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New frontiers in bronchoscopic lung volume reduction for the treatment of severe emphysema

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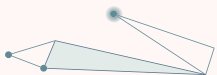
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CHAPTER

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References



1. Agusti A, Hogg JC. Update on the Pathogenesis of Chronic Obstructive Pulmonary Disease. *N Engl J Med*. 2019;381(13):1248-56.
2. Celli BR, Wedzicha JA. Update on Clinical Aspects of Chronic Obstructive Pulmonary Disease. *N Engl J Med*. 2019;381(13):1257-66.
3. Christenson SA, Smith BM, Bafadhel M, Putcha N. Chronic obstructive pulmonary disease. *Lancet*. 2022;399(10342):2227-42.
4. Global Initiative for Chronic Obstructive Lung Disease. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease 2023 report 2023
5. Collaborators GBDCRD. Global burden of chronic respiratory diseases and risk factors, 1990-2019: an update from the Global Burden of Disease Study 2019. *EClinicalMedicine*. 2023;59:101936.
6. Yang IA, Jenkins CR, Salvi SS. Chronic obstructive pulmonary disease in never-smokers: risk factors, pathogenesis, and implications for prevention and treatment. *Lancet Respir Med*. 2022;10(5):497-511.
7. Vogelmeier CF, Román-Rodríguez M, Singh D, Han MK, Rodríguez-Roisin R, Ferguson GT. Goals of COPD treatment: Focus on symptoms and exacerbations. *Respiratory Medicine*. 2020;166:105938.
8. Van Dijk M, Gan CT, Koster TD, Wijkstra PJ, Slebos D-J, Kerstjens HAM, et al. Treatment of severe stable COPD: the multidimensional approach of treatable traits. *ERJ Open Research*. 2020;6(3):00322-2019.
9. Ferguson GT. Why does the lung hyperinflate? *Proc Am Thorac Soc*. 2006;3(2):176-9.
10. Gagnon P, Guenette J, Langer D, Laviolette L, Mainguy V, Maltais F, et al. Pathogenesis of hyperinflation in chronic obstructive pulmonary disease. *International Journal of Chronic Obstructive Pulmonary Disease*. 2014:187.
11. Rossi A, Aisanov Z, Avdeev S, Di Maria G, Donner CF, Izquierdo JL, et al. Mechanisms, assessment and therapeutic implications of lung hyperinflation in COPD. *Respir Med*. 2015;109(7):785-802.
12. Kemp SV, Polkey MI, Shah PL. The epidemiology, etiology, clinical features, and natural history of emphysema. *Thorac Surg Clin*. 2009;19(2):149-58.
13. Cooper CB. The connection between chronic obstructive pulmonary disease symptoms and hyperinflation and its impact on exercise and function. *Am J Med*. 2006;119(10 Suppl 1):21-31.
14. Celli BR. Update on the management of COPD. *Chest*. 2008;133(6):1451-62.
15. Deesomchok A, Webb KA, Forkert L, Lam YM, Ofir D, Jensen D, O'Donnell DE. Lung hyperinflation and its reversibility in patients with airway obstruction of varying severity. *COPD*. 2010;7(6):428-37.
16. van Agteren JE, Carson KV, Tiong LU, Smith BJ. Lung volume reduction surgery for diffuse emphysema. *Cochrane Database Syst Rev*. 2016;10(10):CD001001.
17. Hartman JEW, J.B.A.; Klooster, K.; Carpaij, O.A.; Augustijn, S.W.S.; Slebos, D.J. Survival in COPD patients treated with bronchoscopic lung volume reduction. *Respiratory Medicine*. 2022;196(106825).
18. National Emphysema Treatment Trial Research Group. A Randomized Trial Comparing Lung-Volume-Reduction Surgery with Medical Therapy for Severe Emphysema. *New England Journal of Medicine*. 2003;348(21):2059-73.
19. Shah PL, Herth FJ, van Geffen WH, Deslee G, Slebos DJ. Lung volume reduction for emphysema. *Lancet Respir Med*. 2017;5(2):147-56.

20. Shah PL, Slebos DJ, Cardoso PF, Cetti E, Voelker K, Levine B, et al. Bronchoscopic lung-volume reduction with Exhale airway stents for emphysema (EASE trial): randomised, sham-controlled, multicentre trial. *Lancet*. 2011;378(9795):997-1005.
21. van Geffen WH, Slebos DJ, Herth FJ, Kemp SV, Weder W, Shah PL. Surgical and endoscopic interventions that reduce lung volume for emphysema: a systemic review and meta-analysis. *Lancet Respir Med*. 2019;7(4):313-24.
22. Klooster K, Slebos DJ. Endobronchial Valves for the Treatment of Advanced Emphysema. *Chest*. 2021;159(5):1833-42.
23. Slebos DJ, Shah PL, Herth FJ, Valipour A. Endobronchial Valves for Endoscopic Lung Volume Reduction: Best Practice Recommendations from Expert Panel on Endoscopic Lung Volume Reduction. *Respiration*. 2017;93(2):138-50.
24. Klooster K, ten Hacken NH, Hartman JE, Kerstjens HA, van Rikxoort EM, Slebos DJ. Endobronchial Valves for Emphysema without Interlobar Collateral Ventilation. *N Engl J Med*. 2015;373(24):2325-35.
25. Koster TD, Slebos DJ. The fissure: interlobar collateral ventilation and implications for endoscopic therapy in emphysema. *Int J Chron Obstruct Pulmon Dis*. 2016;11:765-73.
26. Saccomanno J, Hubner RH, Witzernath M, Doellinger F, Dittrich AS, Kontogianni K, et al. Bronchoscopic Measurement of Collateral Ventilation: State of the Art. *Respiration*. 2023;102(4):296-307.
27. Klooster K, Hartman JE, van Dijk M, Koster TD, Slebos DJ. Response to Endobronchial Valve Treatment in Emphysema Patients With Moderate Hyperinflation. *J Bronchology Interv Pulmonol*. 2021;28(1):e14-e7.
28. Criner GJ, Sue R, Wright S, Dransfield M, Rivas-Perez H, Wiese T, et al. A Multicenter Randomized Controlled Trial of Zephyr Endobronchial Valve Treatment in Heterogeneous Emphysema (LIBERATE). *American Journal of Respiratory and Critical Care Medicine*. 2018;198(9):1151-64.
29. Davey C, Zoumot Z, Jordan S, McNulty WH, Carr DH, Hind MD, et al. Bronchoscopic lung volume reduction with endobronchial valves for patients with heterogeneous emphysema and intact interlobar fissures (the BelieVer-HiFi study): a randomised controlled trial. *The Lancet*. 2015;386(9998):1066-73.
30. Kemp SV, Slebos D-J, Kirk A, Kornaszewska M, Carron K, Ek L, et al. A Multicenter Randomized Controlled Trial of Zephyr Endobronchial Valve Treatment in Heterogeneous Emphysema (TRANSFORM). *American Journal of Respiratory and Critical Care Medicine*. 2017;196(12):1535-43.
31. Valipour A, Slebos D-J, Herth F, Darwiche K, Wagner M, Ficker JH, et al. Endobronchial Valve Therapy in Patients with Homogeneous Emphysema. Results from the IMPACT Study. *American Journal of Respiratory and Critical Care Medicine*. 2016;194(9):1073-82.
32. Hartman JE, Klooster K, Koster TD, Ten Hacken NHT, van Dijk M, Slebos DJ. Long-term follow-up after bronchoscopic lung volume reduction valve treatment for emphysema. *ERJ Open Res*. 2022;8(4).
33. Koster TD, Klooster K, Ten Hacken NHT, van Dijk M, Slebos DJ. Endobronchial valve therapy for severe emphysema: an overview of valve-related complications and its management. *Expert Rev Respir Med*. 2020;14(12):1235-47.
34. Slebos DJ, Ten Hacken NH, Hetzel M, Herth FJF, Shah PL. Endobronchial Coils for Endoscopic Lung Volume Reduction: Best Practice Recommendations from an Expert Panel. *Respiration*. 2018;96(1):1-11.
35. Deslee G, Mal H, Dutau H, Bourdin A, Vergnon JM, Pison C, et al. Lung Volume Reduction Coil Treatment vs Usual Care in Patients With Severe Emphysema: The REVOLENS Randomized Clinical Trial. *JAMA*. 2016;315(2):175-84.

