Meeting Report: Consensus Recommendations for a Research Agenda in Exercise in Solid Organ Transplantation

Authors:

*Co-first authors

Affiliations:
Mathur – Dept of Physical Therapy, University of Toronto, Toronto ON, Canada

Janaudis-Ferreira - Sunnybrook Research Institute, Sunnybrook Health Sciences Centre, St John’s Rehab program, Toronto, Canada

Wickerson - Toronto Lung Transplant Program – University Health Network, Toronto, ON, and Dept of Physical Therapy, University of Toronto, Toronto, ON, Canada

Singer – Toronto Lung Transplant Program and Department of Medicine, University Health Network, University of Toronto, Toronto, ON, Canada
Patcai - Department of Medicine, University of Toronto and Sunnybrook Health Sciences Centre - St. John’s Rehab, Toronto ON Canada

Rozenberg – Department of Medicine, Division of Respirology, University of Toronto, Toronto ON, Canada.

Blydt-Hansen – Department of Pediatrics and Child Health, Division of Nephrology, University of Manitoba, Winnipeg MB, Canada

Hartmann: Piedmont Transplant Institute, Atlanta, Georgia

Haykowsky Faculty of Rehabilitation Medicine, University of Alberta; Mazankowski Alberta Heart Institute, edmonton, AB, Canada

Helm Toronto Lung Transplant Program – University Health Network, Toronto, ON, and Dept of Physical Therapy, University of Toronto, Toronto, ON, Canada

High: Department of Internal Medicine, Wake Forest School of Medicine, Winston-Salem, NC, USA

Howes- Multi-Organ Transplant Program, London Health Sciences Centre, London, Ontario
Kamath - Assistant Professor, Department of Paediatrics, University of Toronto & Staff Physician, Division of Gastroenterology, Hepatology and Nutrition, Hospital for Sick Children, Toronto

Lands - Department of Pediatrics, Division of Pediatric Respiratory Medicine, McGill University Health Centre and Quebec Lung Transplant Program, Centre Hospitalier de l’Université de Montréal, Montréal, Quebec

Marzolini - Toronto Rehabilitation Institute/University Health Network, Cardiovascular Prevention and Rehabilitation Program

Sonnenday - Department of Surgery, Department of Health Management & Policy, The University of Michigan, Ann Arbor, Michigan

**Corresponding Author:**

Sunita Mathur, [sunita.mathur@utoronto.ca](mailto:sunita.mathur@utoronto.ca)

**Running Head:** Exercise in Solid Organ Transplantation

**Keywords:** organ transplantation, exercise

**Abbreviations:** QOL – quality of life, RCT – randomized controlled trial, SOT – solid organ transplant, VO2peak – peak oxygen consumption
ABSTRACT

With improved survival rates in solid organ transplantation there has been an increased focus on long-term outcomes following transplant, including return to physical function, health-related quality of life and risk of cardiovascular mortality. Exercise training has the potential to affect these outcomes, however research on the optimal timing, type, dose of exercise, mode of delivery and relevant outcomes is limited. This paper provides a summary of a two-day meeting held in April 2013 (Toronto, Canada) in which a multi-disciplinary group of clinicians, researchers, administrators and patient representatives engaged in knowledge exchange and the development of a research agenda for exercise in solid organ transplant. The key outcome from the meeting was a development of a research agenda for exercise in solid organ transplant, which included the need for larger scale, multi-centre studies on exercise training, development of standardized outcomes for physical function across transplant types, examining novel modes of exercise delivery particularly for long-term adherence to exercise and physical activity, as well as broad outcomes from exercise training studies such as immunity, infection, cognition and economic outcomes. A knowledge translation plan to disseminate the best-available evidence on exercise training in solid organ transplant to practitioners was also formulated.

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INTRODUCTION

Solid organ transplantation is a life-saving intervention for people with end-stage heart, lung, kidney or liver disease. With considerable advances in organ preservation, surgical techniques and immunosuppressive therapy, short-term survival following solid organ transplant (SOT) has greatly improved (1). Specifically over the last decade, the one year patient survival for heart, lung, kidney and liver transplants from deceased donors have improved from approximately 85% to over 90% on average, across transplant types (2). As a result of improved graft survival and reduced deaths from infection/rejection there is a shift in focus towards examining functional limitations, cardiovascular morbidity and mortality in transplant recipients (3). There is also an interest in examining patient-centered outcomes such as functional performance, quality of life, the ability to return to societal roles (4, 5); as well as the impact of physical frailty on candidate selection and transplant outcomes (6). Exercise training has the potential to address these needs and improving long-term outcomes for transplant recipients.

