Journal of Thrombosis and Haemostasis, **8**: 523–532 DOI: 10.1111/j.1538-7836.2009.03726.x

ORIGINAL ARTICLE

Quality of life after pulmonary embolism: validation of the PEmb-QoL Questionnaire

F. A. KLOK,*[1] D. M. COHN,†[1] S. MIDDELDORP,*‡ M. SCHARLOO,§ H. R. BÜLLER,† K. W. VAN KRALINGEN,¶ A. A. KAPTEIN§ and M. V. HUISMAN*

**Section of Vascular Medicine, Department of General Internal Medicine-Endocrinology, Leiden University Medical Center, Leiden; †Department of Vascular Medicine, Academic Medical Center, Amsterdam; ‡Department of Clinical Epidemiology, Leiden University Medical Center, Leiden; §Psychology Unit, Leiden University Medical Center, Leiden; and ¶Department of Pulmonary Medicine, Leiden University Medical Center, Leiden, the Netherlands*

To cite this article: Klok FA, Cohn DM, Middeldorp S, Scharloo M, Büller HR, van Kralingen KW, Kaptein AA, Huisman MV. Quality of life after pulmonary embolism: validation of the PEmb-QoL Questionnaire. *J Thromb Haemost* 2010; **8**: 523–32.

Summary. *Background:* Even though quality of life (QoL) has become a key component of medical care, there is no instrument available that specifically measures QoL after pulmonary embolism (PE). Recently, the Pulmonary Embolism Quality of Life (PEmb-QoL) Questionnaire has been developed to address this gap. *Objective:* To evaluate the validity of the PEmb-QoL questionnaire. *Methods:* We distributed the PEmb-QoL questionnaire and the Short Form-36 (SF-36) questionnaire twice among consecutive subjects with a history of objectively confirmed acute PE. Internal consistency reliability, test-retest reliability, convergent validity and criterion validity, and correlations between the PEmb-QoL and clinical patient characteristics were assessed using standard-scale construction techniques. *Results:* Ninety participants completed the questionnaires twice. Internal consistency was adequate (Cronbach's α 0.62–0.94), as well as test-retest reliability (intra-class correlation coefficients: 0.78–0.94). Furthermore, correlation between the PEmb-QoL questionnaire and the SF-36 questionnaire supported convergent validity. Age, obesity, cardiopulmonary comorbidity, centrally located PE and a family history of venous thromboembolism were shown to be independent determinants of disease-specific QoL. *Conclusion:* The PEmb-QoL questionnaire is a reliable instrument to specifically assess QoL following PE, which is helpful in the identification of patients with decreased QoL following acute PE.

Keywords: PEmb-QoL, pulmonary embolism, quality of life, questionnaire.

Correspondence: Frederikus A. Klok, LUMC, Albinusdreef 2, Mailbox 9600, 2300 RC Leiden, the Netherlands.
Tel.: +3171 5262085, fax: +3171 5248140.
E-mail: F.A.Klok@LUMC.nl

[1]Both authors contributed equally.

Received 20 August 2009, accepted 4 December 2009

Introduction

Pulmonary embolism (PE) is a common disorder characterized by the obstruction of the pulmonary arterial tree by floating thrombi predominantly originating from the leg or pelvic veins [1]. Although PE has traditionally been considered to be an acute disease, the long-term natural course in patients surviving the acute thromboembolic event can be complicated by recurrent episodes of PE or deep vein thrombosis, bleeding complications caused by anticoagulant treatment, arterial cardiovascular events and in rare cases by chronic thromboembolic pulmonary hypertension (CTEPH) [1–4]. CTEPH may present as fatigue, limited exercise tolerance or shortness of breath and affected approximately 4% of PE patients within 2 years following the initial event in one study [3]. Moreover, patients often have residual dyspnea complaints years after the acute thromboembolic event [5].