36. Klooster K, Valipour A, Marquette CH, Boutros J, Mal H, Marceau A, et al. Endobronchial Coil System versus Standard-of-Care Medical Management in the Treatment of Subjects with Severe Emphysema. *Respiration*. 2021;100(8):804-10.
37. Sciruba FC, Criner GJ, Strange C, Shah PL, Michaud G, Connolly TA, et al. Effect of Endobronchial Coils vs Usual Care on Exercise Tolerance in Patients With Severe Emphysema: The RENEW Randomized Clinical Trial. *JAMA*. 2016;315(20):2178-89.
38. Shah PL, Zoumot Z, Singh S, Bicknell SR, Ross ET, Quiring J, et al. Endobronchial coils for the treatment of severe emphysema with hyperinflation (RESET): a randomised controlled trial. *Lancet Respir Med*. 2013;1(3):233-40.
39. Hartman JE, Criner GJ, Moore WH, Van Rikxoort EM, Sciruba FC, Shah PL, et al. HRCT characteristics of severe emphysema patients: Interobserver variability among expert readers and comparison with quantitative software. *European Journal of Radiology*. 2021;136:109561.
40. Slebos DJ, Cicienja J, Sciruba FC, Criner GJ, Hartman JE, Garner J, et al. Predictors of Response to Endobronchial Coil Therapy in Patients With Advanced Emphysema. *Chest*. 2019;155(5):928-37.
41. Herth FJF, Slebos DJ, Shah PL, Hetzel M, Schmid-Bindert G, LaPrad AS, et al. Protocol of a Randomized Controlled Study of the PneumRx Endobronchial Coil System versus Standard-of-Care Medical Management in the Treatment of Subjects with Severe Emphysema (ELEVATE). *Respiration*. 2019;98(6):512-20.
42. Shah PL, Slebos DJ. Bronchoscopic interventions for severe emphysema: Where are we now? *Respirology*. 2020;25(9):972-80.
43. Welling JBA, Klooster K, Hartman JE, Kerstjens HAM, Franz I, Struys M, et al. Collateral Ventilation Measurement Using Chartis: Procedural Sedation vs General Anesthesia. *Chest*. 2019;156(5):984-90.
44. Chandler D, Mosieri C, Kallurkar A, Pham AD, Okada LK, Kaye RJ, et al. Perioperative strategies for the reduction of postoperative pulmonary complications. *Best Pract Res Clin Anaesthesiol*. 2020;34(2):153-66.
45. Pietzsch JB, Busca R, Rott C, Geisler BP, Weber SA, Slebos DJ, et al. Adoption Patterns of Bronchoscopic Lung Volume Reduction Procedures in Germany and Predicted Procedure Volumes for Other European Countries. *Respiration*. 2019;97(1):34-41.
46. Thiruvankatarajan V, Maycock T, Grosser D, Currie J. Anaesthetic management for endobronchial valve insertion: lessons learned from a single centre retrospective series and a literature review. *BMC Anesthesiol*. 2018;18(1):206.
47. Barends CRM, Driesens MK, van Amsterdam K, Struys M, Absalom AR. Moderate-to-Deep Sedation Using Target-Controlled Infusions of Propofol and Remifentanyl: Adverse Events and Risk Factors: A Retrospective Cohort Study of 2937 Procedures. *Anesth Analg*. 2020;131(4):1173-83.
48. Cheng Q, Zhang J, Wang H, Zhang R, Yue Y, Li L. Effect of Acute Hypercapnia on Outcomes and Predictive Risk Factors for Complications among Patients Receiving Bronchoscopic Interventions under General Anesthesia. *PLoS One*. 2015;10(7):e0130771.
49. Salmasi V, Maheshwari K, Yang D, Mascha EJ, Singh A, Sessler DI, Kurz A. Relationship between Intraoperative Hypotension, Defined by Either Reduction from Baseline or Absolute Thresholds, and Acute Kidney and Myocardial Injury after Noncardiac Surgery: A Retrospective Cohort Analysis. *Anesthesiology*. 2017;126(1):47-65.
50. R Core Team. R: A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing; 2021.
51. American Society of Anesthesiologists' ASA Physical Status Classification System <https://www.asahq.org/standards-and-guidelines/asa-physical-status-classification-system2020>

