Thoracic insufficiency syndrome is the inability of the thorax to support normal respiration or lung growth. The term thoracic insufficiency syndrome (TIS), introduced in 1992 by Campbell and Smith, is defined as “the inability of the thorax to support normal respiration or lung growth.” TIS may cause respiratory insufficiency, as indicated by a requirement for oxygen or a need for respiratory support via noninvasive or invasive positive pressure ventilation. However, the diagnosis of TIS does not depend on the presence of respiratory insufficiency. Campbell and Smith recommend the following to aid in diagnosing TIS: “a comprehensive history, physical examination, radiographs, computed tomography scans, lung scans, other imaging studies, arterial and capillary blood gases, pulse oximetry, echocardiograms, and, when feasible, pulmonary function testing.” The severity of TIS and whether or not it is progressive must be determined. Mild TIS may need monitoring but not active intervention. Monitoring for mild TIS may include serial radiographs and physical examination every 4 to 6 months. If untreated, progressive TIS can result in respiratory insufficiency. Goals in treating TIS are to restore thoracic volume and function and to allow for growth of the thorax.
Scoliosis is a lateral curvature spinal deformity. Congenital scoliosis with fused or absent ribs can cause a restrictive thoracic deformity that may contribute to TIS. Traditional correction of scoliosis with spinal fusion may be problematic in children who have not reached skeletal maturity. This problem is due to the need for continued spinal and thoracic growth to avoid stunted vertical growth of the spine and further worsening of TIS by restricting the linear size of the thorax. Karol et al reported that patients who had thoracic spine fusions before the age of 9 years had a high rate of severe restrictive lung disease as evidenced by smaller forced vital capacities. In addition, the amount of reduction in the height of the thoracic spine was correlated with smaller forced vital capacities, suggesting an increased risk of restrictive lung disease with more extensive fusions. Separating the effect of the reduced height of the thoracic spine from the effect of the spinal deformity on pulmonary function is a challenge, and both may play a part in the development of thoracic insufficiency syndrome in patients with scoliosis who undergo spinal fusions early in life. Additionally, if the cause of TIS is due to unilateral or bilateral thoracic deformities, correction of scoliosis alone will not address the restricted size of the thorax.

The vertical expandable prosthetic titanium rib (VEPTR) was designed by Dr Robert Campbell in 1989 to specifically address the scarcity of treatments to correct the 3-dimensional deformity of the thorax (Figure 1). A VEPTR was first successfully implanted in a patient at Christus Santa Rosa Children’s Hospital in San Antonio, Texas. The goal of treatment with a VEPTR is “to achieve the largest, most symmetrical, most functional thorax by skeletal maturity.”

A detailed description of the commonly used expansion thoracostomy surgical technique and insertion of a VEPTR device was published in 2004. In summary, an expandable titanium prosthesis is inserted on the posterior part of the rib cage (Figure 1). One end is hooked to a superior rib and the other end is attached to an inferior rib, the spine, or the ipsilateral iliac crest. After implantation, the rods are covered by soft tissues and muscle, and the incision is sutured closed. These VEPTR devices are serially expanded 2 to 3 times a year to allow for growth as the child ages.

In this article, I describe current practices related to the VEPTR procedure in children with TIS and scoliosis and the nursing implications for the care of these patients. Topics include indications, postoperative nursing care, potential complications, long-term follow-up, quality-of-life issues, and implications for critical care and advanced practice nurses.