Quality of life (QoL) has become an important outcome aspect of medical care. QoL can be assessed by generic or disease-specific questionnaires. The latter are more sensitive than generic questionnaires to detect and quantify small changes that are relevant to patients. Several disease-specific QoL instruments have been developed for deep venous thrombosis (DVT), a condition closely related to PE and considered a manifestation of the same disease entity [6–10]. Furthermore, there are several specific questionnaires for symptoms of the respiratory tract, such as the Cambridge Pulmonary Hypertension Outcome Review (CAMPHOR) [11] or the Chronic Respiratory Disease Questionnaire (CRQ) [12]. However, because respiratory or other symptoms that affect QoL after PE have never been purposely studied, we have developed a new measure, the Pulmonary Embolism Quality of Life (PEmb-QoL) Questionnaire, based on symptoms as reported by 10 interviewed participants with severe complaints following PE. Details of the development of the PEmb-QoL questionnaire have been described previously in this Journal and the complete questionnaire can be found as an Appendix to this paper [13].

The PEmb-QoL questionnaire was modelled on the quality of life after DVT (VEINES-QOL/Sym) questionnaire [6,7,9]. Both questionnaires assess the frequency of symptoms, the time of day at which the complaints are at their worst, and activities of daily living (ADL), as well as work-related problems. However, the PEmb-QoL questionnaire is distinct from the VEINES-QOL/Sym in the inclusion of pulmonary-specific symptoms, adding questions on limitations in daily physical activities, and extending the number of questions on emotional functioning. Moreover, in order not to lose valuable information, we decided to assess the different areas of limitations as separate dimensions, instead of combining items into two subscales (symptoms and QoL), as is the case in the VEINES-QOL questionnaire. In the present paper, we report results from the validation study that was performed to assess the psychometric and clinical characteristics of the questionnaire.

Methods

Participants

The PEmb-QoL questionnaire in Dutch was distributed among consecutive participants of a large follow-up study of patients with a history of acute PE referred to the Leiden University Medical Center. The inclusion criterion was objectively confirmed PE diagnosed between 1 January 2001 and 1 July 2007. All surviving patients were invited for a control visit in our outpatient clinic. We asked a random, consecutive subsample of 93 participants to complete the PEmb-QoL and Short-Form 36 (SF-36) questionnaires shortly before this visit. After first review, incomplete questionnaires were completed at the study visit. For assessment of test-retest reliability, participants were instructed to complete both questionnaires for a second time (within a 2-week period) at home shortly after the visit and return these by mail. Incomplete returned questionnaires were completed by the patients following contact by telephone. We excluded participants with language barriers who could not complete the questionnaires in Dutch. The study protocol was approved by the Medical Review Ethics Committee of the Leiden University Medical Center and all patients provided written informed consent.

Measures

PEmb-QoL questionnaire We applied the disease-specific PEmb-QoL questionnaire, which we developed to assess QoL in patients with PE [13]. The original version of this questionnaire was developed in Dutch. For the creation of the English version (see Appendix), the Dutch version was independently translated by two native English speakers and subsequently back-translated by a third native English speaker. The PEmb-QoL questionnaire contains six dimensions that had been created based on the contents of the items: frequency of complaints, ADL limitations, work-related problems, social limitations, intensity of complaints and emotional complaints. Higher scores indicate worse outcome.

SF-36 questionnaire The SF-36 questionnaire is a generic QoL measure containing eight scales (physical functioning, social functioning, physical role functioning, emotional role functioning, mental health, vitality, bodily pain and general health), scoring 0–100, with higher values indicating better health [14]. Two summary scores are created by combining scales into a physical health summary score and mental health summary score.

