A Case Report

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In Partial Fulfillment of the Requirement
for the Degree of
Doctor of Physical Therapy

By
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This Case Report is submitted in partial fulfillment of the requirements for the degree of Doctor of Physical Therapy.

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The final copy of this case report has been examined by the signatories, and we find that both the content and the form meet acceptable presentation standards of scholarly work in the above mentioned discipline.
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Abstract

Background and Purpose: Necrotizing fasciitis (NF) is a rare flesh-eating bacterium that causes rapid necrosis of soft tissue and fascia. Recent literature has shown the importance of abdominal muscles in biomechanical body movements. The purpose of this case report is to describe the importance of coordinated care amongst multiple disciplines in the development of a novel and effective intervention for physical therapy for a patient with extensive muscle destruction from NF.

Case Description: The patient was a 16-year-old boy admitted to the pediatric intensive care unit with NF of the abdomen and Fournier’s gangrene, who underwent frequent debridement, muscle flaps, and split-thickness skin graft (STSG).

Intervention: Physical therapy was initiated on the first day of his hospital stay and was found to have decreased bilateral ankle dorsiflexion (DF) and positioning needs. Initial physical therapy interventions included passive range of motion (PROM), adaptive positioning techniques, and family education. As David’s medical condition improved, physical therapy interventions advanced to: active-assist range of motion (AAROM), active range of motion (AROM), transfer training, strengthening, postural training, and gait training with adaptations made for massive muscle destruction of the abdomen and perineum.

Outcomes: Prior to physical therapy intervention, David was dependent for all functional mobility and displayed significant ROM deficits. He discharged home with close supervision from family, independent with bed mobility and transfers, and ambulating 150 feet with a rolling walker (RW).
Discussion: This case report describes the massive muscle destruction caused by NF of the abdomen and perineum, and outlines the physical therapy interventions utilized to optimize David’s functional mobility. Further research is needed to examine the long-term emotional and physical outcomes of patients with NF.
Background and Purpose

Necrotizing fasciitis (NF) is a rare flesh-eating bacterium that causes rapid necrosis of soft tissue and fascia (Vayvada, Demirdover, Menderes, & Karaca, 2013). The incidence of NF is 0.4 cases per 100,000 (Trent & Kirsner, 2002). If not identified quickly and managed properly, it is frequently fatal. When NF involves the external genitalia and perineum, it is referred to as Fournier’s gangrene (Endorf, Supple, & Gamelli, 2005). Management of Fournier’s gangrene is difficult secondary to frequent contamination with bowel and urine (Vranckx & D’Hoore, 2012). Aggressive, repetitive debridement is essential to stop the progression of NF. Amputation is frequently a form of treatment for NF of an extremity but is not an option when it affects the central parts of the body. Thus, patients with NF of the trunk and perineal regions have a higher mortality rate than patients with NF of the extremities (Carter & Banwell, 2004).

Literature on the reconstruction of the perineum and abdominal wall in patients with NF discusses the importance of abdominal muscles in biomechanical body movements such as walking, bending, climbing, and posture (Vranckx & D’Hoore, 2012). Abdominal muscles also aide in visceral functions of digestion, micturition, defecation, respiration, and expectoration (Vranckx & D’Hoore, 2012). Without optimal support of the abdominal muscles, a patient is unable to independently complete everyday functional tasks.

Destruction of major muscle groups is a commonality in both third-degree burns and NF. Treatment for both injuries typically includes multiple skin grafts and muscle transfers, which can cause joint contractures and scarring. Distortion of skin and muscle increases a patient’s risk of functional loss as well as psychological problems (Deng et
al., 2016). Loss of functional skills can be compounded by: severe weakness, impaired motor control, decreased cognitive status, pain, risk of graft shearing, and psychological factors such as anxiety and the fear of falling (Trees, Ketelsen, & Hobbs, 2003).

Increasing evidence has shown that early rehabilitation strongly improves physical function (Burtin et al. 2009; Schweickert et al. 2009), thwarts complications such as intensive care unit (ICU) acquired weakness (Kayambu, Boots, & Paratz, 2015; Kress 2009), and reduces the occurrence of psychological symptoms (Jones et al. 2003) in critically ill patients. Deng et al. (2016) completed a retrospective cohort study assessing the effects of mobility training on severe burn patients in their Burn Intensive Care Unit (BICU). Mobility training included: active range of motion (AROM) exercises, transfer training, tilt table training, and progressive ambulation. They concluded that mobility training was effective in achieving better outcomes than passive training for severe burn patients.

