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Appendix I

Electronic Search Strategies

**RCTs - Medline 1976-1998 (on Ovid)**
1. Emphysema/
2. Lung diseases/
3. Airway obstruction/
4. Pulmonary emphysema/
5. Emphysema$.tw.
6. or/1-6
7. Pneumonectomy/
8. Exp surgery lung/
9. Lung/su
10. Thoracotomy/
11. Surgical stapling/
12. Laser surgery/
13. Lung$ and volume$ and reduc$ and surg$.tw.
14. or/7-13
15. randomized controlled trial.pt.
16. controlled clinical trial.pt.
17. randomized controlled trials/
18. random allocation/
19. double blind method/
20. or/15-19
22. Exp clinical trials/
23. (clini$ adj trial$).ti,ab.
24. ((singl$ or doubl$ or trebl$ or tripl$) adj25 (blind$ or mask$)).ti,ab.
25. placebos/
26. placebo$.ti,ab.
27. research design/
28. or/21-27
29. 6 and 14
30. 20 or 28
31. 29 and 30
32. Limit 31 to human

**RCTs - Embase 1976-1998 (via Datastar)**
1. Emphysema.de.
2. Lung-emphysema
3. Obstructive-airway-disease
4. Lung-disease
5. Chronic-obstructive-lung-disease
6. Airway-obstruction
7. Emphysema$
8. 1 or 2 or 3 or 4 or 5 or 6 or 7
9. Lung-surgery
LVRS for COPD

10 Lung-resection
11 Thoracotomy
12 Suturing-method
13 Laser-surgery
14 Lung$2 and volume$2
15 Reduc$ and surgery
16 14 and 15
17 9 or 10 or 11 or 12 or 13 or 14 or 16
18 8 and 17
19 18 and human.de.
20 Clinical-trial
21 Randomized-controlled-trial
22 20 or 21
23 19 and 22

Other analytical studies - Medline 1976-1998 (on Ovid)
1 Emphysema/
2 Lung diseases/
3 Airway obstruction/
4 Pulmonary emphysema/
5 Emphysema$.tw.
6 or/1-6
7 Pneumonectomy/
8 Exp surgery lung/
9 Lung/su
10 Thoracotomy/
11 Surgical stapling/
12 Laser surgery/
13 Lung$ and volume$ and reduc$ and surg$.tw.
14 or/7-13
15 6 and 14
16 Prospective studies/
17 Comparative study/
18 Exp case control studies/
19 Cohort studies/
20 (Case and control).tw.
21 Cohort.tw.
22 or/16-21
23 15 and 22
24 Limit 23 to human

Other analytical studies - Embase 1976-1998 (via Datastar)
1 Emphysema.de.
2 Lung-emphysema
3 Obstructive-airway-disease
4 Lung-disease
5 Chronic-obstructive-lung-disease
6 Airway-obstruction
LVRS for COPD

7 Emphysema$
8 1 or 2 or 3 or 4 or 5 or 6 or 7
9 Lung-surgery
10 Lung-resection
11 Thoracotomy
12 Suturing-method
13 Laser-surgery
14 Lung$ and volume$2
15 Reduc$ and surgery
16 14 and 15
17 9 or 10 or 11 or 12 or 13 or 14 or 16
18 8 and 17
19 18 and human.de.
20 Case and control
21 Cohort
22 Prospective$
23 20 or 21 or 22
24 19 and 23

Cost studies - Medline 1993-1998 (on Ovid)
1 Cost allocation/
2 Cost benefit analysis/
3 Cost control/
4 Cost of illness/
5 Cost savings/
6 Costs and costs analysis/
7 Models, economic/
8 or/1-7
9 Emphysema/
10 Lung diseases/
11 Airway obstruction/
12 Pulmonary emphysema/
13 Emphysema$.tw.
14 Pneumonectomy/
15 Thoracotomy/
16 Surgical stapling/
17 Lung$ and volume$ and reduc$ and surg$.tw.
18 or/9-17
19 8 and 18
20 Lung diseases obstructive/rh
21 Lung diseases obstructive/th
22 Exercise therapy/
23 Respiratory therapy/
24 or/20-23
25 8 and 24
Appendix II

Contacts and Local Clinical Experts

Dr. Sherwood Burge, Respiratory Physician, Birmingham Heartlands Hospital

Karen Hammond, Respiratory Research Nurse, Birmingham Heartlands Hospital

Nicky Harvey, Physiotherapist, Birmingham Heartlands Hospital

Paul Jones, Respiratory Physician, St George's Hospital, London

Paul Kind, Health Economist, Centre for Health Economics, University of York

Amanda Lambert, NHSE, West Midlands Regional Office

Dr Martin Miller, Respiratory Physician, University Hospital, Birmingham

Jean Peters, Research Co-ordinator, Trent Institute for Health Services Research

Francisco Pozo, Respiratory Physician, Hospital Universitario, Madrid, Spain

Mr. Rajesh, Thoracic Surgeon, Birmingham Heartlands Hospital

Jo Walsworth-Bell, Public Health Physician (Retired)

Martin Wildman, Research Registrar in Respiratory Medicine, Birmingham Heartlands Hospital

George Young, GP, Hall Green, Birmingham
## Appendix III

### Inclusion and Exclusion Criteria

<table>
<thead>
<tr>
<th>Inclusion</th>
<th>Exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Population</strong></td>
<td>Patients with diffuse, severe emphysema with significant functional limitation, despite maximum medical therapy.</td>
</tr>
<tr>
<td><strong>Intervention</strong></td>
<td>Lung volume reduction surgery (reduction pneumoplasty or pneumectomy) defined as multiple lung resections and/or plications of diseased lung tissue to reduce lung volume. The following techniques and approaches were all included: open or closed procedure, unilateral or bilateral procedure; laser ablation, stapling or both.</td>
</tr>
<tr>
<td><strong>Outcomes</strong></td>
<td>Studies were included irrespective of which outcomes they addressed. Ideally, they would address clinical and physiological outcomes and should provide data on morbidity and mortality rates associated with the procedure.</td>
</tr>
<tr>
<td><strong>Duplication</strong></td>
<td>When several series emerged chronologically from the same source only the largest and most recent series was included.</td>
</tr>
</tbody>
</table>

### Quality Criteria - pertaining to potential sources of bias

| Selection bias | **A** consecutive case series; cases studied represented all those treated or were shown to have been selected in an unbiased way or were shown not to be significantly different from the total number treated. | **A** selected case series; cases studied were a sub-group of those treated with no detail provided as to how they were selected or cases studies were a sub-group of those treated with no evidence to show that they were not significantly different from the total number treated. |
| Attrition bias | Losses to follow-up of ≤ 25% or adequate management of losses to follow-up e.g. demonstration that they were not significantly different from total population; inclusion in the final analysis; or sensitivity analyses. NB. When losses to follow-up arose due to cases in the series not reaching a given follow-up point studies were included if they treated cases on whom data was available as a cohort with results presented for that discrete cohort before and after the intervention. | Losses to follow-up > 25% and inadequate management of losses to follow-up. |
| Detection bias | Prospective study design; study states that it was conducted prospectively or outcomes of interest were clearly measured before and after the intervention using predefined criteria. | Retrospective study design; study states that it was conducted retrospectively or outcomes of interest were clearly not measured before and after the intervention using predefined criteria. |
Appendix IV

Validity Assessment Criteria

Checklist for the critical appraisal of case series.
Case studies and case series tend to fall fairly low in the hierarchy of evidence relative to other study designs such as RCTs and CCTs. However, in certain situations evidence from this type of research may be all that is available, particularly when the intervention of interest is in the early stages of its development or, conversely, when its effectiveness has been well established in the absence of well-conducted RCTs. Situations where case series are likely to provide valid information tend to be those where the natural history of the condition is understood and it is clear that cases who are untreated will have a poor prognosis. For situations where the prognosis of untreated cases is not known the information from case series is less helpful.

The purpose of this checklist to help the reader identify the strengths and weaknesses of a given case series in order that they may apply its results within certain limits as they are defined. It is important at the outset, however to note a couple of points;

- reliable and validated search strategies for primary study designs other that RCTs and CCTs are not yet available, hence the impact of retrieval and publication bias in reviews of case series is completely unknown and should be acknowledged
- it also possible that unbiased estimates of effect from case series may be contained within other study designs (e.g. each group within a comparative study may constitute a case series in its own right) and this should always be considered

Finally, it is important to stress that this checklist is a guide only. Appraisers may find that what constitutes acceptable assessment criteria may vary between situations and additional criteria specific to the subject area will often be required.

1. Was the study conducted prospectively?

Can be difficult to assess, but if the outcomes are clearly measured before and after the intervention, and criteria are clearly defined for the measurement of outcomes \textit{a priori} it is highly probable that this was the case.

\textit{Information required}
A description within the methods section describing the timing of the relevant events with respect to the initiation of the study, i.e. were cases selected for inclusion in the study before the results of the outcome of interest were known by the investigators.

\textit{Assessment Criteria}
Ideal - Study states that it is conducted prospectively
Acceptable - Evidence that all key outcomes were measured before and after the intervention using clear criteria defined \textit{a priori}. 
Unacceptable - Study states that it was conducted retrospectively or it clearly does not measure key outcomes before and after the intervention
OR
no information.

2. Was the method of selection of cases identified and appropriate?

Again this is not always clear but if the case series has been selected from a wider population of cases treated it is important to assess whether this has been done in an unbiased way.

