Spiration®

SPIRATION VALVE SYSTEM
INSTRUCTIONS FOR USE
Humanitarian Device for Use in the Control of Air Leaks

STERILE EO — Sterilized by EO. Sterile unless package opened or damaged.

Do Not Resterilize

Do Not Re-Use

See Instructions For Use

Temperature Limits: -15°C to +50°C

CAUTION: Humanitarian Device. Authorized by Federal law for use in the control of prolonged air leaks of the lung, or significant air leaks that are likely to become prolonged air leaks, following lobectomy, segmentectomy, or Lung Volume Reduction Surgery (LVRS). The effectiveness of this device for this use has not been demonstrated. Federal Law restricts this device to sale by or on the order of a physician.

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1. Intended Use

The Spiration Valve System is a device to control prolonged air leaks of the lung, or significant air leaks that are likely to become prolonged air leaks following lobectomy, segmentectomy, or Lung Volume Reduction Surgery (LVRS). An air leak present on post-operative day 7 is considered prolonged unless present only during forced exhalation or cough. An air leak present on day 5 should be considered for treatment if it is: 1) continuous, 2) present during normal inhalation phase of inspiration, or 3) present upon normal expiration and accompanied by subcutaneous emphysema or respiratory compromise. Spiration Valve System use is limited to 6 weeks per prolonged air leak.

2. Spiration Valve System Description

The Spiration Valve System consists of a Spiration Valve (IBV) in Cartridge ("Spiration Valve" or "valve") and a Deployment Catheter ("catheter") and Loader ("loader"). The Airway Sizing Kit is an accessory to the Spiration Valve System used to determine the appropriate valve size for each target airway (see Instructions for Use, Airway Sizing Kit).

2.1 Spiration Valve in Cartridge

The valve is designed to limit airflow to the portions of the lungs distal to the valve, while still allowing mucus and air movement in the proximal direction. The valve is comprised of a Nitinol frame and a polymer membrane. The membrane is held against the airway mucosa by 6 flexible struts and will expand and contract with airway movement during breathing. The 5 anchors have tips that gently secure the valve to the airway wall at a controlled depth, preventing the valve from migrating. The valve is designed to be removed by grasping the removal rod with flexible bronchoscopy forceps.

The valve is available in 5, 6, 7, and 9 mm diameters and is pre-packaged in a disposable cartridge that protects the valve during storage and fits in the loader (see Figure 1). The cartridges are uniquely marked to distinguish one valve size from the other. The appropriate valve size is selected after an air leak(s) has been isolated and the airways have been sized using the Airway Sizing Kit.

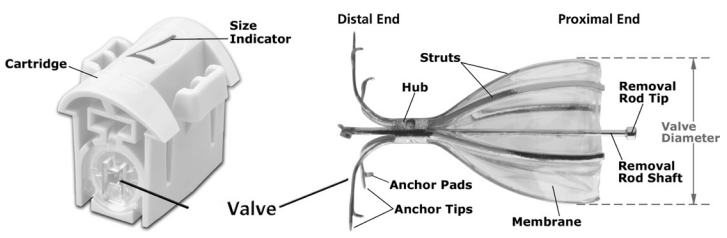

Figure 1: Spiration Valve in Cartridge

2.2 Deployment Catheter and Loader

The loader is a tool used to insert the valve into the tip of the catheter. After the cartridge is placed in the loader, the catheter tip is inserted into the loader and the loader plunger is depressed to load the valve into the tip of the catheter (see Figure 2). The catheter is used to deliver the valve to its target location. The loader and catheter are designed to load and deploy up to a maximum of 10 valves during a single patient procedure. If there are more than 10 valve deployments, a new catheter must be opened and used.