Research reporting effective interventions for patients with severe burns can help inform practice for those with NF. However, current literature does not provide sufficient data focused specifically on NF of the central parts of the body. Thus, there is limited literature related to physical therapy interventions for patients with NF. The purpose of this case report is to describe the importance of coordinated care amongst multiple disciplines in the development of a novel and effective intervention for physical therapy for a patient with extensive muscle destruction from NF.
Case Description

Past Medical and Social History

For the purpose of this case report, the patient will be given the factitious name of David. David was a previously healthy 16-year-old boy with a past medical history of attention deficit hyperactivity disorder (ADHD) and bipolar disorder which was being treated with Abilify. His social history included: mother and step-father, five siblings with four still living in the home, and multiple cats and dogs in the home. David admitted to smoking cigarettes, smoking marijuana, and recent intermittent use of synthetic marijuana (Spice). He had undergone court order drug screens secondary to a previous encounter with law enforcement for vandalism. David had multiple school suspensions but was doing better once he made the school football team. According to David’s parents, he was a highly regarded football player, basketball player, and wrestler for his high school.

Initial Presentation

David presented to a small community hospital after a week and a half of chills, generalized weakness, lethargy, scrotal swelling, pain with breathing, abdominal pain, nausea, vomiting, and testicular pain. He delayed medical care secondary to attributing the abdominal pain from possible withdrawal from Spice and the testicular pain from getting kicked in the left groin area during wrestling practice.

Due to David’s critical status and suspected septic shock, he was flown to a larger hospital for higher management of care. He underwent an emergent laparoscopic appendectomy secondary to perforated appendicitis with significant diffuse peritonitis. David’s medical status stabilized, and he began to return to his prior level of function.
However, six days after the appendectomy David became lethargic, tachycardic, and tachypneic.

**Identification of NF and Surgical Interventions**

David underwent emergent exploratory surgery where NF of the abdomen, flank, and inguinal regions was found. Surgical intervention included extensive debridement of the scrotum as well as the abdomen and flank. Due to the extent of debridement, three wound vacuum assisted closures (VACs) were placed and he remained intubated after surgery. The following day David had a 106˚ rectal temperature and was suffering from acute kidney injury. Thus, he was transferred to a free standing pediatric hospital equipped with urologists and nephrologists.

At the pediatric hospital, David continued to be intubated and on the neuromuscular blockade Rocuronium. The following morning it was determined that the NF of the abdomen and flank had progressed to Fournier’s gangrene. David underwent widespread debridement that included the removal of fascia as well as entire muscles. The muscles removed were: right external obliques, right serratus anterior, and right inferior latissimus dorsi. Debridement extended from the right axilla down to one-third of the right upper leg, where the liver and colon were exposed, and from the left flank to the left inguinal region (Figure 1). The femoral vessels were protected, and the testes were exposed but tucked into the thigh pocket/inguinal canal for preservation. Three wound VACs (68x15 cm to right flank, 30x8 cm to right thigh and 30x8 cm to left flank/scrotum) were placed to optimize healing and vascularization to the areas. David experienced extensive blood loss and required bedside ligation of bleeding arteries as well as constant blood products.
Over the next four days, David returned to the operating room three times for therapeutic bronchoscopies as well as re-debridement of all areas to attain healthy bleeding tissue. A small abscess was drained and a right chest tube placed secondary to a large pleural effusion. After a week of hospitalization at the pediatric hospital, David underwent stage one of abdominal wall reconstruction by the plastic surgery group. A 20x20 piece of strattice dermal matrix was placed over the large abdominal wound. David underwent additional debridement two times, multiple wound VAC changes, and extubation during the next five days. Two days later he underwent stage two of abdominal wall reconstruction via abdominal strattice mesh and rotation flap of right gracilis muscle to perineum (Figure 2). Five days later, his right vastus lateralis muscle was rotated superiorly to assist in closing part of the right trunk defect (Figure 3). Three days later, David underwent another stage of abdominal wall reconstruction that included the placement of 700 square cm of cadaver skin. During that surgery, it was determined
that he had multiple abscesses, poor healing of previous right lateral thorax incision, and a large seroma. A week later, 32 ml of purulent fluid was removed from the right pleural cavity. Three days later, David suffered from bilateral enterocutaneous fistulae. Luckily with the cessation of nasogastric (NG) feeds, the fistula resolved without surgical intervention. David’s abdominal wound was closed ten days later via STSG from his left leg. Throughout all his surgeries, he was on various degrees of bedrest and activity restriction.