*Information required*
Detail within the methods or results section on the numbers treated and the numbers included in the case series and, if they are different, how cases were selected for inclusion and whether they were representative of the wider population.

*Assessment Criteria*
Ideal - Study states that a consecutive series of cases was included in the study.
Acceptable - Evidence that cases were selected for inclusion in an unbiased way or evidence that the characteristics of the included cases were not significantly different from those of the treated population.
Unacceptable - Clear evidence from the numbers that the included cases were a sample of those treated with no detail on the selection process or evidence that they were significantly different from the total population treated.
OR
no information.

3. Was the duration and completeness of follow-up reported and was it adequate?

Detail on losses to follow-up and deaths will usually be available. A particular problem in case series is that frequently only small subgroups of cases have reached given follow-up points which is potentially problematic if not handled carefully.

*Information required*
Numbers and characteristics of losses to follow-up and deaths.

*Assessment Criteria*
Ideal - Follow-up data on 80 - 100% of cases.
Acceptable - Adequate management of deaths and losses to follow-up such as detailing their characteristics, performing sensitivity analyses and/or including them in the final analysis
OR
If losses to follow-up are cases who have not yet reached a given follow-up point, are those for whom data is available treated as a cohort, with results presented for the cohort *only* before and after the intervention?
Unacceptable - Losses to follow up of over 20 - 25% particularly if they are unaccounted for.

OR

Follow-up data for a subgroup of patients followed up to a given point using baseline data for the whole series as a comparator

OR

no information.
Appendix V

Data Abstraction Form

DATA ABSTRACTION AND VALIDITY ASSESSMENT

AIM:

Numbers
Referral Procedures
 Evaluated People
 Treated
 Studied
 Followed up

Consecutive Prospective Yes/No/Don’t know

Follow up duration and completeness

Inclusion Criteria

Exclusion Criteria

Intervention

Unilateral Bilateral Both Unclear
Laser Stapling Both Unclear
Open

Closed

Bovine Pericardial Strip Buttressing Yes/No/Unclear

Pulmonary Rehab Yes/No
Details -

Experience/Setting
<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Assessment</th>
<th>Subjectivity</th>
<th>Pre</th>
<th>Post1</th>
<th>Post2</th>
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<tbody>
<tr>
<td>FEV₁</td>
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<tr>
<td>Dyspnoea</td>
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<td>6MWD</td>
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<tr>
<td>Mortality</td>
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<tr>
<td>LOS</td>
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<tr>
<td>ITU stay</td>
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<tr>
<td>Suppl. O²</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix VI

Included Studies

1. **Argenziano**
   Argenziano M, Thomashow B, Jellen PA et.al.
   Functional comparison of unilateral versus bilateral lung volume reduction surgery.
   Annals of Thoracic Surgery 1997;64:321-327

2. **Bagley**
   Bagley PH, Davis SM, O'Shea M et.al.
   Lung volume reduction surgery at a community hospital: program development and outcomes.
   Chest 1997;111:1552-1559

3. **Benditt**
   Benditt JO, Lewis S, Wood DE et.al.
   Lung volume reduction surgery improves maximal O² consumption, maximal minute ventilation, O² pulse and dead space to tidal volume ratio during leg cycle ergometry.
   American Journal of Respiratory and Critical Care Medicine 1997;156:561-566

4. **Bousamra**
   Bousamra M, Haasler GB, Lipchik RJ et.al.
   Functional and oximetric assessment of patients after lung reduction surgery.
   Journal of Thoracic and Cardiovascular Surgery 1997;113:675-681

5. **Cooper**
   Cooper JD, Patterson GA, Sunderesan RS et.al.
   Results of 150 consecutive bilateral lung volume reduction procedures in patients with severe emphysema.
   Journal of Thoracic and Cardiovascular Surgery 1996;112:1319-1329

6. **Cordova**
   Cordova F, O'Brien G, Furukawa S et.al.
   Stability of improvements in exercise performance and quality of life following bilateral lung volume reduction surgery in severe COPD.
   Chest 1997;112:907-915

7. **Criner**
   Criner GJ, O'Brien G, Furukawa S et.al.
   Lung volume reduction surgery in ventilator dependent COPD patients.
   Chest 1996;110:877-884

8. **Daniel**
   Daniel TM, Chan BB, Bhaskar V et.al.
   Lung volume reduction surgery. Case selection, operative technique and clinical results.
9. Eugene
Eugene J, Dajee, Kayaleh R et.al.
Reduction pneumoplasty for patients with a forced expiratory volume in 1 second of 500 millilitres or less.

10. Eugene
Eugene J, Ott R, Gogia H et.al.
Video-thoracic surgery for treatment of end-stage bullous emphysema and chronic obstructive pulmonary disease.
The American Surgeon 1995;61:934-936

11. Keller
Keller CA, Ruppel G, Hibbett A et.al.
Thoracoscopic lung volume reduction surgery reduces dyspnoea and improves exercise capacity in patients with emphysema.
American Journal of Respiratory and Critical Care Medicine 1997;156:60-67

12. Kotloff
Kotloff RM, Tino G, Bavaria JE et.al.
Bilateral lung volume reduction surgery for advanced emphysema: a comparison of median sternotomy and thoracoscopic approaches.
Chest 1996;110:1399-1406

13. Little
Little MD, Swain JA, Nino J et.al.
Reduction pneumoplasty for emphysema.
Annals of Surgery 1995;222:365-374

14. McKenna
McKenna RJ, Brenner M, Fischel Rjet.al.
Should lung volume reduction surgery be unilateral or bilateral?
The Journal of Thoracic and Cardiovascular Surgery 1996;112:1331-1339

15. Miller
Miller JJ, Lee RB, Mansour KA.
Lung volume reduction surgery: Lessons learned.

16. Sciurbia
Sciurbia FC, Rogers R, Keenan RJ et.al.
Improvement in pulmonary function and elastic recoil after lung volume reduction surgery for diffuse emphysema.
17. **Snell**
Snell GI, Solin P, Weng Chin et. al.
Lung volume reduction surgery for emphysema.
Medical Journal of Australia 1997;167:529-532

18. **Stammerberger**
Stammerberger U, Thurnheer R, Bloch KE et.al.
Thoracoscopic bilateral lung volume reduction surgery for diffuse pulmonary emphysema.
European Journal of Cardiothoracic Surgery 1997;11:1005-1010

19. **Zenati**
Zenati M, Keenan RJ, Sciurbia FC et.al.
Role of lung volume reduction surgery in lung transplant candidates with pulmonary emphysema.
Excluded Studies [and main reasons for exclusion].

1. Bae KT, Slone RM, Gierada DS et.al.
Patients with emphysema: quantitative CT analysis before and after lung volume reduction surgery. Work in progress.
Radiology 1997;203:705-714
[reasons for exclusion: inappropriate outcomes]

2. Benditt JO, Woode DE, McCool FD et.al.
Changes in breathing and ventilatory muscle recruitment patterns induced by lung volume reduction surgery.
American Journal of Respiratory and Critical Care Medicine 1997;155:279-284
[reasons for exclusion: suspicion of duplication]

Bilateral volume reduction surgery for diffuse pulmonary emphysema by video-assisted thoracoscopic.
Journal of Cardiovascular Surgery 1996;112:875-882
[reasons for exclusion: suspicion of duplication]

Effect of surgical lung volume reduction on breathing patterns in severe pulmonary emphysema.
American Journal of Respiratory and Critical Care Medicine 1997;156:553-560
[reasons for exclusion: suspicion of duplication]

5. Brenner M, Kayaleh RA, Milne EN et.al.
Thoracoscopic laser ablation of pulmonary bullae.
[reasons for exclusion: inadequate follow-up]

Objective predictors of response for staple versus laser emphysematous lung reduction.
American Journal of Respiratory and Critical Care Medicine 1997;155:1295-1301
[reasons for exclusion: inadequate follow-up]

7. Brenner M, McKenna RJ, Gelb AF et.al.
Dyspnoea response following bilateral thoracoscopic staple lung volume reduction surgery.
Chest 1997;112:916-923
[reasons for exclusion: inappropriate outcomes]

8. Colt HG, Ries AL, Brewer N et.al.
Analysis of chronic pulmonary disease referrals for lung volume reduction surgery.
Journal of Cardiopulmonary Rehabilitation 1997;17:248-252
[reasons for exclusion: inappropriate outcomes]
The current status of surgery for bullous emphysema.
The Journal of Thoracic and Cardiovascular Surgery 1989;97:351-361
[reasons for exclusion: inappropriate intervention]

10. Cooper JD Trulock EP, Triantafillou AN et.al.
Bilateral pneumectomy (volume reduction) for chronic obstructive pulmonary disease.
[reasons for exclusion: suspicion of duplication]

11. Cooper JD, Patterson GA.
Lung volume reduction surgery for severe emphysema.
Seminars in Thoracic and Cardiovascular Surgery 1996;8(1):52-60
[reasons for exclusion: suspicion of duplication]

12. Cooper JD.
Extended indications for median sternotomy in patients requiring pulmonary resection.
Annals of Thoracic Surgery 1978;26:413-420
[reasons for exclusion: suspicion of duplication]

13. Cooper J, Patterson GA.
Lung volume reduction surgery for emphysema.
[reasons for exclusion: inappropriate intervention]