**Indications**

After a successful single-site, feasibility device trial conducted under an investigational device exemption from the Food and Drug Administration from 1992 to 1994, a multicenter trial was conducted. Similar success in the multicenter trial led to the approval of the VEPTR device under the Humanitarian Device Exemption.
Program in 2004. The approved indication for the VEPTR device is treatment of thoracic insufficiency syndrome in infants and children who are more than 6 months old but have not yet reached skeletal maturity.6 These patients may have TIS caused by congenital scoliosis with fused or absent ribs, neuromuscular or congenital scoliosis without fused ribs, or hypoplastic thorax syndrome (eg, Jeune syndrome, Jarcho-Levin syndrome, achondroplasia). A humanitarian use device is meant to benefit patients with diseases or conditions that affect fewer than 4000 individuals in the United States per year.7

Campbell and Smith2 describe 4 types of “thoracic volume–depletion deformities” as follows: type I, rib absence and scoliosis; type II, fused ribs and scoliosis; type IIIa, foreshortened thorax; and type IIIb, narrowed thorax (Figure 2). In types I and II, the thoracic cage is affected unilaterally, whereas in types IIIa and IIIb, the thorax is affected bilaterally. First described by Campbell et al,4 variations of the VEPTR implantation procedure are used to address these types of deformities.

Over the years, surgeons have expanded use of the VEPTR, working to correct spinal curvatures to maximize thoracic capacity while allowing for linear spinal growth. Other conditions in which a VEPTR has been used include multiple congenital spine deformities, early-onset progressive neuromuscular scoliosis, congenital scoliosis, early-onset scoliosis, infantile idiopathic scoliosis, and myelomeningocele kyphosis.8-13

Only a few published articles delineate experience with VEPTR devices in treating TIS in spondylocostal dysplasia,14 infantile idiopathic scoliosis,15,16 and thoracic kyphosis.1 In a retrospective review published in 2011, Reinker et al15 examined VEPTR devices as a means to control progressive kyphoscoliosis. In an article published in Poland in 2011, Latalski et al10 included kyphosis associated with myelomeningocele as an indication for a VEPTR.

Postoperative Management
Length of Stay

In a single-institution study by Campbell et al,17 a total of 41 patients with congenital scoliosis and fused ribs underwent an opening wedge thoracostomy and VEPTR insertion, and 27 of these were followed up for at least 2 years (mean, 5.7 years). For the initial insertion surgery, among the 27 patients followed up, mean stay in the intensive care unit (ICU) was 7.3 days (range, 2-28 days), and the mean total hospital length of stay was 14 days (range, 9-35 days). After initial insertion surgery, 13 of the 27 required a blood transfusion within the first 2 days after surgery, although blood loss was minimal.

In 2005, Emans et al18 reported the results of their clinical trial of VEPTR devices in which they assessed the safety and efficacy of the expansion thoracostomy surgical technique and the device. A total of 31 patients had VEPTRs placed and were followed up for as long as 5.2 years. In this study, postoperative recovery occurred in the ICU after the initial surgery, and patients remained intubated from 8 hours to 9 days. One postoperative intervention to promote wound healing was the use of foam protectors to protect the skin over prominent devices. Additionally, Campbell’s surgical procedure for the lengthenings or expansions was modified to minimize wound dehiscence and infection by shifting the deep muscular incision to an area separate from the small skin incision at the original surgical site.

The trial conducted under an investigational device exemption from the Food and Drug Administration provided data on 214 patients who received a VEPTR and an additional retrospective analysis of 20 patients with spondylocostal dysplasia.14 Ramirez et al14 reported that those patients were hospitalized 5 to 29 days (mean, 11 days).
Schulz et al\textsuperscript{15} reported on 8 patients who had VEPTRs placed for infantile idiopathic scoliosis. Gadepalli et al\textsuperscript{19} published an article on the 29 VEPTR insertions and 57 lengthening procedures performed on 26 patients in one institution. After initial implantation, mean ICU length of stay was 2.72 days, and mean hospital length of stay was 6.72 days. The postoperative course for the lengthening procedures was characterized by mean stays of 0.26 days in the ICU and 2.44 days in the hospital. Three transfusions were necessary for postoperative bleeding in this study, and 4 patients required placement of a chest tube because of pneumothoraces.