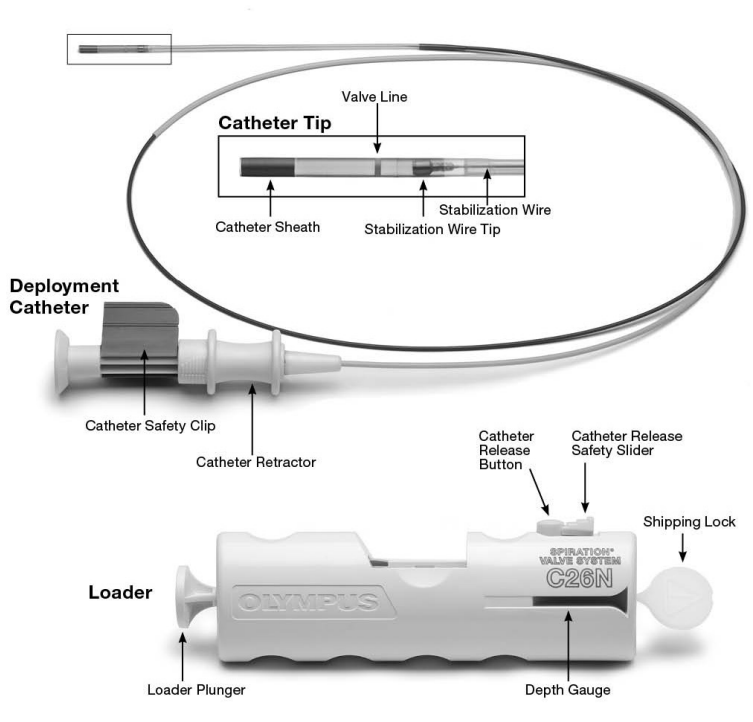

Figure 2: The Deployment Catheter and Loader

The catheter can be passed through a flexible bronchoscope with an instrument channel inner diameter of 2.6mm or larger. After loading, the catheter is advanced through the bronchoscope instrument channel to the target location. The distal end of the catheter includes a valve line which marks the target position of the proximal end of the valve when deployed. The valve is deployed when the operator actuates the deployment handle of the catheter, retracting the catheter sheath to release the valve.

2.3 Resolution of Air Leaks

Treatment of an air leak with a valve may not require complete blockage of all air leakage. Even if not completely sealed, a substantial reduction in an air leak using valves may accelerate the resolution of an air leak, as the progression through the clinical stages of the air leak is improved. For example, if a continuous air leak is not completely resolved, but changed to an expiratory or forced exhalation pattern after valve treatment, such a change will allow the physician to consider discharging the patient with the chest tube(s) connected to a Heimlich valve.

3. Contraindications

- Patient is unable to tolerate a flexible bronchoscopy procedure.
- Patient is allergic to latex.
- Patients with known or suspected sensitivity or allergy to nickel.

4. Warnings

- Atelectasis may occur after the air leak seals; patients should be monitored for this possible complication.

5. Precautions

5.1 General Precautions

- Use of the catheter requires bronchoscopy technical skills and adequate training. The operator must be a physician or medical personnel under the supervision of a physician and be trained in clinical bronchoscopy techniques and the use of the Spiration Valve System. The following instructions will give technical guidelines but do not obviate formal training in bronchoscopic procedures.
- The Spiration Valve System should not be used for patients who have active asthma, bronchitis or clinically significant bronchiectasis.
- Only use a bronchoscope with an instrument channel inner diameter of 2.6mm or larger.
- Valve placement should be done only after air leak isolation and airway sizing with the calibrated balloon catheter.
- Valve placement and removal must be done under bronchoscopic observation with visualization of the target airway.
- Do not allow lubricants to contact the catheter, loader, or valve.
- Once a valve has been loaded and/or deployed, do not attempt to reuse or re-deploy the valve.
- The valve is not designed to be repositioned after it is deployed from the catheter. If the position of the deployed valve is not optimal or appropriate; the valve should be removed and discarded.
- Do not remove the valve from the cartridge.
- Do not use the Spiration Valve System for other than its intended use.
- Do not reuse the catheter and loader for more than one patient procedure. The catheter and loader are not designed to be recleaned, reprocessed, or resterilized.
- Do not deploy more than 10 valves using the catheter and loader. If more than 10 valve deployments are needed, a new catheter and loader must be opened and used.

5.2 MRI Information

The Spiration Valve was determined to be MR-Conditional according to the terminology specified in the American Society for Testing and Materials (ASTM) International, Designation: F2503. Standard Practice for Marking Medical Devices and Other Items for Safety in the Magnetic Resonance Environment. ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, Pennsylvania, 2005.

Non-clinical testing has demonstrated that the Spiration Valve is MR Conditional. A patient with this device can be scanned safely immediately after placement under the following conditions:
- Static magnetic field of 3-Tesla or less
- Spatial magnetic gradient field of 720-Gauss/cm or less
- Maximum MR system reported whole-body-averaged specific absorption rate (SAR) of 3-W/kg for 15 minutes of scanning.