Outcome measures

We expected that the PEmb-QoL dimensions frequency of complaints, ADL limitations, work-related problems, social limitations and intensity of complaints would have the higher correlations with the physical health summary score of the SF-36, whereas emotional complaints would have a higher correlation with the mental health summary score. Finally, we did not expect that patient characteristics at the time of the acute PE would be important determinants of the results of the PEmb-Qol, given the results of a previous study [15]. This study showed that QoL after deep vein thrombosis as assessed by the VEINES-QOL and SF-36 was mostly determined by the presence of the post-thrombotic syndrome and less by severity of the acute clinical event, comorbid conditions, sex or age. To test this hypothesis, we assessed the following patient characteristics: age, sex, obesity (body mass index > 30 kg m^{-2}), active malignancy (cancer with ongoing treatment, treatment within the previous 6 months or in the palliative stages), cardiopulmonary comorbidity (clinically relevant obstructive or restrictive pulmonary function impairment, or systolic or diastolic ventricular dysfunction), centrally located PE according to the original radiological reports, family history of venous thromboembolism and the duration of follow-up from the index thromboembolic event to study inclusion.

Therefore, the outcome measures of this analysis were internal consistency reliability (which assesses whether several items that propose to measure the same general construct produce similar scores), test-retest reliability, convergent validity, criterion validity (as assessed by comparing the PEmb-QoL dimensions with the dimensions of the SF-36 disease generic questionnaire) and the association of patient demographics, comorbid conditions and PE characteristics with higher or lower QoL in our patient population.

Statistical analyses

Means and standard deviations were calculated for normally distributed variables. Non-normally distributed variables were expressed in medians with ranges. We performed a factor analysis on the items of the PEmb-QoL with varimax rotation to examine the underlying constructs. Internal consistency reliability was calculated with Cronbach's α [16]. Following the recommendations of DeVellis, internal consistency reliability was considered adequate if Cronbach's α was higher than 0.7 [17]. Test-retest reliability was expressed as intra-class correlation coefficients. We calculated inter-dimension correlations

and criterion validity with bivariate Spearman correlation coefficients. For the assessment of significant predictors of QoL in our patient cohort, backward conditional linear regression analyses with direct entry were performed to identify independent determinants of QoL. A P-value < 0.05 was considered statistically significant.

Results

Patients

The questionnaires were distributed amongst 93 participants, of whom 90 completed the questionnaire after a median period of 38 months (range 10–91 months) following the PE. Three participants (3.2%) were excluded due to inability to complete this questionnaire in Dutch because of language barriers. The number of missing items was very low; however, the exact number could not be calculated as all missing items were completed by the respondents following contact by phone with the researchers. The included participants were 56 ± 14 years old, 44 (47%) were males, 19 (20%) had cardiopulmonary comorbidity, 12 (13%) had active malignancy, 36 (39%) were obese, 31 (33%) were diagnosed with centrally located PE, 6 (6.5%) received invasive treatment for PE and 19 (20%) suffered from recurrent episodes of PE (Table 1).

Scores of the six dimensions of the PEmb-QoL were 1.5 (interquartile range 1.1–2.4; max 5 points) for frequency of complaints, 1.2 (1.0–1.8; max 3 points) for limitations in activities of daily living (ADL), 1.0 (1.0–1.5; max 2 points) for work-related problems, 1.0 (1.0–1.2; max 5 points) for social limitations, 2.0 (1.0–3.0; max 6 points) for intensity of complaints and 1.6 (1.1–2.4; max 6 points; Fig. 1) for emotional complaints. For all dimensions, a score of 1 point designates no complaints.

Psychometric characteristics of the PEmb-QoL questionnaire

Factor analysis (with varimax rotation) supported the underlying dimensions in general, producing six factors that accounted for 72% of the total variance (Table 2). Some items shared several high loadings (such as item 8 and items 9.g and 9.i). Moreover, a small subset of items had higher factor loadings with other dimensions than the dimensions they were originally designated to (1.h, 4.a, 7, 8 and 9.i). Table 3 lists the internal reliabilities of the dimensions, as expressed by Cronbach's α, as well as inter-dimension correlations between the PEmb-QoL dimensions. Internal reliability was high (≥ 0.87) for the dimensions frequency of complaints, ADL limitations, work-related problems and emotional complaints but lower for the dimension intensity of complaints (α = 0.62). We assessed whether deletion of any of the items in the various dimensions could increase the internal reliability of any of the dimensions (and hence whether the PEmb-QoL questionnaire could be abridged). However, deletion of any of the items from the various dimensions did not lead to substantial improvements of the dimensions' internal consistency reliability. The highest correlations between dimensions were found between intensity of complaints and all other dimensions ($0.60 \leq r \leq 0.82$). Except for work-related problems and frequency of complaints ($r = 0.49$), all dimensions were moderately correlated ($0.56 \leq r \leq 0.82$).