Figure 2. Right gracilis muscle flap to perineum.
Figure 3. Right vastus lateralis muscle rotated superiorly to close flank.

**Initiation of Physical Therapy**

Physical therapy was consulted on David’s first day of admission to the pediatric hospital for possible splint placement. He was critically ill, intubated, and medically paralyzed. David displayed global edema and passive neutral ankle DF bilaterally. Due to his expected prolonged intubation and immobility, he was provided bilateral pre-fabricated resting AFOs to maintain ankle ROM and optimize joint integrity needed for weight-bearing activities. Physical therapy assisted the bedside nurse in positioning the patient in a manner that would minimize global edema as well as offload the ischial tuberosities for optimal healing of the acquired sacral pressure injury. David’s parents were visibly distraught but insisted on actively helping in the patient’s recovery. Physical therapy educated David’s parents on proper donning and doffing of the resting AFOs, positioning techniques, and PROM of David’s extremities. David’s initial physical therapy frequency was 2x/week to minimize his risk of joint contractures as well as reduce his risk of further skin breakdown.
Clinical Impression #1

Due to the complex medical/surgical history, severity of his present condition, and varying degrees of activity restriction, David was at an increased risk of additional pressure injuries, joint contractures, and ICU acquired weakness. He was a good candidate for initiating a physical therapy examination and intervention because of his acquired sacral pressure injury, extensive muscle destruction requiring STSG, muscle flaps, and movement precautions set forward by the surgeons.

Physical Therapy Examination

A more extensive examination was performed two weeks after David’s first physical therapy evaluation. At that time, he was status post stage one and stage two of abdominal wall reconstruction as well as right gracilis muscle flap to the perineum. Plastic surgery allowed active and passive ROM to David’s tolerance. David was extubated but on 30L of Vapotherm; thus, still difficult for him to communicate his needs and wants. David’s overall ROM and mobility were limited by the placement of a right chest tube to wall suction, two large abdominal wound VACs to suction, and two Jackson Pratt (JP) drains.

The examination revealed: significant abdominal pain, decreased bed mobility, decreased AAROM, decreased activity tolerance, and decreased strength. David required moderate assistance to roll supine to left side-lying and maximum assistance to roll supine to right side-lying. Right lower extremity (LE) AAROM was substantial for: 40° knee flexion, 10° straight-leg raise (SLR), and 20° of hip internal rotation (IR). Left LE AAROM was noteworthy for: 70° of knee flexion and 30° of SLR. David lacked 20° of full right neck rotation. AROM of bilateral ankles to neutral ankle DF. With his head of
bed (HOB) elevated to 45°, he lifted his back 30° off the bed with hand-held assist times two. David required frequent rest breaks due to poor breath support. Strength was not formally assessed due to the absence of muscles, pain with tactile stimuli, and inability to move his LEs without assistance. Transfers were not assessed secondary to his pain and the limitations of his medical equipment.

Clinical Impression #2

Prior to this hospitalization, David had fully intact muscles, was independent with all functional mobility, and was a multi-sport high school athlete. On examination in the hospital, the patient was found to have permanent, extensive muscle destruction which resulted in prolonged dependency of respiratory support, global pain, decreased AAROM of LEs, generalized weakness, postural abnormalities, and significant decline in functional mobility. Early initiation of physical therapy to facilitate a “new way” to complete functional tasks without major muscle groups was necessary.