In non-clinical testing, the Spiration Valve produced a temperature rise of less than or equal to 0.5° C at a maximum MR system reported whole-body-average specific absorption rate (SAR) of 3-W/kg for 15 minutes of MR scanning in a 3-Tesla MR system (Excite, Software G3.0-052B, General Electric Healthcare, Milwaukee, WI).

MR image quality may be compromised if the area of interest is in the same area or relatively close to the position of the Spiration Valve. Optimization of MR imaging parameters is recommended.

6. Potential Adverse Effects

- Atelectasis
- Bleeding observed from an airway treated with a valve
- Bleeding due to valve removal and complications of such bleeding such as airway obstruction by blood clot
- Bronchitis
- Damage in the airway and/or tissue near a valve
- Death
- Infection in the tissue distal to a valve
- Local airway swelling or edema at site of valve placement
- Migration of valve out of the lung or within the lung
- Persistent cough
- Pneumothorax
- Shortness of breath
- Tissue hyperplasia or other reaction at site of valve placement
- Valve fracture

7. Preparation for the Procedure

7.1 Items Required and Recommended for Spiration Valve Procedure

Items required (provided with the Spiration Valve System):
- Spiration Valve in Cartridge (multiple sizes)
- Deployment Catheter and Loader (one per patient)
- Airway Sizing Kit
- Olympus Balloon Catheter B5-2C

Additional ancillary equipment required (not provided with the Spiration Valve System):
- Flexible bronchoscope with an instrument channel inner diameter of 2.6mm or larger

Additional ancillary equipment recommended (not provided with the Spiration Valve System):
- An endotracheal (ET) tube of 8.5 or larger should be considered for better control of the upper airways and improved ventilation during isolation of the air leak(s)
- Olympus balloon catheter B7-2Q or a balloon catheter that inflates to 13mm or larger (for balloon occlusion only)

7.2 Items Recommended for Spiration Valve Removal Procedure

- Bronchoscopy forceps
- Flexible bronchoscope compatible with forceps
- An endotracheal (ET) tube (see section 11.1 for details)

8. Packaging Inspection, Storage, and Handling

8.1 Checking the Package

The catheter and loader are supplied sterile and packaged in a sealed pouch. The valve is also supplied sterile and is packaged in a sealed pouch separate from the catheter and loader. Prior to use, inspect the pouches and verify that the seals are intact and that there are no holes or tears.

Caution: If sterility or performance of the device is suspected to be compromised, do not use the device; contact your local Spiration representative.

8.2 Storage Conditions

Store the product at room temperature in a clean and dry environment. Do not use the valve in the cartridge or the catheter and loader if it has been exposed to temperatures above 50° C or below -15° C.

8.3 Handling

- The Spiration Valve System is supplied sterile. Do not attempt to re-sterilize the Spiration Valve System components.
- Do not reuse the catheter and loader for more than one patient procedure.
- Do not reuse a valve once it has been deployed.
- Do not remove the valve from the cartridge.

9. Clinical Use of the Spiration Valve

9.1 Spiration Valve Deployment

- Using bronchoscopic techniques, and only after evaluation and sizing of airways, valves should be deployed in selected airways.
- The location for the deployment of valves may be determined by selective airway occlusion using a balloon catheter.
- Treatment of an air leak may require deployment of a valve in one or more airways. Valves may be deployed in any segment or sub-segment of the lung anatomy (including the lingular segments) that communicates with and contributes to the persistence of an air leak. Single or multiple airway segments of the lungs may be treated with valves. Treatment should be limited to no more than 3 segments by placing valves in segmental or sub-segmental bronchi in the target lung to avoid excessive isolation of tissue from ventilation.

9.2 Spiration Valve Removal

All valves placed for air leaks will be removed using bronchoscopic techniques and bronchoscopy forceps to grasp the removal rod tip.

Conditions and criteria for valve removal:
- Air leak has resolved and damaged tissue is considered sealed.
- Six (6) weeks or less after valve placement.
- Before further intervention to resolve an air leak, such as surgical repair or pleurodesis.

10. Operator's Instructions

10.1 Isolating the Air Leak by Balloon Occlusion

Observation of air bubbles passing through the water seal system connected to the chest tube(s) is a tool for measuring air leaks (it shows presence, size, and changes).