Exercise training, including aerobic, resistance or combined training, has been shown to improve physical function and quality of life in SOT recipients (7). Structured exercise training also has the potential to reduce cardiovascular risk factors, such as hypertension (8), percent body fat (9) and aerobic fitness (7). Despite the potential for exercise training to impact outcomes of SOT, there is limited evidence on several issues surrounding this intervention. Specifically, there is a knowledge gap in terms of the optimal type of training, the effective “dose” of exercise, ideal timing of training (pre-
post transplant), training duration and mode of delivery (home versus hospital). As well, there is no consensus to date on the clinical or physiological outcomes that should be evaluated to determine the efficacy or effectiveness of exercise training for SOT candidates and recipients.

These gaps in knowledge provided the foundation for the Exercise in Solid Organ Transplant Meeting was held in Toronto, Canada, April 18-20th 2013. This two-day meeting was the first of its kind in North America, and brought together researchers, clinicians and stakeholders with expertise in rehabilitation/exercise across different solid organ transplants. The goal of the meeting was to identify common research opportunities and areas of inquiry across SOT and put a unified effort towards producing high impact research in exercise and rehabilitation for transplant recipients, and consequently improve clinical practice. This meeting report summarizes the current evidence for exercise limitation and exercise training in SOT and presents the research agenda developed at the meeting.

**CURRENT EVIDENCE**

**Exercise Limitation**

There is a consistent observation across solid organ transplant recipients that aerobic capacity [or peak oxygen consumption (VO2peak)] is impaired pre-operatively and remains below age-matched normative values post-transplant (10). The limitation in VO2peak appears to be related to peripheral muscle dysfunction (impaired muscle oxygen
extraction and utilization) rather than central factors such as cardiovascular or respiratory limitations, even in heart and lung transplant recipients (11, 12). Furthermore, peripheral adaptations have been observed as a result of exercise training in SOT recipients, such as improved blood lactate (13), mitochondrial function (14), type 1 muscle fibers (15) and muscle strength (15, 16).

Although each SOT has its own unique characteristics and challenges, many issues that affect exercise capacity and physical function are common across the transplant types (10). Pre-transplant factors such as severe chronic disease, deconditioning, anemia and nutritional depletion can affect exercise capacity and physical function in the transplant candidate. Following transplant, extended hospital and intensive care stay, prolonged sedentary time, immunosuppressant medications and episodes of organ rejection may all impact the transplant recipients’ exercise tolerance and health-related quality of life. As shown in Table 1, many of the multi-systemic consequences of chronic diseases and transplant can be ameliorated through structured exercise training.

There is evidence to suggest that greater physical function in transplant candidates and recipients is associated with improved post-transplant outcomes. For example, higher perceptions of physical function (using the Short Form-36 self-report questionnaire) in renal transplant recipients has been associated with a lower hazard for hospitalization and death post-transplant (17); and low physical activity levels has been strongly associated with increased risk for cardiovascular and all-cause mortality (3). In lung and liver transplant recipients, higher pre-transplant exercise capacity has been associated with
lower pre-transplant mortality (18), shorter hospital stay (19), and increased short-term survival post-transplant (20). In summary, there is substantial evidence to suggest an essential role for exercise training both pre- and post-transplant.

**Evidence for Exercise Training in SOT**

Despite the awareness that SOT recipients have significant physical impairments and increased risk for cardiovascular disease and that exercise training has potential for both short- and long-term benefits in this population, there is a lack of high quality randomized controlled trials (RCTs) with long-term follow-up on exercise training for transplant recipients. In a recent systematic review examining the health benefits and risks associated with exercise following a solid organ transplant (7) only 15 RCTs were identified across kidney, liver, heart and lung transplant populations; nine of which were conducted in cardiac transplant. Table 2 shows the characteristics of these published exercise training programs. The authors noted that 20% of these RCTs (three trials) were considered as having high risk of bias based on quality appraisal (7). A summary of the main findings of this systematic review is presented below.