All of these studies\textsuperscript{14,15,17-19} were relatively small clinical series with relatively short follow-up periods, and the results varied widely from study to study. Of note, the treatment populations were widely heterogeneous. In some studies, the sample consisted mostly of patients with certain rare syndromes, whereas in other studies, the sample included a mixture of patients with various rare diseases. These differences may explain the variations in hospital and ICU lengths of stay.

**Monitoring**

In an article published in 2010, DiFazio and Tubman\textsuperscript{20} provide a detailed review of the important aspects of postoperative nursing care for patients who have undergone VEPTR implantation. Table 1 is a summary of necessary postoperative monitoring. Monitoring hemodynamic parameters is important in the postoperative period. Vital signs should be documented per ICU standards, generally hourly. In 3 studies, minimal intraoperative blood loss was reported; mean estimated blood loss was 68 mL (range, 5-400 mL),\textsuperscript{14} 57 mL (range, 4-220 mL),\textsuperscript{17} and 75 mL (range, 25-150 mL).\textsuperscript{13} However, as with any surgery, patients may still have fluid shifts in the body and thus require close observation of fluid balance. Additionally, patients may lose blood postoperatively through drains, chest tubes, or oozing surgical sites. Practitioners must monitor electrolyte and hemoglobin levels, correct any metabolic derangements, and decide if transfusions are necessary on the basis of the hemoglobin levels. Bedside nurses must complete frequent neurovascular checks, because this surgery is associated with risk for brachial plexus injury and spinal cord injury.\textsuperscript{5} Patients may return from the operating room with a chest tube in place.\textsuperscript{21} Campbell et al\textsuperscript{4} removed chest tubes once drainage was less than 1 mL/kg per day; however, the time of removal may vary from patient to patient and according to the surgeon’s preference. Patients may also return with a closed-suction medical device (Jackson-Pratt drain) in place for collecting fluids from the surgical site.

**Pulmonary Function**

In their description of the surgical procedure, Campbell et al\textsuperscript{4} noted that most patients remain intubated and are treated with mechanical ventilation for 3 days. Children may remain intubated in the ICU after initial placement of the VEPTR device and then progress toward extubation.\textsuperscript{18} After extubation, incentive spirometry\textsuperscript{20} and chest physiotherapy are initiated to optimize pulmonary toileting. In a multicenter retrospective study\textsuperscript{22} of 54 children who had VEPTRs implanted, acute respiratory insufficiency developed in 3 children in the immediate postoperative period. This finding highlights the importance of frequent assessments of respiratory status. Hasler et al\textsuperscript{9} reported no postoperative pulmonary problems in their retrospective study of 23 children who had implantation of a VEPTR device to treat noncongenital early-onset spine deformities.

On the basis of my experience in caring for patients with TIS who required tracheostomy and long-term...
ventilator support, increases in ventilator settings may be needed postoperatively, especially if continuous infusion of a narcotic is required for pain management. Stabilization and expansion of the thorax occurs through serial prosthetic lengthenings. Decreases in ventilator settings or the ability to be weaned from mechanical ventilation may occur with this stabilization, although no definitive evidence of improved pulmonary function after VEPTR placement has been reported. Emans et al\(^\text{18}\) reported improvements in lung volumes and spinal curvature, but at the last follow-up, all patients still had TIS. Gadeppali et al\(^\text{19}\) did not think that placement of a VEPTR improved overall pulmonary status. Some surgeons are more conservative in their expectations of VEPTR placement; their aim is not curative treatment, but rather stabilization of the thorax and improvement in pulmonary function, thereby improving quality of life for the child and the child’s family.

Another challenge is the lack of a consistent method for measuring pulmonary function to determine the impact of VEPTR placement. Hemoglobin levels have been investigated as a surrogate marker of pulmonary function, owing to limitations of the current techniques of computed tomography of the thorax and pulmonary function tests (PFTs), as PFTs can be used only when a child is developmentally able to perform them.\(^\text{5,23}\) Information on patients with tracheostomies and ventilator dependence who undergo VEPTR implantation is limited. Emans et al\(^\text{18}\) reported that 2 patients who had tracheostomies and were ventilator dependent before VEPTR placement no longer required ventilator support at the last follow-up after lengthening or expansions. Campbell et al\(^\text{17}\) recounted that 1 patient was able to be weaned off continuous positive-airway pressure support and supplemental oxygen and have the tracheostomy removed with no residual oxygen requirement.