Intervention

Due to the David’s medical condition changing day-to-day, every therapy session began with communication with the surgeons and/or nursing staff as well as examination of his current functional status. Daily examination included but was not limited to: pain, alertness, ROM, strength, positional needs, activity tolerance, functional mobility, and family education. The intervention was deemed effective if “old” goals were met and “new” goals were established. The ultimate outcome was for David to live as normal of a life as possible, despite significant scarring from widespread muscle destruction caused by NF.
After the physical therapy examination, David’s frequency was increased to 6x/week. Therapy sessions focused on bed level activities that included: modified crunches, bilateral LE strengthening exercises, stretching of bilateral hamstrings and gastrocnemius muscles, AROM of neck in all positions, and education on a home exercise program (HEP). The HEP included ankle pumps, straight leg raise (SLR), heel slides, and bilateral hip IR/ER.

Over the next week, David underwent right vastus lateralis muscle flap to his abdomen to provide visceral support and instructed to avoid “crunches.” To optimize his hemodynamics and to introduce gentle LE weight-bearing activities, a tilt table was utilized in treatment sessions. The incline of the tilt table was gradually increased to facilitate tolerance to a more upright position. Full upright on the tilt table was never achieved secondary to 6/10 right LE pain.

David underwent placement of allograft skin to his abdomen in prep for STSG. The plastic surgeon approved out of bed (OOB) activities if there was no friction, torsion, or touching of the right flank area. David was dependently lifted into a cardiac chair to avoid any shearing forces. His functional mobility was limited that week due to 7/10 stomach pain and emotional instability secondary to his family not being at bedside. To improve his mental state, physical therapy coordinated with nursing staff to allow him to go outside. An egg-crate was placed in the cardiac chair to offload his ischial tuberosities to optimize comfort and to allow healing of his previously acquired sacral pressure injury. David displayed decreased tolerance to his legs in the dependent position secondary to increased stretch on the right hip flexors.
David’s movement restrictions were lifted; thus, physical therapy intervention for the next two weeks focused on bed mobility, transfer training, bilateral LE weight-bearing, and pre-gait activities with the absence of major muscle groups. Bed mobility and transfer training were primarily completed on the left side of his body secondary to missing right-sided musculature. Bed mobility always consisted of verbal and tactile cues for proper hand placement on bed railings to assist with log-rolling and to transition from laying on his side to sitting edge of bed (EOB). Log rolling was chosen over a traditional supine to sit transfer due to the extensive muscle destruction and inability to recruit his abdominal musculature. David was unable to stand fully upright due to abdominal weakness and a muscle bulge in the right groin area from the vastus lateralis flap. To optimize David’s OOB mobility outside of therapy sessions, his parents were trained on proper transfer techniques to safely assist him with bed mobility, sitting EOB, and bed to wheelchair (w/c) transfers. As David’s family became independent with transfers, David rapidly improved his overall functional mobility. With the cessation of weekly surgeries and with the gradual increase in anti-gravity strength, David began to complete his therapy sessions in the rehabilitation gym. Therapy interventions in the rehabilitation gym consisted of: LE weight-bearing and weight-shifting while standing in parallel bars, standing activities with the RW to improve his balance, and short ambulation with the RW. Special attention was given to activation of the remaining right quadricep muscles and elongation of bilateral hip flexors and hamstrings to facilitate equal weight-shift with all functional activities. Postural training for midline, upright alignment in standing was provided with verbal cues and demonstration. Attempted
visual cues of a mirror, however, David became extremely emotional upon his “new” image and requested to no longer use the mirror during therapy.

Two and half weeks prior to David’s discharge from the hospital, he underwent his final surgery: STSG from his left thigh to his right flank area with the application of two abdominal binders. David was placed on bedrest for three days with the instructions for log roll only, no twisting his abdomen, no LE ROM but approved AROM of bilateral upper extremities (UEs). With mobility precautions and tremendous pain with log rolling, David suffered a minor setback in his functional mobility. Physical therapy intervention while on bedrest consisted of log rolling and bilateral UE strengthening exercises with five-pound hand weights. David was allowed OOB on post-op day four but was instructed to avoid prone position and any passive hip flexor stretching for six weeks. Physical therapy intervention focused on learning adaptive movement patterns to optimize his independence with all functional mobility. Adaptive movement patterns included using a RW and forward momentum of his upper body with transfers and ambulation due to his inability to fully extend his right hip and knee from a surgical hip flexor contracture and absence of quadriceps musculature, respectively. Due to David’s prolonged hospitalization, he voiced that he wanted to go home with outpatient physical therapy rather than go directly to inpatient rehab. David was instructed that to go home with assistance from his family, he had to meet the following goals: demonstrate independence with all bed mobility and transfers as well as ambulate at least 150 feet with a RW and close supervision. Table 1 contains a summary of David’s physical therapy interventions over the course of his hospitalization.
Table 1
Weekly Physical Therapy Interventions

