessment** - the period before placement on the transplant wait list. It includes the referral package and services required during transplant eligibility assessment.
2. **Pre-Transplant after Listing: Wait List Period** - the period after placement on the wait list, but before the transplant operation.
3. **Preoperative Assessment and Transplant Surgery** - the period from when an organ is matched to the patient, including the preoperative assessment and the surgical procedure.
4. **Post-Transplant: During Hospital Admission** - the period following the transplant operation while the patient is in hospital before discharge.
5. **Post-Transplant: After Discharge** - the period following hospital discharge.

Services for each stage were then categorized into the following two groups:

- **Bundled services:**

These are services that are an essential part of the patient pathway and have a standard expected duration and frequency. For these services, a minimum standard frequency for the typical transplant patient at each phase of the care continuum was assigned. For example, electrocardiogram (ECG) is a bundled service that should take place one time before listing and annually after listing during the wait list period. It is important to note that the set frequencies do not limit every patient's specific service needs. Although the bundles may state that patients should have an ECG annually while on the wait list, some patients may require this more often.

- **Unbundled Services:**

These are services that can potentially be provided to transplant patients but cannot be predicted and/or assigned a standard frequency for a given patient population. Included in this group are services whose frequency varies considerably across centers or services that are required for a patient based on the physician's overall assessment of their health and needs. These services should be provided at the physician's discretion.

Using the expertise of Ontario clinicians, published guidelines, and available data, TGLN provided each transplant program with a draft of the developed service bundles. TGLN solicited feedback from each of the lung transplant centers in Ontario and ensured they had an opportunity to respond to the content in the Clinical Handbook. The centres were asked the following key questions:

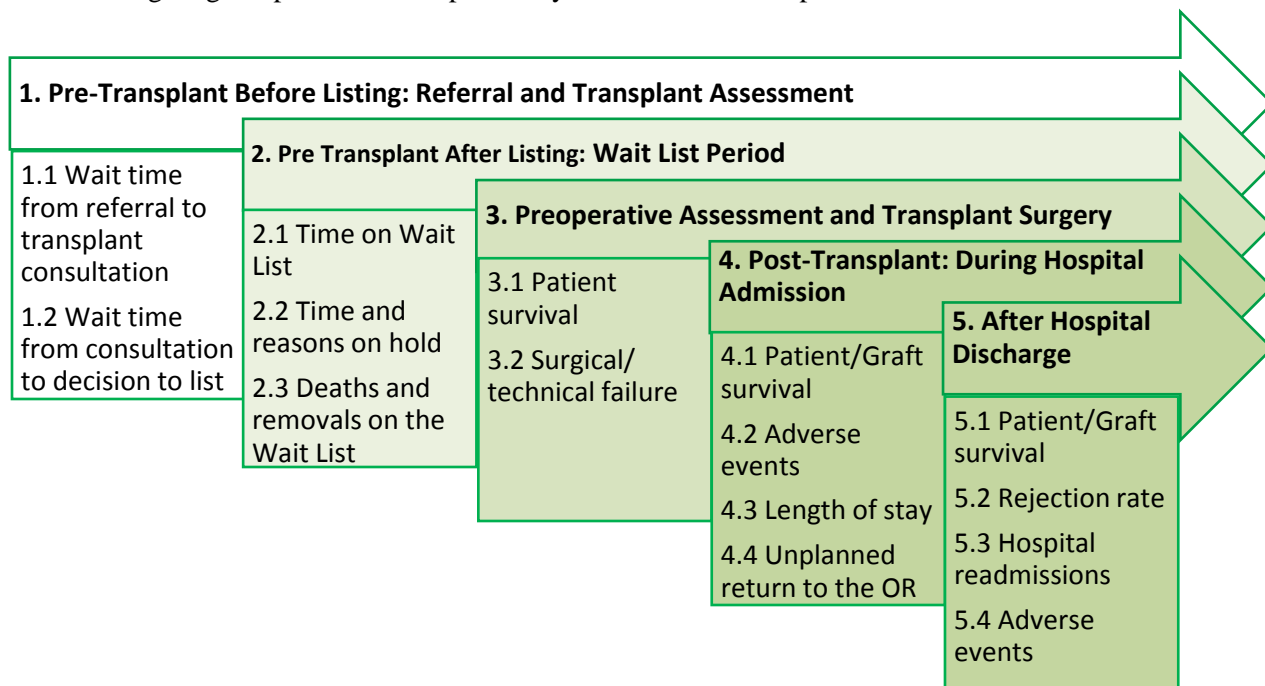
- Are there any services identified that should not be included in the service bundles?
- Are there any services that were not identified in the service bundles but should be included?
- How are the services outlined in the service bundles similar or dissimilar to current practice at your center?
- What resources would be required to implement these practices?
- Are there any barriers to implementing these practices at your centers? Are there any enablers to implementing these practices at your centres?

To ensure transparency in the consultation process, all feedback was collated, with a summary provided to each of the transplant centres detailing the action taken on proposed changes to the service bundles. Centres were then given an opportunity for final review of the revised bundles and asked to submit any final comments.

Monitoring and Evaluation

Efforts to regularly monitor and evaluate the lung transplantation system in Ontario are taken to improve the transplant process and identify opportunities for further improvement. With the expertise of the Provincial Working Groups, TGLN has identified key performance indicators for each stage of the patient care continuum that will help clinicians and administrators monitor quality of care and identify associated opportunities for improvement within their centres.

The following diagram provides a sample of key indicators for each phase of the care continuum.



Indicators during the pre-transplant phases of the care continuum focus on timely transplant assessment, consultation, and wait list management to promote patient safety and timely access to transplant. For the surgical and post-transplant phases, the focus is on patient outcomes, such as patient death, graft failure, length of stay and hospital readmissions and adverse events. Although these are baseline quality indicators that will be collected for all transplant patients, TGLN has worked with the Heart and Lung Working Group to develop definitions that would be most relevant for heart and lung transplant patients.

As part of TGLN’s quality improvement framework, performance indicators will be reported and distributed to transplant programs. Transplant programs may use the reports to evaluate their own processes at each stage of the care continuum and enable centres to track, audit, and evaluate the implementation of the clinical pathway and best practice services within their centres. Through such monitoring, variances can be identified, progress monitored, and practices refined over time to improve patient outcomes.

TGLN, in collaboration with the Heart and Lung Working Group will utilize the performance indicators to monitor and evaluate the transplant system as a whole. The Group may review the current state of the system and make recommendations to support practice changes where notable variations have been identified. Indicators will be reviewed regularly to ensure they remain relevant and align with quality objectives to promote ongoing improvement at both hospital and system levels.