### Pain Management

Another aspect of VEPTR postoperative management is pain control. Adequate pain management is important. Management relies on frequent pain assessments with appropriate pain scales and the use of devices for patient-controlled analgesia with intravenous narcotics for patients who are able to use such a device. For patients who cannot use a device for patient-controlled analgesia, a continuous narcotic infusion can be used, with as-needed doses available to be administered by a nurse for breakthrough pain. Transition to enteral pain medications can occur when bowel function returns.\(^\text{20}\) In my experience, diazepam may be used as needed for muscle spasms. Pain after expansion or lengthening and revision surgeries can be managed by using as-needed doses of morphine, oxycodone, acetaminophen, and diazepam for muscle spasms.

### Incision Care

The incision site is covered with a foam protective dressing and should be kept dry and intact.\(^\text{4}\) In efforts to prevent wound complications, surgeons place as much muscle as possible over the soft tissues covering the device, aiming to minimize skin sloughing.\(^\text{5}\) Dressings are changed according to the orthopedic surgeon’s plan. The dressing should be inspected each shift by a nurse, and the surgical team should be notified of nonintact dressings or drainage. When dressing changes are performed, the incision should be inspected for any signs of infection. In addition to inspection for drainage, dressings should be assessed for contamination by urine or feces; many patients who have a VEPTR procedure are incontinent because of their age or their disease. Proper postoperative positioning works to promote wound healing. For patients who cannot reposition themselves, their positions should be changed at least every 2 hours. Patients should avoid lying on the incision site because of the risk for skin breakdown or dehiscence. Complications can extend ICU and overall hospital stays.

### Potential Complications

Implantation of a VEPTR device and serial expansions are not without risk. Some of the complications are related to the repetitive nature of these expansions, because the original incision is the portal of entry.\(^\text{5}\) Potential complications are listed in Table 2. Complications that have occurred include wound dehiscence,\(^\text{17,24}\) skin sloughing,\(^\text{9,14,15,17,18,21,22,26-30}\) infection of the device or surgical site,\(^\text{9,14,15,17,18,21,22,24,26-30}\) migration of the device,\(^\text{12,15,18,21,22,26-28}\) breakage of the implant,\(^\text{9,10,12,11,26}\) rib fractures,\(^\text{10,18,22,21,27}\) and neurological injuries such as acute brachial plexus palsy,\(^\text{17,18,22,29}\) or spinal cord injury.\(^\text{17}\) A few patients in some studies had respiratory complications, including...
pneumothorax intraoperatively,\textsuperscript{10,12,22} pneumonia,\textsuperscript{12,18} acute respiratory distress syndrome,\textsuperscript{17,18} respiratory distress intraoperatively,\textsuperscript{31} acute respiratory insufficiency immediately postoperatively,\textsuperscript{22} and chronic respiratory insufficiency due to chest wall stiffness after implantation.\textsuperscript{22}

Emans et al\textsuperscript{18} reported 12 complications in 31 patients, for a rate of 39%. The complications included aspiration pneumonia leading to acute respiratory distress syndrome, rib fracture, surgical site infection, acute brachial plexus palsy, and refusion of the thoracostomy.