**Exercise capacity and muscle strength**: The studies included in the meta-analysis showed an improvement in VO$_2$peak among recipients of cardiac (six studies) but not in kidney (one study), liver (two studies) or lung transplant (one study). Differences among the exercise training protocols may explain the conflicting results. However, when data from all the trials were pooled, there was a greater change in VO$_2$peak among transplant
recipients who underwent training (standardized mean difference of 0.47 ml/min/kg).
The clinical relevance of this change is not established in the transplant population, however it is well below the threshold seen in men with cardiovascular disease, where a 3.5 ml/min/kg increase in VO2peak has been shown to be associated with 12% improvement in survival.(21)

Six studies included muscle strength as an outcome; of these, four studies included a strength training component and only one of these studies demonstrated a greater increase in muscle strength in lung transplant recipients after exercise training compared to a control group (8). Interestingly, of the two studies that did not include any strength training (9, 22), one also showed a statistically significant increase in muscle strength in kidney transplant recipients (22). This may have been due to the low level of conditioning of the subjects at baseline, leading to strength improvements even with aerobic training.

**Cardiopulmonary variables:** Three studies showed a decrease in systolic blood pressure (8, 23, 24) and two studies showed significantly lower diastolic blood pressure in lung and heart recipients following training (8, 23).

**Body composition:** Percentage body fat has been shown to be reduced after exercise training in cardiac (25) and liver transplant recipients (9). Lumbar bone mineral density (BMD) has been shown to increase (compared to pre-transplant values) in cardiac
recipients after exercise training (26) while no increase has been observed in lung (27) or liver transplant recipients (9).

**Health-related quality of life:** Six studies assessed quality of life (QOL) and there was evidence that exercise training improves QOL in cardiac transplant recipients (28, 29). There was limited evidence that exercise training improves QOL in lung (8, 30) or liver (9) transplant recipients.

**Other outcomes:** Only one RCT (8) has considered physical activity as an outcome and showed an improvement in physical activity levels in lung transplant recipients after training. This study also observed a trend of lower incidence of diabetes in the trained group (8). Outcomes that require long-term follow up such as costs, graft function, cardiovascular disease, and all-cause mortality have not been considered in any of the existing RCTs.

**MEETING PROCESS**

Three specific objectives were addressed at the meeting: 1) increase communication and collaboration of experts across different types of SOT to develop a wider research network; 2) identify areas of commonality and uniqueness in the current state of knowledge regarding exercise and physical function in SOT, in an effort to consolidate research efforts across transplant types; and 3) identify “high leverage” research questions in exercise-based rehabilitation for SOT.
The two-day meeting was led by a group of five co-investigators (SM, TJF, LW, JP, LS) and eleven additional collaborators from across Canada and the United States. Prior to the meeting, an electronic survey was circulated to the invitees to stimulate ideas around the topic of exercise for solid organ transplantation. A total of 60 participants attended the first day of the meeting including researchers, clinicians, health-care administrators and patient representatives. This portion of the meeting was a knowledge exchange where invited speakers presented the evidence for exercise training and exercise limitation in SOT and potential areas for future research (see Appendix for agenda). The remainder of the meeting was allocated to small group discussions leading to the development of a research agenda on exercise for SOT (see Appendix for discussion topics) and developing steps for future engagement of a collaborative research network. Participation on day two was limited to 23 individuals interested in this goal.

**MEETING OUTCOMES**

The ideas generated from the group discussions on topics related to exercise in solid organ transplant and high leverage research questions are summarized below. The research agenda developed from the meeting is provided in Table 3.

**Clinical Trials in Exercise**
Although RCTs in exercise were identified from the literature in all SOTs, there was a need to further understand and define the nature of the exercise intervention itself. Exploring “dose-dependent” effects of exercise training and defining the key elements of an exercise program were discussed. The type of training (aerobic, resistance), intensity of training (traditional moderate-intensity versus high intensity interval training), duration of the program and pre-exercise assessments are highly variable in the literature. Therefore, future studies need to clearly define the training variables and progression of exercise, in order to examine the “dose-response” relationship of exercise in transplant.