52. Lawson RW, Peters JI, Shelledy DC. Effects of fiberoptic bronchoscopy during mechanical ventilation in a lung model. *Chest*. 2000;118(3):824-31.
53. Nay MA, Auvet A, Mankikian J, Herve V, Dequin PF, Guillon A. Evaluation of a flexible bronchoscope prototype designed for bronchoscopy during mechanical ventilation: a proof-of-concept study. *Anaesthesia*. 2017;72(6):719-28.
54. Rittayamai N, Katsios CM, Beloncle F, Friedrich JO, Mancebo J, Brochard L. Pressure-Controlled vs Volume-Controlled Ventilation in Acute Respiratory Failure: A Physiology-Based Narrative and Systematic Review. *Chest*. 2015;148(2):340-55.
55. Hsia D, DiBlasi RM, Richardson P, Crotwell D, Debley J, Carter E. The effects of flexible bronchoscopy on mechanical ventilation in a pediatric lung model. *Chest*. 2009;135(1):33-40.
56. Pathak V, Welsby I, Mahmood K, Wahidi M, MacIntyre N, Shofer S. Ventilation and anesthetic approaches for rigid bronchoscopy. *Ann Am Thorac Soc*. 2014;11(4):628-34.
57. Antonogiannaki EM, Georgopoulos D, Akoumianaki E. Patient-Ventilator Dyssynchrony. *Korean J Crit Care Med*. 2017;32(4):307-22.
58. Blanch L, Bernabe F, Lucangelo U. Measurement of air trapping, intrinsic positive end-expiratory pressure, and dynamic hyperinflation in mechanically ventilated patients. *Respir Care*. 2005;50(1):110-23; discussion 23-4.
59. Junhasavasdikul D, Telias I, Grieco DL, Chen L, Gutierrez CM, Piraino T, Brochard L. Expiratory Flow Limitation During Mechanical Ventilation. *Chest*. 2018;154(4):948-62.
60. Sudfeld S, Brechnitz S, Wagner JY, Reese PC, Pinnschmidt HO, Reuter DA, Saugel B. Post-induction hypotension and early intraoperative hypotension associated with general anaesthesia. *Br J Anaesth*. 2017;119(1):57-64.
61. Robinson BJ, Ebert TJ, O'Brien TJ, Colincio MD, Muzi M. Mechanisms whereby propofol mediates peripheral vasodilation in humans. Sympathoinhibition or direct vascular relaxation? *Anesthesiology*. 1997;86(1):64-72.
62. Hall GL, Filipow N, Ruppel G, Okitika T, Thompson B, Kirkby J, et al. Official ERS technical standard: Global Lung Function Initiative reference values for static lung volumes in individuals of European ancestry. *Eur Respir J*. 2021;57(3).
63. Pellegrino R, Viegi G, Brusasco V, Crapo RO, Burgos F, Casaburi R, et al. Interpretative strategies for lung function tests. *Eur Respir J*. 2005;26(5):948-68.
64. Quanjer PH, Tammeling GJ, Cotes JE, Pedersen OF, Peslin R, Yernault JC. Lung volumes and forced ventilatory flows. *Eur Respir J*. 1993;6 Suppl 16:5-40.
65. O'Donnell DE, Laveneziana P. Physiology and consequences of lung hyperinflation in COPD. *European Respiratory Review*. 2006;15(100):61-7.
66. van der Meer AN, de Jong K, Hoekstra-Kuik A, Bel EH, Ten Brinke A. Dynamic hyperinflation impairs daily life activity in asthma. *Eur Respir J*. 2019;53(4).
67. Stevens D. Static hyperinflation is associated with ventilatory limitation and exercise tolerance in adult cystic fibrosis. *Clin Respir J*. 2018;12(5):1949-57.
68. Stanojevic S, Kaminsky DA, Miller MR, Thompson B, Aliverti A, Barjaktarevic I, et al. ERS/ATS technical standard on interpretive strategies for routine lung function tests. *Eur Respir J*. 2022;60(1).
69. Koster TD, Dijk MV, Slebos DJ. Bronchoscopic Lung Volume Reduction for Emphysema: Review and Update. *Semin Respir Crit Care Med*. 2022;43(4):541-51.

70. Everaerts S, Vandervelde CM, Shah P, Slebos DJ, Ceulemans LJ. Surgical and bronchoscopic pulmonary function-improving procedures in lung emphysema. *Eur Respir Rev.* 2023;32(170).
71. World Health Organization (WHO). Length/height-for-age [Available from: <https://www.who.int/tools/growth-reference-data-for-5to19-years/indicators/height-for-age>].
72. Quanjer PH, Stanojevic S, Cole TJ, Baur X, Hall GL, Culver BH, et al. Multi-ethnic reference values for spirometry for the 3-95-yr age range: the global lung function 2012 equations. *Eur Respir J.* 2012;40(6):1324-43.
73. de Weger WW, Klooster K, Ten Hacken NH, van Dijk M, Hartman JE, Slebos DJ. Determining Static Hyperinflation in Patients with Severe Emphysema: Relation Between Lung Function Parameters and Patient-Related Outcomes. *Lung.* 2020;198(4):629-36.
74. Sciruba FC, Ernst A, Herth FJF, Strange C, Criner GJ, Marquette CH, et al. A Randomized Study of Endobronchial Valves for Advanced Emphysema. *New England Journal of Medicine.* 2010;363(13):1233-44.
75. Hartman JE, Roodenburg SA, van Dijk M, Koster TD, Klooster K, Slebos D-J. Response to endobronchial valve treatment: it's all about the target lobe! *ERJ Open Res.* 2023;In press.
76. Naunheim KS, Wood DE, Krasna MJ, DeCamp MM, Jr., Ginsburg ME, McKenna RJ, Jr., et al. Predictors of operative mortality and cardiopulmonary morbidity in the National Emphysema Treatment Trial. *J Thorac Cardiovasc Surg.* 2006;131(1):43-53.
77. Klooster K, Hartman JE, Ten Hacken NHT, Slebos DJ. Improved Predictors of Survival after Endobronchial Valve Treatment in Patients with Severe Emphysema. *Am J Respir Crit Care Med.* 2017;195(9):1272-4.
78. Garner J, Kemp SV, Toma TP, Hansell DM, Polkey MI, Shah PL, Hopkinson NS. Survival after Endobronchial Valve Placement for Emphysema: A 10-Year Follow-up Study. *Am J Respir Crit Care Med.* 2016;194(4):519-21.
79. Gompelmann D, Benjamin N, Bischoff E, Kontogianni K, Schuhmann M, Hoffmann H, et al. Survival after Endoscopic Valve Therapy in Patients with Severe Emphysema. *Respiration.* 2019;97(2):145-52.
80. Hopkinson NS, Kemp SV, Toma TP, Hansell DM, Geddes DM, Shah PL, Polkey MI. Atelectasis and survival after bronchoscopic lung volume reduction for COPD. *Eur Respir J.* 2011;37(6):1346-51.
81. Herth FJ, Eberhardt R, Gompelmann D, Ficker JH, Wagner M, Ek L, et al. Radiological and clinical outcomes of using Chartis to plan endobronchial valve treatment. *Eur Respir J.* 2013;41(2):302-8.
82. Donohue JF. Minimal clinically important differences in COPD lung function. *COPD.* 2005;2(1):111-24.
83. Hartman JE, Ten Hacken NH, Klooster K, Boezen HM, de Greef MH, Slebos DJ. The minimal important difference for residual volume in patients with severe emphysema. *Eur Respir J.* 2012;40(5):1137-41.
84. Puhan MA, Chandra D, Mosenifar Z, Ries A, Make B, Hansel NN, et al. The minimal important difference of exercise tests in severe COPD. *Eur Respir J.* 2011;37(4):784-90.
85. Welling JB, Hartman JE, Ten Hacken NH, Klooster K, Slebos DJ. The minimal important difference for the St George's Respiratory Questionnaire in patients with severe COPD. *Eur Respir J.* 2015;46(6):1598-604.
86. Welling JBA, Hartman JE, van Rikxoort EM, Ten Hacken NHT, Kerstjens HAM, Klooster K, Slebos DJ. Minimal important difference of target lobar volume reduction after endobronchial valve treatment for emphysema. *Respirology.* 2018;23(3):306-10.
87. Agarwala P, Salzman SH. Six-Minute Walk Test: Clinical Role, Technique, Coding, and Reimbursement. *Chest.* 2020;157(3):603-11.
88. Pinto-Plata VM, Cote C, Cabral H, Taylor J, Celli BR. The 6-min walk distance: change over time and value as a predictor of survival in severe COPD. *Eur Respir J.* 2004;23(1):28-33.

