

# Value of a Multidisciplinary Team Approach to Treatment of Emphysema



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## KEYWORDS

• LVRS • Lung volume reduction surgery • National emphysema treatment trial (NETT)

## KEY POINTS

- Successful lung volume reduction surgery (LVRS) requires a well-organized multidisciplinary team effort.
- The multidisciplinary team should include the lung transplant team to help decide if the best treatment for the patient would be LVRS or lung transplant.
- LVRS is potentially indicated for patients who are symptomatic despite maximal medical management for bullous emphysema.
- Patients for LVRS have severe obstructive disease (forced expiratory volume in 1 second 20%–40% predicted, total lung volume >120%, and residual volume >120%) and a heterogeneous pattern of emphysema.

## INTRODUCTION

Lung volume reduction surgery (LVRS) can greatly improve the quality of life for patients with failed medical management for severe emphysema. Chronic obstructive pulmonary disease is a leading cause of death in the western world with at least 2 million patients with emphysema.<sup>1</sup> Very intensive work is required for the evaluation and treatment of these patients. These patients have extremely poor pulmonary function and conditioning so their treatment carries substantial risk.

The pathophysiology behind emphysema is the loss of elastic recoil of the lungs leading to frequent air trapping in increase in the nonfunctional portions of the lung.<sup>1</sup> The elastic recoil of the lungs is poor,<sup>2</sup> such that they do not decompress well with expiration. The lung remains

hyperexpanded and the diaphragm is flattened and very low in the chest; it cannot move. LVRS was developed to remove the nonfunctioning portions of the lung, those simply occupying space, making more physical space within the chest for the portions of the lung with continued function.<sup>1</sup> The basic physiology behind LVRS is to improve the elastic recoil of the emphysematous lung. Patients with severe emphysema have high TLC (total lung capacity) and the RV (residual volume) is high so the diaphragm is low in the chest. The total elastic recoil is the average of the recoil if all areas of the lung. If the lung is uniformly bad (homogeneous), resection of some of that bad tissue does not generally improve the recoil because the average elastic recoil does not improve. The optimal scenario is a heterogeneous pattern of

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emphysema, where the lungs have bad, nonfunctional areas of lung tissue and some better areas. By removing the bad areas, the better areas can expand and function more effectively. Removing bad areas of lung with poor elastic recoil increases the overall average of recoil for the whole lung so breathing improves. The RV is better. The diaphragm is higher in the chest and can function much better because it can move caudally with inspiration. LVRS is performed in patients with a heterogeneous pattern of emphysema.<sup>3,4</sup>

Although initially reported by Brantigan and Mueller,<sup>5</sup> this was popularized by Cooper and colleagues<sup>6</sup> when they reported on a series of 20 patients using a linear stapler to cut out the bad tissue. The National Emphysema Treatment Trial (NETT) validated this technique, especially for patients with upper lobe emphysema predominance<sup>3</sup> and demonstrated its durability.<sup>7</sup> Importantly, the NETT also highlighted patient risk factors where LVRS should be avoided.<sup>3,7</sup> To avoid mortality due to poor patient selection and postoperative complications, multidisciplinary teams for LVRS are a key to success and the foundation of any LVRS program.<sup>8</sup>

Here, we have been tasked to discuss the importance of the LVRS multidisciplinary team approach to treatment of emphysema.

## INTRODUCTION TO THE TEAM

The pulmonary medicine and thoracic surgery divisions are the core of the LVRS multidisciplinary team. At some institutions, a combination multidisciplinary clinic, consolidating patient visits, is offered to provide consults and testing (eg, plethysmography, computerized tomography [CT] scan, as well as a radionuclide perfusion scan).<sup>1</sup> Team meetings discuss patients and appropriate plans for each. The core composition includes pulmonologists, thoracic surgeons, radiologists, physical therapists, and an LVRS coordinator. Other important team members include the immediate postoperative care team composed of anesthesiologists, nurses, and respiratory therapists.

## LUNG VOLUME REDUCTION SURGERY COORDINATOR

The quality of an LVRS program is greatly enhanced by a high-functioning coordinator. In the middle of the 1990s, our LVRS program was very busy with approximately 8 operations per week. The coordinator streamlines screening and evaluation processes.<sup>8</sup> In our program, we required, at a minimum, a medical history, pulmonary function test, and CT scan to identify potential candidates for the procedures. Documentation of

consensus recommendations by the multidisciplinary team is also a fundamental role of the LVRS coordinator.<sup>8</sup> Oey and Waller<sup>8</sup> described a documentation form used to standardize information and keep it readily accessible with completion being the role of the coordinator. If they appeared to be good candidates, they then came to our clinic for an in-person evaluation. Our coordinator was extremely busy in the process of organizing these extensive evaluations, coordinating the evaluations of the information mailed to us, organizing clinic visits, and during their subsequent operation if they were deemed appropriate candidates.