Studies on different modes of aerobic training such as interval (characterized by short periods of high intensity exercise alternated with longer periods of lower intensity exercise) or circuit weight training (characterized by a series of weight lifting exercises completed with minimal rests to elicit gains in cardiovascular and musculoskeletal fitness) were identified as modes of training that could be applicable to certain subgroups of patients but required further study. For example, interval training has been studied in a limited number of transplant patients but has promising results to date in both lung transplant candidates (31) and heart transplant recipients (32). Also the role for resistance training pre-transplant to improve muscle strength and muscle mass, particularly in frail patients, was identified as a future area of study.

**Outcomes for clinical trials in exercise**

The group discussed areas of research that may have the greatest impact in transplant rehabilitation. The development of a large rehabilitation/physical function database for
transplant centres and standardized procedures for outcomes was identified as an important first step to creating a national database for transplant research. Physical function measures that were proposed for a database included standardized physical function tests (e.g. Short Physical Performance Battery), physical activity questionnaires and indices of physical frailty (walking speed, weakness, weight loss). The need for measures to be validated in the transplant population was voiced during the discussions.

It was discussed that a broader scope of research should be adopted and the impact of rehabilitation beyond physical function and exercise capacity is essential to demonstrating the effectiveness of this intervention. Outcomes of choice included length of hospital stay as an impact of pre-transplant rehabilitation, economic outcomes (cost of rehabilitation) and healthcare utilization, ability to change “frailty”, cardiovascular risk, bone health, QOL, allograft survival, risk of infection, risk of rejection and mortality. There was also discussion on the need to examine post-transplant care along the lines of a “chronic disease management model” and for research on exercise to be paired with nutritional interventions.

**Mode of Exercise Delivery**

Group exercise programs were the favored mode of exercise delivery due to advantages such as greater compliance and motivation to exercise in group settings, as well as social support (e.g. opportunities for friendly “competition” as a motivator, development of peer and caregiver support). Home-based programs were also recognized as an important
avenue for exercise delivery and research, especially post-transplant. Benefits of home exercise in the post-transplant phase included the transition towards independence and maintaining a physically active lifestyle. Innovations in Telehealth or remote monitoring of patients either pre- or post-transplant were identified as potential avenues for research.

Even though end-stage organ disease is often accompanied by deconditioning, it was repeatedly mentioned that the effects of pre-transplant exercise on post-transplant outcomes is unknown indicating a relevant area of research. Long-term benefits of exercise training were discussed as a gap in current research that could be addressed through various home or community-based exercise delivery modes (e.g. fitness centers, web-based platforms and “tele-rehabilitation”).

Multi versus single organ research

There was a general consensus that multi-organ transplant research could have several advantages over single organ research. These advantages included allowing for greater sample size and comparison across transplant types thus having more impact in a larger number of people, which could be more appealing to funding agencies. There were some similarities recognized in both the pre- and post-transplant rehabilitation needs across transplant types such as general deconditioning and motivation to exercise, which could justify a rehabilitation strategy for all types of transplants.
There was also recognition within the group that there are organ-specific issues affecting rehabilitation that may not be addressed with multi-organ rehabilitation programs or research questions. For example, there are substantially longer waiting times (i.e. years) for people waiting for kidney transplant compared to heart or lung transplant candidates (i.e. months) (2), which could affect the type of exercise program that is required or feasible in these distinct populations. Therefore subgroup analyses was suggested for large, multi-organ studies.

**Opportunities for Research in Exercise for Solid Organ Transplant**

A number of existing and emerging opportunities for conducting research and improving clinical care in the area of exercise for solid organ transplant arose from the meeting discussions (see Figure 1). It was apparent that there was existing infrastructure, expertise and human resources at the current transplant centres that could be utilized to conduct research. There was also potential to utilize new technologies such as Telehealth to support exercise and physical activity interventions for long-term management, and to accommodate those living in areas remote from the rehabilitation centres. There was a strong need to disseminate the best available evidence for exercise training in pre- and post-transplant patients to improve availability of exercise programs for all types of SOT candidates and recipients. The existence of current partners that could assist with improving research productivity in the area of exercise and physical activity, including academic institutions, transplant organizations and research networks, were identified.
The goal of developing partnerships and formalizing existing collaborations with these groups was emphasized as a way to move the research agenda forward.