The 23 patients in the study by Hasler et al\textsuperscript{9} had 23 complications; a 22% risk of complication per insertion procedure and a 12% risk per expansion procedure. White et al\textsuperscript{13} reported complications in 6 of the 14 patients with spine-spine VEPTR implants, a rate of 43%. A retrospective review\textsuperscript{29} of complications in growing spinal implants revealed an elevated complication rate (2.37 complications per patient) in children with VEPTR compared with the rate in children with hybrid devices (0.86 complications per patient) or dual growing rods (2.06 complications per patient). Campbell et al\textsuperscript{17} reported 52 complications in 22 patients. The most common major complications were migration of the VEPTR rib device, skin sloughing, and associated infections. In children with infantile idiopathic scoliosis who had VEPTR implantation, 3 of 9 patients (33%) had complications, including erosion of rib at the VEPTR attachment site in 2 patients and 2 weeks of lower extremity pain postoperatively that resolved without intervention.\textsuperscript{35}

Despite the seemingly high rates of complications, the rates are not weighted and many of the studies had small heterogeneous groups of patients, so an accurate reflection of the actual risks of treatment is difficult. However, in a study by Campbell et al,\textsuperscript{17} the sample of 27 patients was relatively homogeneous, with fused ribs and congenital scoliosis. Campbell et al reported 52 complications in 22 patients. An infection occurred in 11% of the patients, a relatively low infection rate. This rate may be more representative of the actual risk of VEPTR implantation. Although the data are limited, prognoses are poor for patients with the rare diseases that may be treated with VEPTR placement. Akbarnia et al\textsuperscript{8} reported a 50% mortality rate due to severe restrictive lung disease in patients with Jeune syndrome, and Betz et al\textsuperscript{31} reported that the syndrome is almost universally fatal within the first year of life. In the study by Betz et al, the mortality rate after VEPTR implantation was 50%, but the patients who survived were 5 years 6 months to 8 years 9 months old at the time the article was published in 2008, a vast improvement compared with the natural death rate. In patients with spondylothoracic dysplasia, early death has been reported.\textsuperscript{32} Betz et al\textsuperscript{31} cited research that indicated nearly a 100% mortality rate in children with Jarcho-Levin syndrome; however, Betz et al had a 0% mortality rate after VEPTR implantation in their 24 patients with this syndrome. Although patients undergoing VEPTR insertion and expansions may have significant complications after the procedure, their chances of survival increase dramatically with the use of the VEPTR device.

As stated earlier, the repetitive nature of surgical expansions contributes to wound complications. Additionally, skin sloughing and wound dehiscence are associated with low body weight, a common preoperative problem in TIS patients. Even with aggressive nutritional interventions, including enteral tube feedings via a nasogastric tube or a gastrostomy tube, patients in need of a VEPTR may undergo the implantation of the device while underweight. Surgical site infections are another complication that can cause increases in length of hospital stay, the need for antibiotic therapy, and further

### Table 2: Potential complications

<table>
<thead>
<tr>
<th>Skin complications</th>
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<tr>
<td>Wound dehiscence</td>
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<td>Skin sloughing</td>
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<td>Infection</td>
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<td>Surgical site</td>
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<td>Device</td>
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<td>Device-related complications</td>
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<td>Device migration</td>
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<td>Breakage of implant</td>
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<td>Rib fractures</td>
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<td>Neurological injuries</td>
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<td>Acute brachial plexus palsy</td>
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<td>Spinal cord injury</td>
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<td>Respiratory complications</td>
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<td>Intraoperative</td>
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<tr>
<td>Pneumothorax</td>
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<td>Respiratory distress</td>
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<td>Postoperative</td>
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<td>Pneumonia</td>
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<td>Acute respiratory distress syndrome</td>
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<td>Pulmonary edema</td>
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<td>Acute respiratory insufficiency</td>
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<td>Chronic respiratory insufficiency related to chest wall stiffness with device</td>
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\textsuperscript{10,12,22} Pneumothorax, pneumonia, acute respiratory distress syndrome, respiratory distress intraoperatively, acute respiratory insufficiency immediately postoperatively, and chronic respiratory insufficiency due to chest wall stiffness with device.
procedures to clean the wound. In a multicenter analysis of surgical site infections after spinal surgeries for scoliosis, the infection rates varied considerably according to the underlying diseases and procedure types. Compared with a rate of 2.6% for patients with idiopathic scoliosis, the infection rate was significantly higher in patients with nonidiopathic scoliosis: neuromuscular, 9.2%; syndromic, 8.8%; congenital, 3.9%; or other types of scoliosis, 8.4%. Patients with syndromic and neuromuscular scoliosis have high rates of infection for unknown reasons, a situation that can contribute to postoperative complications. Examination of surgical site infection rates in children with a VEPTR device or a growing rod revealed that revision procedures were associated with significantly higher rates of infection (10.3%) than were insertion (8.4%) and lengthening procedures (3.3%). These rates were also higher than rates for spinal fusion insertion (5.5%) and revision (6.3%).