<table>
<thead>
<tr>
<th>Period</th>
<th>Clinical Challenges</th>
<th>Interventions</th>
<th>David’s Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>intubated and heavily sedated</td>
<td>communication techniques: shake head yes and no or thumbs up for “yes” and thumbs down for “no”</td>
<td>happy that basic needs were understood but frustrated that he couldn’t fully communicate needs/wants</td>
</tr>
<tr>
<td></td>
<td>mildly tight gastrocnemius muscles due to degree of debridement and removal of muscles, tilting of bed allowed but no flexing of trunk</td>
<td>provided pre-fabricated AFOs, on 2 hours/off 2 hours</td>
<td>parents stated they felt he “liked” the AFOs; David maintained neutral ankle alignment</td>
</tr>
<tr>
<td></td>
<td>sacral pressure injury</td>
<td>tilted bed to 6-7°</td>
<td>tolerated less than 3 minutes</td>
</tr>
<tr>
<td></td>
<td>no ROM of shoulders, trunk, or hips due stage 1 abdominal surgery</td>
<td>off-loaded pressure on ischial tuberosities in supine</td>
<td>nodded head “yes” when asked if that position felt better</td>
</tr>
<tr>
<td></td>
<td></td>
<td>taught parents positioning, PROM of allowed joints</td>
<td>occasional grimace with PROM but overall appeared more comfortable when repositioned</td>
</tr>
<tr>
<td>Week 2</td>
<td>extubated but on Vapotherm: quickly fatigued and occasional desaturations</td>
<td>worked on abdominal support techniques, such as abdominal splinting, to optimize breath support</td>
<td>refused to wear an abdominal binder or participate in abdominal splinting; decided to not talk or whisper</td>
</tr>
<tr>
<td></td>
<td>extreme weakness due to prolonged bedrest and recent stage 2 abdominal wall surgery with right gracilis muscle flap to perineum</td>
<td>attempted sitting EOB; implemented modified crunches; worked on bed mobility: log rolling bilaterally; bed in chair mode up to 70°; provided HEP: ankle pumps, SLR, heel slides, hip IR/ER</td>
<td>abdominal pain after 3-4 minutes sitting EOB, dropped oxygen to 87-88%; used shoulders to help reposition but required max assist to roll due to pain and weakness</td>
</tr>
</tbody>
</table>
### Physical Therapy Interventions

<table>
<thead>
<tr>
<th>Period</th>
<th>Clinical Challenges</th>
<th>Interventions</th>
<th>David’s Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 2</td>
<td>strong preference for left neck rotation &amp; left lateral trunk flexion due pain and weakness; minimal space to assist due to drains and staples</td>
<td>AROM and strengthening of right neck and trunk; postural training with verbal cues and tactile facilitation</td>
<td>AROM of right neck rotation to 70-80°, held &lt;5 seconds at a time; unaware of right trunk weakness, full support for midline posture</td>
</tr>
<tr>
<td>Week 3</td>
<td>continued significant weakness especially of abdomen and right UE/LE due to recent surgeries</td>
<td>manually resisted ankle DF/PF and heel slides; long arc quads (LAQs)</td>
<td>2/5 bilateral ankle DF, 4/5 bilateral ankle PF, minA for left heel slide and maxA for right heel slide, quad strength with LAQ: 3/5 on left and 1/5 on right</td>
</tr>
<tr>
<td></td>
<td>no crunches due right vastus lateralis muscle flap to right flank; chest tube out but now with 5 JP drains</td>
<td>transferred to tilt table: pinned drains to gown and avoided shearing forces; dependent x4 people</td>
<td>40° for 15 minutes, rest at 25° for 4 minutes then another 3 minutes at 40°; refused tilt table next day</td>
</tr>
<tr>
<td>Week 4</td>
<td>s/p allograft skin graft to right flank: approved OOB activities if no friction, torsion, or touching of the right flank area depression</td>
<td>dependent lift to cardiac chair: 4 people due to weakness and multiple lines/leads</td>
<td>Tolerated 1 hour with head elevated 30-40°, quiet but appeared relaxed, stay outside for 30 minutes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>outside (in cardiac chair) 1st time since hospitalized</td>
<td></td>
</tr>
<tr>
<td>Weeks 5 &amp; 6</td>
<td>no movement precautions: significant weakness and functional limitations due to massive muscle destruction</td>
<td>rehab gym: weight-bearing, weight-shifting, and pre-gait activities: squats, steps in parallel bars; postural training, elongation of hip flexors and hamstrings with active hip extension</td>
<td>required 1-2 minutes sitting rest break after every 2-3 minutes of standing activity; emotional break-down as struggled with simple tasks; cried when saw himself in mirror for 1st time, refused to look until after discharge</td>
</tr>
</tbody>
</table>
Table 1 (continued)