Plan for Future Review and Update

The clinical pathway and service bundles will be revised when appropriate to ensure developments in lung transplant best practice are reflected. Upon the release of new or updated best practice guidelines, new evidence, or policy changes TGLN will conduct a review of the Clinical Handbook. If no guidelines are published, the Clinical Handbook will be reviewed every 2 years by the Provincial Heart and Lung Working Group. Comments received will be incorporated and reviewed by the Working Group as necessary.

IV. Overview of Lung Transplantation

In 2017, 295 lung transplants were performed and 1, 725 Canadians (excluding Quebec) were living with lung transplants [7]. Lung transplantation remains one of the final options for improving the quality of life for patients suffering from advanced pulmonary diseases. A lung transplant replaces a person’s deteriorating lung(s) with a donor’s lung(s) [8]. Patients who are diagnosed with advanced lung disease according to disease-specific criteria (ref ISHLT guidelines) may be eligible to be placed on the lung transplant waiting list if they are expected to derive survival and/or quality of life benefit from transplantation.

Globally speaking, the leading indication for lung transplantation is COPD, which accounted for 36.5% of the total adult lung transplantations in the world between the years 1995 and 2015 [9]. Idiopathic pulmonary fibrosis was the leading indication for lung transplant cases between 2008 and 2017; COPD and emphysema indicated 24% of lung transplants during this period [7].

Lung transplantation is a treatment option that has provided significant survival and quality of life benefits for patients who suffer greatly from irreversibly diseased lungs [10, 11, 12, 13]. **Table 1** shows favourable survival rates of patients who have undergone lung transplantation in Canada [14]. Infection and chronic allograft dysfunction (CLAD) are the main causes of death in lung transplant recipients after their transplant [15, 16]. Prospects to optimize lung transplantation and increase long-term survival continue to improve as technology and research efforts by programs such as the Toronto Lung Group develop innovative methods like ex-vivo lung perfusion to optimize lung transplantation activities and prevent adverse complications [17, 18].

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
3 Months	91.7	92.8	97.1	90.6	93.0	96.0	93.5	95.0	94.4	95.6
1 Year	85.0	86.8	92.0	84.6	86.0	89.9	85.8	88.9	87.8	
3 Years	66.5	70.5	81.1	73.2	75.5	79.8	76.0			
5 Years	56.4	61.2	68.7	64.3	65.5					

Source: Canadian Organ Replacement Register, 2017, Canadian Institute for Health Information

V. Lung Transplantation in Ontario

Data and Volumes

Between 2010 and 2018, over 1, 100 lung transplantations have been performed in Ontario. There are two centres at which lung transplant procedures are performed. Adult transplants are performed at Toronto General Hospital and paediatric transplants are performed at The Hospital for Sick Children. **Table 2** shows both the number of lung transplants that have been completed in Ontario from 2010 to 2018 as well as the number of patients on the wait list at the end of each calendar year.

Table 2: Lung-only transplantation volumes in Ontario, 2010-2018									
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Number of Transplants	83	102	104	131	112	127	145	166	195
Number Wait Listed at end of Year (Snapshot)	57	67	85	86	87	74	64	68	53

Source: TGLN, 2019

Table 3 shows the average number of days from being wait listed to lung transplantation from 2010 to 2018. Wait time has ranged between 110 to 216 days. Current and future initiatives will be aimed at further reducing wait times.

Table 3: Average Wait Time to Transplant 2010-2018 (days)								
2010	2011	2012	2013	2014	2015	2016	2017	2018
171	193	165	216	198	204	160	114	110

Source: TGLN, 2019

Trillium Gift of Life Network

Trillium Gift of Life Network (TGLN) is an agency of the Ontario Ministry of Health and Long-Term Care established in 2002 with responsibility for co-ordinating the donation of organs and tissue in Ontario. Its mandate was extended to include transplantation in 2011/12 following recommendations from the *2010 Auditor General's Report on Organ and Tissue Transplantation* and the *2009 Organ and Tissue Wait Times Expert Panel Report* for an integrated donor and transplant system.

TGLN's transplant strategy aims to support the development of a sustainable end-to-end transplant system and to continually strive to improve the dimensions of quality, safety, effectiveness, access, patient centered care – all to enable better patient outcomes. This includes developing a provincial transplant system that provides equitable access through standardized processes and planning to enable better patient outcomes, and harmonizing the patient journey across the transplant continuum from pre-transplant through to post-transplant care.

Strategies to further enhance the provincial lung transplant system are facilitated by TGLN through the Provincial Heart and Lung Working Group, which includes medical and administrative membership from each of Ontario's lung transplant programs. The Working Group's mandate is to consider all aspects related to the transplant patient's journey and recommend evidence-based policies and practices to ensure equitable access to quality patient care.

TGLN and the Provincial Heart and Lung Working Group have implemented the following key initiatives aimed at improving patient access and equity, and the quality of care along the patient continuum:

- **Provincial Lung Allocation Algorithm**

As there are not enough donor lungs to meet the demand, every effort is made to ensure that allocation is as fair and equitable as possible. The Working Group regularly reviews and updates the lung allocation algorithm to ensure that it gives fair consideration of candidates' circumstances and medical needs, as well medical utility, by trying to increase the length of time patients and organs survive.

- **Referral and Listing Criteria**

In its report, the Auditor General recommended that TGLN, in conjunction with transplant hospitals and physicians, should “determine the best way to communicate referral criteria to non-transplant physicians, so that individuals who would benefit from a transplant (including from a quality-of-life perspective) are added to the wait list.”

TGLN has since taken measures to improve the referral process so that all patients who meet the criteria can be referred for transplant specialist consultation and assessment. These measures include:

- Standardized referral and listing criteria to increase transparency and help support equitable access to transplant.

- **Performance Measurement and Monitoring**

In May 2013, TGLN finalized a set of performance indicators to be developed as part of its quality framework for system monitoring and improvement. This includes thirteen key metrics from the Auditor General recommendations such as patient wait time, organ yield, deaths and removal on the wait list, patient and graft survival, and organ disposition.

The development of the Clinical Handbook is part of the ongoing provincial initiative to facilitate Ontario's goals of consistently delivering high quality lung transplant care across the province.

Transplantation Process

As lung transplantation is the preferred form of therapy for patients who suffer from advanced pulmonary diseases and may also have no alternative medical therapy options, it is important for patients to be referred to the Ontario lung transplant programs (i.e. Toronto General Hospital and The Hospital for Sick Children) in a timely manner. To support referrals, TGLN has developed *Ontario's Referral and Listing Criteria for Adult Lung Transplantation* (available on the TGLN website

<https://www.giftoflife.on.ca/en/professionals.htm>). The criteria lists conditions that constitute absolute contraindications to lung transplantation and was developed as a tool for lung transplant programs.