14. Delarue NC, Woolf DE, Sanders FG.
Surgical treatment for pulmonary emphysema.
Canadian Journal of Surgery 1977;20:222-230
[reasons for exclusion: inappropriate intervention]

15. Fischel RJ, McKenna RJ, Peters H.
Thoracoscopic lung volume reduction surgery.
Surgical Rounds 1996;19:272-278
[reasons for exclusion: suspicion of duplication]

16. Fitzgerald MX, Keelan PJ, Cugell DW et.al.
Long-term results of surgery for bullous emphysema.
Journal of Thoracic and Cardiovascular Surgery 1974;68:566-587
[reasons for exclusion: inappropriate intervention]

17. Fujita RA, Barnes GB.
Morbidity and mortality after thoracoscopic pneumoplasty.
[reasons for exclusion: inappropriate outcomes]
18. Gaissert HA, Trulock EP, Cooper JD et.al.  
Comparison of early results after volume reduction or lung transplantation for chronic obstructive pulmonary disease.  
[reasons for exclusion: retrospective analysis]

19. Gelb AF, Brenner M, McKenna RJ et.al.  
Lung function 12 months following emphysema resection.  
Chest 1996;110:1407-1414  
[reasons for exclusion: inappropriate outcomes]

20. Gelb AF, Zamel N, McKenna RJ et.al.  
Mechanism of short-term improvement in lung function following emphysema resection.  
American Journal of Respiratory and Critical Care Medicine 1996;154:945-951  
[reasons for exclusion: inadequate follow-up]

21. Gelb AF, McKenna RJ, Brenner M et.al.  
Contributions of lung and chest wall mechanics following emphysema resection.  
Chest 1996;110:11-17  
[reasons for exclusion: suspicion of duplication]

22. Gierada DS, Sloane RM, Bae KT et.al.  
Pulmonary emphysema: comparison of preoperative quantitative CT and physiologic index values with clinical outcome after lung volume reduction surgery.  
Radiology;1997:235-242  
[reasons for exclusion: inappropriate outcomes]

23. Goldstraw P, Petrou M.  
The surgical treatment of emphysema. The Brompton Approach.  
[reasons for exclusion: inappropriate intervention]

24. Hazelrigg SR, Boley TM, Naunheim KS et.al.  
Effect of bovine pericardial strips on air leak after stapled pulmonary resection.  
Annals of Thoracic Surgery 1997;63:1573-1575  
[reasons for exclusion: inappropriate outcomes]

25. Hazelrigg S, Boley T, Henkle J et.al.  
Thoracoscopic laser bullectomy: a prospective study with three-month results.  
The Journal of Thoracic and Cardiovascular Surgery 1996;112:319-327  
[reasons for exclusion: inadequate follow-up]

Relation between pre-operative inspiratory lung resistance and the outcome of lung reduction surgery for emphysema.  
[reasons for exclusion: not a consecutive case series]
27. Iwa T, Watanabe Y, Fukatani G.
Simultaneous bilateral operations for bullous emphysema by median sternotomy.
[reasons for exclusion: inappropriate intervention]

28. Keenan RJ, Landreneau RJ, Sciurbia FC et.al.
Unilateral thoracoscopic surgical approach for diffuse emphysema.
The Journal of Thoracic and Cardiovascular Surgery 1996;111:308-316
[reasons for exclusion: inadequate follow-up]

29. Krucylak PE, Naunheim KS, Keller CA et.al.
Anaesthetic management of patients undergoing video-assisted lung reduction for
treatment of end-stage emphysema.
[reasons for exclusion: inappropriate outcomes]

30. Lewis RJ, Caccavale RJ, Sisler GE.
VATS-Argon beam coagulator treatment of diffuse end-stage bilateral bullous disease
of the lung.
[reasons for exclusion: inadequate follow-up]

31. Martinez FJ, Montes de Oca, Whyte RI et.al.
Lung volume reduction surgery improves dyspnoea, dynamic hyperinflation and
respiratory muscle function.
[reasons for exclusion: not a consecutive case series]

32. McKenna RJ, Fischel RJ, Brenner M et.al.
Combined operations for lung volume reduction surgery and lung cancer.
Chest 1996;110:885-888
[reasons for exclusion: suspicion of duplication]

33. McKenna RJ, Fischel RJ, Brenner M et. al.
Use of the Heimlich valve to shorten hospital stay after lung reduction surgery for
emphysema.
[reasons for exclusion: inappropriate outcomes]

34. Naunheim KS, Keller CA, Krucylak PE et.al.
Unilateral VATS lung reduction.
[reasons for exclusion: suspicion of duplication]

35. O'Donnell DE, Webb KA, Bertley JC et.al.
Mechanisms of relief of exertional breathlessness following unilateral bullectomy and
lung volume reduction surgery in emphysema.
Chest 1996;110:18-27
[reasons for exclusion: inappropriate intervention]
Lung volume reduction in patients with severe diffuse emphysema.  
Chest 1996;110:28-34  
[reasons for exclusion: retrospective analysis]

37. Rubin JW, Finney NR, Borders BM et.al.  
Intrathoracic biopsies, pulmonary wedge resection and management of pleural disease: Is video assisted closed chest surgery the approach of choice?  
American Surgeon 1994;60:860-864  
[reasons for exclusion: inappropriate intervention]

38. Slone RM, Gierada DS.  
Radiology of pulmonary emphysema and lung volume reduction surgery.  
Seminars in Thoracic and Cardiovascular Surgery 1996;8(1):61-82  
[reasons for exclusion: inappropriate outcomes]

Lung volume reduction surgery: comparison of preoperative radiological features and clinical outcome.  
Radiology 1997;204:685-693  
[reasons for exclusion: inappropriate outcomes]

40. Suga K, Nishigauchi K, Matsunagna N.  
Three-dimensional surface displays of perfusion SPET in the evaluation of patients with pulmonary emphysema for thoracoscopic lung volume reduction surgery.  
Nuclear Medicine Communications 1997;18:25-32  
[reasons for exclusion: inappropriate intervention]

41. Swanson SJ, Mentzer SJ, DeCamp MM et.al.  
Journal of the American College of Surgeons 1997;185:25-32  
[reasons for exclusion: inadequate follow-up]

42. Szekely LA, Oelberg DA, Wright Cameron et.al.  
Preoperative predictors of operative morbidity and mortality in COPD patients undergoing bilateral lung volume reduction surgery.  
Chest 1997;111:550-558  
[reasons for exclusion: retrospective analysis]

43. Teschler H, Stamatis G, el-Raouf Farhat AA et.al.  
Effect of surgical lung volume reduction on respiratory muscle function in pulmonary emphysema.  
European Respiratory Journal 1996;9:1779-1784  
[reasons for exclusion: inappropriate outcomes]

44. Triantafillou AN.  
Anaesthetic management for bilateral volume reduction surgery.  
[reasons for exclusion: inappropriate outcomes]
45. Tschernko EM, Wisser W, Wanke T et.al.  
Changes in ventilatory mechanics and diaphragmatic function after lung volume reduction surgery in patients with COPD.  
Thorax 1997;52:545-550  
[reasons for exclusion: suspicion of duplication]

46. Tschernko EM, Wisser W, Hofer S.  
The influence of lung volume reduction surgery on ventilatory mechanics in patients suffering from severe chronic obstructive pulmonary disease.  
Anaesthesia and Analgesia 1996;83:996-1001  
[reasons for exclusion: inappropriate outcomes]

47. Wakabayashi A, Brenner M, Kayaleh RA et.al.  
Thoracoscopic carbon dioxide laser treatment of bullous emphysema.  
[reasons for exclusion: retrospective analysis]

48. Wakabayashi A.  
Thoracoscopic laser pneumoplasty in the treatment of diffuse bullous emphysema.  
Annals of Thoracic Surgery 1995;60:936-942  
[reasons for exclusion: retrospective analysis]

49. Wakabayashi A.  
Unilateral thoracoscopic laser pneumoplasty of diffuse bullous emphysema.  
[reasons for exclusion: retrospective analysis]

50. Wang SC, Fischer KC, Slone RA et.al.  
Perfusion scintigraphy in the evaluation for lung volume reduction surgery: correlation with clinical outcome.  
Radiology 1997;205:243-248  
[reasons for exclusion: inappropriate outcomes]

51. Weder W, Schmidt RA, Russi EW.  
Thoracoscopic lung volume reduction surgery for emphysema.  
International Surgery 1996;81:229-234  
[reasons for exclusion: suspicion of duplication]

52. Weder W, Thurnheer R, Stammberger U et.al.  
Radiologic emphysema morphology is associated with outcome after lung volume reduction.  
Annals of Thoracic Surgery 1997;64:313-319  
[reasons for exclusion: inappropriate outcomes]

53. Wisser W, Tschernko E, Senbaklavaci O et.al.  
Functional improvement after volume reduction: sternotomy versus videoendoscopic approach.  
Annals of Thoracic Surgery 1997;63:822-828  
[reasons for exclusion: retrospective analysis]
54. Yusen RD, Trulock EP, Pohl MS et al.  
Results of lung volume reduction surgery reduction in patients with emphysema.  
Seminars in Thoracic and Cardiovascular Surgery 1996;8:99-109  
[reasons for exclusion: suspicion of duplication]

55. Yusen RD, Lefrak SS.  
Evaluation of patients with emphysema for lung volume reduction surgery.  
Seminars in Thoracic and Cardiovascular Surgery 1996;8(1):83-93  
[reasons for exclusion: suspicion of duplication]