Table 1 Demographics of 90 included patients

Male sex (*n*, %)	43 (48)
Age (years ± SD)	56 ± 14
Cardiopulmonary comorbidity (*n*, %)	18 (20)
Active malignancy (*n*, %)	12 (13)
Obesity* (*n*, %)	35 (39)
Centrally located PE (*n*, %)	31 (34)
Invasive treatment for PE† (*n*, %)	6 (6.7)
Recurrent PE (*n*, %)	18 (20)
Time to registration event‡ (range)	3 years and 2 months (10 months–7 years and 7 months)

*Body mass index > 30 kg m^{-2}.
†Thrombolysis, surgery or VCF for first acute PE.
‡Time span between registration acute PE and study inclusion.
PE, pulmonary embolism; *n*, number.

The results of the test-retest analysis are presented in Table 4. Intra-class correlation coefficients for test-retest analysis varied between 0.78 for work-related problems and 0.94 for frequency of complaints.

The results of the criterion validity are reported in Table 5. As expected, the PEmb-QoL dimensions frequency of complaints, ADL limitations, work-related problems, social limitations and intensity of complaints had higher associations with the physical health summary score of the SF-36 questionnaire, whereas emotional complaints were most strongly associated with the mental health summary score. Frequency of complaints was most strongly correlated with vitality ($r = -0.56$), social functioning ($r = -0.55$) and physical functioning ($r = -0.46$). The strongest correlations for ADL limitations were physical functioning ($r = -0.78$), social functioning ($r = -0.61$) and vitality ($r = -0.66$). Work-related problems most strongly correlated with physical role functioning ($r = -0.58$) and physical functioning ($r = -0.53$). The dimension social limitations was correlated with several SF-36 dimensions. We observed strong correlations with physical functioning ($r = -0.54$), social functioning ($r = -0.55$) and vitality ($r = -0.53$). Intensity of complaints was strongly correlated with the same SF-36 dimensions as frequency of complaints (but with higher correlation coefficients). The strongest correlations for emotional complaints were mental health ($r = -0.57$), vitality ($r = -0.69$) and social functioning ($r = -0.60$).

Associations between clinical characteristics and the PEmb-QoL

After multivariate analysis including all patient demographics, comorbid conditions and PE-characteristics, younger age, obesity, cardiopulmonary comorbidity and centrally located PE were shown to be independent predictors for decreased disease-specific QoL (Table 6). Inversely, a family history of