In order to submit a referral, hospitals are required to complete all the tests and assessments outlined in the Toronto Adult Lung and Heart- Lung Transplantation Referral Form (available on the UHN website: https://www.uhn.ca/Transplant/Health_Professionals/Referrals/Pages/dr_referral_lung_transplant_clinic.aspx). The referring physicians are responsible for liaising with transplant programs and referring all appropriate patients.

Pre-Transplant Before Listing: Referral and Initial Assessment

This phase refers to the period before placement on the lung transplant wait list. It includes the referral package and services required during the transplant eligibility assessment.

Lung transplantation should be considered for patients with advanced and irreversible pulmonary disease that is either not amenable to or progresses despite medical and surgical therapy. Guidelines for medical practitioners to utilize when referring a patient to a transplant program for assessment are outlined in the *Ontario's Referral and Listing Criteria for Adult Lung Transplantation*. The criteria identifies the requirements which have to be met for evaluation to be considered, and lists conditions that constitute absolute contraindications to lung transplantation.

The Adult Lung Transplant Referral Form includes the patient information, medical history, and lab and diagnostic testing results required for the referral package. Once a referral is received, the referral package is reviewed to determine whether candidates are eligible for a transplant consultation.

After administrative processing, candidates will undergo further testing and consultation to evaluate their eligibility for transplant. The evaluation is aimed at assessing the degree of advanced lung disease and management to date, options for bridging to transplantation (e.g. Extracorporeal Life Support), chances of recovery from surgery, maximizing short- and long-term survival, and assessing the potential impact of transplantation on quality of life. Evaluation of the suitability of lung transplant candidates includes a broad range of medical, surgical, immunologic, and psychosocial assessments.

To determine candidacy, patients may be subjected to various cardiopulmonary assessments. Examples include, but are not restricted to, oximetry, arterial blood gases, six-minute walk, chest CT, X-ray, pulmonary function tests (PFTs), and lung perfusion scans. ECGs, cardiac stress tests and in some patients, coronary angiography and right heart catheterization are also necessary to assess cardiac function and disease. ABO and anti-HLA antibody testing also take place to match organs and prevent organ rejection should the patient eventually receive an organ [19]. To ensure the patient does not have any active infections or pre-existing diseases that could affect organ matching, serology of the hepatitis B virus (HBV), the hepatitis C virus (HCV), the human immunodeficiency virus (HIV), and other antibodies are taken.

Patient evaluation should also investigate other risk factors and contraindications, knowledge of which help with determining transplant eligibility and optimizing outcomes. Age, thoracic size, and existing comorbidities are some of the factors that must be considered when determining transplant eligibility in order to “reduce morbidity and mortality in the post-transplant period” [20, 21, 22]. For example, an older recipient age is associated with certain increased risks after transplantation. In adults, comorbidities like concomitant coronary artery disease must be considered since coronary re-vascularization may be required [22].

Given the importance of adherence to therapy in transplant outcomes, all patients should have a pre-transplant psychosocial evaluation to assess for cognitive impairment, mental illness, risk of non-adherence to therapy, drug or alcohol abuse, and social and emotional supports [23]. Patients should also receive transplant information in order to make better informed decision about whether or not to proceed with transplant. Education should include the risks of the operation, side effects, immunosuppression, post-transplant morbidities, follow up, short and long term outcomes, and mortality estimates.

A full list of consultations, diagnostics and lab tests for patients undergoing assessment is outlined in the service bundle named “Pre-transplant Before Listing: Referral and Initial Assessment.” The referral and transplant assessment process is carried out at both referring centres and transplant centres either as an outpatient or inpatient, and may take several months to complete.

Pre-Transplant After Listing: Wait List Period

This phase refers to the time period after placement on the wait list, but before the transplant surgery.

Once the transplant team has agreed to pursue transplantation, patients are placed on the Ontario Lung Transplant Wait List. Donor organs are allocated on principles of equity and fairness, taking into consideration blood type, donor size, medical urgency, organ suitability, and wait time.

As the waiting time for a lung transplant can vary from a few days to several years, patients will continue to be monitored by the transplant program to ensure their ongoing eligibility for transplant. A full list of consultations, diagnostics and lab tests are outlined in the service bundle named “Pre-Transplant After Listing: Wait List Period.”

If a patient develops a new medical issue or is temporarily unable to receive a transplant while on the wait list, they will be placed on hold. For example, if a patient develops an infection that is a contraindication to transplant, they will be placed on hold until it has been resolved. Candidates with an “on hold” status are not eligible for organ allocation, but will continue to accrue wait time.

Preoperative Assessment and Transplant Surgery

This phase refers to the time period from the acceptance of the donor lung to the preoperative assessment and the surgical procedure.

TGLN notifies the candidate’s transplant program of potential deceased organ donor matches, and the transplant program contacts the patient once an organ has been accepted for a specific patient based on the criteria outlined above. Patients not in the hospital will be asked about the current state of their health and if no new medical problems that are contraindications have developed, they will be admitted to the hospital for the transplant. All patients will receive a final assessment for surgical suitability before undergoing transplant surgery. The final assessment for transplant surgery can include consultations with anaesthesia, the transplant respirologist, and the transplant surgeon. As this assessment needs to be thorough, lab and diagnostic tests are conducted in addition to these consultations. It is also important to note that sometimes, the transplant may be cancelled even after the patient is already in the hospital and being worked up for the transplant procedure due to the donor organ being deemed unsuitable after the full assessment of donor organs. At this stage, the patient will also be informed if the donors have any specific diseases or risk behaviours that will require specific additional post-transplant tests for monitoring.

A full list of consultations, diagnostics and lab tests are outlined in the service bundle named “Preoperative Assessment and Transplant Surgery.” A multidisciplinary clinical team completes the patient assessment,

prepares the patient for transplant, and performs the transplant surgery. The timing of a lung transplant surgery varies depending on the complexity of the procedure.

Post-Transplant: During Hospital Admission

This phase refers to the time period following the transplant surgery until the day of hospital discharge.

Transplant programs are responsible for patient management during the post-transplant, hospital admission phase. During this phase, clinical teams closely monitor patients to ensure the necessary testing and interventions are completed. They are closely monitored in the ICU where they will remain until stabilized before being transferred to the designated ward. A full list is outlined in the service bundle named “Post-transplant: During Hospital Admission.”

