


Position statement on endoscopic lung volume reduction in South Africa: 2022 update

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On behalf of the Assembly on Interventional Pulmonology of the South African Thoracic Society

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Chronic obstructive pulmonary disease (COPD) remains one of the most common causes of morbidity and mortality in South Africa. Endoscopic lung volume reduction (ELVR) was first proposed by the South African Thoracic Society (SATS) for the treatment of advanced emphysema in 2015. Since the original statement was published, there has been a growing body of evidence that a certain well-defined sub-group of patients with advanced emphysema may benefit from ELVR, to the point where the current Global Initiative for Chronic Obstructive Lung Disease (GOLD) Guidelines and the United Kingdom National Institute for Health and Care Excellence (NICE) advocate the use of endoscopic valves based on level A evidence.

Patients aged 40 - 75 years with severe dyspnoea (COPD Assessment Test score ≥ 10) despite maximal medical therapy and pulmonary rehabilitation, with forced expiratory volume in one second (FEV₁) 20 - 50%, hyperinflation with residual volume (RV) $>175\%$ or RV/total lung capacity (TLC) $>55\%$ and a six-minute walking distance (6MWD) of 100 - 450 m (post-rehabilitation) should be referred for evaluation for ELVR, provided no contraindications (e.g. severe pulmonary hypertension) are present. Further evaluation should focus on the extent of parenchymal tissue destruction on high-resolution computed tomography (HRCT) of the lungs and interlobar collateral ventilation (CV) to identify a potential target lobe. Commercially available radiology software packages and/or an endobronchial catheter system can aid in this assessment.

The aim of this statement is to provide the South African medical practitioner and healthcare funders with an overview of the practical aspects and current evidence for the judicious use of the valves and other ELVR modalities which may become available in the country.

Keywords. Coils, emphysema, endoscopic lung volume reduction, valves

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Chronic obstructive pulmonary disease (COPD) remains one of the most common causes of morbidity and mortality, both in South Africa (SA) and globally.^[1] In southern Africa and many other low- and middle-income countries (LMICs), long-term biomass fuel exposure and tuberculosis contribute to the disease burden.^[2] COPD is generally managed with inhaled pharmacotherapy, as well as smoking cessation, pulmonary rehabilitation, vaccination and domiciliary oxygen in advanced cases.^[1]

Surgical lung volume reduction improves clinical and functional status and mortality in a subgroup of patients with predominant upper-lobe emphysema and low exercise capacity.^[3] Endoscopic lung volume reduction (ELVR), a far less invasive alternative, was first proposed by the South African Thoracic Society (SATS) for the treatment of advanced

emphysema in 2015.^[4] Since the original statement was published, numerous high-quality randomised trials have been completed, adding to the growing body of evidence that a certain well-defined sub-group of patients with advanced emphysema may benefit from ELVR. In recognition of this, the current Global Initiative for Chronic Obstructive Lung Disease (GOLD) Guidelines advocate the use of endoscopic valves based on level A evidence, as does the UK National Institute for Health and Care Excellence (NICE) guidelines in these selected patients.^[5]

Endobronchial valves are currently commercially available in SA, but very few centres have the capacity to properly evaluate prospective candidates and potentially offer ELVR to appropriate patients. The high cost and potential complications of these interventions are crucial points that underscore the need for careful patient selection to best

identify those who may or may not benefit from ELVR-related procedures.^[6]

The aim of this statement is to provide the SA medical practitioner and healthcare funders with an updated overview of the practical aspects and current evidence for the judicious use of the valves and other ELVR modalities, such as endobronchial coil treatment, which may become available in the country.

The rationale and caveats for lung volume reduction

A reduced alveolar surface area owing to the formation of blebs and bullae and reduced elastic recoil are hallmark features of emphysema. Early airway closure occurs during expiration, with resultant air trapping and hyperinflation. Consequently, the range of expansion of preserved areas of lung tissue decreases. Furthermore, air trapping and hyperinflation place the diaphragm at a mechanical disadvantage owing to its flattened configuration.^[7] These processes all lead to refractory dyspnoea in patients with advanced emphysema.