89. Celli BR, Cote CG, Marin JM, Casanova C, Montes de Oca M, Mendez RA, et al. The body-mass index, airflow obstruction, dyspnea, and exercise capacity index in chronic obstructive pulmonary disease. *N Engl J Med*. 2004;350(10):1005-12.
90. Puhan MA, Garcia-Aymerich J, Frey M, ter Riet G, Anto JM, Agusti AG, et al. Expansion of the prognostic assessment of patients with chronic obstructive pulmonary disease: the updated BODE index and the ADO index. *Lancet*. 2009;374(9691):704-11.
91. Dolliver WR, Diaz AA. Advances in Chronic Obstructive Pulmonary Disease Imaging. *Barc Respir Netw Rev*. 2020;6(2):128-43.
92. Machado A, Marques A, Burtin C. Extra-pulmonary manifestations of COPD and the role of pulmonary rehabilitation: a symptom-centered approach. *Expert Rev Respir Med*. 2021;15(1):131-42.
93. Esteban C, Arostegui I, Aramburu A, Moraza J, Aburto M, Aizpiri S, et al. Changes in health-related quality of life as a marker in the prognosis in COPD patients. *ERJ Open Res*. 2022;8(1).
94. Celli B, Locantore N, Yates JC, Bakke P, Calverley PMA, Crim C, et al. Markers of disease activity in COPD: an 8-year mortality study in the ECLIPSE cohort. *Eur Respir J*. 2021;57(3).
95. Jones PW, Quirk FH, Baveystock CM, Littlejohns P. A self-complete measure of health status for chronic airflow limitation. The St. George's Respiratory Questionnaire. *Am Rev Respir Dis*. 1992;145(6):1321-7.
96. French A, Balfe D, Mirocha JM, Falk JA, Mosenifar Z. The inspiratory capacity/total lung capacity ratio as a predictor of survival in an emphysematous phenotype of chronic obstructive pulmonary disease. *Int J Chron Obstruct Pulmon Dis*. 2015;10:1305-12.
97. World Health Organization (WHO). Chronic obstructive pulmonary disease (COPD). [https://www.who.int/news-room/fact-sheets/detail/chronic-obstructive-pulmonary-disease-\(copd\)2022](https://www.who.int/news-room/fact-sheets/detail/chronic-obstructive-pulmonary-disease-(copd)2022).
98. Snider GL, J. K, Thurlbeck WM, Bengali ZH. The definition of emphysema. Report of a National Heart, Lung, and Blood Institute, Division of Lung Diseases workshop. *Am Rev Respir Dis*. 1985;132(1):182-5.
99. Herth FJF, Noppen M, Valipour A, Leroy S, Vergnon J-M, Ficker JH, et al. Efficacy predictors of lung volume reduction with Zephyr valves in a European cohort. *European Respiratory Journal*. 2012;39(6):1334-42.
100. Ju J, Li R, Gu S, Leader JK, Wang X, Chen Y, et al. Impact of emphysema heterogeneity on pulmonary function. *PLoS One*. 2014;9(11):e113320.
101. National Emphysema Treatment Trial Research Group. Patients at High Risk of Death after Lung-Volume-Reduction Surgery. *New England Journal of Medicine*. 2001;345(15):1075-83.
102. Koster TD, Klooster K, van Dijk M, van Erp-Zeilstra A, Willems Van Beveren A, Pruijm J, et al. Perfusion measured with HRCT-approximated perfusion is comparable to SPECT/CT for patients with severe COPD. *ERS International Congress; Barcelona: European Respiratory Society; 2022*. p. 3800.
103. Theilig D, Doellinger F, Poellinger A, Schreiter V, Neumann K, Hubner R-H. Comparison of distinctive models for calculating an interlobar emphysema heterogeneity index in patients prior to endoscopic lung volume reduction. *International Journal of Chronic Obstructive Pulmonary Disease*. 2017;Volume 12:1631-40.
104. Dos Santos Yamaguti WP, Paulin E, Shibao S, Chammas MC, Salge JM, Ribeiro M, et al. Air trapping: The major factor limiting diaphragm mobility in chronic obstructive pulmonary disease patients. *Respirology*. 2008;13(1):138-44.
105. Dunham-Snary KJ, Wu D, Sykes EA, Thakrar A, Parlow LRG, Mewburn JD, et al. Hypoxic Pulmonary Vasoconstriction. *Chest*. 2017;151(1):181-92.