## PULMONOLOGIST

A pulmonologist is important for helping to screen potential patients and perioperative care. The pulmonologist needs to make sure that medical management, including medicines and pulmonary rehabilitation, have been optimized. This includes maximizing therapy, while limiting steroids, through the hospitalization for the LVRS.<sup>9</sup> Patients need to be limited enough to justify LVRS, but not so debilitated that their risk for surgery is too high. Pulmonary plethysmography is important to make sure that the patient is in the right range to be considered for LVRS. Generally, appropriate surgical candidates have a forced expiratory volume in 1 second (FEV1) between 20% and 40% of predicted, TLC greater than 120%, a high RV (greater than 200%), and diffusing capacity for carbon monoxide (DLCO) between 20% and 40% of predicted. FEV1 or DLCO of less than 20% predicted have a higher risk of death.<sup>10</sup> The pulmonologist also helps with the perioperative management of these patients.

There are some developing roles for endobronchial valves in patients with emphysema, especially those with homogeneous emphysema, as LVRS increases mortality these patients.<sup>3,7,11</sup> It is often reserved for patients who have surgical contraindications or choose endobronchial valves.<sup>1</sup> An involved and expansive multidisciplinary team, including those interventional pulmonologists who place endobronchial valves, subsequently covers all plausible alternate therapies. Although emphysema has a spectrum of symptoms that occasionally will lead a patient down a path to pursue lung transplantation, it can be beneficial, but not required, to have pulmonologists involved in lung transplantation as members of the team.<sup>8</sup>

## THORACIC SURGEON

The surgeon needs to be involved in the total management for LVRS. Although initially performed via

sternotomy, safety and patient benefit via bilateral video-assisted thoroscopic surgery has been demonstrated; therefore, a surgeon must be proficient in this technique.<sup>12</sup> Technical aspects, including the volume of lung removed and the buttressing of staple lines are critical to success.<sup>13</sup> A surgeon removing an insufficient volume of the upper lobe simply leads the patient to a forum of operative risk without potential benefit.<sup>14</sup> The surgeon needs to lead the team and understand all aspects of screening, selection, the operation, and postoperative care. Because emphysema can progress to lung transplantation, it can be beneficial, but not required, to have thoracic surgeons involved in lung transplantation as members of the LVRS multidisciplinary team.<sup>8</sup> The surgeon has the greatest to gain from a multidisciplinary team for treatment of LVRS. This surgery, as demonstrated by the NETT trial, carries much greater risk of complication and death in certain groups. The multidisciplinary team can help with this evaluation and risk stratification to ensure that patients receiving LVRS are the most ideal patients of success.

## RADIOLOGIST

An understanding of the imaging of patients who are potential candidates is critical to a multidisciplinary group. Severely emphysematous lungs have good compliance so they expand well, but poor elastic recoil so they do not decompress well with expiration. The CT shows hyperexpanded lungs and flat diaphragms. The radiologic imaging is the most important most important criteria for LVRS. Ideal imaging should select nonfunctional areas of lung with poor elastic recoil to be resected and the opposite to remain. Unfortunately, no such imaging currently exists.

The CT scan is the most important imaging test to select candidates for LVRS. Thin-slice CT demonstrates the severity of emphysema better than the standard thicker (5-mm) slices of CT scans. The NETT used a scale of 1 to 4 grading of the amount of emphysema. The chest was divided into 4 sections and rated the amount of emphysema in cross sections in those 4 areas. Ratings were as follows: 1 (0%–25%), 2 (26%–50%), 3 (51%–75%), and 4 (76%–100%) as the % emphysema seen in cross sections. An example of significant heterogeneity would be 4 at the apex and 2 at the base.

The quantitative perfusion test is a good test to demonstrate heterogeneity. Most centers prefer to perform this at their center to avoid intertechnique variability.<sup>1,8</sup> Poor perfusion at the apex and good perfusion at the bases of the lungs

documents good heterogeneity. There is occasional discordance between the quantitative perfusions scan and the CT scan.<sup>8</sup> Some centers will offer surgery to patients with heterogeneity localized to the lower lobes with appropriate patient counseling.<sup>1</sup> In some cases, the perfusion scan shows heterogeneity not seen on CT scan.

## REHABILITATION COORDINATOR

Pulmonary rehabilitation is imperative for preoperative rehabilitation and patient selection for LVRS. Patients with severe emphysema are generally quite de-conditioned because their level of activity and exercise is severely limited. Per Medicare guidelines, patients for LVRS need to complete a pulmonary rehabilitation program before LVRS. This program spans 6 to 10 weeks.<sup>9,15</sup> This helps to recondition patients and reduce their complication rates postoperatively. A patient's exercise tolerance is assessed using a standard shuttle walk or a 6-minute walk test. After rehabilitation, patients are reassessed for surgical candidacy.<sup>9</sup> Another important benefit is that the rehabilitation coordinator can evaluate the patient's motivation.

