A teaching documentation tool was created for the education of patients with the HeartMate Vented Electric Left Ventricular Assist System (VE LVAS, Thoratec Corp, Pleasanton, Calif). The HeartMate VE LVAS is a device that provides cardiovascular support to patients waiting for a heart transplant. This device allows those patients to wait at home rather than in the hospital. In the past, patients could wait in the hospital for up to a year, unable to be discharged without a transplant. Convalescing at home with the HeartMate VE LVAS allows patients to recover from some of the debilitating effects of their cardiac disease and subsequent hospitalization. They can return to work or school and are able to lead far more normal lives.

In this article, we describe the development of a tool used to educate patients and evaluate educational and clinical outcomes. The staff at the University of Washington Medical Center, Seattle, Wash, initially felt overwhelmed by the vast body of knowledge required to care for patients with a HeartMate VE LVAS and the responsibility of teaching this information to patients and patients’ families. By remaining focused on patients’ needs required for discharge, staff nurses developed a program to prepare these patients for discharge home with the HeartMate VE LVAS.

Background

Heart failure is defined as the inability of the heart to effectively pump oxygenated blood to meet the metabolic demands of the body. This devastating condition affects 4.7 million people a year in the United States alone. When conventional medical therapies are unsuccessful, cardiac transplantation is an option for treatment and to prolong life. Unfortunately, only 2300 patients each year receive heart transplants, because the number of patients awaiting transplants far exceeds the number of organs available.

Implantation of the HeartMate VE LVAS provides a bridge to trans-
plantation by maintaining blood flow sufficient to meet the metabolic demands of the body. Thus the patient can wait at home, maintaining an acceptable quality of life while waiting for a transplant. The increased flow of oxygenated blood to organs and tissues provided by the HeartMate VE LVAS enables patients to attain better physical conditioning.

In addition, patients who used the HeartMate VE LVAS improved in the psychological, emotional, and social aspects of their lives when discharged home. They fared significantly better than transplantation candidates without an LVAS at home and better than inpatients with an LVAS. Thirty percent of outpatients with an LVAS were able to return to work or school, 33% to sexual activity, and 44% to driving. All outpatients who had an LVAS were able to perform activities of daily living.

With the HeartMate VE LVAS (Figure 1), patients are free to move around on battery power without pushing the console that other left ventricular assist systems require. Using battery power, patients can take walks, bicycle, and use exercise equipment for physical conditioning. With proper training, patients can leave the hospital and wait for their transplant at home.

Development

Before discharge, patients must learn to care for themselves and manage their equipment. They learn about emergency procedures and equipment, care of the exit site for the percutaneous lead, and how to change power sources safely. They must demonstrate the understanding of multiple alarms, including the

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**Figure 1** The HeartMate Vented Electric Left Ventricular Assist System (VE LVAS) consists of an implanted pump and a percutaneous lead, which connects to a system controller and then to a power source (power base unit [PBU] or batteries). The pump is made of titanium and is approximately 5 cm (2 in) thick and 10 cm (4 in) in diameter. It weighs 1.2 kg (2.6 lb) and consists of 2 chambers: the blood chamber and the air/motor chamber separated by a flexible diaphragm. Inside the pump, the surfaces are specially textured to help form a lining that mimics the lining of blood vessels. This feature helps prevent formation of blood clots within the pump; thus, patients do not require anticoagulation as with other ventricular assist devices. The HeartMate VE LVAS contains porcine valves, guiding blood to flow in 1 direction only: through the pump and into the aorta. The HeartMate VE LVAS depends on preload to fill, just as a native ventricle does. The pump rate responds to the amount of blood returning to the heart, increasing to meet the needs of an exercising body and decreasing when the patient is at rest.

Reprinted with permission from Thoratec Corp, Pleasanton, Calif.
required corrective actions. In addition, patients learn what signs and symptoms to monitor and report to the mechanical device coordinator. A teaching documentation tool provides a comprehensive approach to organizing and documenting the required education.

When this program was started in 1998, published nursing literature about the HeartMate VE LVAS was limited. As a result, it was necessary to develop a knowledge base and staff education program based on a literature review, the manufacturer’s handbook, contact with other hospitals, and use of the actual equipment. Staff nurses from the cardiothoracic intensive care unit and the acute care unit joined to create a ventricular assist device resource team. This group developed a comprehensive program to provide thorough teaching of patients and to ensure quality care and education from implantation to transplantation.

The team members ascertained outcomes of patients and learning needs to be addressed. This information facilitated the development of a teaching documentation tool to provide consistency in education and adequate documentation of the teaching of patients and the patients’ family members.