Physical Therapy Interventions

<table>
<thead>
<tr>
<th>Period</th>
<th>Clinical Challenges</th>
<th>Interventions</th>
<th>David’s Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weeks 7 &amp; 8</td>
<td>STSG of left thigh to right flank: bedrest for 3 days with log roll only, no twisting abdomen, no LE ROM but approved ROM of bilateral UEs significant scarring and absence of major muscle groups</td>
<td>worked on patient being independent with log rolling and improving UE strength with use of 5 lb weights to improve transfers adaptive ways to be independent with bed mobility, transfers, and walk 150 feet with RW: bed mobility with bed flat, transfers with 1 hand on RW and 1 hand on chair/bed, and gait with RW: verbal and visual cues for upright trunk to decrease risk of falls at home</td>
<td>5-7/10 pain with rolling; became emotional, required non-pharm pain: deep breathing and distraction, to calm determined to be independent, refused assistance from therapists or family; attempted to stand upright but kyphotic thoracic trunk and at least 45° bilateral trunk flexion due to permanent changes to physical structure</td>
</tr>
</tbody>
</table>

Interdisciplinary Team

Due to the severity of David’s condition and his prolonged hospitalization, multiple disciplines were involved in his care in addition to physicians, nursing, and physical therapy. David received occupational therapy (OT) throughout his entire hospitalization to facilitate independence with his activities of daily living (ADLs) to return to his prior level of function. Speech therapy (ST) was involved at the beginning of his hospitalization to optimize breath support to allow for audible communication and prevent aspiration pneumonia during re-introduction of food. Child life, palliative care, music therapy, and pet therapy provided diversion activities to minimize the stress of a prolonged hospitalization. Psychology provided coping techniques to deal with stress,
Outcomes

All the David’s goals developed during initial evaluation were met within the first month of intervention. He met his goal to tolerate LE splints on for two hours and off for two hours in one week. Within two weeks, David’s parents verbalized and demonstrated understanding of ROM, splint wear, and positioning techniques with 100% accuracy. David was breathing on room air and maintaining optimal oxygen saturations within one month.

New goals were added to David’s plan of care as he progressed with his functional mobility, approximately one goal a week (Table 2). On the day of discharge from the hospital, David had met all but two of his goals. He was pain free and completed all bed mobility and transfers with modified independence. David ambulated a minimum of 150 feet with modified independence and RW but displayed at least 45° bilateral hip flexion. His balance had slightly improved but still unable to stand without assistance for more than five seconds at a time. David was discharged home with close supervision from family and was provided a RW for household distances and a rental w/c for distances more than 150 feet. He was scheduled for an outpatient physical therapy evaluation at a sports clinic near his home within one week of discharge from the hospital.
Table 2
Physical Therapy Goal Completion