56. Zenati M, Keenan RJ, Landreneau RJ et al.  
Lung reduction as a bridge to lung transplantation in pulmonary emphysema.  
[reasons for exclusion: inappropriate intervention]
### Appendix VII

**Characteristics of Included Studies**

<table>
<thead>
<tr>
<th>Study Reference</th>
<th>Study Design</th>
<th>Strengths and Weaknesses</th>
<th>Criteria for Entry to Study</th>
<th>Intervention</th>
<th>Outcomes</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bagley</td>
<td>Consecutive case series. n=55 82% followed up for three months. No information on assessment of outcome</td>
<td>Advanced emphysema unhappy with the limits imposed by the disease. Small amounts of airways inflammation. Recent completion of a pulmonary rehabilitation programme. RV &gt;150% of predicted. PA systolic pressure &lt; 50mmHg. Smoking cessation for at least 1 year.</td>
<td>Recent high dose steroid use. Other active medical problems.</td>
<td>Stapling with BPS buttressing. Bilateral via median sternotomy. 8 weeks pulmonary rehabilitation pre-op.</td>
<td>Pulmonary function tests. 6 MWD Chronic Respiratory Diseases Questionnaire.</td>
<td>Baseline data - 6MWD and subjective data obtained post-rehabilitation. Pulmonary function test baseline data collected at various points particularly for very ill cases. Setting/experience - early experience in a 320 bed community hospital in the USA. NB. Results presented as numbers of patients achieving a significant improvement post-operatively.</td>
</tr>
<tr>
<td>Benditt</td>
<td>Consenting cases of a consecutive series - included cases studied compared to those excluded and shown not to be significantly different. N=21 (of 47) 100% follow-up to 3 months. No information on assessment of outcome.</td>
<td>Evidence of emphysema on CT scan. Severe airflow limitation. FEV1 &gt;15% and &lt;35% of predicted. TLC &gt;120% RV &gt;150% Air trapping and hyperinflation. Smoking cessation for at least 3 months.</td>
<td>Aged &gt; 75 years. Excessive daily sputum production. Significant co-morbidity.</td>
<td>Stapling with BPS buttressing. Bilateral via median sternotomy.</td>
<td>Pulmonary function tests to ATS standards.</td>
<td>Baseline data - no detail on when this was obtained. Setting/experience - part of a year long programme at the University of Washington in Seattle, USA.</td>
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<tr>
<td>Cooper</td>
<td>Consecutive case series. n=150 67% followed up to 6 months; 37% to 1 year; and 13% to 2 years; all treated as discrete cohorts. No information on assessment of outcome.</td>
<td>Emphysema with hyperinflation and heterogeneity. Marked physiological impairment (FEV&lt; 35% of predicted). Marked restriction in activities of daily living despite maximal medical therapy. Aged &lt; 75 years. Acceptable nutritional status (70% to 130% of ideal body weight). Ability to participate in vigorous pulmonary rehabilitation programme. No co-existing major medical problems that would significantly increase operative risk. Willingness to undertake risk of morbidity and mortality associated with the procedure. Smoking cessation for at least 6 months. Diffuse disease with no target areas. Insufficient thoracic distension advanced age or associated medical problems. FEV, too good. Pleural disease. Better suited to lung transplantation. PA carbon dioxide &gt;55mmHg in association with other problems. Marked kyphosis. Stapling with BPS buttressing. Bilateral via median sternotomy. 6 weeks pulmonary rehabilitation pre-op. Pulmonary function tests. Exercise testing 6 MWD Morbidity and mortality. Dyspnoea - Mahler index and MMRC. Quality of life - Nottingham Health Profile and SF36. Baseline data - generally obtained pre-and post rehab but presented separately. Setting/experience - the most recent results of a large programme at Washington University, Missouri, USA, which commenced in 1993.</td>
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<tr>
<td>Cordova</td>
<td>Consecutive case series. n=69 25 patients reached 3 months with 100% follow up and were treated as a discrete cohort. No information on assessment of outcome.</td>
<td>New York Heart Association class iii-iv. Evidence of airflow obstruction and hyperinflation by pulmonary function studies. (i.e. post-bronchodilator FEV, 30% of predicted). FRC or TLC &gt;120% of predicted. Discrepancy between helium dilution and FRC body box determination of lung volumes by &gt;500ml. Documented hyperinflation on chest radiograph. Diffuse emphysema documented on CT scan. Ventilation-perfusion mismatch documented in planned resected lung by VQ scan. Patients with severe and refractory hypoxaemia. Severe hypercapnic respiratory failure requiring mechanical ventilation. Presence of severe cardiovascular disease. Presence of severe pulmonary hypertension (mean PA pressure &gt;500Hg). Severe debilitated state with total body weight &lt;70% of ideal. Presence of significant extrapulmonary end-organ dysfunction expected to limit survival. Psychosocial dysfunction. Continued smoking. Stapling. Bilateral via median sternotomy. All patients underwent pulmonary rehabilitation for 8 weeks pre-op and 3 months post-op. Pulmonary function tests to ATS Standards. Exercise testing. 6MWD Quality of life - Sickness Impact Profile. Baseline data - measurements were obtained after pulmonary rehabilitation. Setting/experience- first 25 cases of 69 treated in a 2-year programme at Temple University Hospital, Philadelphia, USA.</td>
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<td>LVRS for COPD</td>
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</tbody>
</table>
| **Criner** | Consecutive case series.  
| Setting/experience - part of a 2 year programme at Temple University Hospital Philadelphia, USA.  
| NB. All very ill cases. |
| **Daniel** | Consecutive case series.  
| n=26 | 65% followed up to three months but treated as a discrete cohort (n=17). No information on assessment of outcome. | Diagnosis of COPD. No smoking for more than 1 month. Aged <75 years. FEV\(_1\) between 15% and 35% of predicted. PA carbon dioxide < 55mmHg. Prednisone dosage < 20 mg daily. PA pressure <55mmHg by echocardiogram. Commitment to pre & post-operative supervised pulmonary rehabilitation for 6 weeks. | Previous thoracotomy or pleurodesis. Symptomatic coronary heart disease, chronic asthma or bronchitis. | Stapling with BPS buttressing. Bilateral via median sternotomy. Pulmonary rehabilitation pre and post op for 6 weeks. | Pulmonary function tests quality of life - tool not stated.  
| Setting/experience - 1 year experience at the University of Virginia, USA. |
| **Eugenea** | Consecutive case series.  
| Setting/experience - part of an 18 month experience at the Western Medical Centre, Anaheim, California, USA.  
| NB. All very ill cases. |
| **Eugeneb** | Consecutive case series.  
| n=28 | 100% followed up to 3 months. No information on assessment of outcome. | Dyspnoea severely impairing lifestyle. Inability to work or self care. No improvement on maximal medical management. Bullous or diffuse emphysema with hyperinflation on CT scan. Markedly low FVC and FEV\(_1\), and high lung volumes. | Not stated. | Laser and/or stapling with BPS buttressing. Unilateral. Via thoracoscopy. No information on pulmonary rehabilitation. | Pulmonary function tests. Dyspnoea - tool not stated.  
| Setting/experience - early experience (Nov 1993 - July 1994) at the Western Medical Centre, Anaheim and the University of California, Irvine, USA.  
| NB. All very ill cases. |
| **Keller** | Consecutive case series.  
| Setting/experience - first 25 cases in a series of 75 at St Louis University, Missouri, USA. |
### LVRS for COPD