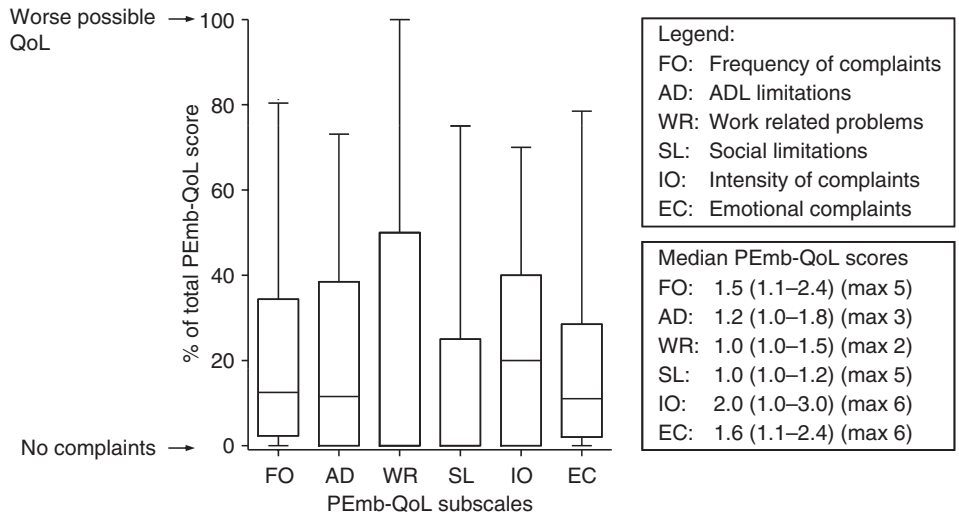

Fig. 1. Results of the PEmb-QoL scores of patients with a history of acute pulmonary embolism. Scores are presented as median with interquartile range. Minimum score for all six subscales was 1, maximum scores are presented between brackets. Higher PEmb-QoL scores are associated with decreased quality of life. ADL, activities of daily living.

venous thromboembolism independently predicted lower intensity of complaints and emotional complaints and also was a predictor of better social function. Markedly, the multivariate models including these independent determinants of QoL predicted the measured QoL in the individual dimensions of the PEmb-QoL only for 5.7–16% (linear regressions' coefficient of determination).

Discussion

The results from this validation study indicate that this newly developed disease-specific health-related QoL instrument, the PEmb-QoL questionnaire, is a valid and reliable instrument to assess QoL following PE. Internal reliability for all dimensions (except intensity of complaints) was adequate and comparable to the reliability of the VEINES-QOL/Sym scales [6]. Test-retest reliability was also adequate. The inter-correlations between the PEmb-QoL dimensions demonstrated logical relationships. Intensity of complaints correlated with a worse outcome in all other dimensions. This was expected as this dimension might actually affect a person's well-being in general. Also, its association with frequency of complaints is high, suggesting these dimensions could be taken together to form one summary score for symptom severity, comparable to the VEINES-QoL/Sym summary score.

We observed a tendency towards small floor and ceiling effects in some of the PEmb-QoL dimensions. This was assumed to be attributable to the time between the events and completion of the questionnaires. Therefore, we expect that other patient samples including those with a more recent event will show less floor or ceiling effects. Furthermore, we observed that work-related problems most strongly correlated with physical role functioning and physical functioning. We hypothesized that this observation is explained by the fact that both dimensions focus on the extent of limitations when performing work or physical exercise. Emotional complaints were more strongly associated with mental health and vitality as compared with emotional role functioning. This is also conceivable, as the wording of the items of this PEmb-QoL dimension closely match the items of the SF-36 dimensions mental health and vitality. Also, the correlation between social limitations and social functioning was (almost) as high as the correlation with physical functioning and vitality. This is a plausible observation as well, because social activities are also influenced by the capability to perform exercises such as climbing stairs or walking a certain distance.

After multivariate analysis, several demographic and symptom factors associated with better or worse health-related QoL were identified. Higher age, obesity and comorbid conditions predicted decreased QoL in our study population. This is to be expected, as these factors have previously been shown to be important determinants of health status in healthy persons and patients suffering from various diseases [15,18,19]. Notably, the presence of family members who have a history of the same condition was associated with improved social status, decreased intensity of complaints and a smaller amount of emotional complaints. We hypothesized that this phenomenon might be attributed to enhanced social support, which is an important aspect of QoL [20,21]. Although we were able to identify several significant determinants of QoL in our patient population, combining these in multivariate prediction models did not result in precise prediction of the QoL for individual patients because our models predicted only 5.7–16% of the variance in PEmb-QoL scores. This observation is in accordance with the result of a previous study, which indicated limited effects of patient demographics and comorbid conditions on the QoL of patients with DVT [15].