ELVR with valves, in principle, aims to achieve complete or partial atelectasis of the targeted region, thereby reducing its volume and redirecting airflow to less affected regions.^[8,9] Dynamic hyperinflation decreases, and diaphragm and chest wall mechanics improve. The remaining lung tissue in theory has better elastic properties, which can restore the outward radial pull on the small airways, thereby increasing expiratory airflow. Reducing inhomogeneity of regional ventilation and perfusion improves ventilation/perfusion matching.

There are, however, some caveats to ELVR. Devices designed to cause bronchial occlusion, for example, have been shown to be inefficient in cases where significant interlobar collateral ventilation is present.^[8,10] In these patients, treatment with endobronchial coils could be a better option. Coils, in theory, also re-tension the airway network to mechanically increase elastic recoil in the emphysematous lungs and tether airways open, thereby preventing airway collapse.^[11]

Modalities and devices Unidirectional intrabronchial and endobronchial valves

Technical aspects

Two devices are currently commercially available in SA: Zephyr endobronchial valves

(Pulmonx Inc., USA) and IBV (previously known as Spiration) intrabronchial valves (Olympus Respiratory America., USA). Both devices are self-expanding and delivered using a catheter that is introduced through the working channel of a large working channel flexible bronchoscope under either general anaesthesia or conscious sedation.^[8] Zephyr valves are inserted with single-use catheters that are used to both size the target airway and deploy the valves. Calibrated balloon catheters are used to size the airways in case of IBV valves, which are then deployed using dedicated deployment catheters.

Zephyr valves are made of a nitinol (nickel-titanium) mesh covered by silicone and contain a double silicone membrane which opens during expiration and closes during inspiration.^[8] The valves are available in four sizes (Fig. 1), two for segmental (4.0-LP and 4.0 EBV) and two for lobar bronchi (5.5-LP and 5 EBV). Anchorage of the valve to the airway is facilitated by the irregular surface and self-expanding strength of the mesh.

IBV valves (Fig. 2) are umbrella-shaped devices made of a nitinol mesh covered by a polyurethane membrane.^[8] The valve is secured to the airway wall by hook-like anchors and can be removed by pulling on a proximal central rod. It is available in four different sizes (5, 6, 7 and 9 mm).

Evidence

Endobronchial and intrabronchial valves are the most extensively studied devices for ELVR, to the point where their use in a subgroup of patients with advanced COPD is graded ‘evidence A’ by GOLD.^[5] The major randomised controlled trials (RCTs) are summarised in Table 1.

The STELVIO-trial provided some of the strongest evidence for the importance of absence of collateral ventilation in the target lobe assuring the beneficial response to ELVR with valves.^[12] Dutch investigators randomly assigned 68 patients with severe emphysema (with both homogeneous and heterogeneous involvement) and a confirmed absence of collateral ventilation to bronchoscopic endobronchial-valve treatment (EBV group) or to continued standard medical care (control group). Primary outcomes were changes from baseline to 6 months in forced expiratory volume in 1 second (FEV₁), forced vital capacity (FVC), and 6-minute walk distance (6MWD). Intention-to-treat analyses showed significantly greater improvements in the EBV group than in the control group from baseline to 6 months: the increase in FEV₁ was greater in the EBV group than in the control group by 140 mL (95% confidence interval (CI) 55 - 225), the increase in FVC was greater by 347 mL (95% CI 107 - 588), and the increase in the 6MWD was greater

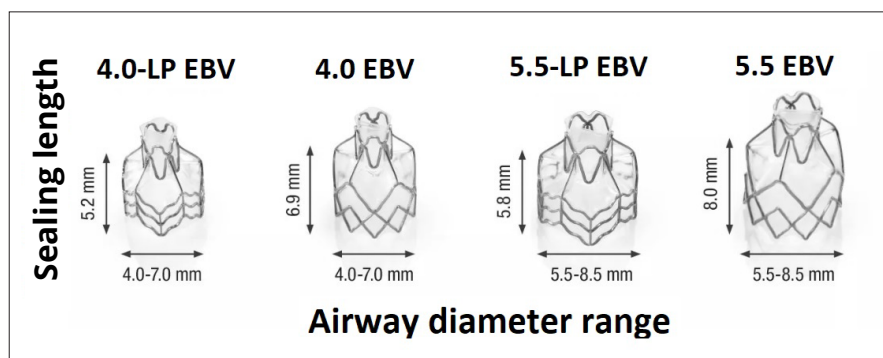


Fig. 1. Endobronchial (Zephyr) valves of varying diameters for lobar or segmental occlusion.