<table>
<thead>
<tr>
<th>Goal</th>
<th>Baseline</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient will display at least 4/5 LE strength bilaterally 2/3 trials</td>
<td>Established week 2: Left knee flexion: 2/5</td>
<td>Not met at discharge: Left knee flexion: 3+/5</td>
</tr>
<tr>
<td>in prep for more independent functional mobility.</td>
<td>Right knee flexion: 2-/5</td>
<td>Right knee flexion: 3/5</td>
</tr>
<tr>
<td></td>
<td>Left ankle DF: 2/5</td>
<td>Left ankle DF: 3+/5</td>
</tr>
<tr>
<td></td>
<td>Right ankle DF: 2/5</td>
<td>Right ankle DF: 3+/5</td>
</tr>
<tr>
<td>Patient will tolerate bed in chair mode at 80° of head elevation for</td>
<td>Established week 3: Tolerated 70° for 7-8</td>
<td>Goal discontinued at week 4: patient allowed</td>
</tr>
<tr>
<td>at least an hour 2x/day for improved pulmonary function and to</td>
<td>minutes</td>
<td>OOB, thus, bed in chair mode was no longer</td>
</tr>
<tr>
<td>improve overall endurance in prep for more independent functional</td>
<td></td>
<td>an appropriate goal</td>
</tr>
<tr>
<td>mobility.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient will tolerate 20 minutes of tilt table at least 60 degrees</td>
<td>Established week 3: 30° tilt for 8 minutes</td>
<td>Goal discontinued at week 4: Patient with</td>
</tr>
<tr>
<td>2/3 trials to promote LE weight bearing in prep for ambulation.</td>
<td></td>
<td>strong dislike after 2 attempts, refused tilt</td>
</tr>
<tr>
<td></td>
<td></td>
<td>table on 3rd session</td>
</tr>
<tr>
<td>Patient will independently sit EOB, without UE support, for 20</td>
<td>Established week 5: Sat EOB with mod</td>
<td>Goal met at week 7: Sat independently EOB</td>
</tr>
<tr>
<td>minutes 2/3 trials to facilitate more independent functional</td>
<td>assistance (A) for 20 minutes</td>
<td>for 20 minutes 100% of time</td>
</tr>
<tr>
<td>mobility.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient will transfer bed to/from w/c with close supervision 2/3</td>
<td>Established week 5: maxA bed to w/c minA w/c</td>
<td>Goal met at week 7: Modified independent bed</td>
</tr>
<tr>
<td>trials for more independent functional mobility.</td>
<td>to bed</td>
<td>to/from w/c</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient will ambulate 50 feet with RW and minA 2/3 trials in prep</td>
<td>Established week 5: 5 feet in parallel bars</td>
<td>Goal met at week 7: 50 feet with RW and CGA</td>
</tr>
<tr>
<td>for more independent functional mobility.</td>
<td>with close supervision 1x</td>
<td>2/3 trials</td>
</tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient will verbalize pain less than 3/10 for 2 consecutive</td>
<td>Established week 6: 5/10 shoulder pain</td>
<td>Goal met at week 7: 0/10 pain for 2</td>
</tr>
<tr>
<td>sessions to optimize mobility.</td>
<td></td>
<td>consecutive sessions</td>
</tr>
</tbody>
</table>
Table 2 (continued)
Physical Therapy Goal Completion

<table>
<thead>
<tr>
<th>Goal</th>
<th>Baseline</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parents will be independent with transfers after STSG to optimize patient’s functional mobility.</td>
<td>Established week 7: minAx1</td>
<td>Goal met at discharge: Independent with all transfers</td>
</tr>
<tr>
<td>Patient will ambulate 150 feet with RW and close supervision 2/3 trials to facilitate more independent functional mobility.</td>
<td>Established week 7: 50 feet and 44 feet with RW and CGAX1</td>
<td>Goal met at week 8: 150 feet with RW and close supervision 2/3 trials</td>
</tr>
<tr>
<td>Patient will ambulate 200 feet independently with RW and upright posture 2/3 trials for more age-appropriate gait pattern.</td>
<td>Established week 7: 590 feet with RW and at least 60° hip flexion</td>
<td>Goal not met at discharge: 150 feet modified independent with at least 45° hip flexion</td>
</tr>
<tr>
<td>Patient will always display good static standing balance to facilitate more independent functional activities.</td>
<td>Established week 8: poor static standing balance</td>
<td>Goal not met at discharge: poor static standing balance, less than 5 seconds alone</td>
</tr>
</tbody>
</table>

**Post-Discharge**

David returned to the hospital a month after being discharged to receive intravenous antibiotics for a small abscess on his left leg (Figure 3). Due to his short stay, no acute PT was initiated. David and his mother reported that he had been receiving outpatient physical therapy 3x/week for LE strengthening, postural training, and gait training. David had return to school full-time the previous week and was independently ambulating around his school’s campus with good balance and without any signs of fatigue. David stated he was participating in boxing and the only thing he could not do was run forward.
Discussion

The purpose of this case report was to describe the importance of coordinated care amongst multiple disciplines in the development of a novel and effective intervention for physical therapy for a patient with extensive muscle destruction from NF. This case report has shown how strong, coordinated care between a solid multidisciplinary team in the treatment of an extremely complex case with major surgical interventions and permanent changes to physical structure led to a remarkable outcome.