1. Insert the balloon catheter into the instrument channel of the bronchoscope. Refer to the Instruction for Use provided with the balloon catheter for its operation. Start in proximal airways before moving distally, as needed.
2. Evaluate if an airway segment contributes to the air leak by slowly inflating the balloon until the balloon seals the airway. Then, determine if the air leak has decreased or stopped.
3. If the air leak has not decreased or stopped, deflate the balloon, pull the balloon catheter into the bronchoscope, and evaluate the next airway segment.
4. If the air leak decreases or stops, this indicates the airway contributes to the air leak. Follow airway sizing instructions for appropriate valve placement.
5. Multiple airways may contribute to an air leak. Additional balloon occlusions and valve placements may be required.

10.2 Selecting the Spiration Valve Size

Use a balloon catheter (B5-2C) together with the Airway Sizing Kit to determine the appropriate valve size to use for each target airway.

Caution: Incorrect valve size will reduce device effectiveness.

10.3 Loading the Spiration Valve

1. Remove the loader and catheter from the packaging.
2. Release the disposable shipping lock from the loader by pushing the catheter release safety slider forward, then pressing the catheter release button down until an audible "click" is heard. Remove the shipping lock from the loader.

   Caution: If a "click" is not heard, fully re-insert the shipping lock into the loader. Repeat step 2.
3. Pull the loader plunger all the way back.
4. Remove the catheter from the protective tube in the packaging.
5. Select a cartridge of the determined valve size. Remove the cartridge from the packaging. Verify a valve is inside the cartridge (see Figure 3).

Figure 3: Spiration Valve and Cartridge

6. Insert the cartridge into the loader until it locks into place.
7. Verify the catheter retractor is fully forward and the green safety clip is installed over the yellow portion of the handle.
8. Inspect the catheter's distal tip for damage prior to inserting it into the loader. Damage may include kinks, deformation, tears, or protrusions. If the catheter is damaged, use a new catheter.
9. Grasp the catheter as shown in Figure 4 so that it can be fully inserted into the loader without kinking or damage. There is a depth gauge (see Figure 4) on the side of the loader that shows where the catheter should be grasped while inserting it into the loader.

Figure 4: Depth gauge on loader used to determine where to grasp Deployment Catheter

10. Insert the catheter into the loader until an audible "click" is heard.

    Caution: If a "click" is not heard, release the catheter by pushing the catheter release safety slider forward, then pressing the catheter release button down until an audible "click" is heard. Remove the catheter from the loader. Repeat step 8. Not hearing a "click" when inserting the catheter into the loader means the catheter has not been properly locked into place inside the loader and the valve may not load properly.
11. Fully push the loader plunger to load the valve into the catheter.
    Verify that the plunger cannot be pushed any further.
12. Release the catheter by pushing the catheter release safety slider forward, then pressing the catheter release button down until an audible "click" is heard. Remove the catheter from the loader.
13. **Visually inspect** the catheter tip to ensure that the valve is loaded correctly.

    Caution: If any anchor tips protrude from the catheter tip, do not insert the catheter into the bronchoscope. In this case, the valve must be replaced. Pull the catheter retractor to eject the valve for disposal. Direct the catheter tip into a container to avoid losing the ejected valve. Obtain a new cartridge and load the new valve into the catheter by repeating previous steps.
14. Pull the loader plunger all the way back and remove the cartridge.

10.4 Deployment of the Spiration Valve

1. While holding the catheter at the proximal end of the catheter tip, carefully insert the catheter into the instrument channel of the bronchoscope using slow, short strokes.

   Important:
   - Only use a bronchoscope with an instrument channel inner diameter of 2.6 mm or larger.
   - Do not bend or force the distal end of the catheter while inserting into the bronchoscope. This may cause a kink in the catheter which may prevent the valve from deploying.
2. While the bronchoscope is in a central airway without a bend, advance the catheter until the stabilization wire tip and removal rod tip are visible.

   Caution: Applying excessive force to advance the catheter through a bend in the bronchoscope could result in damage to the catheter and/or the instrument channel of the bronchoscope.

Preparing to Advance the Catheter to the Target Location

3. Retract the catheter into the bronchoscope until the end of the catheter tip is just visible at the end of the bronchoscope and does not interfere with its operation.