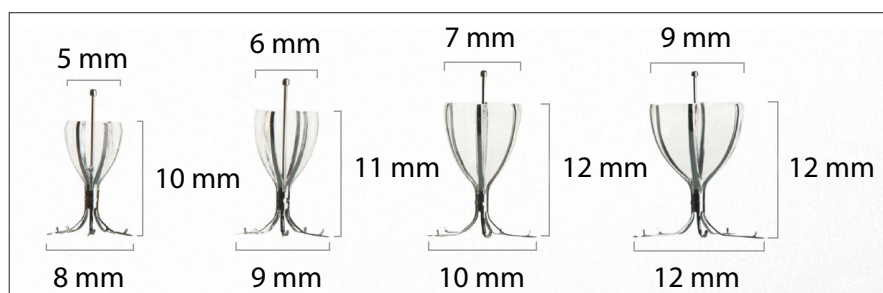


Fig. 2. Intrabronchial (IBV) valves of varying diameters.

Table 1. Summary of the major randomised controlled studies on intrabronchial and endobronchial valves

Study (year)	Study design			Main outcomes (v. standard of care*)			
	Device	n (treated/ randomised)	Follow-up (months)	Δ SGRQ (points)*	Δ 6MWD (m)*	Δ FEV ₁ (% or absolute)*	Δ RV (mL)
STELVIO (2015) ^[12]	EBV	34/68	6	-17 v. -3	+60 v. -4	+21 v. +3%	-672
IMPACT (2016) ^[26]	EBV	43/93	3	-9 v. +1	+23 v. -17	+14% v. -3%	-480
TRANSFORM (2017) ^[13]	EBV	65/97	6	-7 v. -1	+36 v. -43	+21% v. -9%	-670
LIBERATE (2018) ^[14]	EBV	128/190	12	-8 v. -1	+13 v. -26	+17% v. -1%	-490
REACH (2019) ^[27]	IBV	59/91	6	-8 v. +1	+21 v. -16	+91mL v. -24mL	-420
EMPROVE (2019) ^[15]	IBV	113/172	12	-8 v. +5	-4 v. -13	+99mL v. -32mL	-402

Δ = change; SGRQ = St George's Respiratory Questionnaire (measured in points); FEV₁ = forced expiratory volume in one second; RV = residual volume; 6MWD = six-minute walking distance; EBV = endobronchial valve; IBV = intrabronchial valve.

by 74 m (95% CI 47 - 100) ($p < 0.01$ for all). Serious treatment-related adverse events in this group included pneumothorax (18% of patients) and events requiring valve replacement (12%) or removal (15%).

The prospective, multicentre TRANSFORM study yielded equally impressive results.^[13] Patients with heterogeneous emphysema and absence of collateral ventilation were randomised (2:1) to EBVs plus standard of care or standard of care alone (SoC). Primary outcome at 3 months post procedure was the percentage of subjects with FEV₁ improvement from baseline of 12% or greater. Changes in FEV₁, residual volume (RV), 6MWD, St. George's Respiratory Questionnaire score (SGRQ), and modified Medical Research Council (mMRC) score were assessed at 3 and 6 months, and target lobe volume reduction on chest computed tomography at 3 months. At 3 months, 55.4% of the EBV group and 6.5% of SoC subjects had an FEV₁ improvement of $\geq 12\%$ ($p = 0.001$). Improvements were maintained at 6 months (Table 1). A total of 89.8% of EBV subjects had target lobe volume reduction greater than or equal to 350 mL. Between-group differences for changes at 6 months were statistically and clinically significant: EBV–SoC for RV 700 mL; 6MWD 78.7 m; SGRQ, -6.5 points; mMRC dyspnoea score, -0.6 points (all $p = 0.05$). Pneumothorax was the most common adverse event, occurring in 19 of 65 (29.2%) of EBV subjects.