Briefly, patients often begin a triple-drug immunosuppression regimen consisting of calcineurin inhibitors, antiproliferative agents and corticosteroids, which are usually based on the transplant recipient’s immunological risk [24]. Agents are used in combination to achieve sufficient immunosuppression, while minimizing the toxicity associated with individual agents.

Most patients can be transferred to the designated ward within 2-5 days (this period may be longer for paediatric patients) once hemodynamically stable and once they no longer require critical care management and surveillance. Hospitalization extends when adverse events and complications occur [25]. If the lung transplant team, after assessing daily vitals and other medical results, deems the patient well enough, the patient will be discharged with a medical and physiotherapy plan [25]. Patients remain in hospital until they no longer require in hospital care and/or monitoring. Discharge to an inpatient rehabilitation program may be required in some cases.

Post-Transplant: After Discharge

Following discharge from hospital, the transplant team and appropriate healthcare providers monitor patients through outpatient clinic visits, ensure the necessary testing is completed, interpret lab and diagnostic results, and collaborate with other members of the multidisciplinary team as required. The transplant team also monitors and adjusts immunosuppression therapy to prevent organ rejection, and screens for rejection with pulmonary function testing and surveillance bronchoscopy with transbronchial biopsies.

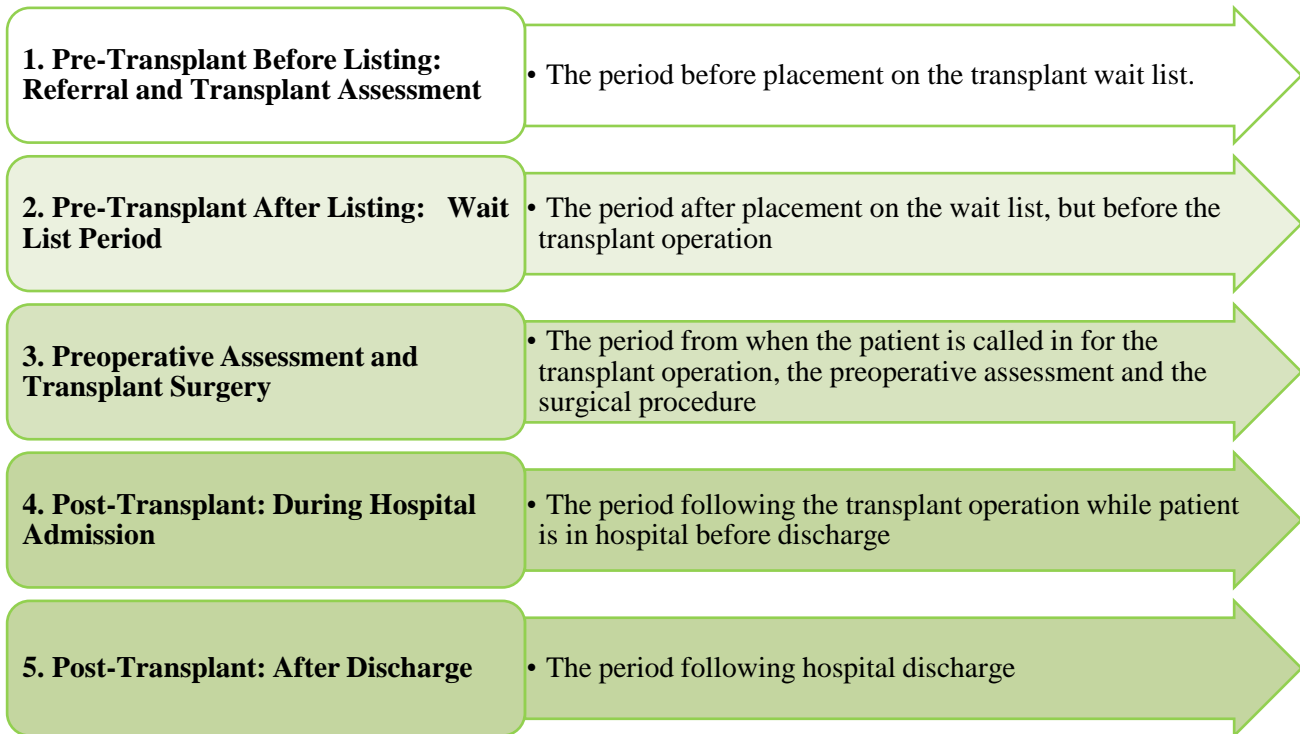
The twelve months after lung transplantation requires close monitoring as this is the period of highest risk for acute rejection, opportunistic infections, and adverse medication effects. Lifelong follow-up is required as patients are always at increased risk of these complications. Due to immunosuppression after the lung transplant, recipients are more prone to infection. Recipients also require monitoring through surveillance bronchoscopy with bronchoalveolar lavage and blood viral load measurements.

Chronic medical complications including cytopenia, hypertension, diabetes, renal dysfunction, osteoporosis, hyperlipidemia and gastrointestinal disorders are common after lung transplantation. Keeping these complications in mind, regular lab work is indicated. Likewise, imaging must regularly include scans like bone mineral density, gastric emptying, standard chest x-ray, and chest CT.

The full list of tests and diagnostics for this phase of care is outlined in the service bundle named “Post-Transplant: After Discharge.”