Teaching Patients

Teaching patients and documenting what has been taught are always important but especially when preparing for the discharge of patients with complicated, life-sustaining equipment such as the HeartMate VE LVAS. Because most patients who have these systems are adults, the principles of adult learning were an important consideration. Adult learning is dynamic. It is “typically self-directed and self-initiated . . . oriented toward immediate application and toward solving real-life problems of the learner.” In addition, teaching of patients incorporated the 7 steps of the process model described by Knowles5 (Table 1).

The patients’ educational program encompassed an overview of general postoperative surgical care and basic concepts related to the HeartMate VE LVAS. Ideally, these topics would be covered preoperatively with each patient and his or her family, but many situations did not allow preoperative teaching. For example, 2 patients went directly from the cardiac catheterization laboratory to the operating room for implantation on an emergent basis. When preoperative teaching was not possible, education began with the patients’ family members immediately after surgery and included basic information such as how to operate the HeartMate VE LVAS, possible outcomes for patients, and healing concerns. Specific content depended on the family’s readiness to learn and how quickly they were able to grasp the material presented. The nurse caring for each patient was key in assessing the readiness of the patient’s family to learn. Even before the patient was fully awake and extubated, some families were ready to begin learning specifics such as the importance of preventing infection and how to switch power sources safely.

In order to be discharged, patients must demonstrate a thorough understanding of and be competent with their care and equipment. For example, an improper change of power source could cause the pump to stop, endangering the patient’s life. Infections after LVAS implantation are common; in most studies, the prevalence is 30% to 50%. Proper care of the exit site and recognition of signs and symptoms of infection are of the utmost importance. The air vent is necessary to allow free flow of air between the pump and the atmosphere. Fluid entering the air vent can damage the implanted pump itself, in the worst-case scenario causing the motor to seize and stop. All of this information must be verbalized, and the skills related to proper care of the exit site and recognition of signs and symptoms of infection must be demonstrated by the patient before discharge.

Table 1 Knowles’s process model for adult learning

<table>
<thead>
<tr>
<th>Step</th>
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<tbody>
<tr>
<td>1. Establish a climate conducive to learning</td>
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<td>2. Create a mechanism for mutual planning</td>
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<tr>
<td>3. Diagnose the needs for learning</td>
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<tr>
<td>4. Formulate program objectives that will meet the needs</td>
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<tr>
<td>5. Design a pattern of learning experience</td>
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<tr>
<td>6. Conduct those learning experiences with suitable techniques and materials</td>
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<tr>
<td>7. Evaluate the learning outcomes and rediagnose learning needs</td>
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assessed and revised when appropriate.” The tool was essential for documenting the educational content, monitoring the patient’s progress in learning the information, ensuring consistent teaching, and communicating to other nurses about material that had been covered. The teaching documentation tool that was developed provided guidance through the objectives that were established for teaching patients and their families.

Topics for teaching patients, such as the system controller, were broken into small, manageable “microsubjects” that could be covered in a few minutes (Table 2). An example of a microsubject would be “demonstrates correct changing of system controller battery cell.” The microsubjects enabled nurses to document exactly what was taught, to whom it had been taught, and what part of the topic needed further reinforcement.

Teaching Objectives

The teaching documentation tool is an 8-page–long form that lists all the teaching objectives with checklists to indicate methods, outcomes, and follow-up (see Figure 2, a page of the form). The form starts by listing teaching objectives for the patient or the patient’s family related to postoperative care during the hospital stay (all information from the teaching tool is reprinted here with permission of the University of Washington Medical Center ©1999):

1. Review information in the patient handbook
   - Patient has handbook
2. States importance of pain control for activities
3. States understanding and demonstrates activity limitations while HeartMate VE LVAD (HeartMate LVAS and HeartMate LVAD are used interchangeably in the healthcare community) in place
   - Proper sternal precautions include no lifting, pulling, or pushing objects weighing more than 10 pounds [4.5 kg] during first 6 weeks after implantation
4. States understanding of emotional responses to surgery and device implantation for patient and caregiver
5. Demonstrates proper use of shower kit
   - States why it is important to keep all fluids away from filter and air vent
6. States understanding of importance of diet in wound healing and possible need for small frequent meals

The teaching documentation tool lists the teaching objectives for the patient or the patient’s family related to home care:

1. States understanding of activity limitations while at home
   - No swimming or water sports, including boating and hot tubs
   - No driving
   - Demonstrates accurately taking temperature
   - Demonstrates proper wound care of exit site
     - Demonstrates dressing change using clean technique
     - Identifies and states signs and symptoms of exit site infection
     - States importance of no fluid/liquids to be in contact with vent port AT ALL TIMES
   - States details of follow-up care and contact person
   - States importance of maintaining 2-hour drive proximity to hospital after discharge
   - States to the nurse the equipment that must be carried on person at all times
     - Hand pump
     - Hospital’s paging number—asks for heart transplant coordinator
     - Charged batteries
   - States when to call transplant coordinator
     - Infection
     - Fever
     - Red heart alarm
     - Unresolved fatigue
     - Unresolved dizziness
     - Any time going to emergency department or calling emergency medical services
   - Correctly identifies each part of the VE LVAD system:
     - LVAD pump
     - Percutaneous lead
     - External air vent and filter
     - Electric connector
     - System controller
     - Batteries and clips
     - Power base unit
     - Display module
     - Hand pump
     - Emergency power pack
   - States purpose of each part of VE LVAD system:
     - LVAD pump
     - Percutaneous lead
     - External air vent and filter
     - Electric connector
     - System controller
     - Batteries and clips
### VE LVAD Evidence of Teaching

**Based on patient's needs and concerns**

<table>
<thead>
<tr>
<th>Date</th>
<th>Patient or family will:</th>
<th>Teaching Objectives</th>
<th>Methods, Outcomes, Follow-Up</th>
<th>✔️ When achieved</th>
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<td>Demonstrates proper wound care of exit site</td>
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<td>States to RN equipment to carry on person at all times</td>
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<td>• hospital paging number-asks for heart transplant coordinator</td>
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<td>• charged batteries</td>
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<td>States when to call heart transplant coordinator</td>
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<td>• any time going to ER or calling EMS</td>
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<td>Correctly identifies each part of VE LVAD system:</td>
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<td>1. LVAD pump</td>
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<td>3. external air vent and filter</td>
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<td>4. electric connector</td>
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<td></td>
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<td>5. system controller</td>
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</table>

**KEY: USE ALL THAT APPLY FROM EACH LIST**

<table>
<thead>
<tr>
<th>Persons Present</th>
<th>Methods</th>
<th>Outcomes</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT-Patient</td>
<td>AV-Audio/Visual Tools</td>
<td>V-Verbalized Understanding</td>
<td>D-Describes/Able to Restate</td>
</tr>
<tr>
<td>P-Partner</td>
<td>T-Task Demonstrated</td>
<td>RD-Return Demonstrated</td>
<td>F-Further instruction/Reinforcement Needed</td>
</tr>
<tr>
<td>FA-Family</td>
<td>W-Written Materials</td>
<td>I-Individualized Teaching (One-on-One)</td>
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</tr>
<tr>
<td>FR-Friend</td>
<td>O-Other</td>
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**Interdisciplinary Team Member's Initials/Signature**

**Interdisciplinary Team Member's Initials/Signature**

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**Figure 2** A page of the teaching documentation tool, showing setup of form, abbreviations to use, and signatures required.

VE LVAD indicates Vented Electric Left Ventricular Assist Device. HeartMate LVAD and HeartMate LVAS are used interchangeably in the healthcare community. Reprinted with permission from University of Washington Medical Center, ©1999.
the patient or the patient’s family related to the system controller:

States purpose of the system controller
Correctly identifies each symbol on system controller face:
• Mode switch
• Alarm reset
• Fuel gauge
• Red heart
• Yellow wrench
Demonstrates normal use of system controller, including:
• Defines auto mode rate
• Defines fixed mode rate
• Defines power-saving mode rate
• Defines basal rate
• Battery check
• Alarm reset
Demonstrates controller self-test and states why it is important to check system every day
Demonstrates changing modes and identifying which mode currently in
States when to change controller battery cell
Demonstrates correct changing of controller battery cell
States reasons to change system controller
Demonstrates appropriate technique and safety factors when changing system controller

Yellow Wrench Advisories and Red Heart Alarms
States difference between yellow wrench advisories and red heart alarms
Identifies potential cause of each yellow wrench advisory
• Power cable disconnected
• Low flow, <2 L/min
• Low stroke volume, <30 mL
• Inoperative or malfunctioning controller
• Controller cell low
• Rate control fault
• Power limiting advisory
Demonstrates key interventions for each yellow wrench advisory:
• Power cable disconnected
• Low flow, <2 L/min
• Low stroke volume, <30 mL
• Inoperative or malfunctioning controller
• Controller cell low
• Rate control fault
• Power limiting advisory
Demonstrates connecting system controller to power base unit attached to display module to see cause of alarm
Demonstrates immediate action for any yellow wrench advisory until cause is known
• Check connections
• Attach to display module
• Check the controller cell
Identifies potential cause of each red heart alarm
• Low flow, <1.5 L/min
• Low beat rate, <35/min
• Low stroke volume, <25 mL
• Cable disconnected at percutaneous lead