The mobility functions of the bed and the cardiac chair allowed for a change in position as well as placing the patient’s legs in a dependent position for improved
circulation. Due to the passive nature of a tilt table, it is rarely used in any physical therapy setting anymore. However, due to David’s activity restrictions, inability to tolerate his legs in the dependent position, and his emotional instability from being dependent on other people, a tilt table was a critical intervention in his recovery. Trees, Ketelsen, and Hobbs (2003) explained how the utilization of a tilt table as a form of physical therapy intervention not only provided weight through the patient’s LEs but also offered a greater sense of motivation and achievement when he/she was able to complete an activity without assistance.

Being in a hospital is a journey that includes multiple encounters that may impact the success of any intervention (Muhammad, Almadani, Hashemi, & Liaqat, 2015). Progressive care between physicians, nursing, PT, and the addition of other healthcare professions allowed for a remarkable outcome for David. Other healthcare professions included OT, ST, psychology, and nutrition. OT frequently collaborated with PT to determine the safest, most efficient way for David to complete his ADLs. Early introduction of ST for communication allowed David to express his needs and wants to minimize the frustration of not being about to vocalize. Psychology provided an integral part in the treatment of the David’s depression. Management of total parenteral nutrition (TPN) from the nutritionist allowed for David’s increased protein production essential in optimal wound healing throughout his hospitalization.

There were several limitations of this case report. This case report was centered around a single patient. Patients with NF present in unique ways; thus, the interventions in this case report may not be appropriate for every patient with NF. This case report provided intervention for a 16-year-old male. NF can affect either gender and is not age-
specific. Due to the high mortality rates from NF, there is an extreme lack of research on physical therapy intervention in patients with NF. Limited research does not allow for a standardized protocol for a diagnosis. A technique that was not utilized with this patient but could have potentially benefited him was the use of a customized abdominal brace for improved abdominal support. Suzara and Oken (2014) found significant functional gains with the use of a custom abdominal brace that provided lumbar and abdominal support in an adult female with functional limitations after the removal of abdominal tissue from NF.

**Conclusion**

This case report highlights the importance of a strong multidisciplinary team in the development of physical therapy interventions for an extremely complex case of NF that required major surgical interventions and resulted in permanent changes to his physical structure. Coordination of the surgeon’s approval of the progression of movements and the therapists’ selection and progression of appropriate activities and assistive devices was vital in the patient’s notable outcome. The multidisciplinary team approach addressed each of the discipline-specific issues and allowed PT to use adaptive techniques to improve the patient’s ROM, strength, and activity tolerance needed for him to be independent with his functional mobility.

Permanent, major muscle destruction not only changes a person physically but emotionally. Muhammad et al. (2014) state it has been made known that even one year after discharge from the hospital many patients stricken with life-threatening illnesses have not returned to work due to psychological and physical issues. The severity of the patient’s muscle destruction and emotional distress from NF could have resulted in an
unfavorable outcome; however, the multidisciplinary team approach allowed the patient to emotionally cope and accept his physical deformities. It is critical for physical therapists to be aware of the psychological impact that life-threatening disorders have on patients and seek advice from the multidisciplinary team on how best to address patients’ needs. Further research is needed to examine the long-term physical and emotional outcomes of patients with NF.

NF is often a fatal condition. Quick medical intervention and early initiation of PT resulted in an optimal outcome in a critically ill adolescent with NF. Communication with the surgeons led to appropriate PT interventions for an adolescent with permanent physical deformities from severe muscle destruction. PT intervention started with the development of communication techniques and breath support activities from ST that assisted with the patient’s tolerance of position changes in the bed that led to eventual progression to OOB activities. OT assisted PT with the facilitation of the patient’s independence with bed mobility, transfers, and ADLs as well as the development of adaptive strengthening exercises that optimized his overall functional mobility. Without a multidisciplinary approach, PT intervention would not have been successful for this patient.
References