106. Wienker J, Darwiche K, Walscher J, Winantea J, Hagemann M, Buscher E, et al. Clinical Impact of Compensatory Hyperinflation of the Nontreated Adjacent Lobe After Bronchoscopic Lung Volume Reduction with Valves. *Int J Chron Obstruct Pulmon Dis.* 2022;17:1523-36.
107. Coxson HO, Nasute Fauerbach PV, Storness-Bliss C, Muller NL, Cogswell S, Dillard DH, et al. Computed tomography assessment of lung volume changes after bronchial valve treatment. *Eur Respir J.* 2008;32(6):1443-50.
108. Brown MS, Kim HJ, Abtin FG, Strange C, Galperin-Aizenberg M, Pais R, et al. Emphysema lung lobe volume reduction: effects on the ipsilateral and contralateral lobes. *Eur Radiol.* 2012;22(7):1547-55.
109. Welling JBA, Hartman JE, Augustijn SWS, Kerstjens HAM, Vanfleteren L, Klooster K, Slebos DJ. Patient Selection for Bronchoscopic Lung Volume Reduction. *Int J Chron Obstruct Pulmon Dis.* 2020;15:871-81.
110. Hartman JE, Vanfleteren L, van Rikxoort EM, Klooster K, Slebos DJ. Endobronchial valves for severe emphysema. *Eur Respir Rev.* 2019;28(152).
111. Roodenburg SA, Klooster K, Hartman JE, Koster TD, van Dijk M, Slebos DJ. Revision Bronchoscopy After Endobronchial Valve Treatment for Emphysema: Indications, Findings and Outcomes. *Int J Chron Obstruct Pulmon Dis.* 2021;16:1127-36.
112. Herth FJF, Slebos DJ, Criner GJ, Valipour A, Sciruba F, Shah PL. Endoscopic Lung Volume Reduction: An Expert Panel Recommendation - Update 2019. *Respiration.* 2019;97(6):548-57.
113. Laboratories ATSCoPSfCPF. ATS statement: guidelines for the six-minute walk test. *Am J Respir Crit Care Med.* 2002;166(1):111-7.
114. Macintyre N, Crapo RO, Viegi G, Johnson DC, van der Grinten CP, Brusasco V, et al. Standardisation of the single-breath determination of carbon monoxide uptake in the lung. *Eur Respir J.* 2005;26(4):720-35.
115. Miller MR, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates A, et al. Standardisation of spirometry. *Eur Respir J.* 2005;26(2):319-38.
116. Wanger J, Clausen JL, Coates A, Pedersen OF, Brusasco V, Burgos F, et al. Standardisation of the measurement of lung volumes. *Eur Respir J.* 2005;26(3):511-22.
117. Bestall JC, Paul EA, Garrod R, Garnham R, Jones PW, Wedzicha JA. Usefulness of the Medical Research Council (MRC) dyspnoea scale as a measure of disability in patients with chronic obstructive pulmonary disease. *Thorax.* 1999;54(7):581-6.
118. Jones PW, Harding G, Berry P, Wiklund I, Chen WH, Kline Leidy N. Development and first validation of the COPD Assessment Test. *Eur Respir J.* 2009;34(3):648-54.
119. Koster TD, Charbonnier JP, Pruijm J, Gietema HA, Posthuma R, Vanfleteren L, et al. High-Resolution Computed Tomography-approximated Perfusion Is Comparable to Nuclear Perfusion Imaging in Severe Chronic Obstructive Pulmonary Disease. *Am J Respir Crit Care Med.* 2023;208(4):495-8.
120. Kohonen T. Essentials of the self-organizing map. *Neural Netw.* 2013;37:52-65.
121. Kohonen T. Self-Organizing Maps. <https://link.springer.com/book/10.1007/978-3-642-56927-2>: Springer; 2001. Available from: <https://link.springer.com/book/10.1007/978-3-642-56927-2>.
122. Darwiche K, Karpf-Wissel R, Eisenmann S, Aigner C, Welter S, Zarogoulidis P, et al. Bronchoscopic Lung Volume Reduction with Endobronchial Valves in Low-FEV1 Patients. *Respiration.* 2016;92(6):414-9.
123. Trudzinski FC, Hoink AJ, Leppert D, Fahndrich S, Wilkens H, Graeter TP, et al. Endoscopic Lung Volume Reduction Using Endobronchial Valves in Patients with Severe Emphysema and Very Low FEV1. *Respiration.* 2016;92(4):258-65.

124. Lenga P, Ruwwe-Glosenkamp C, Grah C, Pfannschmidt J, Ruckert J, Eggeling S, et al. Endoscopic lung volume reduction with endobronchial valves in very low D (LCO) patients: results from the German Registry - Lungenemphysemeregister e.V. *ERJ Open Res.* 2021;7(1).
125. van Dijk M, Hartman JE, Klooster K, Ten Hacken NHT, Kerstjens HAM, Slebos DJ. Endobronchial Valve Treatment in Emphysema Patients with a Very Low DLCO. *Respiration.* 2020;99(2):163-70.
126. Lenga P, Grah C, Ruwwe-Glosenkamp C, Saccomanno J, Ruckert J, Eggeling S, et al. Endoscopic Lung Volume Reduction with One-Way Valves in Patients with Severe Chronic Obstructive Pulmonary Disease with Hypercapnia. *Respiration.* 2022;101(9):823-32.
127. Roetting M, Kriegsmann K, Polke M, Polke N, Kontogianni K, Eberhardt R, et al. Endoscopic Valve Therapy in COPD Patients with Hypercapnia. *Respiration.* 2022;101(10):918-24.
128. Klooster K, van Dijk M, Koster TD, Hartman JE, Slebos DJ. Bronchoscopic Lung Volume Reduction With Endobronchial Valves Exclusively of the Middle Lobe in Patients With Emphysema. *J Bronchology Interv Pulmonol.* 2023;30(2):192-5.
129. van Dijk M, Sue R, Criner GJ, Gompelmann D, Herth FJF, Hogarth DK, et al. Expert Statement: Pneumothorax Associated with One-Way Valve Therapy for Emphysema: 2020 Update. *Respiration.* 2021;100(10):969-78.
130. Hartman JE, Klooster K, Groen H, Ten Hacken NHT, Slebos DJ. Cost-effectiveness of endobronchial valve treatment in patients with severe emphysema compared to standard medical care. *Respirology.* 2018.
131. Pietzsch JB, Garner A, Herth FJ. Cost-effectiveness of endobronchial valve therapy for severe emphysema: a model-based projection based on the VENT study. *Respiration.* 2014;88(5):389-98.
132. Vigneswaran J, Krantz S, Howington J. Economic Considerations of Lung Volume Reduction Surgery and Bronchoscopic Valves. *Thorac Surg Clin.* 2021;31(2):211-9.
133. Chew J, Mahadeva R. The role of a multidisciplinary severe chronic obstructive pulmonary disease hyperinflation service in patient selection for lung volume reduction. *J Thorac Dis.* 2018;10(Suppl 27):S3335-S43.
134. Oey I, Waller D. The role of the multidisciplinary emphysema team meeting in the provision of lung volume reduction. *J Thorac Dis.* 2018;10(Suppl 23):S2824-S9.
135. Mannino DM, Higuchi K, Yu TC, Zhou H, Li Y, Tian H, Suh K. Economic Burden of COPD in the Presence of Comorbidities. *Chest.* 2015;148(1):138-50.
136. Yin HL, Yin SQ, Lin QY, Xu Y, Xu HW, Liu T. Prevalence of comorbidities in chronic obstructive pulmonary disease patients: A meta-analysis. *Medicine (Baltimore).* 2017;96(19):e6836.
137. Eberhardt R, Gerovasili V, Kontogianni K, Gompelmann D, Ehlken N, Herth FJ, et al. Endoscopic lung volume reduction with endobronchial valves in patients with severe emphysema and established pulmonary hypertension. *Respiration.* 2015;89(1):41-8.
138. van der Molen MC, Hartman JE, Vanfleteren L, Kerstjens HAM, van Melle JP, Willems TP, Slebos DJ. Reduction of Lung Hyperinflation Improves Cardiac Preload, Contractility, and Output in Emphysema: A Clinical Trial in Patients Who Received Endobronchial Valves. *Am J Respir Crit Care Med.* 2022;206(6):704-11.
139. Hartman JE, Klooster K, Slebos DJ, Ten Hacken NH. Improvement of physical activity after endobronchial valve treatment in emphysema patients. *Respir Med.* 2016;117:116-21.
140. National Institute for Health and Care Excellence (NICE). Endobronchial valve insertion to reduce lung volume in emphysema. <https://www.nice.org.uk/guidance/ipg6002017>.