In the largest prospective study to date, the LIBERATE investigators found similar significant differences after 12 months of follow-up (summarised in Table 1) and concluded that Zephyr EBV provides clinically meaningful benefits in lung function, exercise tolerance, dyspnoea and quality of life, with an acceptable safety profile in patients with little or no collateral ventilation in the target lobe.^[14]

The EMPROVE study was the largest study to evaluate the effectiveness and safety of the IBV valves.^[15] In this multicentre, open-label, randomised controlled trial, subjects with severe, heterogeneous emphysema were randomised 2:1 to IBV with medical management (treatment) or medical management alone (control). Of note is the fact that lack of collateral ventilation was assessed on computed tomography rather than the Chartis device. The primary efficacy outcome was the difference in mean FEV₁ from baseline to 6 months. The primary safety outcome was the incidence of composite thoracic serious adverse events. The mean FEV₁ showed statistically significant improvements between the treatment and control groups—between-group difference at 6 and 12 months, respectively, of 0.101 L (95% Bayesian credible (BCI), 0.060 – 0.141) and 0.099 L (95% BCI, 0.048 – 0.151). At 6 months, the treatment group had statistically significant improvements in all secondary endpoints except 6MWD. Composite thoracic serious

adverse event incidence through 6 months was greater in the treatment group (31.0% v. 11.9%), primarily due to a 12.4% incidence of serious pneumothorax.

Coils

Technical aspects

Coils were commercially available in SA from 2014 to 2017. These coils were nitinol devices that had been preformed to a shape that results in parenchymal retraction after deployment.^[11] The coils were implanted via a flexible bronchoscope under general anaesthesia or conscious sedation and fluoroscopic guidance using a proprietary delivery system. The airway in the selected segment was identified with a low-stiffness guidewire (under fluoroscopy), after which a catheter was passed over the guidewire and the length of the airway measured. The guidewire was then removed, and a straightened coil was introduced into the distal end of the catheter with a grasper, after which the catheter was removed while the proximal end of the coil was initially advanced and then released, assuming its preformed shape. A second-generation coil, known as the Lung Tensioning Device by Free Flow Medical Inc (Freemont, USA), is currently being investigated for safety and efficacy in COPD, and may become commercially available in the future.

Evidence

At least two large prospective randomised studies have evaluated the effect of endobronchial coils on exercise tolerance. The RENEW study, performed in multiple centres in North America and Europe, found that among patients with emphysema and severe hyperinflation treated for 12 months, the use of endobronchial coils compared with usual care resulted in an improvement in median exercise tolerance that was modest and of uncertain clinical importance, with a higher likelihood of major complications compared with standard care.^[16] Likewise, in a preliminary study of patients with severe emphysema followed up for 6 months, bronchoscopic treatment with nitinol coils compared with usual care resulted in modest improved exercise capacity with high short-term costs.^[17]

The ELIVATE study was unfortunately prematurely terminated when the production of the first-generation coils was discontinued.^[18] Owing to premature study termination, only 120 patients instead of 210 patients were randomised. At study termination, 91 patients (57 coil and 34 control) had 6-month results available. Analyses showed significantly greater improvements in favour of the coil group, with an increase in FEV₁ of 10.3 % and SGRQ by -10.6 points.^[18]

Table 2. General indications and contraindications for endobronchial lung volume reduction with endobronchial and intrabronchial valves in patients with stable emphysema**Indications**

- 40 - 75 years
- Dyspnoea (CAT score ≥ 10) despite maximal medical therapy and pulmonary rehabilitation
- FEV₁ 20 - 50%
- Hyperinflation with RV >175% or RV/TLC >55%
- 6MWD 100 - 450 m (post rehabilitation)

Contraindications

- Collateral ventilation between target lobe and adjacent lobe/non-intact fissures
- Current smoking (last 6 months)
- DL_{CO} <20% of predicted
- Severe hypercapnia (PaCO₂ >8 kPa) or severe hypoxia (P_aO₂ <6.0 kPa) at room air (sea level)
- Giant bullae (>1/3 of hemithorax)
- Previous thoracotomy, pleurodesis, lung transplantation or lung volume reduction surgery
- Excessive sputum/frequent infectious exacerbations
- Pulmonary hypertension (RVSP >50 mmHg)
- Left ventricular ejection fraction <40%
- Active infection
- Unstable cardiac conditions
- Significant pleural or interstitial changes on HRCT
- Maintenance immunosuppressive agents or prednisone >10 mg daily
- Any type of antiplatelet or anticoagulant therapy which cannot be stopped for seven days prior to procedure