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Follow-up</th>
<th>Outcome assessment</th>
<th>FEV&lt;sub&gt;1&lt;/sub&gt;</th>
<th>Hyperinflation</th>
<th>Hypoventilation</th>
<th>Hypoxia</th>
<th>Bronchospasm</th>
<th>Sputum</th>
<th>Functional Status</th>
<th>Pulmonary Function Tests</th>
<th>Setting/Experiences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kotloff</td>
<td>Consecutive case series</td>
<td>40-400</td>
<td>N/A</td>
<td>20-30% of predicted</td>
<td>Severe hyperinflation</td>
<td>Large zones of hypoventilated and hypoperfused lung</td>
<td>Gigant bulllectomy</td>
<td>PA carbon dioxide &gt;50mmHg PA systolic pressure &gt;50mmHg</td>
<td>Continued smoking</td>
<td>Poor functional status</td>
<td>Pulmonary function tests</td>
<td>Baseline data - obtained after pulmonary rehabilitation. Setting/experience - part of a programme at the University of Pennsylvania, USA (duration not stated).</td>
</tr>
<tr>
<td>Little</td>
<td>Consecutive case series</td>
<td>55-551</td>
<td>N/A</td>
<td>20-30% of predicted</td>
<td>Severe hyperinflation</td>
<td>Large zones of hypoventilated and hypoperfused lung</td>
<td>Gigant bulllectomy</td>
<td>PA carbon dioxide &gt;50mmHg PA systolic pressure &gt;50mmHg</td>
<td>Continued smoking</td>
<td>Poor functional status</td>
<td>Pulmonary function tests</td>
<td>Baseline data - when pulmonary rehabilitation was undertaken baseline data was obtained after this. Setting/experience - part of a wider programme at the University of Nevada, USA.</td>
</tr>
<tr>
<td>McKenna</td>
<td>Consecutive case series</td>
<td>166-166</td>
<td>N/A</td>
<td>20-30% of predicted</td>
<td>Severe hyperinflation</td>
<td>Large zones of hypoventilated and hypoperfused lung</td>
<td>Gigant bulllectomy</td>
<td>PA carbon dioxide &gt;50mmHg PA systolic pressure &gt;50mmHg</td>
<td>Continued smoking</td>
<td>Poor functional status</td>
<td>Pulmonary function tests</td>
<td>Baseline data - unclear when this was obtained. Setting/experience - results of a year long programme at the Lung Centre, Chapman Medical Centre, California, USA.</td>
</tr>
<tr>
<td>Miller</td>
<td>Consecutive case series</td>
<td>53-53</td>
<td>N/A</td>
<td>20-30% of predicted</td>
<td>Severe hyperinflation</td>
<td>Large zones of hypoventilated and hypoperfused lung</td>
<td>Gigant bulllectomy</td>
<td>PA carbon dioxide &gt;50mmHg PA systolic pressure &gt;50mmHg</td>
<td>Continued smoking</td>
<td>Poor functional status</td>
<td>Pulmonary function tests</td>
<td>Baseline data - no information on when baseline measurements were obtained. Setting/experience - early results of an 18 month programme at Emory University Medical School, Georgia, USA.</td>
</tr>
<tr>
<td>Study</td>
<td>Case Series</td>
<td>Follow-up</td>
<td>Outcome Assessment</td>
<td>Criteria</td>
<td>Procedure</td>
<td>Setting/Experience</td>
<td>Notes</td>
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<tr>
<td>Sciurbia</td>
<td>Consecutive case</td>
<td>n=20</td>
<td>100%</td>
<td>Outcome assessment by trained independent assessor.</td>
<td>Giant bullae. Dominant bronchiectasis, chronic bronchitis or clinical cor pulmonale. Systolic PA pressure &gt;50mmHg. Severe epistaxis or inability to tolerate oesophageal balloon placement. Severe dyspnoea despite maximal medical therapy. Clinically stable for 1 month pre-study. FEV&lt;sub&gt;1&lt;/sub&gt; &lt; 0.5 and RV &gt;140% predicted after bronchodilators.</td>
<td>Laser and stapling. Unilateral and bilateral. Open and closed procedures. No information on pulmonary rehabilitation.</td>
<td>6MWD (standardised). Dyspnoea - Mahler index. Pressure/volume relations. Elastic recoil. Baseline data - obtained 1-4 weeks pre-op. Setting/experience - first 20 cases in the University of Pittsburgh, USA programme from October 1999 to February 1995.</td>
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<tr>
<td>Stammerberger</td>
<td>Consecutive case</td>
<td>n=42</td>
<td>85%</td>
<td>No information on assessment of outcome.</td>
<td>Severe COPD. FEV&lt;sub&gt;1&lt;/sub&gt; &lt;35% predicted. Considerable hyperinflation - TLC &gt;130% and RV &gt;200%. Flattened diaphragm. High motivation. No smoking for 6 months. No further improvement possible on medical management.</td>
<td>Stapling. Bilateral via thoracoscopy. No systematic pulmonary rehabilitation.</td>
<td>Pulmonary function tests. 6MWD Dyspnoea - MMRC scale.</td>
<td>Baseline data - no information. Setting/experience - results of experience in Switzerland which began in Jan 1994 to Sept 1996. NB. 12MWD results halved to give 6MWD.</td>
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</tbody>
</table>
Zenati Consecutive case series. N=3586% followed up to 3 months. No information on assessment of outcome.

Patients who met the criteria for LVRS and lung transplantation. End stage diffuse emphysema. Severely impaired quality of life despite maximal medical therapy. Post bronchodilator FEV₁ < 30% predicted. Disabling dyspnoea at <50 yards walking.


Pulmonary function tests. 6MWD. Dyspnoea - Mahler index and Borg scale.

Baseline data - no information. Setting/experience - 18 month experience at Pittsburgh Medical Centre, USA from July 1994 to December 1995.

Abbreviations use in table:
- 6MWD: six minute walking distance
- CT: computerised tomography
- VQ: ventilation perfusion
- BPS: bovine pericardial strips
- FRC: fixed residual capacity
- RV: residual volume
- FVC: forced vital capacity
- PA: pulmonary artery
- FEV₁: forced expiratory volume in 1 second
- TLC: total lung capacity
- MMRC: modified Medical Research Council
- ATS: American Thoracic Society
### Appendix VIII

#### Results of all included studies for mortality, length of stay, dyspnoea, QOL and supplemental $O^2$

<table>
<thead>
<tr>
<th>Study Ref.</th>
<th>Deaths</th>
<th>QOL</th>
<th>Dyspnoea</th>
<th>Supplemental $O^2$</th>
<th>Mean LOS (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argenziano</td>
<td>6/92 &lt; 30 d. (6%) 8/86 ≥ 30 d. (9%) Overall 14/92 (15%)</td>
<td></td>
<td>MRC score pre 4.1 ± 0.8 post 1.7 ± 1.3</td>
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<tr>
<td>Bagley</td>
<td>3/55 hospital (5%) 3/52 home (6%) overall 11%</td>
<td>Mean change on CRQ Fatigue - 3.16 [p&lt;0.001] Emotional function - 4.84 [p&lt;0.0031] Mastery - 3.61[p&lt;0.0005]</td>
<td>Mean change on CRQ score 5.84 [p&lt;0.0001]</td>
<td>Pre 41/55 (74%) v. Post 25/42 (60%) overall 18[6-76] elective 16[6-76] urgent 33[16-56]</td>
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<td>Bousamra</td>
<td>3/45 hospital (7%) 2/42 home (5%) overall 9%</td>
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<td></td>
<td>Continuous; Pre 18/45 (40%) Post 3/37 (8%) On exertion; Pre 9/45 (20%) Post 13/37 (35%) Overall; Pre 60% Post 43%</td>
<td>16</td>
</tr>
<tr>
<td>Cooper</td>
<td>6/150 &lt;90d. (4%) 4/144 ≥90 d. (3%) overall 7%</td>
<td>SF36 n = 108 compared with 1 year ago; 78% much better 20% somewhat better 1% about the same 1% somewhat worse 0% much worse NHP areas where significant improvement occurred [p&lt;0.05] at 6months; physical mobility energy vitality Areas of general improvement (not statistically significant) emotional reaction job or work</td>
<td>MRC score pre 2.8 v. post 1.2 Mahler Index pre 0.83 v. post 2.2</td>
<td>6 months; Continuous; Pre 52% v. Post 16% [p&lt;0.001] Overall; Pre 92% v. Post 44% [p&lt;0.001] 1 year Continuous; Pre 58% v. Post 16% Overall; Pre 92% v. Post 51% 2 years Continuous; Pre 26% v. Post 0% Overall; Pre 84% v. Post 32%</td>
<td>13.5 (median 10) Last 50 cases - 10 (median 7)</td>
</tr>
<tr>
<td>Name</td>
<td>Group</td>
<td>Description</td>
<td>Improvement %</td>
<td>p-value</td>
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<tr>
<td>Cordova</td>
<td>0/25</td>
<td>Mean Sickness Impact Profile scores for 76%</td>
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<td>Pre 7 Post 18 p&lt;0.0002</td>
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<td>Physical scores 4 v. 13 p&lt;0.008</td>
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<td>Psychosocial scores 4 v. 11 p&lt;0.02</td>
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<tr>
<td>Criner</td>
<td>0/3</td>
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<tr>
<td>Daniel</td>
<td>1/17</td>
<td>Day 12 (6%) expressed a marked improvement</td>
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<td>17% somewhat better</td>
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<td>4% worse</td>
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<td>Eugene</td>
<td>1/44</td>
<td>Day 15 (2%) reported a subjective improvement</td>
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<td>2/43 days 40&amp;50 (5%)</td>
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<td>2/41 days 46&amp;90 (5%)</td>
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<td>3/39 &lt;9 m. (8%)</td>
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<td>4/36 &lt;2 y. (11%)</td>
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<td>Overall 22/28 (78.6%) reported a subjective improvement</td>
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<td>22/28 &lt;9 m. (8%)</td>
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<td>4/36 &lt;2 y. (11%)</td>
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<tr>
<td>Eugene</td>
<td>0/28</td>
<td>Hospital (11%)</td>
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<td>22/28 (78.6%) reported a subjective improvement</td>
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<td>22/28 &lt;9 m. (8%)</td>
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<td>4/36 &lt;2 y. (11%)</td>
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<tr>
<td>Keller</td>
<td>0/25</td>
<td>BD TDI functional impairment mean increase from 1.0 (SD 6.3) to 1.72 (SD 0.7)</td>
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<td>Magnitude of effort mean increase mean increase from 1.16 (SD 0.54) to 2.12 (SD 0.8)</td>
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<td>Magnitude of task mean increase mean increase from 1.20 (SD 0.57) to 2.28 (SD 0.7)</td>
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<td>Mean transitional focus score</td>
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<td>Median 7 days</td>
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</table>
### LVRS for COPD

