Greatest than 80% of children diagnosed with cancer will survive for 5 or more years.1 With cure rates rising, emphasis in pediatric oncology is being placed not only on cure, but also on improving the quality of life of pediatric cancer survivors. Cancer treatment for acute lymphoblastic leukemia (ALL) involves chemotherapy that eliminates cancerous cells in the body. However, these treatments also damage the healthy cells of the body resulting in multi-system late effects. Physical performance impairments and physical activity limitations are among the documented late effects of childhood cancer.2,3 Decreased motor skill level, muscle weakness, balance impairments and impairments in ankle dorsiflexion range of motion (ROM) occur in survivors of pediatric ALL.4,5 These impairments begin early in treatment and can contribute to physical performance limitations long into adulthood. Emerging research is demonstrating the relationship of these impairments to chemotherapy-induced peripheral neuropathy, a known side effect of treatment in ALL.6,7 These neuromuscular impairments lead to decreased walking efficiency, which in turn, can contribute to cardiopulmonary health concerns as an adult.8 Research demonstrates that these impairments occur during treatment and continue past treatment, and may be improved by physical therapy or exercise intervention.9 Due to this evidence and observed clinical trends in our patients, the physical and rehabilitation services department, together with the cancer and blood disorders clinic at Children’s Minnesota, began a proactive physical therapy program for children and adolescents with ALL: The Stoplight Program.

THE STOPLIGHT PROGRAM

For children and adolescents with Acute Lymphoblastic Leukemia

The Stoplight Program

In 2004, Children’s Minnesota began offering physical therapy services to all children diagnosed with ALL. We observed that families often allowed more sedentary behavior following diagnosis due to fear of what their child could or should do during cancer treatment. We also found that parents would overestimate their child’s abilities as related to those of their peers, unaware of the weakness or difficulty that occurred during regular child’s play. Many families accepted impairments as a “normal” during cancer treatment, and did not know they could do something to help their child lead an active lifestyle with their peers. Since starting The Stoplight Program, we are now able to identify impairments, educate families, and advance our children and adolescents along the developmental continuum of safe and successful physical activity that will follow them into a long and healthy future.

The Stoplight Program

The Stoplight Program is based on the levels of a traffic light with red representing moderate to severe impairments, yellow representing mild impairments, and green representing no impairments. Education is given to the family on activities they can do when their child is in a specific level, and tailored exercises are prescribed as the child continues through the program depending on their individual impairments. A child may move from one level to another and receive a changed level of physical therapy intervention depending on current chemotherapy cycle and functional level. Please refer to Table 1 for a synopsis of the outcome measurements we use and interventions we provide. Physical therapy visit frequency typically ranges from one visit per month with emphasis on home programming, to one visit per week with emphasis on neuromuscular training. Timing of physical therapy visits is shown in Table 2.

Lessons Learned

Since its inception, our program has evolved secondary to information learned from our families and from our research program as it has developed. We started by educating both our physical therapy staff and our oncology staff on the common impairments that occur in survivors of ALL. Next, physical therapists began assessing patients at set time points that were thought to be critical to the onset of known impairments and recommending physical therapy intervention based on severity of these impairments.

Over the years, we have adjusted the timing of our assessments to better meet the child and family’s needs and priorities during treatment. We have become more aggressive in our treatment of ankle flexibility, strength and gait abnormalities because of the long-term patterns we have seen with our interventions and emerging research findings. In addition, we have embedded physical therapists into the cancer and blood disorders clinic to allow coordination of physical therapy and oncology visits. Physical therapists provide therapy during oncology clinic visits, often during infusions. Our patients have improved access to physical therapy services, and better collaboration between the patient, family, oncology and physical therapy team. Families report greater satisfaction and ability to follow through on recommended therapies because they don’t have to schedule a separate visit at a separate location.