CAT score = COPD assessment test score; FEV₁ = forced expiratory volume in one second; TLC = total lung capacity; RV = residual volume; P_aCO₂ = partial pressure of carbon dioxide; P_aO₂ = partial pressure of oxygen; 6MWD = six-minute walking distance; DL_{CO} = carbon monoxide diffusing capacity; HRCT = high-resolution computed tomography; RVSP = right ventricular systolic pressure as measured at echocardiography.

Current evidence suggests that appropriate candidates with both heterogeneous and homogeneous emphysema could experience clinically significant benefit from ELVR using coils, irrespective of collateral ventilation or complete lobar collapse, but availability and prohibitive cost have globally limited the modality's uptake.^[19]

Other devices/techniques**Bronchoscopic thermal vapour ablation**

Bronchoscopic thermal vapour ablation (BTVA, Uptake Medical Corp., USA), which is currently not commercially available in SA, uses high-temperature water vapour delivered into the target lung segments through a catheter with the precise amount of energy required to induce thermal damage and an inflammatory reaction resulting in permanent airway fibrosis.^[8] An initial pilot study that included 11 patients with severe heterogeneous emphysema found modest improvement at a cost of an excess of serious adverse complications, including 5 cases of probable bacterial pneumonia and 2 cases of COPD exacerbation.^[20] In a larger study in patients with heterogeneous upper-lobe emphysema, a higher dose of vapour was administered.^[21] More significant changes in functional improvement were observed. There is still little evidence available for thermal vapour ablation; hence the evidence is still based on the STEP-UP trial conducted in upper-lobe-predominant disease.^[22] Compared with standard medical management, targeted thermal vapour ablation of more diseased segments and preservation of less diseased segments has resulted in clinically meaningful and statistically significant improvements in lung function and quality of life at 6 months, with an acceptable safety profile.^[22]

Sealants

Biological lung volume reduction, using the lung sealant system, is another irreversible ELVR technique that employs a synthetic polymer to block small airways and collateral channels while promoting atelectasis, remodelling and scar formation.^[19] The technology, which is not available in SA, is currently undergoing further evaluation and can only be used in clinical trials in well-selected centres.^[19]

Evidence-based approach to ELVR in SA
Initial evaluation

Current evidence suggests that not all classes and phenotypes of emphysema will benefit from ELVR, and that each technique appears to provide greater benefit to specific subgroups of patients.^[8] Only endoscopic valves are currently commercially available in South Africa, and only a few centres have the capacity to properly evaluate prospective candidates and potentially offer ELVR to appropriate cases. The cost of these interventions makes careful patient selection imperative to prevent insertion in patients unlikely to gain clinical benefit and wasteful expenditure.

The initial screening for suitable candidates should be done at sub-specialist (pulmonologist) level in South Africa, and on patients with stable disease with no recent exacerbations and optimal therapy. The initial evaluation should include a thorough history (focusing on level of dyspnoea, functional impairment, past thoracic surgery, comorbidities and smoking status) and a physical examination. Patients should have completed pulmonary rehabilitation and nutrition support should be instituted (where appropriate) to address cachexia or obesity.^[19]