Table 2 Rotated component matrix

Pemb-QoL items	Frequency of complaints	ADL limitations	Work-related problems	Social limitations	Intensity of complaints	Emotional complaints
1a	**0.771**	0.230	0.202	−0.095	0.223	0.023
1b	**0.806**	0.172	0.029	0.062	0.115	0.047
1c	**0.608**	0.232	−0.014	−0.044	0.040	0.298
1d	**0.757**	0.154	−0.078	0.062	0.151	0.255
1e	**0.628**	0.195	−0.063	−0.359	0.321	0.083
1f	**0.766**	0.075	0.163	−0.061	−0.042	0.242
1g	**0.772**	0.144	0.101	−0.044	−0.019	0.298
1h	0.267	0.424	0.045	0.000	**0.617**	0.190
2	N.A.					
3	N.A.					
4a	0.200	0.158	−0.049	**−0.779**	−0.029	−0.020
4b	0.239	**0.674**	0.322	0.275	0.166	0.129
4c	0.522	**0.568**	0.273	0.182	0.051	0.129
4d	0.118	**0.601**	0.321	0.098	0.433	0.098
4e	0.186	**0.785**	0.251	0.099	0.142	0.085
4f	0.109	**0.860**	0.121	0.011	0.073	0.188
4g	0.138	**0.757**	0.215	0.073	0.391	0.059
4h	0.122	**0.832**	0.084	0.086	−0.009	0.156
4i	0.104	**0.778**	0.231	0.166	0.083	0.162
4j	0.250	**0.833**	0.184	−0.116	0.164	0.101
4k	0.243	**0.845**	0.054	−0.033	−0.006	0.197
4l	0.224	**0.845**	0.020	−0.002	−0.052	0.228
4m	0.291	**0.696**	−0.057	0.070	−0.155	0.157
5a	0.182	0.463	**0.603**	0.133	0.099	0.250
5b	0.105	0.514	**0.651**	0.056	0.132	0.282
5c	0.113	0.559	**0.672**	−0.045	0.147	0.194
5d	0.171	0.565	**0.633**	−0.058	0.171	0.194
6	0.349	**0.600**	0.192	−0.005	0.038	0.311
7	**0.792**	0.314	0.061	−0.167	0.232	0.109
8	0.314	**0.554**	0.178	−0.032	**0.507**	0.291
9a	0.458	0.144	0.108	0.324	−0.044	**0.503**
9b	0.170	0.105	0.164	0.007	0.161	**0.811**
9c	0.042	0.147	−0.003	0.062	0.089	**0.266**
9d	0.284	0.210	0.111	0.066	0.184	**0.834**
9e	0.339	0.231	0.125	0.061	0.141	**0.791**
9f	0.097	0.218	0.138	0.113	0.156	**0.811**
9g	**0.433**	0.333	0.368	0.009	0.093	**0.439**
9h	0.059	0.374	0.245	0.250	0.043	**0.460**
9i	**0.500**	**0.389**	**0.347**	0.252	−0.076	0.283
9j	0.352	0.353	−0.055	0.158	−0.072	**0.592**

ADL, activities of daily living; Bold numbers indicate highest factor loadings.

Table 3 Internal consistency reliability and correlations between PEmb-QoL dimensions

PEmb-QoL dimensions	PEmb-QoL questions	Number of items	Cronbach's α	Frequency of complaints	ADL limitations	Work-related problems	Social limitations	Intensity of complaints
Frequency of complaints	Question 1*	8	0.90		–	–	–	–
ADL limitations	Question 4*	13	0.94	0.67**		–	–	–
Work-related problems	Question 5*	4	0.87	0.49**	0.66**		–	–
Social limitations	Question 6	1	N.A.	0.62**	0.69**	0.64**		–
Intensity of complaints	Questions 7/8	2	0.62	0.82**	0.73**	0.60***	0.66**	
Emotional complaints	Question 9*	10	0.91	0.60**	0.60**	0.56**	0.63**	0.71***

ADL, activities of daily living; *items reversely scored (higher scores indicate more complaints); N.A., not applicable; ** $P < 0.01$.