Positioning the Bronchoscope for Spiration Valve Deployment

4. **Under bronchoscopic observation**, advance and position the bronchoscope so that the target airway location is visible and the tip of the catheter can be directed into the target airway site without bending or kinking the catheter.
5. Advance the catheter so that the valve line passes beyond the target location.

   Caution:
   - While directing the catheter to the target airway site, do not apply excessive force to advance the catheter.
   - If it is necessary to remove the loaded catheter from the bronchoscope, relax the bronchoscope's distal tip first.
6. Pull the catheter back slowly so that the valve line is at the target location. The valve line marks the position where the proximal end of the valve will contact the airway wall once deployed. After deployment, the valve may settle 1–2mm distally over time, so the operator should account for this effect.

   Caution: If the catheter is pushed to position prior to deployment, the valve may deploy distal to the target location.
7. If the valve line is not at the desired target location, repeat steps 5 and 6. Performing steps 5 and 6 in sequence reduces movement of the catheter inside the bronchoscope channel during deployment.

Deploying the Spiration Valve

Important:
- The valve line and target location must be visible prior to deploying the valve.
- Hold the catheter sheath at the bronchoscope instrument channel entry port to maintain the valve line at the target location, so the catheter does not move during deployment.

8. **Under bronchoscopic observation**, using a smooth continuous motion, pull on the catheter retractor to deploy the valve. Forces on the catheter can be decreased by limiting bends in the bronchoscope and the catheter and/or by reducing the speed that the catheter retractor is pulled during deployment.
9. Once the valve is completely deployed, immediately remove the catheter from the bronchoscope.
10. While holding the catheter uncoiled, advance the catheter retractor and re-install the safety clip.

Checking Spiration Valve Placement

11. Visually examine the valve for position and fit. The valve should be opened and opposing against all borders of the airway.

    Caution: If the position of the deployed valve is not optimal or appropriate, remove and properly dispose of the valve.
12. After valve deployment, evaluate the reduction of the air leak and determine if additional valves should be deployed.
13. As needed, repeat the loading and deployment steps for each additional valve required.

    Caution: The catheter and loader are designed to load and deploy up to 10 valves. After 10 valves are loaded and deployed from a loader and catheter, use a new catheter and loader. Using a catheter and loader more than 10 times may lead to system failure.

    Important: Ensure the catheter safety clip is installed onto the catheter first before loading the next valve.

11. Spiration Valve Removal

11.1 Recommended Use of ET Tube

Removal of valves should be conducted **under bronchoscopic observation**. It is recommended that valves should be removed through an endotracheal (ET) tube or other intubation system that facilitates access to the airways for the following reasons:
- Allows better control of the upper airways and facilitates ventilation and anesthesia
- Facilitates the manipulation of the flexible bronchoscope into the areas where valves need to be removed
- Facilitates removal of the valves by protecting the vocal cords and other structures of the upper airways

The procedure can be performed without intubation, but this decision should be made by the physician after he or she has acquired enough experience with the Spiration Valve System.

11.2 Removing the Spiration Valve

1. Insert the appropriate forceps (see Table 1) through the instrument channel of the bronchoscope, directing the forceps to the target location (see Instructions for Use provided by the forceps manufacturer).

Table 1: Forceps Selection

Forceps	Recommended Use
Cupped Biopsy	When the removal rod tip can be visualized and accessed by the biopsy forceps.
Rat-Tooth Jaw Grasping	When the removal rod shaft is being grasped.
Pediatric Biopsy	When the maneuverability of the bronchoscope is limited by standard sized forceps but the removal rod tip can be visualized and grasped.

2. Grasp the removal rod shaft or removal rod tip with the appropriate forceps and gently pull the valve until it is dislodged from the airway wall. Use care to make sure that the removal rod does not get caught in the fenestration of the forceps when removing the valve (see Figure 5).

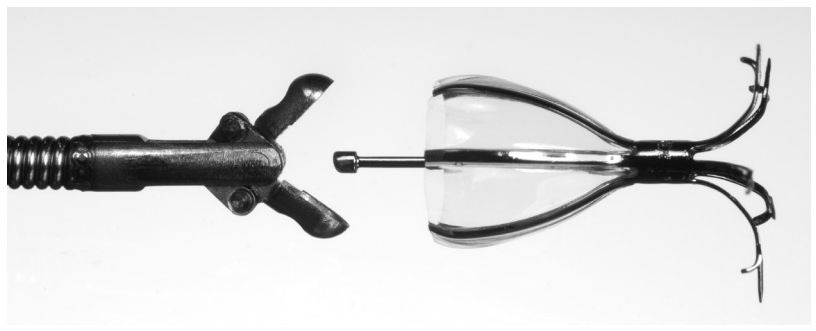

Figure 5: Spiration Valve Removal with Forceps

Important: Before removing the valve from the trachea, pull the valve close to the end of the bronchoscope (see Figure 6).