SUMMARY

Exercise and physical activity are important interventions that have the potential to improve outcomes for SOT candidates and recipients. To date, there is limited research supporting the benefits of exercise training, particularly for long-term benefits and outcomes beyond exercise capacity and quality of life. This meeting of experts and stakeholders in the area of exercise for solid organ transplant allowed for the development of a research agenda and knowledge translation plan, in order to streamline research efforts in this field to produce the most important and high quality research evidence.
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**Table 1.** Secondary consequences of solid organ transplant that can be improved through exercise training

**Table 2.** Characteristics of randomized controlled trials of exercise training programs included in the available literature (adapted from Didsbury et al.(7))

**Table 3.** Research Agenda for Exercise in Solid Organ Transplant

**Figure 1.** Existing and emerging opportunities to conduct research in rehabilitation for solid organ transplant recipients

**Appendix.** Meeting Agenda
REFERENCES


Table 1. Secondary consequences of solid organ transplant that can be improved through exercise training

<table>
<thead>
<tr>
<th>Body System</th>
<th>Secondary Effect of Transplant</th>
<th>Effect of Exercise Training*</th>
</tr>
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<tbody>
<tr>
<td>Skeletal Muscle</td>
<td>• Loss of muscle mass</td>
<td>• ↑ muscle mass</td>
</tr>
<tr>
<td></td>
<td>• Muscle weakness</td>
<td>• ↑ muscle strength</td>
</tr>
<tr>
<td></td>
<td>• Muscle fatigue</td>
<td>• ↑ muscle endurance</td>
</tr>
<tr>
<td>Bone</td>
<td>• Osteopenia</td>
<td>• ↑ bone density/bone strength</td>
</tr>
<tr>
<td></td>
<td>• Osteoporosis</td>
<td>• ↑ balance</td>
</tr>
<tr>
<td></td>
<td>• Increased risk of fracture</td>
<td>• ↓ risk of falls</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>• Cardiovascular deconditioning</td>
<td>• ↑ aerobic capacity</td>
</tr>
<tr>
<td></td>
<td>• Hypertension</td>
<td>• ↓ blood pressure</td>
</tr>
<tr>
<td>Endocrine/</td>
<td>• Diabetes</td>
<td>• ↑ glucose tolerance</td>
</tr>
<tr>
<td>Metabolic</td>
<td>• Weight gain</td>
<td>• improve body composition (↓ fat mass, ↑ fat free mass)</td>
</tr>
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</table>