Demonstrates key interventions for each red heart alarm

• Low flow, <1.5 L/min
• Low beat rate, <35/min
• Low stroke volume, <25 mL
• Cable disconnected at percutaneous lead

Demonstrates immediate action for any red heart alarm until cause is known:
• Check connections
• Attach to display model
• Prepare to hand pump
• Contact transplant coordinator

The teaching documentation tool lists the teaching objectives for the patient or the patient’s family related to the power base unit (PBU) and batteries:

States understanding of PBU functions and care of batteries
• Identifies toggle switch
• States life of internal PBU battery
• Identifies buttons on face of PBU, including alarm reset
• States what to do for each warning
  A/C fail
  Low battery

Identifies principles of battery care
• States when to change batteries
• States meaning of charge lights (green, yellow, and red)
• States life of individual battery as 180 charges
• States life of battery per charge as 4 to 7 hours
• States meaning of expiration date on each battery
• States acceptable temperature range for batteries
• States how to change expired batteries for new batteries
• Demonstrates correct insertion of batteries into PBU

The teaching documentation tool lists the teaching objectives for the patient or the patient’s family related to changing power sources:

Demonstrates safety and correct technique in changing from PBU to batteries
• Gather 2 battery clips, 2 charged batteries
• Place the batteries near the black and white connector cables
• Place charged battery into clip by aligning arrows and push the battery all the way into the clip until you hear a click
• Unscrew white PBU connector and connect to one battery
• Repeat with the black connector
• When connecting the cables, remember to only hand tighten all connections
...related to the hand pump: the patient or the patient’s family tool lists the teaching objectives for
CRITICAL CARENURSE
46
States reasons to hand pump and
Demonstrates safety and correct technique in changing from batteries to PBU
• Place the PBU connectors near the black and white connector cables
• Unscrew white connector cable from battery and connect to PBU white connector
• Repeat with the black connector cable
• When connecting the cables, remember to only hand tighten all connections
Demonstrates safety and correct technique in changing batteries only
• Gather 2 fully charged batteries
• To remove batteries from the clip, hold the release button and pull out the battery (an alarm will sound)
• Match the arrows on the clip and the battery, slide the battery into place until you hear the click
• Repeat the procedure for the second battery
States reasons to connect to emergency power pack
Demonstrates safety and correct technique in attaching to emergency power pack

The teaching documentation tool lists the teaching objectives for the patient or the patient’s family related to the hand pump:
States reasons to hand pump and safety factors for connection
Demonstrates appropriate hand pump technique
• DISCONNECT POWER SOURCE THEN SYSTEM CONTROLLER PRIOR TO HAND PUMPING
• Remove the vent air filter and attach the hand pump to the drive line
• Press and hold the purge valve (white button) while deflating the black bulb
• Release the purge valve and release the black bulb

Implementing the Tool
Preparing to implement the teaching documentation tool includes an assessment of the patient’s readiness to learn. In addition to the individual needs of adult learners, our patients had emotional issues as well as physical recovery from the surgery that affected their readiness to learn. In some instances, the patient had little if any warning before the HeartMate VE LVAS was implanted. One patient went directly from the emergency department to the cardiac catheterization laboratory and then to surgery for implantation. Waking up with the LVAS came as a complete surprise to him. Other patients had lived with heart failure for some time and were more prepared for the possibility of implantation of a HeartMate VE LVAS. For these patients, use of the device was a way to buy more time while waiting for a transplant. All of our patients needed time to adjust to the pump, not only its sounds and weight but also its constant reminder of their dependence upon this device.

Teaching was individualized to each patient’s learning abilities and educational level. With education ranging from sixth grade to graduate school, patients profited most from different learning methods. A variety of methods were used to present the information: written material, one-on-one teaching sessions, and hands-on practice with the equipment. Some of the material to be taught, such as the alarms of the HeartMate VE LVAS, is very complex and can be confusing. Flash cards were developed to simplify the information and allow patients to easily review the material whenever they had a few minutes (Figure 3). Patients showed achievement by verbalizing the material or demonstrating the behavioral objective. Our ultimate goal, documentation of the patient’s ability to care for himself or herself and manage the equipment, was clearly recorded.