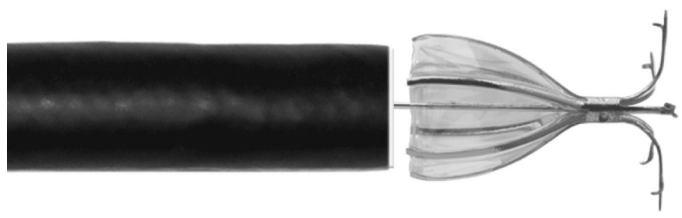

Figure 6: Spiration Valve close to the end of the bronchoscope prior to removal

3. While still firmly holding onto the valve with the forceps, simultaneously remove the bronchoscope and the forceps from the patient.

   Caution: Do not attempt to bring the whole valve through the instrument channel of the bronchoscope. This may cause damage to the bronchoscope.
   Important: Do not release the valve from the forceps until the valve is completely removed from the patient. During removal, the valve struts may invert.
4. All valves are single use only.

12. Clinical Studies

12.1 Post Approval Study

Spiration conducted a post approval study of the Spiration Valve System. The study methods and results are summarized in Table 3.

Table 3: Post Approval Study Methods and Results

Study Methods	
Objective	Characterize the safety profile of the Spiration Valve System
Design	Prospective Multi-Center Observational Study
Study Population	Inclusion Criteria • Subject has an air leak present on day 7 after lobectomy, segmentectomy, or lung volume reduction surgery (LVRS), or on day 5 if the air leak is 1) continuous, 2) present during normal inhalation phase of inspiration, or 3) present upon normal expiration and accompanied by subcutaneous emphysema or respiratory compromise Exclusion Criteria • Air leak only on force exhalation or cough • Subject has significant active asthma, pneumonia, bacterial bronchitis or clinically significant bronchiectasis • Subject is unable to provide informed consent and there is no designated authority to sign for the incapacitated patient • Subject is not an appropriate candidate for, or unable to tolerate, flexible bronchoscopy procedures Subject has co-morbidities or factors that will prevent follow-up during the study period
Data Source	Study specific case report forms
Key Study Endpoints	• Adverse events reported during the study were analyzed and summarized. • Probable benefit information gathered during study was analyzed and summarized.
Number of Study Sites, Subjects, and Follow-up Rate	39 subjects were enrolled at 11 sites 100% (32/32 as per protocol)
Study Visits and Length of Follow-up	Following valve placement, subjects were followed through valve removal or 6 weeks, whichever was earlier
Results	
Final Safety Findings	Two adverse events were reported for the 32 subjects treated. • 1 systolic arrest occurred prior to valve placement; not device related • 1 atelectasis and thick mucus secretion; possibly device related
Final Effectiveness Findings	• Of the 39 subjects enrolled, 32 received valves (as per protocol); 7 subjects did not receive valves due to inability to localize air leak (5), resolution of air leak (1), and inability to access air leak.30 (94%) showed a positive response to valve placement. Two (6%) showed no improvement in air leak. • 30 (94%) showed a positive response to valve placement. Two (6%) showed no improvement in air leak. • 11 of 30 responders completely resolved, 19 showed improvement. • Post-Procedure Days in Hospital: 6.0±6.1 (0 min, 27 max); 0.7±2.2 in ICU (0 min, 10 max) • Days Valves in Place (n=27): 53.6±33.1 (10 min; 185 max)
Study Strengths / Weaknesses	Strengths • Prospective recruitment • Thorough follow-up for adverse event determination Weaknesses • Lack of control arm to determine underlying adverse event rate in population • Lack of discrete secondary endpoints to evaluate efficacy • Limited number of female patients (10), small sample size (32)

13. Patient Information

A Patient Information Pamphlet is available for potential patients (Patient Information for the Spiration Valve System, Humanitarian Device for Use in the Control of Air Leaks). Patients who receive treatment will be given a wallet card that indicates the patient has valve(s) and lists the procedure doctor's contact information.