The NETT demonstrated effectiveness of pulmonary rehabilitation and the centrality of its utilization to select appropriate candidates for surgery.<sup>15</sup> It was also initially designed to improve physical and psychological function, as well as educate patients on their own lung disease. These sessions involved supervised exercise, education, and psychosocial session by a mental health provider.<sup>15</sup> The use of pulmonary rehabilitation improved the 6-minute walk distance achieved, improvements in dyspnea, and quality of life.<sup>15</sup> Pulmonary rehabilitation produced substantial improvement in 20% of patients so they did not need LVRS.

In our experience, occasionally when we do a consultation for LVRS, patients will state that they are very motivated to move forward with an LVRS intervention and they want to be compliant with all instructions perioperatively and postoperatively. We had 2 such patients guarantee that they were highly motivated to succeed following the operation. Both awakened after their anesthetic to say they wanted to die. Aligning with their wish, they both did not comply with postoperative requirements and so, in fact, did die from pneumonia. Although patients may want to be compliant, pulmonary rehabilitation, under the direction of the coordinator, can ensure they have the will and strength to follow through. Sometimes the patients talk a good story but in reality, they are not motivated to achieve the outcomes

required. Continuity and centralization of a coordinator running a program permits active involvement in rehabilitation as well as someone with insight and honesty on a patient's true level of motivation.

## ANESTHESIOLOGIST

Although the anesthesiologist does not need to be an integral member of the selection team, the operative success of LVRS hinges on the appropriate management of these patients in the operating theater. The anesthesiologist must command a solid grasp of the pathophysiology of emphysema as well as the details of the LVRS itself.<sup>16</sup> Anesthesia should be proficient with one-lung ventilation and the use of epidural analgesia.<sup>16</sup> Patients will require standard lung isolation via a double lumen tube during the operation. For anesthesia, propofol is strongly considered, as it maintains pulmonary vasoconstriction decreasing the shunt fraction and does not rely on the lungs of elimination.<sup>16</sup> For intraoperative ventilation, it is key to realize that patients are at risk for barotrauma and gas trapping.<sup>16</sup> Pressure-controlled ventilation should be used rather than volume-controlled ventilation during the LVRS.<sup>16</sup> To avoid hyperinflation, a long inspiratory to expiratory ratio should be used (Q). It is also critical to monitor intraoperative carbon dioxide as patients undergo periods of single lung ventilation and this can limit gas exchange. Some level of hypercapnia will inevitably develop. Critical to success is early extubation, which should occur immediately after surgery to minimize the risks of the dreaded postoperative air leak.<sup>16</sup>

## NURSING

To operate on patients with very poor pulmonary function can carry substantial risk. Our nurses had great pride of ownership that drove them to making sure patients did well. For example, 1 patient after LVRS had an arterial blood gas in the recovery room with a CO<sub>2</sub> of 140. The nurse caring for the patient did a fabulous job to make the patient breath better. The patient did not require reintubation and ultimately did very well. The goal was to not have any patients intubated in the recovery room or postoperatively in the hospital. Patients needed to ambulate 4 times a day in the hallways and actively participate in all aspects of pulmonary toilet postoperatively. Our overall results were very good because of the fine nursing care.

**Table 1**  
Overlapping and different indications for LVRS and lung transplantation

Possible Indication	LVRS	Lung Transplantation
Heterogeneous	Yes	Yes
Homogeneous	No	Yes
Hyperinflated	Yes	No
Restricted	No	Yes
Emphysema	Yes	Yes
Fibrosis	No	Yes
Age, y	<75	<60

## RESPIRATORY THERAPY

Chest physiotherapy is an important part to the postoperative recovery and should be used on postoperative day 1.<sup>16</sup> A center performing LVRS should have the appropriate patient support for respiratory therapy.

## LUNG TRANSPLANTATION

Both LVRS and lung transplantation are reasonable treatments for selected patients with emphysema. The operations have some unique and some overlapping indications (Table 1). The LVRS team leaders need to understand both procedures to select the optimal treatment for patients with overlapping indications. The benefits from LVRS usually last a few years. Therefore, LVRS may be a better choice for a younger patient if lung transplantation is still an option after the benefit of LVRS is gone.

## SUMMARY

Aside from the contribution to the team by different individuals, the multidisciplinary team must have guidelines on agreement of basic selection criteria, protocols, and assessments.<sup>8</sup> As mentioned previously, the provider who benefits the most from the multidisciplinary care team approach to LVRS is the surgeon. The person who supersedes this benefit is the patient, whether it is confirming their candidacy for LVRS or avoiding a poor outcome. As an inappropriate candidate for LVRS, the patient is set-up to be the greatest benefactor from and invested multidisciplinary team for LVRS. It cannot be reiterated enough that patient selection, as clearly outlined by the NETT, is the key to a successful LVRS program, so it is therefore inferred that the success of the program lies simply with those doing the selecting.

**CLINICS CARE POINTS**

- Identify highly motivated patients
- Avoid postoperative intubation
- Aggressive postoperative ambulation and pulmonary toilet
- Epidural catheters to facilitate postoperative pain control

**DISCLOSURE**

None.

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