<table>
<thead>
<tr>
<th>Study</th>
<th>Follow-Up</th>
<th>Overall (5%)</th>
<th>MMRC</th>
<th>Patients</th>
<th>BDI</th>
<th>TDI</th>
<th>Borg</th>
<th>Borg</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Kotloff</td>
<td>5/80 &lt; 30 d. (6%)</td>
<td>6/75 &gt; 30 d. (8%)</td>
<td>11/80 &gt; overall (14%)</td>
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<tr>
<td>Kotloff</td>
<td>1/40 &lt; 30 d. (2%)</td>
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<tr>
<td>Little</td>
<td>3/55 overall (5%)</td>
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<tr>
<td>McKenna</td>
<td>5/166 &lt; 30 d. (3%)</td>
<td>14/166 &gt; 30 d. to 1 y. (8%)</td>
<td>17/166 overall (10%)</td>
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<tr>
<td>Miller</td>
<td>3/53 hospital (6%)</td>
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<td>Sciurbia</td>
<td>0/20</td>
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<td>Snell</td>
<td>1/20 day 28 (5%)</td>
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<tr>
<td>Stammerberger</td>
<td>0/42 &lt;30days</td>
<td>3/40 &gt; 30days (7%)</td>
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<tr>
<td>Zenati</td>
<td>0/35</td>
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</table>

(overall) 6.12 (SD 2) from BDI of 3.36 (SD 1.47)
Appendix IX

Probability Estimates for Decision Tree Chance Nodes

<table>
<thead>
<tr>
<th>Options</th>
<th>Probability Estimate</th>
<th>Cumulative Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVRS/early death v. survival</td>
<td>0.03 (v. 0.97)</td>
<td>0.03</td>
</tr>
<tr>
<td>LVRS/late death v. survival</td>
<td>0.1 (v. 0.9)</td>
<td>0.097</td>
</tr>
<tr>
<td>LVRS/survive/improvement</td>
<td>0.70</td>
<td>0.611</td>
</tr>
<tr>
<td>LVRS/survive/no improvement</td>
<td>0.30</td>
<td>0.262</td>
</tr>
<tr>
<td>No LVRS/early death v. survival</td>
<td>0 (v. 1)</td>
<td>0</td>
</tr>
<tr>
<td>No LVRS/late death v. survival</td>
<td>0.4 (v. 0.6)</td>
<td>0.4</td>
</tr>
<tr>
<td>No LVRS/survive/improvement</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>No LVRS/survive/no improvement</td>
<td>1</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Mortality rates
Mortality rates for the intervention were obtained from the included studies. The IQR for early mortality (<30 days or hospital deaths) was 0-6%, and for late mortality (≥30 days or home deaths) was 1-8%.

The annual mortality rate for a population with a given FEV$_1$ of <0.75 litre has been estimated as 30%, and for a population with an FEV$_1$ <30% of predicted as around 10%, which declines rapidly with age. For example, a patient aged < 60 with an FEV$_1$ 40-49% of predicted (Stage II COPD) has a predicted mortality of around 25%. (Advanced age is, however, currently a contra-indication for LVRS.) A conservative estimate of the probability of death in 1 year without the intervention is thus around 0.2, or 0.4 over 2 years.

The probability of early death for patients not undergoing the procedure is clearly 0, and the natural history of COPD is such that all patients will continue to decline making the probability of improvement without the intervention also 0.

Subjective Improvements
Estimates for the probabilities of improvement were obtained from those included studies which measured subjective improvement in some way and from objective data on supplemental oxygen use.

Cooper recorded data using the SF36 collected data on 108 patients of whom, compared with 1 year ago;
78% were much better
20% were somewhat better
1% were about the same
1% were somewhat worse
0% were much worse

---


In the study by Daniel 79% expressed a marked improvement, 17% were somewhat better and 4% were worse.

Around 66% of those requiring oxygen either on exertion or continuously did not require it after the procedure

A conservative estimate of the probability of improvement after the intervention is probably somewhere around 0.7.

The calculation of the cumulative probabilities derived from the decision model for all outcomes is outlined below.

**Cumulative Probabilities as derived from the Decision Tree.**

1. LVRS

<table>
<thead>
<tr>
<th>Product</th>
<th>Probability of early death</th>
<th>Probability of late death</th>
<th>Probability of outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.03</td>
<td>0.03</td>
<td>0.1</td>
<td>early death</td>
</tr>
<tr>
<td>0.097</td>
<td>0.97</td>
<td>0.9</td>
<td>late death</td>
</tr>
<tr>
<td>0.611</td>
<td>0.97</td>
<td>0.7</td>
<td>improvement</td>
</tr>
<tr>
<td>0.262</td>
<td>0.97</td>
<td>0.3</td>
<td>no improvement</td>
</tr>
</tbody>
</table>

2. Medical Management

<table>
<thead>
<tr>
<th>Product</th>
<th>Probability of early death</th>
<th>Probability of late death</th>
<th>Probability of outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>early death</td>
</tr>
<tr>
<td>0.4</td>
<td>1</td>
<td>0.4</td>
<td>late death</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0.6</td>
<td>improvement</td>
</tr>
<tr>
<td>0.6</td>
<td>1</td>
<td>0.6</td>
<td>no improvement</td>
</tr>
</tbody>
</table>
Appendix X

Utility Analysis

EQ-5D
No good quality data on quality of life based on the EQ-5D was identified. Unpublished data from a small pilot study of the effectiveness of LVRS suggests that typical candidates for the operation will have a starting EQ-5D of around 37 and a post-operative EQ-5D of between 64 and 88. Given the limitations of this study and supporting information (outlined below) obtained from other relevant studies, the point estimates for EQ-5D were taken as 40 pre-operatively and 70 post-operatively. Patients who got worse either post-operatively or through general deterioration were assigned a utility score of 30. Other data from this study cross-checked against the results of the review suggested that the populations were similar.

Staging and LVRS
The table below summarises the basis for the American Thoracic Society system for COPD.

American Thoracic Society staging system for COPD

| Stage | FEV₁ of |%
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage I</td>
<td>&gt;49% of predicted</td>
<td></td>
</tr>
<tr>
<td>Stage II</td>
<td>35-49% of predicted</td>
<td></td>
</tr>
<tr>
<td>Stage III</td>
<td>&lt;35% of predicted</td>
<td></td>
</tr>
</tbody>
</table>

The results of the FEV₁ for the included studies suggests that most patients eligible for LVRS can be crudely classified as having Stage III COPD (mean FEV₁ 26% of predicted) and will move post-operatively to Stage II (mean FEV₁ 37% of predicted). Although this information was used partially as the basis for the utility estimates, its limitations, particularly in relation to the poor correlation between physiological and functional outcomes, should be borne in mind (see text of report).

SGRQ and EQ-5D
The table below summarises the SGRQ scores and FEV₁ data for studies which collected data on both outcomes. In addition, results linking EQ-5D data with FEV₁ data or SGRQ data are also presented. The mean SGRQ score for Stage II COPD was 53 (±9). For ease of analysis the mean SGRQ score for Stage II (post-operative patients) was assumed to be around 50. Jones and colleagues have estimated that an intervention which is moderately or very effective will results in an 8 - 12 point change in SGRQ score. Donald and colleagues have shown that a change in 6MWD

---


of 48 metres is equivalent to a clinical improvement where patients described themselves as “a little bit better”. Given that the mean improvement in the included studies was 80 metres, it can be assumed that the intervention is moderately effective. This would therefore bring about a change in SGRQ of around 10 points. Using this information and that from the table, the SGRQ of Stage III COPD (pre-operative patients) is assumed to be around 60. Additional, unpublished data suggests that patients with an SGRQ of 78 will have an EQ-5D score of 56, and in the study by Harper and colleagues an SGRQ of 65 equates with a EQ-5D of 53. Based on this Stage III patients with a SGRQ of around 60 are assumed to have an EQ-5D of 50. Stage II patients can be assumed to have an EQ-5D of 60.


Summary of SGRQ and EQ-5D scores and FEV\textsubscript{1} data by COPD stage for identified studies which collected data on both outcomes.

<table>
<thead>
<tr>
<th>Study</th>
<th>Mean FEV\textsubscript{1}</th>
<th>SGRQ</th>
<th>EQ-5D</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stage I &gt;49%</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ferrer</td>
<td>n/a</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td><strong>Stage II 35-49%</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wedzicha</td>
<td>36%</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>Osman</td>
<td>39%</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>Okubadejo</td>
<td>42%</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>Eisery</td>
<td>46%</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>Harper</td>
<td>47%</td>
<td>65</td>
<td>52.4</td>
</tr>
<tr>
<td>Ferrer\textsuperscript{a}</td>
<td>n/a</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>Wildman</td>
<td></td>
<td>77.7</td>
<td>56.0</td>
</tr>
<tr>
<td><strong>Stage III &lt;35%</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ferrer\textsuperscript{a}</td>
<td></td>
<td>55</td>
<td></td>
</tr>
</tbody>
</table>

The table below summarises the utilities assigned to each of the key outcomes in the model for the SGRQ and the EQOL.

Summary of utility estimates for key outcomes in the Decision Model.