Follow-up of patients as they reach adulthood to monitor long-term effects of VEPTR implantation is an important area of research in which data are limited.

Respiratory insufficiency requires additional energy to support breathing and is associated with poor nutritional status. Theoretically, treatment of TIS could improve the ability of a child to grow and gain weight, because some of the energy originally required to breathe could instead be directed toward growth. In a study by Skaggs et al, patients had significant improvement in nutritional status after placement of a VEPTR, as indicated by weight percentile gains.

Multiple techniques have been used to assess improvement in lung function of patients with TIS after VEPTR implantation. The Cobb angle is a measure of the degree of spinal curvature in scoliosis, and a goal in many of the VEPTR studies is to determine if an improvement in the Cobb angle correlates with improved lung function. Measurement of lung volume via computed tomography before and after surgery and comparisons with normal lung volume has also been studied to determine if placement of a VEPTR improves pulmonary function.

In a study by Gadepalli et al, the data did not suggest improvement in pulmonary status according to lung volume measured via computed tomography or lung function measured by using PFTs. Caubet et al sought to determine if hemoglobin levels could be used as a marker of pulmonary function. Elevated hemoglobin levels are associated with chronic hypoxia, and in the study of Caubet et al, patients had normalization of previously elevated hemoglobin levels 6 to 24 months after implantation of a VEPTR or a growing rod. Caubet et al suggest that hemoglobin can be used to evaluate the outcomes of these surgical procedures. Standard PFTs in patients old enough and developmentally able to participate in the tests (generally older than 6 or 7 years) are used to determine pulmonary function. Additionally, specialized PFTs have been used in efforts to measure lung function. Other methods may include measurement of arterial or capillary blood gases.

Long-term Follow-up

Expansion surgeries, done via reopening the skin through the original incision and lengthening the VEPTR rod through distraction (moving the inferior and superior ends of the VEPTR device in opposite directions, thereby making the device longer), are generally done every 4 to 6 months until skeletal maturity is reached. Although this course is the one proposed, periods between lengthenings may be greater, as when illnesses and problems arranging travel to the institution produce delays in the expansion surgeries.
Nurses play an important role in supporting patients during recovery and are ideally positioned to provide education to patients’ families.

Quality of Life and Future Research

Only a few articles on the impact of VEPTR on quality of life have been published. In a 2008 study by Vitale et al,38 the parents of 45 patients who were undergoing VEPTR implantation completed a questionnaire (the Child Health Questionnaire) designed to determine the functional status and psychological well-being of the children and caregiver burden of the parents. The results indicated no significant short-term improvement in quality of life, but Vitale et al postulated that the treatment may maintain the quality of life and the burden on caregivers that might otherwise worsen if the TIS progressed without treatment. The investigators38 noted that the preoperative scores of TIS patients are among the lowest in pediatric patients, lower than those of children with asthma, epilepsy, heart disease, and childhood cancer. Patients with TIS are extremely ill, and the goal of VEPTR implantation is to improve their quality of life by stabilizing the thorax to maximize pulmonary development. Families of children who require mechanical ventilation or noninvasive ventilation 24 hours a day can benefit from even moderate improvements in pulmonary function after VEPTR placement that might allow the child to tolerate time during the day without ventilatory support.