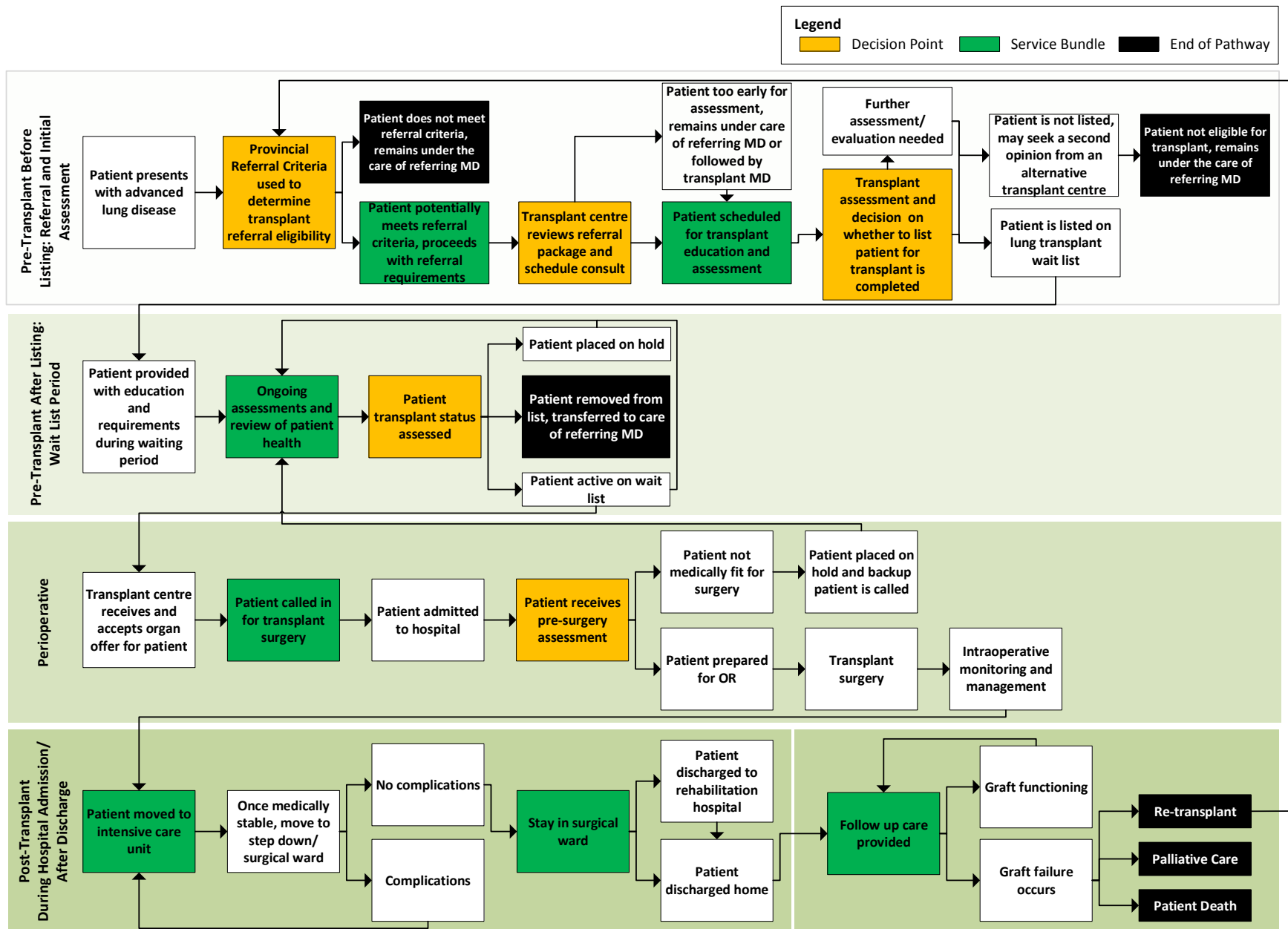
VI. Clinical Pathway for Lung Transplantation

The clinical pathway outlines the process that the typical Ontario patient can expect when moving through the transplant system. It is categorized into the following five key stages of the patient care continuum:



The pathway is intended to be a general guide to the transplant process and identify what patients can expect to receive during the specific time periods. It presents decision points and phases of treatment (service bundles) within an episode of care. Because the decision points determine whether or not a patient moves to the next stage of the transplant process, **Appendix A** outlines the criteria for patient referral and listing. The list of services for each service bundle are detailed in next section (**section VII**).

The clinical pathway and service bundles should be used in tandem to guide the care of lung transplant patients in Ontario.



VII. Service Bundles

The Service Bundles outline the full scope of services and the frequencies with which they may be provided to the typical transplant patient at each stage of their transplant care continuum. The timing of when these services should be administered during the care continuum are indicated in the Clinical Pathway. Although all services will be provided as part of the transplant process, not all will be carried out at the transplant centre.

Because of differences in service needs for adult and paediatric patients, separate service bundles have been created for each group.

Unbundled services, which refer to services that cannot be predicted and/or do not have a standard frequency for a given patient population are not listed.

The Clinical Pathway and Service Bundles do not to replace the professional skill and judgment of healthcare providers, but rather ensure minimum standards of care are met for all patients regardless of where care is being provided. They cannot be used to apply to all patients in all circumstances and cannot be used as a legal resource.

The following bundles follow such legend:

	Adults <u>and</u> Paediatrics
	Adults Only
	Paediatrics Only
	Cystic Fibrosis Only
[Text]	Cystic Fibrosis Paediatrics

Lung Transplant Bundle

Pre-Transplant Before Listing: Referral and Transplant Assessment

Clinical Care: Transplant programs are responsible for patient management and determining whether the patient is medically suitable to receive a transplant. Tests included in the referral package should be completed by the referring centre. Once the referral is received, transplant programs work to complete the required consultations, diagnostics, and lab testing to enable the multidisciplinary clinical team to assess the patient for transplant eligibility.

The assessment schedule is dependent upon the patient's condition and will be carried out as either an inpatient or outpatient. Patients who qualify for listing are registered in the TGLN registry. Patient management during this phase is supported by the following personnel:

- RN, Nurse Practitioner, Transplant Respirologist, and other specialists as needed
- Allied health care (social work, physiotherapy, occupational therapy, pharmacy, and nutrition)
- Administrative support

In addition to the recommendations below, all transplant hospitals are expected to have their own protocols on how to treat complications common to all lung disease patients. Each program has expertise in patient management and the flexibility to consult with multidisciplinary teams to inform complex care practices beyond the scope of existing recommendations.

With Referral Package	
CT Chest	within 1 year (not required for adult pulmonary hypertension patients)
Chest X-Ray	within 1 year
Cardiac Stress Test (≥ 40 years)	within 1 year
ECHO	within 1 year
Complete PFT (>6 years)	within 3 months

Immunologic Evaluation	
ABO	one time
PRA	one time, then as needed

Ultrasound	
Abdominal Ultrasound	one time

Other Tests/Assessments	
Skin Test-TB*	one time
6-minute walk test	one time
Oximetry	one time
*QuantIFERON should be performed instead of the skin test if paediatric patient was born either in a tuberculosis-endemic country (outside Western Europe, Canada, USA, Australia, New Zealand), is indigenous Canadian, or is foreign-born with a previous BCG vaccination.	

Consultations	
Transplant Education (i.e. Nurse Coordinator)	ongoing
Infectious Disease	Paeds: one time Adults: if clinically indicated
Transitional pain team	Paeds: as needed Adults: if clinically indicated
Social Worker	one time, then as needed
Dietitian	one time, then as needed
Physiotherapist	one time
Surgical	one time
Respiratory Medicine	one time, then as needed
Cardiology, patients with cardiac disease	one time, then as needed
Mental Health Assessment (neuropsychologist, psychiatry, psychology, or social work)	Paeds: as needed Adults: one time
Anaesthesia	one time
Palliative Care Team	Paeds: one time Adults: as needed
GI/Hepatology	as needed
ENT	as needed
Dental	as needed
Nephrology	as needed
Nurse Practitioner	One time (for patients whose initial visit was via telehealth and who require a physical examination)

Services continued on next page...