141. Klooster K, Hartman JE, Ten Hacken NH, Slebos DJ. One-Year Follow-Up after Endobronchial Valve Treatment in Patients with Emphysema without Collateral Ventilation Treated in the STELVIO Trial. *Respiration*. 2017;93(2):112-21.
142. Gompelmann D, Gerovasili V, Kontogianni K, Schuhmann M, Eberhardt R, Herth FJF, Polke M. Endoscopic Valve Removal >180 Days since Implantation in Patients with Severe Emphysema. *Respiration*. 2018;96(4):348-54.
143. Chung FT, Lin SM, Chou CL, Chen HC, Liu CY, Yu CT, Kuo HP. Factors leading to obstructive granulation tissue formation after ultraflex stenting in benign tracheal narrowing. *Thorac Cardiovasc Surg*. 2010;58(2):102-7.
144. Hu HC, Liu YH, Wu YC, Hsieh MJ, Chao YK, Wu CY, et al. Granulation tissue formation following Dumon airway stenting: the influence of stent diameter. *Thorac Cardiovasc Surg*. 2011;59(3):163-8.
145. McGrath DJ, Thiebes AL, Cornelissen CG, O'Brien B, Jockenhoevel S, Bruzzi M, McHugh PE. Evaluating the interaction of a tracheobronchial stent in an ovine in-vivo model. *Biomech Model Mechanobiol*. 2018;17(2):499-516.
146. Nouraei SA, Petrou MA, Randhawa PS, Singh A, Howard DJ, Sandhu GS. Bacterial colonization of airway stents: a promoter of granulation tissue formation following laryngotracheal reconstruction. *Arch Otolaryngol Head Neck Surg*. 2006;132(10):1086-90.
147. Ost DE, Shah AM, Lei X, Godoy MCB, Jimenez CA, Eapen GA, et al. Respiratory infections increase the risk of granulation tissue formation following airway stenting in patients with malignant airway obstruction. *Chest*. 2012;141(6):1473-81.
148. Thompson AB, Huerta G, Robbins RA, Sisson JH, Spurzem JR, von Essen S, et al. The bronchitis index. A semiquantitative visual scale for the assessment of airways inflammation. *Chest*. 1993;103(5):1482-8.
149. Schmal F, Fegeler W, Terpe HJ, Hermann W, Stoll W, Becker K. Bacteria and granulation tissue associated with Montgomery T-tubes. *Laryngoscope*. 2003;113(8):1394-400.
150. Sarmand N, Gompelmann D, Kontogianni K, Polke M, Herth FJ, Eberhardt R. New bacterial growth in bronchial secretions after bronchoscopic valve implantation. *Int J Chron Obstruct Pulmon Dis*. 2018;13:565-70.
151. Debiante L, Reitzel R, Rosenblatt J, Gagea M, Chavez MA, Adachi R, et al. A Design-Based Stereologic Method to Quantify the Tissue Changes Associated with a Novel Drug-Eluting Tracheobronchial Stent. *Respiration*. 2019;98(1):60-9.
152. Saad CP, Murthy S, Krizmanich G, Mehta AC. Self-expandable metallic airway stents and flexible bronchoscopy: long-term outcomes analysis. *Chest*. 2003;124(5):1993-9.
153. Criner GJ, Eberhardt R, Fernandez-Bussy S, Gompelmann D, Maldonado F, Patel N, et al. Interventional Bronchoscopy. *Am J Respir Crit Care Med*. 2020;202(1):29-50.
154. Guibert N, Saka H, Dutau H. Airway stenting: Technological advancements and its role in interventional pulmonology. *Respirology*. 2020;25(9):953-62.
155. Murgu SD, Egressy K, Laxmanan B, Doblare G, Ortiz-Comino R, Hogarth DK. Central Airway Obstruction: Benign Strictures, Tracheobronchomalacia, and Malignancy-related Obstruction. *Chest*. 2016;150(2):426-41.
156. Ayub A, Al-Ayoubi AM, Bhora FY. Stents for airway strictures: selection and results. *J Thorac Dis*. 2017;9(Suppl 2):S116-S21.
157. Criner GJ, Delage A, Voelker K, Hogarth DK, Majid A, Zgoda M, et al. Improving Lung Function in Severe Heterogenous Emphysema with the Spiration Valve System (EMPROVE). A Multicenter, Open-Label Randomized Controlled Clinical Trial. *Am J Respir Crit Care Med*. 2019;200(11):1354-62.