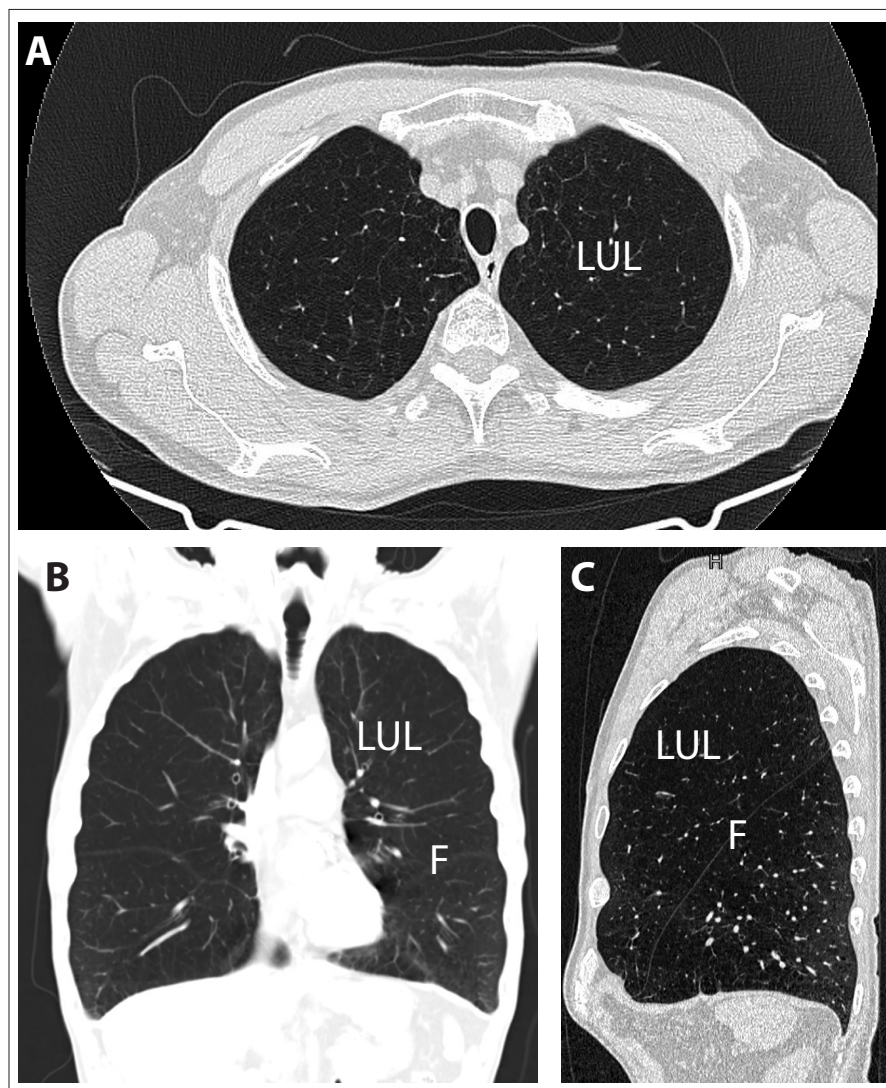


Fig. 3. An example of a high-resolution computed tomography scan of the lung with the target lobe identified. The (A) axial, (B) coronal and (C) sagittal views of an HRCT obtained from a patient who was deemed an appropriate candidate for ELVR with valves. In this case, the fissures (F) were 98% intact, with 74% destruction of the left upper lobe (ULL), which had a volume of 2 320 mL, making it the ideal target lobe.

ELVR candidates should be limited significantly because of lung hyperinflation.^[9] Routine special investigations should include an inspiration and expiration HRCT of the chest (to estimate heterogeneity, fissure integrity, degree of tissue destruction and possible underlying lung cancer or other pathology) and a full functional assessment. Full pulmonary function testing (post-bronchodilator) should include measurements of FEV₁, forced vital capacity (FVC), RV, total lung capacity (TLC), RV/TLC, diffusing capacity of lung for carbon monoxide (DL_{CO}), 6MWD, arterial blood gas and echocardiography (to exclude pulmonary hypertension). When an elevated right ventricular systolic pressure measured by

echocardiography (>50 mmHg) is identified, a right-heart catheterisation is indicated to rule out pulmonary hypertension.^[19]

The general indications and contraindications for ELVR are summarised in Table 2. Patients with severe and very severe airflow obstruction (FEV₁ 20 – 50%) who are highly symptomatic with a COPD Assessment Test (CAT) score ≥10, mMRC ≥2, hyperinflation (RV ≥175% or RV/TLC ≥55%) and a reduced 6MWD (100 – 450 m) may be considered for lung volume reduction therapies.^[9,19]

ELVR should not be offered to active smokers, patients with pulmonary hypertension >50 mmHg, unstable cardiac pathology, active respiratory infections,

extremely poor exercise tolerance, patients with no clear evidence of hyperinflation, and patients who are on any type of antiplatelet or anticoagulant therapy which cannot be stopped for 7 days prior to the procedure.^[19]

Further specialised evaluation: Assessment of radiology and collateral ventilation

Appropriate or borderline candidates should be referred to an expert centre with the capacity to evaluate, treat and follow up these candidates, including the managing of complications and removal of devices if required. These centres should individualise the interventions based on disease phenotype, degree of tissue destruction, fissure integrity, lobar volumes, the presence of collateral ventilation and pulmonary impairment.