Continued from previous page...

Laboratory Testing	
Venous/Capillary blood gases	one time, then as needed
CBC	one time, then as needed
Arterial blood gases	one time, then as needed
GGT	one time, then as needed
Electrolytes: sodium, potassium, chloride	one time, then as needed
Total bilirubin, Albumin, Total Protein, ALP, AST, ALT	one time, then as needed
Multiscreen panel: calcium, phosphate, urea, creatinine, magnesium, glucose	one time, then as needed
Cholesterol, Triglycerides, HDL, LDL (Fasting)	one time, then as needed
HbA1C	Adults: one time, then as needed CF Paeds: one time, then as needed
PT, PTT, INR	one time, then as needed
Sputum – AFB/C&S/Fungus	one time
Vitamins A, D, and E	one time
Modified oral glucose tolerance test	one time
Fasting glucose	one time
Isohemagglutinins	For infants: one time
HLA/PRA	one time

Infectious Profile	
CMV serology (IgM, IgG)	one time
EBV serology	one time
CMV PCR	one time
EBV PCR	one time
Hepatitis A antibody	one time
HBcAB: Hepatitis B core antibody	one time
HBsAg: Hepatitis B surface antigen	one time
HBsAB: Hepatitis B surface antibody	one time
VZV antibody	one time
Hepatitis C antibody	one time
HSV	one time
Toxoplasmosis	one time

Diagnostic Testing	
Bone Mineral Density (>5 years)	one time
Chest X-Ray	one time
CT Scan of sinuses, for CF and bronchiectasis	one time
CT Chest	one time
GFR (Serum)	one time
Quantitative Ventilation/Perfusion Scan	one time
Upper GI	one time as needed
ECG	one time
2D Echo	one time
Complete PFTs (>6 years)	one time
Coronary Angiography (≥50 years or as clinically indicated)	one time
Right Heart Catheterization (concomitant with coronary angiography or as clinically indicated)	one time
Stress Test	one time
Indirect calorimetry	one time
Audiology	one time (if needed)

Infectious Profile (cont'd)	
Stool for VRE, MRSA, and multiplex screening	one time
Urine C&S	one time
Urine CMV	one time (if needed)
West Nile testing	one time (if needed)
Nasopharyngeal swab	one time (if needed)
Strongyloides serology	one time
Immunoglobulins (IgG, IgM, IgA, IgE)	one time
HIV	one time
MMR IgG	one time
5mL RED TOP blood to be sent to virology for storage to be saved for future testing	one time

Pre-Transplant After Listing: Wait List Period

Clinical Care: Transplant programs are responsible for patient management in partnership with the patient's referring respirologist, and determining whether the patient remains medically suitable to receive a transplant. Transplant programs will complete the required consultations, diagnostics, and lab testing to enable the multidisciplinary clinical team to assess the patient for ongoing transplant eligibility. Ongoing assessment is carried out at both inpatient and outpatient transplant clinics while the patient is on the wait list. Patient management during this phase is supported by the following personnel:

- RN, Nurse Practitioner, Transplant Surgeon, Transplant Respirologist
- Allied health care (social work, physiotherapy, occupational therapy, pharmacy, psychology, pain management team, and nutrition)
- Administrative support
- Interstitial Lung Disease/ Pulmonary Hypertension/ Cystic Fibrosis Clinics/ Transplant infectious disease

In addition to the recommendations below, all transplant hospitals are expected to have their own protocols on how to treat complications common to all lung disease patients. Each program has expertise in lung transplant patient management and the flexibility to consult with multidisciplinary teams to inform complex care practices beyond the scope of existing recommendations.

Consultations	
Transplant Education (i.e. Nurse Coordinator)	ongoing
Social Worker	ongoing
Dietitian	ongoing
Physiotherapist	ongoing
Infectious disease	ongoing, if indicated
Cardiology, patients with cardiac disease	ongoing, if indicated
Palliative Care Team	ongoing, if indicated
Psychosocial Team	as needed
ICU staff (for potential ECLS)	one time
Psychology	ongoing, if indicated
Psychiatry	if indicated

Infectious Profile	
CMV Serology	Paeds: q3 months if negative Adults: Annual if negative
EBV Serology	Paeds: q3 months if negative Adults: Annual if negative
HBcAB: Hepatitis B core antibody	as needed
HBsAB: Hepatitis B surface antibody	as needed
HBsAg: Hepatitis B surface antigen	as needed

Laboratory Testing	
CBC	q3 months
PT, PTT, INR	q3 months
Electrolytes: sodium, potassium, chloride	q3 months
Multiscreen panel: calcium, phosphate, creatinine, magnesium, glucose	q3 months
Total bilirubin, Bilirubin, Albumin, Total Protein, ALP, AST, ALT, GGT	q3 months
Sputum for Culture and Sensitivity, AFB, fungus	q3 months
Isohemagglutinins (for infants)	once at time of listing, q monthly, urgently when the identified potential organ donor is ABO-incompatible

Immunologic Evaluation	
PRA	q3 months

Services continue on the next page...

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Imaging	
ECG	once, then as necessary
Chest X-ray	once, then as necessary
CT Chest	Paeds: q6-12 months, then as necessary Adults: q3-6 months
ECHO	Paeds: q6 months as needed Adults: q3-6 months, then as necessary
GFR	annual

Other Tests/Assessments	
Cardiac Stress Test	annual if needed
6-minute walk test	Paeds: q6-8 weeks Adults: q3 months

Preoperative Assessment and Transplant Surgery

Clinical Care: The transplant programs are responsible for patient management during the preoperative assessment and transplant surgery phase of the transplant process. TGLN liaises with programs regarding potential deceased organ donor matches, and contacts patients once a match has been found. Patients have their current health status assessed to ensure they are fit for surgery. The clinical team completes the patient assessment, prepares the patient for the transplant, and performs the procedure. Patient management and monitoring for the perioperative period is supported by the following personnel:

- RN
- Nurse Practitioner
- Transplant surgeon
- Transplant surgical fellow
- Transplant medical fellow
- Transplant respirologist
- Administrative support

In addition to the recommendations below, all transplant hospitals are expected to have their own protocols on how to treat complications common to all lung disease patients. Each program has expertise in lung transplant patient management and the flexibility to consult with multidisciplinary teams to inform complex care practices beyond the scope of existing recommendations.