158. Hartman JE, Shah PL, Sciurba F, Herth FJF, Slebos DJ, Group RS. Endobronchial coils for emphysema: Dual mechanism of action on lobar residual volume reduction. *Respirology*. 2020;25(11):1160-6.
159. Zoumot Z, Kemp SV, Singh S, Bicknell SR, McNulty WH, Hopkinson NS, et al. Endobronchial coils for severe emphysema are effective up to 12 months following treatment: medium term and cross-over results from a randomised controlled trial. *PLoS One*. 2015;10(4):e0122656.
160. Fiorelli A, D'Andrilli A, Bezzi M, Ibrahim M, Anile M, Diso D, et al. Complications related to endoscopic lung volume reduction for emphysema with endobronchial valves: results of a multicenter study. *J Thorac Dis*. 2018;10(Suppl 27):S3315-S25.
161. Jones K. Chapter 9 - Fibrotic Response to Biomaterials and all Associated Sequence of Fibrosis. In: Badylak SF, editor. *Host Response to Biomaterials*. Oxford: Academic Press; 2015. p. 189-237.
162. Anderson JM, Rodriguez A, Chang DT. Foreign body reaction to biomaterials. *Semin Immunol*. 2008;20(2):86-100.
163. Klopffleisch R, Jung F. The pathology of the foreign body reaction against biomaterials. *J Biomed Mater Res A*. 2017;105(3):927-40.
164. Selders GS, Fetz AE, Radic MZ, Bowlin GL. An overview of the role of neutrophils in innate immunity, inflammation and host-biomaterial integration. *Regen Biomater*. 2017;4(1):55-68.
165. Zhou G, Groth T. Host Responses to Biomaterials and Anti-Inflammatory Design-a Brief Review. *Macromol Biosci*. 2018;18(8):e1800112.
166. Anderson J, Cramer S. Chapter 2 - Perspectives on the Inflammatory, Healing, and Foreign Body Responses to Biomaterials and Medical Devices. In: Badylak SF, editor. *Host Response to Biomaterials*. Oxford: Academic Press; 2015. p. 13-36.
167. Major MR, Wong VW, Nelson ER, Longaker MT, Gurtner GC. The foreign body response: at the interface of surgery and bioengineering. *Plast Reconstr Surg*. 2015;135(5):1489-98.
168. Noppen M, Pierard D, Meysman M, Claes I, Vincken W. Bacterial colonization of central airways after stenting. *Am J Respir Crit Care Med*. 1999;160(2):672-7.
169. Ratnovsky A, Regev N, Wald S, Kramer M, Naftali S. Mechanical properties of different airway stents. *Med Eng Phys*. 2015;37(4):408-15.
170. Zindel J, Kubes P. DAMPs, PAMPs, and LAMPs in Immunity and Sterile Inflammation. *Annu Rev Pathol*. 2020;15:493-518.
171. Pouwels SD, Heijink IH, ten Hacken NH, Vandenabeele P, Krysko DV, Nawijn MC, van Oosterhout AJ. DAMPs activating innate and adaptive immune responses in COPD. *Mucosal Immunol*. 2014;7(2):215-26.
172. Pouwels SD, Hesse L, Faiz A, Lubbers J, Bodha PK, Ten Hacken NH, et al. Susceptibility for cigarette smoke-induced DAMP release and DAMP-induced inflammation in COPD. *Am J Physiol Lung Cell Mol Physiol*. 2016;311(5):L881-L92.
173. Shlomi D, Peled N, Shitrit D, Bendayan D, Amital A, Kramer MR. Protective effect of immunosuppression on granulation tissue formation in metallic airway stents. *Laryngoscope*. 2008;118(8):1383-8.
174. Tsai CH, Ogawa R. Keloid research: current status and future directions. *Scars Burn Heal*. 2019;5:2059513119868659.
175. Eom JS, Kim H, Jeon K, Um SW, Koh WJ, Suh GY, et al. Tracheal wall thickening is associated with the granulation tissue formation around silicone stents in patients with post-tuberculosis tracheal stenosis. *Yonsei Med J*. 2013;54(4):949-56.

176. Pouwels SD, Heijink IH, Brouwer U, Gras R, den Boef LE, Boezen HM, et al. Genetic variation associates with susceptibility for cigarette smoke-induced neutrophilia in mice. *Am J Physiol Lung Cell Mol Physiol*. 2015;308(7):L693-709.
177. Stramiello JA, Mohammadzadeh A, Ryan J, Brigger MT. The role of bioresorbable intraluminal airway stents in pediatric tracheobronchial obstruction: A systematic review. *Int J Pediatr Otorhinolaryngol*. 2020;139:110405.
178. Xu J, Ong HX, Traini D, Byrom M, Williamson J, Young PM. The utility of 3D-printed airway stents to improve treatment strategies for central airway obstructions. *Drug Dev Ind Pharm*. 2019;45(1):1-10.
179. Murgu SD, Laxmanan B. Biomechanical Properties of Airway Stents: Implications for Clinical Practice. *J Bronchology Interv Pulmonol*. 2016;23(2):89-91.
180. Roodenburg SA, Pouwels SD, Slebos DJ. Airway granulation response to lung-implantable medical devices: a concise overview. *Eur Respir Rev*. 2021;30(161).
181. Kirby M, Smith BM. Quantitative CT Scan Imaging of the Airways for Diagnosis and Management of Lung Disease. *Chest*. 2023.
182. Stoeckel D, Pelton A, Duerig T. Self-expanding nitinol stents: material and design considerations. *Eur Radiol*. 2004;14(2):292-301.
183. Saylor DM, Sivan S, Turner P, Shi H, Soneson JE, Weaver JD, et al. Temperature dependence of nickel ion release from nitinol medical devices. *J Biomed Mater Res B Appl Biomater*. 2021;109(8):1188-97.
184. Burian M, Neumann T, Weber M, Brandt R, Geisslinger G, Mitrovic V, Hamm C. Nickel release, a possible indicator for the duration of antiplatelet treatment, from a nickel cardiac device in vivo: a study in patients with atrial septal defects implanted with an Amplatzer occluder. *Int J Clin Pharmacol Ther*. 2006;44(3):107-12.
185. Elkiran O, Karakurt C, Kocak G, Taskapan C. Serum Nickel and Titanium Levels after Transcatheter Closure of Atrial Septal Defects with Amplatzer Septal Occluder. *Cardiol Res Pract*. 2019;2019:7891746.
186. Rigatelli G, Cardaioli P, Giordan M, Aggio S, Chinaglia M, Braggion G, Roncon L. Nickel allergy in interatrial shunt device-based closure patients. *Congenit Heart Dis*. 2007;2(6):416-20.
187. Franzen DP, Lang C, Agorastos N, Freitag L, Kohler M, Schmid-Grendelmeier P. Evaluation of Nickel Release from Endobronchial Valves as a Possible Cause of Hypersensitivity Pneumonitis in a Patient Treated with Bronchoscopic Lung Volume Reduction. *Int Arch Allergy Immunol*. 2017;174(3-4):144-50.
188. Gupta A, Burgess JK, Borghuis T, de Vries MP, Kuipers J, Permentier HP, et al. Identification of damage associated molecular patterns and extracellular matrix proteins as major constituents of the surface proteome of lung implantable silicone/nitinol devices. *Acta Biomater*. 2022;141:209-18.
189. Kuo CY, Wong RH, Lin JY, Lai JC, Lee H. Accumulation of chromium and nickel metals in lung tumors from lung cancer patients in Taiwan. *J Toxicol Environ Health A*. 2006;69(14):1337-44.
190. Morton J, Tan E, Suvarna SK. Multi-elemental analysis of human lung samples using inductively coupled plasma mass spectrometry. *J Trace Elem Med Biol*. 2017;43:63-71.
191. Deslee G, Klooster K, Hetzel M, Stanzel F, Kessler R, Marquette CH, et al. Lung volume reduction coil treatment for patients with severe emphysema: a European multicentre trial. *Thorax*. 2014;69(11):980-6.
192. Hartman JE, Klooster K, Augustijn SWS, van Geffen WH, Garner JL, Shah PL, et al. Identifying Responders and Exploring Mechanisms of Action of the Endobronchial Coil Treatment for Emphysema. *Respiration*. 2021;100(5):443-51.
193. Klooster K, Ten Hacken NH, Franz I, Kerstjens HA, van Rikxoort EM, Slebos DJ. Lung volume reduction coil treatment in chronic obstructive pulmonary disease patients with homogeneous emphysema: a prospective

feasibility trial. *Respiration*. 2014;88(2):116-25.