Physical therapy services provided through The Stoplight Program have been reimbursed well through insurance as need for medical intervention is documented through reliable and valid outcome measurements. Our research regarding the development and testing of the Pediatric-modified Total Neuropathy Score (Ped-mTNS) has demonstrated a relationships between chemotherapy-induced peripheral neuropathy, ankle flexibility, ankle strength, and walking quality and endurance. Due to this finding, we began using the Ped-mTNS as part of The Stoplight Program in 2017. We complete the measurement approximately every three months during intense treatment and every six months during maintenance phase until the score is in the normal range (<4) or the recovery has plateaued over one year’s time.

Program Evaluation

Individual patients are evaluated prior to the end of physical therapy intervention to determine their functional outcome. As a whole, the program is currently completing research studies so that we may summarize and publish the effectiveness by determining short and long-term outcomes of this proactive physical therapy intervention. Recent research published in 2019 on The Stoplight Program revealed improved motor function and greater activity level in Stoplight participants versus a control group 18 months after cancer treatment completion.10

### Activity level

<table>
<thead>
<tr>
<th>Outcome measurement</th>
<th>Red</th>
<th>Red Intervention</th>
<th>Yellow</th>
<th>Yellow Intervention</th>
<th>Green/Discharge Crit.</th>
<th>Green Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lansky Play Performance Scale/Karnofsky Performance Scale*</td>
<td>≤60</td>
<td>Strengthening</td>
<td>Activity modification</td>
<td>70–90</td>
<td>Strengthening</td>
<td>Cycle training</td>
</tr>
</tbody>
</table>

### Active ankle ROM

<table>
<thead>
<tr>
<th>Goniometry*</th>
<th>≤90</th>
<th>Strengthening</th>
<th>Ankle/Foot Orthotics (AFOs)</th>
<th>Neuromuscular reeducation</th>
<th>Gait training</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤90*</td>
<td>Strengthening</td>
<td>Gait</td>
<td>AFOs</td>
<td>Motor skill training</td>
<td>Balance training</td>
</tr>
</tbody>
</table>

### Floor to stand

<table>
<thead>
<tr>
<th>½ kneel to stand*</th>
<th>Unable</th>
<th>Strengthening</th>
<th>Motor skill training</th>
<th>Needs upper extremity support</th>
<th>Strengthening</th>
<th>Motor skill training</th>
<th>Independent</th>
</tr>
</thead>
</table>

### Gait

<table>
<thead>
<tr>
<th>GAIT rite* 6 min Walk Test*</th>
<th>≤1.5-2 S.D.</th>
<th>Balance training</th>
<th>1–3.5 S.D.</th>
<th>Balance training</th>
<th>≤1 S.D.</th>
<th>Balance incorporated in physical activity</th>
</tr>
</thead>
</table>

### Balance

<table>
<thead>
<tr>
<th>Balance</th>
<th>≤1.5-2 S.D.</th>
<th>≤1 S.D.</th>
<th>≤1 S.D. below mean</th>
</tr>
</thead>
</table>

### Gross motor skills

<table>
<thead>
<tr>
<th>PDMS II or BOT-2⁺⁻¹</th>
<th>≤1.5-2 S.D. below mean</th>
<th>≤1-1.5 S.D.</th>
<th>≤1-1.5 S.D. below mean</th>
</tr>
</thead>
</table>

### Chemotherapy-induced peripheral neuropathy

<table>
<thead>
<tr>
<th>Pediatric-modified Total Neuropathy Score (ped-mTNS)*</th>
<th>5</th>
<th>&gt;10°</th>
<th>Moderate</th>
</tr>
</thead>
</table>

### TABLE 1.


### TABLE 2.

<table>
<thead>
<tr>
<th>PT visit type</th>
<th>Inpatient evaluation</th>
<th>Outpatient evaluation</th>
<th>Initial discharge</th>
<th>Follow-up outpatient evaluations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day post-diagnosis</td>
<td>Day 2–4</td>
<td>Weeks 6–8</td>
<td>Green criteria met</td>
<td>Every six months until two evaluations with no impairments</td>
</tr>
</tbody>
</table>

### Chemotherapy cycle

<table>
<thead>
<tr>
<th>Induction</th>
<th>Consolidation</th>
<th>Typically maintenance</th>
<th>Maintenance/post-treatment</th>
</tr>
</thead>
</table>

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