Evaluating the Tool
The teaching documentation tool enabled us to meet our goals of organizing skills to be taught, documenting the instruction provided, and documenting the level of understanding of patients and their families. Additionally, nurses commented that the tool reinforced the nurses’ understanding of the information to be conveyed and ensured that it was covered in a clear and consistent manner. The tool also provided a means for nurses to communicate with nurses on other shifts and units as a patient’s learning progressed. Because the teaching documentation was organized in a single place, it increased efficiency in determining what skills remained to be mastered. Updating of patients’ charts was simplified by having the information already spelled out on the tool. The learning outcomes and teaching objectives were very specific, concise, and unambiguous. The necessary behaviors and self-care skills were spelled out in concrete, measurable terms.

Staff nurses were able to use the teaching documentation tool as a guide for teaching and to take an involved approach to each patient’s care. The tool reflected the complex-...
ity and depth of teaching patients that bedside nurses provided for patients with a HeartMate VE LVAS and provided valuable feedback about each patient’s readiness for discharge.

Ensuring a safe discharge required having patients demonstrate both routine and emergent care. The teaching documentation tool can be used to record a patient’s progress in learning this care. Using this tool as evidence of a patient’s readiness for release, nurses actively participated in decision making about discharging patients from the hospital. For example, a patient was confused immediately after implantation. As his mental status improved, he started asking questions about his equipment. The patient learned quickly and demonstrated the required actions competently. At this point, the bedside nurse approached the nurse practitioner in charge of the patient’s care about plans for discharge. The nurses set a specific date for discharge based on his readiness and demonstrated ability to manage his care at home.

Figure 3 Flash cards used by patients to review material they have learned about their Vented Electric Left Ventricular Assist Device (VE LVAD). Front of flash card is shown at left and back of flash card is shown at right.

HeartMate LVAD and HeartMate LVAS are used interchangeably in the healthcare community. BPM indicates beats per minute; LPM, liters per minute; PBU, power base unit; perc, percutaneous, SNE, acute care unit.

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Patients with a HeartMate VE LVAS can care for themselves safely and competently at home. When our patients who had the device called for information or to report changes, the calls were appropriate. Patients found themselves in a variety of situations, both mundane and critical, in which they showed the ability to keep a cool head, solve problems, and extrapolate from the information taught them.

For example, Mr K. was shopping for groceries when he heard an unfamiliar alarm tone. He calmly checked his system controller for an alarm, and when he did not find one, he went home to attach his system controller to his display module. When there was still no alarm message, he called the mechanical device coordinator for advice. After talking through the situation thoroughly, they were able to determine together that the “alarm” he had heard had nothing to do with his HeartMate VE LVAS but was the beeper he was given by the transplant coordinator. Even though he was unsure of the alarm, he was able to remain calm and to troubleshoot his equipment independently before calling the mechanical device coordinator.

On the opposite end of the concern spectrum, Mr B. was able not only to change his system controller at home by himself but also to change his “Y” connector. He had a cracked Y connector on one of his clinic visits, and the mechanical device coordinator helped him disconnect himself from the system controller (thus stopping his pump) and change out the cracked connector. He then needed to reconnect the system controller to his percutaneous lead and connect the system controller to power before his pump would restart. The next time his Y connector cracked, he was able to change it himself at home. Because this procedure is one that gives even experienced resource team members pause, it was particularly significant that Mr B. felt that he had the appropriate training to attempt it at home.

These examples confirm that our teaching program was comprehensive and effective. The teaching documentation tool, as both guide and record of patients’ education, is successful.

Conclusions

Of the 16 patients who had a HeartMate VE LVAS implanted, 12 were successfully discharged. One could not be discharged without significant rehabilitation because of blindness resulting from a hypotensive episode in the cardiac catheterization laboratory before the device was implanted. He received a transplant and was successfully discharged. Two other patients could not be discharged because they required dialysis 3 times a week, and no local dialysis center could accommodate a patient with a HeartMate VE LVAS. One patient died before his discharge planning could be finalized.

The teaching documentation tool outlines a process for educating patients and evaluating educational and clinical outcomes to facilitate successful discharge. It is a road map for teaching and documentation of each patient’s progress. The learning outcomes and teaching objectives are specific and concise while allowing individual patients’ learning styles. The necessary behaviors and self-care skills are spelled out in concrete and measurable terms. The discharge of 12 patients able to manage their self-care and equipment at home illustrates the success of the tool.

Acknowledgments

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