194. Slebos DJ, Klooster K, Ernst A, Herth FJF, Kerstjens HAM. Bronchoscopic lung volume reduction coil treatment of patients with severe heterogeneous emphysema. *Chest*. 2012;142(3):574-82.

195. Roodenburg SA, Hartman JE, Deslee G, Herth FJF, Klooster K, Sciruba FC, et al. Bronchoscopic Lung Volume Reduction Coil Treatment for Severe Emphysema: A Systematic Review and Meta-Analysis of Individual Participant Data. *Respiration*. 2022;101(7):697-705.

196. Stewart LA, Clarke M, Rovers M, Riley RD, Simmonds M, Stewart G, et al. Preferred Reporting Items for Systematic Review and Meta-Analyses of individual participant data: the PRISMA-IPD Statement. *JAMA*. 2015;313(16):1657-65.

197. Graham BL, Steenbruggen I, Miller MR, Barjaktarevic IZ, Cooper BG, Hall GL, et al. Standardization of Spirometry 2019 Update. An Official American Thoracic Society and European Respiratory Society Technical Statement. *Am J Respir Crit Care Med*. 2019;200(8):e70-e88.

198. Jones PW. St. George's Respiratory Questionnaire: MCID. *COPD*. 2005;2(1):75-9.

199. Fellrath JM, Scherer T, Franzen DP, Lovis A, von Garnier C, Plojoux J, Soccal PM. Endobronchial coil therapy in severe emphysema: 6-month outcomes from a Swiss National Registry. *J Thorac Dis*. 2018;10(Suppl 23):S2711-S8.

200. Hartman JE, Klooster K, Gortzak K, ten Hacken NH, Slebos DJ. Long-term follow-up after bronchoscopic lung volume reduction treatment with coils in patients with severe emphysema. *Respirology*. 2015;20(2):319-26.

201. Slebos DJ, Hartman JE, Klooster K, Blaas S, Deslee G, Gesierich W, et al. Bronchoscopic Coil Treatment for Patients with Severe Emphysema: A Meta-Analysis. *Respiration*. 2015;90(2):136-45.

202. Agusti A, Bel E, Thomas M, Vogelmeier C, Brusselle G, Holgate S, et al. Treatable traits: toward precision medicine of chronic airway diseases. *European Respiratory Journal*. 2016;47(2):410-9.

203. Bakker JT, Klooster K, Bouwman J, Pelgrim GJ, Vliementhart R, Slebos DJ. Evaluation of spirometry-gated computed tomography to measure lung volumes in emphysema patients. *ERJ Open Res*. 2022;8(1).

204. Eberhardt R, Slebos DJ, Herth FJF, Darwiche K, Wagner M, Ficker JH, et al. Endobronchial Valve (Zephyr) Treatment in Homogeneous Emphysema: One-Year Results from the IMPACT Randomized Clinical Trial. *Respiration*. 2021;100(12):1174-85.

205. Gompelmann D, Heinhold T, Rotting M, Bischoff E, Kontogianni K, Eberhardt R, Herth FJF. Long-term follow up after endoscopic valve therapy in patients with severe emphysema. *Ther Adv Respir Dis*. 2019;13:1753466619866101.

206. Hartman JE, Klooster K, Koster TD, Carpaij OA, van Dijk M, Slebos DJ. Impact of Endobronchial Valve Treatment on Lung Function Decline. *Respiration*. 2023;102(12):1003-6.

207. Lam M, Migonney V, Falentin-Daudre C. Review of silicone surface modification techniques and coatings for antibacterial/antimicrobial applications to improve breast implant surfaces. *Acta Biomater*. 2021;121:68-88.

208. Kuramitsu S, Sonoda S, Ando K, Otake H, Natsuaki M, Anai R, et al. Drug-eluting stent thrombosis: current and future perspectives. *Cardiovasc Interv Ther*. 2021;36(2):158-68.

209. Martin MJ, Dulohery Scrodin MM, Edell ES, Aguirre EA, Rajagopalan S, Bartholmai BJ, Peikert T. Bronchoscopic Lung Volume Reduction: Highlighting the Patient Selection Process. *Mayo Clin Proc*. 2023;98(9):1347-52.

210. Konstantina K, Judith B, Franziska T, Claus Peter H, Felix Jf H, Ralf E. Evaluation of the Lung Volume Reduction Reverser System (LVR-R) in treating patients with severe emphysema. Feasibility and safety at 6 months follow up; preliminary results. *European Respiratory Journal*. 2021;58(suppl 65):PA3799.

211. Susanne D, Franziska T, Judith B, Claus Peter H, Ralf E, Felix JH, et al. Safety and feasibility of the Lung Volume Reduction Reverser System (LVR-R) in patients with severe emphysema: preliminary results after 1 year follow up. *European Respiratory Journal*. 2023;62(suppl 67):OA2592.
212. Sun C, Kang J, Yang C, Zheng J, Su Y, Dong E, et al. Additive manufactured polyether-ether-ketone implants for orthopaedic applications: a narrative review. *Biomater Transl*. 2022;3(2):116-33.
213. Come CE, Kramer MR, Dransfield MT, Abu-Hijleh M, Berkowitz D, Bezzi M, et al. A randomised trial of lung sealant versus medical therapy for advanced emphysema. *Eur Respir J*. 2015;46(3):651-62.
214. Herth FJ, Valipour A, Shah PL, Eberhardt R, Grah C, Egan J, et al. Segmental volume reduction using thermal vapour ablation in patients with severe emphysema: 6-month results of the multicentre, parallel-group, open-label, randomised controlled STEP-UP trial. *Lancet Respir Med*. 2016;4(3):185-93.
215. Ing AJ, Jayapadman A, Kim WV, Ly C, Ho-Shon K, Lilburn P, et al. Reversal of collateral ventilation using endoscopic polymer foam in COPD patients undergoing endoscopic lung volume reduction with endobronchial valves: A controlled parallel group trial. *Respirology*. 2022;27(12):1064-72.