Standard HRCT of the lungs performed on a multi-detector scanner platform with thin (1 mm) slices and some overlap is required to characterise the extent, distribution and heterogeneity of emphysema, degree of lobar destruction, and integrity of the lobar fissures.^[19] HRCT is also used to ensure the absence of significant comorbidity or abnormalities that require further assessment.^[19] HRCT assessment can best be evaluated in all three planes – axial, coronal and sagittal (Fig. 3).^[9] The integrity of the fissures can be assessed, and possible EBV target(s) can be preliminarily identified.^[9] In patients with heterogeneous disease, it is paramount for ELVR to target and treat the most diseased regions of the lung while preserving the less diseased functional regions.^[23] There are commercially available software packages that can aid in the quantitative analysis, e.g. StratX Lung Report (Pulmonx Corp., USA). Scan images are deidentified and uploaded in Digital Imaging and Communications in Medicine (DICOM) format to a central server, which will measure the intactness of the fissures, degree of parenchymal destruction and suggest a target lobe (if present).^[9]

Identification and determination of the severity of emphysema can be performed with computerised analysis of HRCT scans utilising the so-called heterogeneity score (HS) or index (HI). The HS is calculated from the quantitative analysis of scans using software that detects and measures the % difference at –950 Hounsfield units (HU) (using CT slices ≤1 mm) between ipsilateral

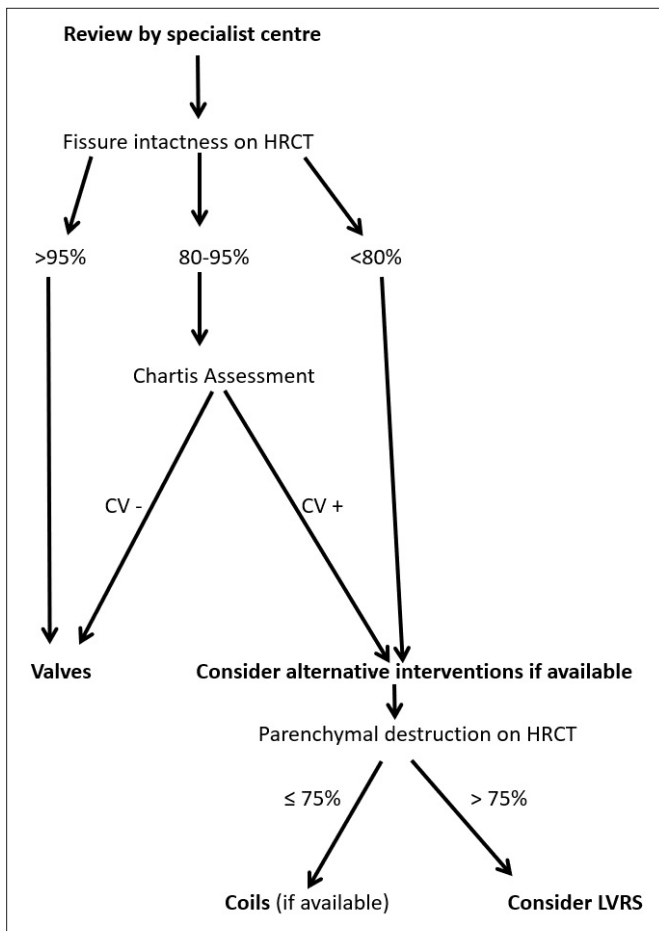


Fig. 4. A general recommended approach to ELVR in South Africa. (HRCT = high-resolution computed tomography; CV = collateral ventilation; LVRS = lung volume reduction surgery.)

upper and lower lobes.^[10] There is currently no universally accepted definition for heterogeneity. In most trials reported, a >10 – 20% difference in the proportion of pixels <–910 HUs or a >10% difference in the proportion of pixels <–950 HU has been used.