Consultations	
Anaesthesia	one time
Transplant respirologist	one time

Imaging	
Chest X-Ray	one time
ECG	one time

Immunologic Evaluation	
PRA	one time

Infectious Profile	
CMV serology	one time if previously negative
EBV serology	one time if previously negative
CMV PCR	one time if previously negative
EBV PCR	one time if previously negative

Laboratory Testing	
CBC	one time
PT, PTT, INR	one time
Electrolytes: sodium, potassium, chloride	one time
Multiscreen panel: calcium, phosphate, urea, creatinine, magnesium, glucose	one time
Total bilirubin, ALP, AST, ALT	one time
Sputum culture—Gram Stain and fungal culture	one time
ABO and Crossmatch	one time
Pregnancy test (females 12-55 years of age)	one time
Isohemagglutinins (for infants)	urgently when a potential organ donor that is ABO-incompatible is identified

Transplant Surgery
Preoperative assessment and monitoring by surgical team
Transplant surgery including transplant surgeon, surgical team, anesthesiologist, operating room staff, and all other resources required during the surgery.

Post-Transplant: During Hospital Admission

Clinical Care: Transplant programs are responsible for patient management during the post-transplant, hospital admission phase. During this phase, clinical teams continue to monitor patients, administer pain medication, and ensure necessary testing and interventions are completed. Patients will initially be monitored in the intensive care unit before being transferred to the surgical ward. Patients also begin their immunosuppression therapy. Ongoing patient management, monitoring, education and nursing care is supported by the following personnel:

- RN, Nurse Practitioner and Transplant Respiriologist
- Allied health care (social work, physiotherapy, occupational therapy, pharmacy, and nutrition)
- Administrative support

In addition to the recommendations below, all transplant hospitals are expected to have their own protocols on how to treat complications common to all transplant and lung disease patients. Each program has expertise in lung transplant patient management and the flexibility to consult with multidisciplinary teams to inform complex care practices beyond the scope of existing recommendations.

Consultations	
Lung Transplant Team	daily
Physiotherapist	daily
Patient Education	multiple structured sessions, then as needed
Dietitian or Nutritionist	one time, then as needed
Occupational Therapist	as needed
Child Life Specialist	one time, then as needed
Paediatrics Advanced Care Team	until discharge
Thrombosis	as needed
Social Work	one time, then as needed

Immunologic Evaluation	
PRA	with biopsy or as indicated

Diagnostic Testing	
Chest X-Ray	daily for 7 days, then as needed
ECG	daily x 2 days, then as needed
2D Echo (heart and lung)	as needed
Echo (lung)	as needed

Infectious Profile	
CMV PCR	q2 weeks
EBV PCR	q2 weeks

Other Tests/ Assessments	
Bronchoscopy/biopsy	2 weeks and 6 weeks post-op and as needed
PFTs	at 2-3 weeks

Services continue on the next page...

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Laboratory Testing	
Cyclosporine or Tacrolimus Trough level	daily
CBC and Differential	STAT on admission, q6 hours until re-assessed, reassessed daily
PT, PTT, INR	STAT on admission, q6 hours until re-assessed, reassessed daily
Electrolytes: sodium, potassium, chloride	STAT on admission, q6 hours until re-assessed, reassessed daily
Multiscreen panel: calcium, phosphate, urea, creatinine, magnesium, glucose	STAT on admission, q6 hours until re-assessed, reassessed daily
Total bilirubin, Bilirubin, Albumin, Total Protein, ALP, AST, ALT	STAT on admission, q6 hours until re-assessed, reassessed daily, then daily to weekly, patient dependent
Isohemagglutinins (ABO-incompatible infants only, <18 months old)	daily for first week, then weekly for three weeks, then q2 weeks for 2 months, then monthly for 4 months, then q3-6 months or as clinically indicated
Ammonia	daily x 14 days, then as needed
Arterial blood gases	daily as needed
Arterial /Venous/ Capillary blood gases	STAT on admission, q6 hours until re-assessed, reassessed daily, then daily if needed
Troponin stat	q12x 24 hours
CK-MB stat	q12x 24 hours
Lactate	q6 hours as clinically indicated

Post-Transplant: After Discharge

Clinical Care: Transplant programs are responsible for patient management during the post-transplant phase, after discharge from the hospital. The transplant team and appropriate health care providers monitor patients through outpatient clinic visits, ensure the necessary testing is completed, interpreting laboratory and diagnostic results and collaborating with other members of the multidisciplinary transplant team as required. The transplant program also monitors and adjusts immunosuppression therapy to prevent organ rejection. Ongoing patient management and monitoring is completed by the transplant program and is supported by the following personnel:

- RN, Nurse Practitioner and Transplant Respiriologist
- Allied health care (social work, physiotherapy, occupational therapy, pharmacy, and nutrition)
- Administrative support

Consultations	
Transplant Respirologist	every visit
Physiotherapy /Rehabilitation	3x/week for 3 months
Dermatology	annually
Transplant Education (i.e. Nurse Coordinator)	ongoing as needed
Social Worker	as needed
Psychology	as needed
Nephrology	as needed
Infectious Diseases	as needed
Thrombosis	as needed
Cardiology	as needed
Gastroenterology	as needed
Psychiatry	as needed

Immunologic Evaluation	Adults	Paediatrics
PRA	<ul style="list-style-type: none"> • 6 weeks • 3, 6, 9, 12, 24 months 	<ul style="list-style-type: none"> • at 2 weeks • at 6 weeks • at 3, 6, 9, 12, and 24 months, then as needed

Infectious Profile	
CMV PCR	as needed
EBV PCR	as needed
Hepatitis B serology	q12 months then annually as indicated
Varicella Serology	q12 months then annually as indicated
CMV Serology	as needed
EBV Serology	as needed

Other Tests/Assessments	Adults	Paediatrics
Rehabilitation visits	•3x/week for 3 months	•3x/week for 3 months, then at 6 and 12 months
6-minute walk test	•3, 6, 9, 12, 18, and 24 months, then annual	•6 and 12 months then annual
Developmentally appropriate exercise/physiotherapy	3x/week for 3 months, then 6 and 12 months, then annual	
Ophthalmology	annually	

Services continued on next page...