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Stage</th>
<th>SGRQ</th>
<th>EQOL</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVRS/survive/improvement</td>
<td>II</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td>LVRS/survive/ no improvement/worse</td>
<td>III</td>
<td>60</td>
<td>40/30</td>
</tr>
<tr>
<td>LVRS/early mortality</td>
<td>n/a</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>LVRS/die late</td>
<td>n/a</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>no LVRS/die</td>
<td>n/a</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>no LVRS/survive/improvement</td>
<td>II</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td>no LVRS/survive/no improvement</td>
<td>III</td>
<td>60</td>
<td>40</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Ferrer M, Alonso J, Morera J et.al. Chronic obstructive pulmonary disease stage and health-related quality of life. Annals of Internal Medicine 1997; 127(12):1072-1079

\textsuperscript{b} Wedzicha JA, Bestall JC, Garrod R et.al. Randomized controlled trial of pulmonary rehabilitation in severe chronic obstructive pulmonary disease patients, stratified with the MRC dyspnoea scale. European Respiratory Journal 1998;12:363-369

\textsuperscript{c} Osman IM, Godden DJ, Friend JA and Douglas JG. Quality of life and hospital re-admission in patients with chronic obstructive pulmonary disease. Thorax 1997;52(1):67-71

\textsuperscript{d} Okubadejo AA, Jones PW and Wedzicha JA. Quality of life in patients with chronic obstructive pulmonary disease and severe hypoxaemia. Thorax 1996; 51:44-47


\textsuperscript{f} Harper R, Brazier JE, Waterhouse JC et.al. Comparison of outcome measures for patients with chronic obstructive pulmonary disease (COPD) in an outpatient setting. Thorax 1997;52:879-887

\textsuperscript{g} Wildman MJ, Groves J Lenaghan J et.al. Hospital mortality, functional capacity, health related quality of life and acute physiology in 242 patients hospitalised with exacerbations of chronic obstructive pulmonary disease. Unpublished.
Calculation of QALY's using the EQ-5D

1. LVRS/survive/improvement
   - 1 week @ 0.3 = 0.005769
   - 1 week @ 0.4 = 0.007692
   - 1 week @ 0.5 = 0.009615
   - 1 week @ 0.6 = 0.011538
   - 100 weeks @ 0.7 = 1.346154
   - Total = 1.380769

2. LVRS/survive/no improvement
   - 1 week @ 0.3 = 0.005769
   - 103 weeks @ 0.4 = 0.792308
   - Total = 0.798077
   - OR
   - 104 weeks @ 0.3 = 0.6

3. LVRS/early death
   - 2 weeks @ 0.3 = 0.011538
   - OR
   - 1 week @ 0.3 = 0.005769
   - 1 week @ 0.4 = 0.007692
   - Total = 0.013462

4. LVRS/late death
   - 1 week @ 0.3 = 0.005769
   - 1 week @ 0.4 = 0.007692
   - 1 week @ 0.5 = 0.009615
   - 1 week @ 0.6 = 0.011538
   - 48 weeks @ 0.7 = 0.646154
   - Total = 0.680769
   - OR
   - 1 week @ 0.3 = 0.005692
   - 51 weeks @ 0.4 = 0.392308
   - Total = 0.398077
   - OR
   - 52 weeks @ 0.3 = 0.3

5. no/LVRS/early death
   - 2 weeks @ 0.4 = 0.015385

6. no/LVRS/late death
   - 52 weeks @ 0.4 = 0.4
   - OR
   - 52 weeks @ 0.3 = 0.3

7. no LVRS/survive/improve
   - 1 week @ 0.4 = 0.007692
   - 1 weeks @ 0.5 = 0.009615
   - 1 week @ 0.6 = 0.011538
   - 101 weeks @ 0.7 = 1.359615
   - Total = 1.388462

8. no LVRS/survive/no improvement
   - 104 weeks @ 0.4 = 0.8
   - OR
   - 104 weeks @ 0.3 = 0.6
Appendix XI

Cost Analysis

A full breakdown of individual unit costs and their sources, is presented in the table below. These unit costs form the basis of the cost estimates for different events and treatment options in the management of COPD.

<table>
<thead>
<tr>
<th>UNIT</th>
<th>Number/Price</th>
<th>COST (£'s)</th>
<th>SOURCE</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVRS</td>
<td>total per case</td>
<td>6200</td>
<td>Shropshire HA</td>
<td>1998</td>
</tr>
<tr>
<td>District Nurse</td>
<td>daily visit for 2 weeks @ £35 each</td>
<td>490</td>
<td>PSSRU</td>
<td>1997</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>6690</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maximum Medical Management (MMM) (all over 1 year)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventolin Inhaler</td>
<td>2 per month @ £2.30</td>
<td>55</td>
<td>MIMS (COPD guidelines, validated by local practitioner)</td>
<td>1998</td>
</tr>
<tr>
<td>Atrovent Inhaler</td>
<td>2 per month @ £4.21</td>
<td>101</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phyllocontin Continus</td>
<td>2 per month @ £3.29</td>
<td>79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Becloforte Inhaler</td>
<td>2 per month @ £23.10</td>
<td>554</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serevent Inhaler</td>
<td>2 per month @ £28.60</td>
<td>686</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total drug costs</td>
<td></td>
<td>1475</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Oxygen Concentrator                             | 15 hours per day         | 800        | Devilbiss Healthcare | 1998     |
| GP visits                                       | 1 per month @ 30 each    | 360        | PSSRU                 | 1997     |
| Outpatient Appointment                          | 2 per year @ £52 each    | 104        | PSSRU                 | 1997     |
| Total                                          |                          | 2739       |              |          |

| Pulmonary Rehabilitation |                          | 500        | estimate from existing research validated by local practitioner | 1998     |

| Emergency Admission                           |                          |            |              |          |
| GP visit                                      | (at 1 per year)          |            | PSSRU and Acute Care 96 | 1996/97  |
| Ambulance Transfer                            | 1 @ £163                 | 30         |              |          |
| A/E attendance                                | 1 @ £178                 | 163        |              |          |
| Inpatient Days                                | 10 @ 195                 | 178        |              |          |
| Total                                         |                          | 1950       |              |          |
| Death                                         |                          | 2321       | rough equivalent to emergency admission. | 1996/97  |

---

* Netten A and Dennett J. Unit costs of health and social care. PSSRU, University of Kent at Canterbury, 1997


* Tiep BL. Disease management of COPD with pulmonary rehabilitation. Chest 1997;112(6):1630-56


The table below summarises the cost estimates over one year for the main treatment options and events which might occur in a population of people with severe COPD, derived from the unit costs outlined above.

**Cost estimates for the main treatment options and events.**

<table>
<thead>
<tr>
<th>Treatment/event</th>
<th>Cost Estimate</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVRS</td>
<td>£6690</td>
<td></td>
</tr>
<tr>
<td>MMM - Maximum Medical Management</td>
<td>£2739</td>
<td></td>
</tr>
<tr>
<td>RMM - Reduced Medical Management</td>
<td>£1960</td>
<td>MMM minus 50% steroids, 50% O²</td>
</tr>
<tr>
<td>PR - Pulmonary Rehabilitation</td>
<td>£500</td>
<td>one course</td>
</tr>
<tr>
<td>EA - Emergency Admission</td>
<td>£2321</td>
<td></td>
</tr>
<tr>
<td>Death</td>
<td>£2321</td>
<td>Except early post-LVRS deaths</td>
</tr>
</tbody>
</table>

The total costs for each outcome in the decision tree over 2 years were estimated using different combinations of treatment options and events, generating best and worst case estimates where appropriate. These calculations are presented below.

**Calculation of cost estimates for main outcomes.**

1. LVRS/early death
   - Year 1
     - LVRS 6690
     - PRx1 500
     - Total 7190

2. LVRS/late death
   - Year 1
     - LVRS 6690
     - PRx2 1000
     - MMM 2739
     - Death 2321
     - Total 12750
   - OR
     - Year 1
       - LVRS 6690
       - PRx2 1000
       - RMM 1960
       - Death 2321
       - Total 11971

3. LVRS/survive/improvement
   - Year 1
     - LVRS 6690
     - PRx2 1000
     - RMM 1960
     - Year 2
       - RMM 1960
       - PRx1 500
       - Total 12110
   - OR
     - Year 1
       - LVRS 6690
       - PRx2 1000
       - MMM 2739
     - Year 2
       - MMM 2739
       - PR x1 500
       - Total 13668
4. LVRS/survive/no improvement  
   Year 1  
   LVRS  6690  
   PRx2  1000  
   MMM  2739  
   Year 2  
   MMM  2739  
   PRx1  500  
   EAx1  2321  
   **15989**  

5. no LVRS/early death  
   Year 1  
   Death  **2321**  

6. no LVRS/late death  
   Year 1  
   PRx1  500  
   MMM  2739  
   Death  2321  
   **5560**  

7. no LVRS/survive/improvement  
   Year 1  
   PRx1  500  
   RMM  1960  
   Year 2  
   PRx1  500  
   RMM  1960  
   **4920**  

8. no LVRS/survive/no improvement  
   Year 1  
   PRx1  500  
   MMM  2739  
   EA x1  2321  
   Year 2  
   PRx1  500  
   MMM  2739  
   EA  2321  
   **11120**
Appendix XII

Cost-Utility Analysis

Total expected cost of LVRS: £13041
Total expected QALY’s for LVRS: 1.09 EQ-5D

Total expected cost of Medical Management: £8896
Total expected QALY’s for Medical Management: 0.64 EQ-5D

Thus;

Additional cost of LVRS over Medical Management: £4145 without carer
Additional QALY’s gained: 0.45

Additional cost per QALY gained: £4145/0.45 = £9211
Appendix XIII

Sensitivity Analysis

IHQL
No data was available which facilitated estimates of IHQL for COPD patients. Estimates in this instance were made using the 3-dimensional classification based on knowledge about patients before and after LVRS obtained from descriptions in the literature and informal discussion with and observation of individual cases. The key sources were;

A review of LVRS described a group of patients who pre-operatively were dependent on others for all their activities of daily living, the majority of which were required continuous supplemental oxygen.a

Similarly, Cooper describes a pre-operative population who are unable to shower or bathe, get dressed alone or leave the house without great difficulty. Again, most require continuous supplemental oxygen.b

A patient who had undergone the operation at a local thoracic surgery unit described his pre-operative state as being very similar to those above. In addition, he described troublesome pain and stiffness in his limbs and chest. One year post-operatively he was able to perform all his own activities of daily living, no longer required supplemental oxygen and even undertook light DIY and gardening jobs around the house.c

The information within the included studies for dyspnoea and supplemental oxygen are useful indicators for improvements in quality of life after the intervention. Interpretation of the dyspnoea results indicates that in all series patients experienced significant improvements in their degree of dyspnoea. The mean post-operative score for the MMRC scale of 1.8, places patients almost midway on a scale where 0 equates to dyspnoea only on strenuous exertion and 4 equates to life-limiting dyspnoea which prevents the patient from leaving the house or dressing. Most patients scored between 3 and 4 before the intervention. This implies considerable improvements in quality of life suggesting that post-operatively the majority of patients would be able handle their own activities of daily living, get out and about more easily and even undertake light jobs around house and garden.