The Chartis Pulmonary Assessment System (Pulmonx Inc., Redwood City, USA) is an endobronchial catheter system to evaluate the presence and percentage of interlobar collateral ventilation.^[24] A balloon catheter, connected to a console, is inserted via a bronchoscope into the airway of the treatment target lobe, and inflated, thereby temporarily occluding the airway and preventing direct outflow of inspired air. A near-constant rate of expiratory airflow during the assessment is seen in cases with collateral ventilation, whereas a steady reduction in flow is observed in the absence of collateral ventilation.

In recent years, semi-automated analysis evaluating the integrity of the fissure on a thin-slice HRCT has been developed by several companies.^[9] In a study by Koster *et al.*,^[25] data from four prospective studies were pooled and analysed using semi-automated software to quantify the completeness of interlobar fissures. These fissure completeness scores (FCSs) were compared with a reference standard of achieving ≥350 mL of target lobe volume reduction after EBV treatment. A subgroup of patients with partially complete fissures was identified where software had a lower accuracy, and the complementary value of Chartis was investigated in this group. A

fissure was defined as complete (FCS >95%), incomplete (FCS <80%), or partially complete (FCS >80 <95%). The positive predictive value of complete fissures using the FCS was 88.1%, and the negative predictive value of incomplete fissures on FCS was 92.9%. Experts therefore recommend that where there is partial integrity of the fissure (80 – 95% complete), a Chartis measurement should be performed. Above 95%, a Chartis is optional, while below 80% it is not useful to further evaluate a patient for treatment with valves.^[19]

Recommended approach in SA

The suggested approach presented in this statement is based on the current evidence (outlined above), international expert opinion, local expertise and local commercial access to devices. A general suggested approach to ELVR in SA is summarised in Fig. 4. Currently, only valve therapy is readily commercially available.

SATS recommend that all ELVR procedures should be performed in the context of a local and/or international registry and only in centres accredited by the Assembly on Interventional Pulmonology of SATS. Centres should be able to perform radiological assessment as discussed above (including remote access to commercially available software packages) and to perform a Chartis assessment for collateral ventilation when indicated.

Selecting the ideal target lobe is crucial for outcome and to avoid serious complications. For safety, only a single lobe can be treated per procedure.^[9] Selecting the optimal target lobe requires combining diagnostic information, where there is both absence of collateral ventilation and at least 30% emphysematous destruction. The ideal target lobe should have the highest level of emphysema heterogeneity, the lowest perfusion present on nuclear perfusion scintigraphy (or alternative perfusion methods if performed), balanced lung volumes, and most air trapping (with the use of expiratory HRCT scan, especially in homogeneous cases).^[9] Klooster and Slebos recently described a very practical approach to ELVR with valves in several different cases utilising available imaging and related technology.^[9]

Van Dijk *et al.*^[6] published an expert opinion summarising the management of pneumothorax associated with one-way valve therapy with a pragmatic approach and guidance in various settings. Although not based on high-level evidence, centres performing ELVR should be familiar with the risk factors for, and management of, this common complication.

It is suggested that patients should be admitted to a high-care facility for one day after the procedure, and to a general medical ward thereafter for a minimum of three days, as the majority of pneumothoraces will occur in the first four days.^[6,9] An intercostal drain (ICD) and a sterile pack should be readily available, as well as a clinician skilled in diagnosing a pneumothorax and inserting an ICD when indicated.

Conclusions

Current high-level evidence suggests that in a very well-defined subgroup of patients with severe emphysema, ELVR will be of benefit, provided that a well-structured approach in general evaluation and identification of the target lobe is followed. Only endoscopic valves are currently commercially available in SA.

Declaration. CFNK, RNVZS, KD and BWA are members of the AJTCCM editorial board. This manuscript was not given any priority over other manuscripts and was subjected to the same review process as any other. Another editor assumed responsibility for overseeing the peer review of this submission, and the authors' editorial board member status had no bearing on editorial consideration and a final decision.

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