In the study by Gadepalli et al,19 a modified Scoliosis Research Society questionnaire was used to assess some aspects of quality of life. Although scores after placement of a VEPTR were positive, they did not differ significantly from preoperative scores. Despite the lack of statistical significance, parental impression of self-image and self-confidence was better postoperatively than it had been preoperatively. The questionnaire was modified from the original, and the modified tool may be insensitive to the issues of TIS because it is intended for use in patients with scoliosis.

Neither the Child Health Questionnaire nor the Scoliosis Research Society instrument is specifically for children with respiratory insufficiency, a characteristic that might limit the usefulness of the tools in patients with TIS who may undergo VEPTR insertion. The paucity of studies on quality of life in children with TIS (with or without surgical intervention such as VEPTR implantation) warrants further research; currently no quality-of-life questionnaire is available for TIS specifically. Other areas for research include determining better measures of improvement of lung function after VEPTR implantation in patients with TIS and further examining quality-of-life issues in these patients.

Implications for Critical Care Nurses

Critical care nurses who work in pediatric ICUs need to be knowledgeable about the VEPTR procedure, the necessary postoperative monitoring, and potential complications. Nurses play an important role in supporting patients and the patients’ families during the immediate postoperative period and as patients begin recovering, progressing to the point of transfer to a general unit or discharge from the hospital. Patients with TIS often have extremely rare diseases and will travel to tertiary treatment centers far from their homes for VEPTR placement and management. Being away from their normal support systems both frequently and for potentially longer periods if complications occur can cause stress on the child and the child’s family, adding complexity to the care of these children and their families. Nurses are also ideally positioned to provide education to patients’ families about the expected course in the ICU and the care families will need to provide as the child recovers. One particular area is skin care. The orthopedic surgeon will determine the specific incisional care plan, but the bedside nurse will be demonstrating this care and teaching it to patients’ families.

Implications for Advanced Practice Nurses

Collaboration is an important aspect of the role of an advanced practice nurse in the immediate postoperative period to manage the initial recovery after VEPTR implantation as well as the recovery after VEPTR expansions. Because of the repetitive expansions of a VEPTR device, patients and their families most likely...
will have multiple ICU admissions. Advanced practice nurses can develop relationships with patients and patients’ families during this time and provide all of them with further support. Advanced practice nurses can also collaborate with the multidisciplinary team, including personnel from the nutritional, pulmonary, and orthopedic surgery services preoperatively. VEPTR candidates require optimized preoperative nutrition. Adequate nutrition is especially important for wound healing and is also necessary for continued growth between expansion surgeries. Advanced practice nurses are instrumental in coordinating discharge planning and patient-family education for patients who have undergone VEPTR implantation. Planning for discharge may vary with each patient, according to the severity of the patient’s TIS, whether complications occur, and the required level of support and necessary care coordination.

**Conclusion**

Children with TIS and scoliosis have unique needs, and children who undergo VEPTR treatment require specialized care. Published information on the postoperative nursing care for VEPTR patients is limited. Critical care and advanced practice nurses working in the pediatric ICU may encounter these patients in the postoperative period after initial implantation of the VEPTR device and after subsequent surgeries. Knowledge of the postoperative care, potential complications, and long-term follow-up allow advanced practice nurses to safely manage care for these patients and critical care nurses to deliver this care. CCN

**Financial Disclosures**

None reported.

**Letters**

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**To learn more about pediatric care in the critical care setting, read “Increasing Parental Participation During Rounds in a Pediatric Cardiac Intensive Care Unit” by Blankenship et al in the American Journal of Critical Care, November 2015;24;5:532-538. Available at www.ajcconline.org.**

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Use of a Vertical Expandable Prosthetic Titanium Rib in Children With Thoracic Insufficiency Syndrome and Scoliosis
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