The results for supplemental oxygen present a slightly conflicting picture. In those studies which collected this data, around 50% of cases still required supplemental oxygen. For about 20% this was required continuously and for the other 30%, only on exertion. This data, suggests that relative improvements in dyspnoea may

a Lavell D and Higgins V, Lung Surgery. When less is more. Registered Nurse 1995;July:40-45
c Personal communication
overestimate absolute improvements. Nevertheless it is the relative improvements which are probably the most important as far as quality of life improvements are concerned.

Finally, the relationship between anxiety and depression and COPD is well-documented. SGRQ scores of around 50 are associated with clinically significant depression.

On this basis, using the IHQL 3-dimensional classification, typical health states for baseline, improved and deteriorated patients might be as follows;

**Baseline (Stage III COPD) - 0.648 (D6P3E3)**
Disability - Confined to chair, therefore can only get out with assistance. Can only do the lightest of tasks e.g. switch on the TV. Can feed self, but needs help with all other self care activities. Very limited ability to perform role functions.
Discomfort (Physical) - Moderate pain.  
Distress (Emotional) - Moderate distress: anxious and depressed most of the time, but happy and relaxed some of the time.

**Deterioration - 0.498 (D7P3E4)**
Disability - Confined to bed. Needs help with all self-care activities. Minimal ability to perform role functions.
Discomfort (Physical) - Moderate pain.  
Distress (Emotional) - Moderate distress: anxious and depressed most of the time, but happy and relaxed some of the time.

**Post-operative (Stage II COPD) - 0.861 (D4P2E2)**
Disability - Able to get around house and do lighter physical work. Some difficulty in getting around community due to weakness or other physical limitations. Can perform all self-care activities. Ability to perform role functions limited. 
Discomfort (Physical) - Slight pain.  
Distress (Emotional) - Slight distress: happy and relaxed most of the time, but anxious and depressed some of the time.

---

### Calculation of QALY's using the IHQL

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Time Period</th>
<th>Probability</th>
<th>QALY Calculation</th>
<th>Total QALY</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVRS/survive/improvement</td>
<td>1 week @ 0.50</td>
<td>= 0.009615</td>
<td></td>
<td>0.009615</td>
</tr>
<tr>
<td>LVRS/survive/improvement</td>
<td>1 week @ 0.65</td>
<td>= 0.0125</td>
<td></td>
<td>0.0125</td>
</tr>
<tr>
<td>LVRS/survive/improvement</td>
<td>102 weeks @ 0.86</td>
<td>= 1.686923</td>
<td></td>
<td>1.686923</td>
</tr>
<tr>
<td>LVRS/survive/improvement</td>
<td>Total</td>
<td></td>
<td></td>
<td><strong>1.709038</strong></td>
</tr>
</tbody>
</table>

| LVRS/survive/no improvement           | 1 week @ 0.50| = 0.009615  |                  | 0.009615        |
| LVRS/survive/no improvement           | 103 weeks @ 0.65 | = 1.2875    |                  | 1.2875          |
| LVRS/survive/no improvement           | Total        |             |                  | **1.297115**    |
| LVRS/survive/no improvement           | OR           |             |                  | **1.0**         |

| LVRS/early death                     | 2 weeks @ 0.65| = 0.025     |                  | 0.025           |
| LVRS/early death                     | OR           |             |                  |                 |
| LVRS/early death                     | 1 week @ 0.50| = 0.009615  |                  | 0.009615        |
| LVRS/early death                     | 1 week @ 0.65| = 0.0125    |                  | 0.0125          |
| LVRS/early death                     | Total        |             |                  | **0.022115**    |

| LVRS/late death                      | 1 week @ 0.50| = 0.009615  |                  | 0.009615        |
| LVRS/late death                      | 1 week @ 0.65| = 0.0125    |                  | 0.0125          |
| LVRS/late death                      | 50 weeks @ 0.86 | = 0.826923 |                  | 0.826923        |
| LVRS/late death                      | Total        |             |                  | **0.849038**    |
| LVRS/late death                      | OR           |             |                  |                 |
| LVRS/late death                      | 1 week @ 0.50| = 0.009615  |                  | 0.009615        |
| LVRS/late death                      | 51 weeks @ 0.65 | = 0.6375   |                  | 0.6375          |
| LVRS/late death                      | Total        |             |                  | **0.647115**    |
| LVRS/late death                      | OR           |             |                  | **0.5**         |
| LVRS/late death                      | 52 weeks @ 0.50 | = 0.5     |                  | **0.5**         |

| no/LVRS/early death                  | 2 weeks @ 0.65| = 0.025     |                  | 0.025           |

| no/LVRS/late death                   | 52 weeks @ 0.65 | = 0.65    |                  | **0.65**        |
| no/LVRS/late death                   | OR           |             |                  |                 |
| no/LVRS/late death                   | 52 weeks @ 0.50 | = 0.5     |                  | **0.5**         |

| no LVRS/survive/improve              | 2 weeks @ 0.65| = 0.025     |                  | 0.025           |
| no LVRS/survive/improve              | 102 weeks @ 0.86 | = 1.686923 |                  | 1.686923        |
| no LVRS/survive/improve              | Total        |             |                  | **1.711923**    |

| no LVRS/survive/no improvement       | 104 weeks @ 0.65 | = 1.3     |                  | **1.3**         |
| no LVRS/survive/no improvement       | OR           |             |                  | **1.0**         |

OR = Original Record
Carer costs
The cost of the carer represents an attempt to quantify and incorporate the costs of "care". It acknowledged that in many instances this will not be quantifiable in terms of monetary costs to the NHS, and often these costs will be borne by other sectors.

<table>
<thead>
<tr>
<th>Carer (untrained)</th>
<th>1 hour per day @ £8 per hour</th>
<th>2920</th>
<th>PSSRU</th>
<th>1997</th>
</tr>
</thead>
</table>

Incorporating carer costs into the model gives a total cost for Maximum Medical Management of £5695. The costs for each outcome are as for those in Appendix XI substituting this cost (£5695) for that of Maximum Medical Management without carer costs (£2739).

Cost Utility Analysis

| Total expected cost of LVRS: | £14857 with carer | £13041 without carer |
| Total expected QALY’s for LVRS: | 1.09 EQ-5D | 1.44 IHQL |
| Total expected cost of Medical Management: | £13568 with carer | £8896 without carer |
| Total expected QALY’s for Medical Management: | 0.64 EQ-5D | 1.04 IHQL |

Thus;

Additional cost of LVRS over Medical Management: £1289 with carer | £4145 without carer
Additional QALY’s gained: | 0.45 | 0.4
Additional cost per QALY gained: | £1289/0.45 = £2864 | £4145/0.45 = £9211 | £4145/0.4 = £10362

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Netten A and Dennett J  Unit costs of health and social care.  PSSRU, University of Kent at Canterbury, 1997
Appendix XIV

List of Abbreviations

LVRS  Lung Volume Reduction Surgery
COPD  Chronic Obstructive Pulmonary Disease
EQ-5D  EuroQol
QALY  Quality Adjusted Life Year
BTS  British Thoracic Society
FEV₁  Forced Expiratory Volume in 1 second
CO₂  Carbon Dioxide
QOL  Quality of Life
AHCPR  Agency for Health Care Policy and Research
ARIF  Aggressive Research Intelligence Facility
IHQL  Index of Health Related Quality of Life
IQR  Inter-quartile Range
VATS  Video-assisted Thoracic Surgery
MS  Median Sternotomy
6MWD  6 Minute Walking Distance
CRQ  Chronic Respiratory Disease Questionnaire
SF36  Short Form 36
SIP  Sickness Impact Profile
MMRC  Modified Medical Research Council
BDI  Baseline Dyspnoea Index
TDI  Transitional Dyspnoea Index
BFS  Baseline Focal Score
TDS  Transitional Focal Score
SMD  Standardised Mean Difference
SGRQ  St. George's Respiratory Disease Questionnaire
VC  Slow Vital Capacity
FRC  Functional Residual Capacity
TLCO  Diffusing Capacity for Carbon Monoxide or Gas Transfer Factor