* demonstrated effects of aerobic and resistance training in clinical populations, not specifically organ transplant
<table>
<thead>
<tr>
<th>Author</th>
<th>Country</th>
<th>Year</th>
<th>Organ</th>
<th>Time-post transplant (weeks)</th>
<th>Treatment duration (weeks)</th>
<th>Intervention</th>
<th>n</th>
<th>Comparison</th>
<th>n</th>
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<tbody>
<tr>
<td>Bernardi</td>
<td>Italy</td>
<td>2007</td>
<td>Heart</td>
<td>24</td>
<td>24</td>
<td>cycle; 30min/5days/wk</td>
<td>13</td>
<td>standard medical care</td>
<td>11</td>
<td>Home-based</td>
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<td>Braith</td>
<td>USA</td>
<td>1996</td>
<td>Heart</td>
<td>8</td>
<td>24</td>
<td>Supervised lumbar extension 1 day/week; variable resistance exercises</td>
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<td>standard medical care</td>
<td>8</td>
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<td>Braith</td>
<td>USA</td>
<td>2008</td>
<td>Heart</td>
<td>8</td>
<td>12</td>
<td>12 wks supervised treadmill exercise</td>
<td>9</td>
<td>standard medical care</td>
<td>7</td>
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<td>Haykowsky</td>
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<td>Heart</td>
<td>260</td>
<td>12</td>
<td>12 wks supervised aerobic and strength training</td>
<td>22</td>
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<td>Hermann</td>
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<td>Heart</td>
<td>336</td>
<td>8</td>
<td>8 wks supervised aerobic interval training program</td>
<td>14</td>
<td>standard medical care</td>
<td>13</td>
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<td>Karapolat</td>
<td>Turkey</td>
<td>2007</td>
<td>Heart</td>
<td>78</td>
<td>8</td>
<td>8 wks flexibility, stretching, aerobic (treadmill or bike)</td>
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<td>Kobashigawa</td>
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<td>Heart</td>
<td>2</td>
<td>26</td>
<td>Supervised resistance and aerobic exercises</td>
<td>14</td>
<td>Usual care (unstructured therapy at home)</td>
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<td>Heart</td>
<td>265</td>
<td>24</td>
<td>Aerobic exercises (cycling)</td>
<td>20</td>
<td>standard medical care</td>
<td>12</td>
<td>Hospital and home</td>
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<td>Wu</td>
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<td>Heart</td>
<td>130</td>
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<td>Walking and resistance training; 3</td>
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<td>Year</td>
<td>Disease</td>
<td>Immediate upon discharge</td>
<td>Program</td>
<td>Control</td>
<td>Control Program</td>
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<tr>
<td>Langer</td>
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<td>2012</td>
<td>Lung</td>
<td>Immediately upon discharge</td>
<td>Supervised exercise 3x/wk (aerobic and resistance exercise)</td>
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<td>18 standard medical care</td>
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<td>Lung</td>
<td>8</td>
<td>Supervised lumbar extension exercises for 6 months</td>
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<td>8 standard medical care</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>8 Hospital-based</td>
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<tr>
<td>Juskowa</td>
<td>Poland</td>
<td>2006</td>
<td>Kidney</td>
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<td>Supervised resistance exercises for 15-30 min, repeat program alone on alternate days</td>
<td>5</td>
<td>32 standard medical care</td>
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<td>37 Hospital-based</td>
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<td>Painter</td>
<td>USA</td>
<td>2002</td>
<td>Kidney</td>
<td>8</td>
<td>Independent home-based exercise 4 days/wk; 30 min/session (primarily walking or cycling)</td>
<td>48</td>
<td>52 standard medical care</td>
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<td>43 Home-based</td>
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<td>Krasnoff</td>
<td>USA</td>
<td>2006</td>
<td>Liver</td>
<td>8</td>
<td>Home-based aerobic exercises, 3 days/wk; 30 min/session</td>
<td>84</td>
<td>49 Usual care</td>
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<td>70 Home-based</td>
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**Table 3. Research Agenda for Exercise in Solid Organ Transplantation**

<table>
<thead>
<tr>
<th>Identified Issue or Gap</th>
<th>Research Strategies</th>
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| 1. Lack of large, multi-centre studies in exercise                                      | Development of national, collaborative networks to conduct multi-centre studies  

Plan and execute exercise studies across solid organ types (heart, liver, lung, kidney) in post-transplant phase  

Studies on “novel” methods of exercise training such as interval training, resistance training to improve frailty  

Conduct "sub-group analyses" to determine the groups of patients with the most needs for exercise training both pre- and post-transplant |
| 2. Lack of standardized outcomes for exercise studies                                   | Validation of physical function tests, physical activity scales and frailty measures in adult and pediatric transplant groups  

Development of a standardized outcomes database across adult and pediatric transplant centers to collect common data |
| 3. Lack of evidence-based guidelines for exercise training pre- and post-transplant     | Dissemination of "best available evidence" to healthcare professionals, healthcare administrators, patients & families, advocacy groups  

Continued "knowledge synthesis" of new studies in transplant and exercise  

Conduct of larger trials in exercise as described in #1 & #2 |
| 4. Need for chronic disease management model for post-transplant care; view transplant as "accelerated aging" | Include collaborative research in nutritional and exercise interventions to address chronic disease  

Examine impact of exercise and physical activity on long-term cardiovascular risk, morbidity and mortality from |
| 5. Exercise in "novel outcomes"                                                                 | Future studies of effects of exercise training in immunity, infection, organ rejection, cognitive outcomes |
|                                                                                              | Addition of study outcomes such as length of hospital stay, healthcare economics (cost of rehab, healthcare utilization), morbidity, mortality |
|                                                                                              | Conduct research across the spectrum from clinical research to healthcare policy |

| 6. Lack of long-term exercise studies in post-transplant phase | Future studies on long-term adherence, compliance with physical activity and exercise in pediatric and adult populations |
|                                                              | Examine long-term outcomes such as effect of exercise on development of chronic disease (diabetes, obesity, hypertension, cardiovascular disease) |
|                                                              | Examine new modes to encourage and maintain exercise & physical activity post-transplant (home exercise, community-based programs, Telehealth, web-based interventions) |
### Appendix 1 – Meeting Agenda