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Laboratory Testing	Adults	Paediatrics
CBC	<ul style="list-style-type: none"> • weekly and as needed: <3 months • q2 weeks and as needed: 3-6 months • monthly and as needed: 6-24 months • q3 months if stable or as needed: >2 years 	<ul style="list-style-type: none"> • weekly for 8 weeks • q monthly; then • q3 monthly if stable or as needed >2 years
PT, PTT, INR	prior to bronchoscopy	
Electrolytes: sodium, potassium, chloride	<ul style="list-style-type: none"> • weekly and as needed: <3 months • q2 weeks and as needed: 3-6 months • monthly and as needed: 6-24 months • q3 months if stable or as needed: >2 years 	<ul style="list-style-type: none"> • weekly for 8 weeks • q monthly; then • q3 monthly if stable or as needed >2 years
Calcium, phosphate, magnesium	<ul style="list-style-type: none"> • weekly and as needed: <3 months • q2 weeks and as needed: 3-6 months • monthly and as needed: 6-24 months • q3 months if stable or as needed: >2 years 	<ul style="list-style-type: none"> • weekly for 8 weeks • q monthly; then • q3 monthly if stable or as needed >2 years
Creatinine, urea	<ul style="list-style-type: none"> • weekly and as needed: <3 months • q2 weeks and as needed: 3-6 months • monthly and as needed: 6-24 months • q3 months if stable or as needed: >2 years 	<ul style="list-style-type: none"> • weekly for 8 weeks • q monthly; then • q3 monthly if stable or as needed >2 years
Total Bilirubin, Bilirubin, ALP, AST, ALT, GGT	<ul style="list-style-type: none"> • weekly and as needed: <3 months • q2 weeks and as needed: 3-6 months • monthly and as needed: 6-24 months • q3 months if stable or as needed: >2 years 	<ul style="list-style-type: none"> • weekly up to 6 weeks • q2-3 months until 2 years

Laboratory Testing (cont'd)	Adults	Paediatrics
Albumin, Total Protein	<ul style="list-style-type: none"> • weekly and as needed: <3 months • q2 weeks and as needed: 3-6 months • monthly and as needed: 6-24 months • q3 months if stable or as needed: >2 years 	<ul style="list-style-type: none"> • weekly and as needed to 6 weeks • monthly until 2 years, then q3 months if stable or as needed >2 years
Mycophenolic Acid Levels	as indicated	
Cyclosporine levels or tacrolimus levels	<ul style="list-style-type: none"> • weekly and as needed: <3 months • q2 weeks and as needed: 3-6 months • monthly and as needed: 6-24 months • q3 months if stable or as needed: >2 years 	<ul style="list-style-type: none"> • weekly and as needed to 3 months • monthly to 2 years • q3 months >2 years
Lipid Profile	• 3, 6, 9, 12, 18, 24 months, then annual	• 3 and 12 months
Isohemagglutinin (Infant ABO incompatible)	daily for the first week, then weekly for 3 weeks, then q2 weeks for 2 months, then monthly for 4 months, then q3-6 months, or as clinically indicated	
Esophageal impedance/manometry/ pH impedance	3 months, if needed/tolerated	
Vitamins A, D, E	• as indicated	<ul style="list-style-type: none"> • q3-6 months for 1st year • q6-12 months > 2years

Services continued on next page...

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Imaging	Adults	Paediatrics
Chest X-Ray	<ul style="list-style-type: none"> • weekly to 3 months • 6, 9, 12, 18, 24 months • annually >2 years 	<ul style="list-style-type: none"> • weekly to 6 weeks, no issues q2 weeks • q3 months to 2 years • annual >2 years
Chest CT	<ul style="list-style-type: none"> • 3, 6, 9, 12, 18, 24 months 	<ul style="list-style-type: none"> • 6 and 12 months, then annually and as needed
PFTs	<ul style="list-style-type: none"> • weekly and as needed: < 3 months • q2 weeks and as needed: 3-6 months • monthly and as needed: 6-24 months • q3 months if stable or as needed: >2 years 	<ul style="list-style-type: none"> • q1-2 weeks to 3 months • monthly >3 months
Bronchoscopy with BAL and biopsies	<ul style="list-style-type: none"> • 2 and 6 weeks • 3, 6, 9, 12, 18, 24 months or as needed 	<ul style="list-style-type: none"> • 2 and 6 weeks • 3, 6, 9, 12 months • as needed >1 year
Echo (only PPH or congenital heart disease patients)	<ul style="list-style-type: none"> • if indicated 	<ul style="list-style-type: none"> • if indicated
Bone Mineral Density	<ul style="list-style-type: none"> • every 1-3 years 	<ul style="list-style-type: none"> • (>5 years old) 12 months, then annual
Gastric emptying	<ul style="list-style-type: none"> • 3 months 	<ul style="list-style-type: none"> • as indicated
GFR	6 and 12 months, then annual	
Upper GI	3 months, if indicated pH impedance: if indicated	

VIII. Implementation

The Clinical Handbook is a compendium of evidence-based and clinical consensus guidelines created with the goal of improving quality of transplant care delivery and patient outcomes as measured through performance indicators. This toolkit is not intended to replace the professional skill and judgement of healthcare providers, nor inhibit the development of new and innovative transplant solutions.

Successful implementation of the Handbook can be facilitated by leveraging the following components:

- **Building a shared vision for clinical practice:** The Clinical Handbook is an opportunity to share clinical consensus guidelines that will allow the system to provide even better quality care, while increasing system efficiencies.
- **Engaging leadership for change:** Senior leaders can support the vision for change by providing a clear message about the implications of implementation.
- **Supporting clinical engagement:** From the outset, staff, physicians and other clinicians should be provided with sufficient information that will help them understand the importance of this initiative, including its impact on patient care.

To achieve a shared vision for clinical practice, transplant centres are encouraged to review their current processes in relation to the clinical pathway and identify any variation that exists. As transplantation is a complex system, when a variation is identified, transplant centers are encouraged to work within their centers to understand the variation in developing their local clinical pathway. To help with the review process the following roadmap to implementation has been suggested.

Roadmap to Lung Transplant Clinical Pathway and Service Bundles Implementation

Current State Assessment

- Review processes for each stage of care for the patient groups outlined in the Handbook

Clinical Practice Assessment

- Review Clinical Handbook

Gap Analysis

- Conduct pathway and services bundle gap analysis
- Identify improvement opportunities

Closing the Gap

- Develop implementation plan

Ongoing Evaluation

- Use performance indicators to monitor implementation and identify areas for further improvement.

The Clinical Handbook provides an opportunity to build a shared vision for clinical practice for lung transplantation to improve quality of care, while maximizing the effective use of available resources. In order to make informed and accurate decisions, the importance of high-quality data cannot be emphasized enough. As outlined in section III, TGLN has developed a list of quality indicators that can be used to evaluate each stage of the patient care continuum. Such indicators will enable centres to track, audit, and evaluate the implementation of the clinical pathway and service bundles at organizational level. Through such monitoring, variances can be identified, progress monitored, and practices refined over time to improve patient outcomes.

The Heart and Lung Working Group will utilize performance metrics to review clinical practices and make recommendations to support practice changes where notable variations in practice have been identified. The Clinical Handbook will be reviewed regularly by the Working Group and when appropriate, updated with new recommended practices, evidence, and policy changes.

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