**Meeting Agenda: Invited Speaker Presentations**

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<tr>
<th>Topic</th>
<th>Speaker/Institution</th>
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<tr>
<td>Review of Evidence for Exercise Limitations and Exercise Training in Solid Organ Transplant Availability, characteristics and barriers of transplant rehabilitation programs in Canada Personal Perspective on Lung Transplant and Rehabilitation</td>
<td>Drs. Sunita Mathur &amp; Tania Janaudis Ferreira University of Toronto &amp; Sunnybrook Research Institute, Toronto Ms. Lisa Wickerson, BSc(PT), MSc, University Health Network, Toronto &amp; University of Toronto Lung transplant recipient &amp; caregiver</td>
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<td>Exercise training in heart failure &amp; heart transplant recipients</td>
<td>Dr. Mark Haykowsky, University of Alberta, Edmonton</td>
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<td>Skeletal muscle performance and exercise capacity in lung disease The Relationship Between the Six-Minute Walk Test, the MELD-Na Score and Length of Stay Following Liver Transplantation</td>
<td>Dr. Larry Lands, McGill University, Montreal Ms. Nancy Howes, BSc(PT), MSc, London Health Sciences Centre</td>
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<td>Transplantation in older adults – implications for rehabilitation</td>
<td>Dr. Kevin High, Wake Forest University, Winston-Salem</td>
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<td>Older adult candidates for kidney transplantation – implications for rehabilitation</td>
<td>Dr. Erica Hartmann, Piedmont Transplant Institute, Atlanta</td>
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<td>Frailty Among Candidates for Liver Transplantation</td>
<td>Dr. Chris Sonnenday, University of Michigan, Ann Arbor</td>
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<td>Frailty in Children Awaiting Liver Transplantation</td>
<td>Dr. Binita Kamath, SickKids Hospital, Toronto</td>
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<td>Quality of life in lung transplant recipients</td>
<td>Dr. Lianne Singer, Toronto Lung Transplant Program, University Health Network, Toronto</td>
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<td>Development of an inpatient rehabilitation program for solid organ transplant recipients</td>
<td>Dr. John Patcai, Sunnybrook Health Sciences Centre - St John’s Rehab Hospital, Toronto</td>
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<td>Cardiac Rehabilitation following Heart Transplant</td>
<td>Drs. Susan Marzolini &amp; Paul Oh, University Health Network – Toronto Rehab Institute</td>
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<td>Personal Perspective on Liver Transplant and Rehabilitation</td>
<td>Liver transplant recipient</td>
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Facilitated Discussions:

| Review of Pre-Meeting e-Survey Results | Meeting facilitator |
| Facilitated Discussion #1: *identify existing strengths and opportunities for collaborative transplant rehabilitation research* | *Small groups rotated to 3 out of 4 topics:*  
- Multi-organ vs single-organ research  
- Pre- versus post- transplant research  
- Resources to conduct transplant research  
- Novel approaches to conduct exercise in transplant |
| Facilitated Discussion #2: *research questions and funding* | • identify “high leverage” research questions in transplant rehabilitation  
• determine how best to leverage funding for transplant rehabilitation research |
| Facilitated Discussion #3: *development of research agenda* | • draft research agenda and knowledge translation plan  
• explore opportunities to form collaborative research teams |
Higher volume of patients in the main transplant centers

Expertise of rehabilitation professionals in the main transplant centres acting as a resource to the peripheral centres

Availability of existing hospital gyms, physiotherapy departments and exercise labs in the transplant centres

Use of Telehealth and home-based programs to increase compliance to exercise and physical activity interventions

Dissemination of best available evidence to clinicians, managers and policy makers leading to improved clinical care

Use of best available evidence to design future research studies and attract research funding

Link with Universities and academic teaching hospitals as a potential source of research personnel/trainees (e.g. graduate students)

Link with patient advocacy groups and professional associations as an important means of knowledge translation and potential source of funding

Link with ongoing research networks in transplantation (e.g. Canadian National Transplant Research Program)