Limitations of our study comprise the exclusion of three participants due to language barriers and the lack of detailed comparison with healthy subjects. This comparison is difficult because the PEmb-QoL was designed for patients with acute PE and is by definition not applicable to subjects without this disease. Furthermore, the PEmb-QoL dimensions were created based on the contents of the items and not on the results of varimax rotation. *Post hoc* varimax rotation analysis

Table 4 Test-retest reliability

	Intra-class correlation coefficient
Frequency of complaints	0.94***
ADL limitations	0.87***
Work-related problems	0.78***
Social limitations	0.83***
Intensity of complaints	0.85***
Emotional complaints	0.81***

ADL, activities of daily living; ***$P < 0.001$.

demonstrated that although most items fitted well in the proposed dimensions, some items had more than one high loading (for instance item 8 and 9.i) or had higher loadings in dimensions other than those they were designated to. On the other hand, item 9.c had low loadings on all dimensions. As this was the first report of factor analysis of the PEmb-QoL questionnaire, future studies should assess whether some items might fit better in other dimensions, possibly allowing removal or regrouping of some of the items. Finally, we were unable to assess responsiveness in this cohort.

This disease-specific questionnaire was developed to assist physicians in monitoring treatment interventions after acute PE. The advantage of disease-specific questionnaires over generic instruments of QoL is that these can be considered to have higher sensitivity for detecting subtle but clinically relevant alterations in QoL caused by the studied condition or treatment [22]. Although we were able to show correlations between the outcome of the PEmb-QoL and the condition of patients with a history of acute PE, our study design did not allow assessing whether this QoL instrument could be used in treatment decisions. Hence, further studies are needed.

In summary, the PEmb-QoL is a valuable instrument for determining the disease-specific QoL in patients with previous acute PE. This questionnaire is a valid and reliable instrument of QoL following acute PE and may identify patients with impaired health perception. The clinical applicability of the PEmb-QoL and its potential role in the management of patients with acute PE remains to be studied in clinical outcome studies.

Table 5 Correlations between PEmb-QoL dimensions and SF-36 subscales

	SF-36									
PEmb-QoL	Physical functioning	Social functioning	Physical role functioning	Emotional role functioning	Mental health	Vitality	Bodily pain	General health	Physical health summary	Mental health summary
Frequency of complaints	−0.46**	−0.55**	−0.33**	−0.28**	−0.45**	−0.56**	−0.42**	−0.55**	−0.44**	−0.42**
ADL limitations	−0.78**	−0.61**	−0.53**	−0.39**	−0.45**	−0.66**	−0.49**	−0.63**	−0.66**	−0.39**
Work-related problems	−0.53**	−0.50**	−0.58**	−0.43**	−0.40**	−0.54**	−0.29**	−0.53**	−0.51**	−0.39**
Social limitations	−0.54**	−0.55**	−0.45**	−0.31**	−0.38**	−0.53**	−0.35**	−0.51**	−0.50**	−0.35**
Intensity of complaints	−0.62**	−0.66**	−0.44**	−0.32**	−0.55**	−0.67**	−0.49**	−0.60**	−0.55**	−0.48**
Emotional complaints	−0.45**	−0.60**	−0.38**	−0.43**	−0.57**	−0.69**	−0.41**	−0.59**	−0.40**	−0.57**

ADL, activities of daily living; **$P < 0.01$.

Table 6 Multivariate linear regression of PEmb-QoL dimensions and SF-36 subscales: unstandardized regression (beta) coefficients with *P*-values only of independently significant determinants of quality of life

	Frequency of complaints	ADL limitations	Work-related problems	Social limitations	Intensity of complaints	Emotional complaints
Gender[†]						
Age (per year)	−0.15*					
Obesity[‡§]		0.26**	0.18*	0.36*	0.49*	
Cardiopulmonary comorbidity[§]		0.26*			0.21*	
Active malignancy[§]						
Centrally located PE[§]	0.45*	0.23*				
Follow-up period (per day)[¶]						
Family history of VTE[†]				−0.40*	−0.50*	−0.55*

Higher PEmb-QoL scores are associated with decreased quality of life. ADL, activities of daily living.
[†]1, male; 2, female.
[‡]Body mass index > 30 kg m^{-2}.
[¶]Time span between registration acute pulmonary embolism and study inclusion in days. *$P < 0.05$, **$P < 0.01$.

Acknowledgements

The Netherlands Heart Foundation (2006B056). The Dutch Organisation for Health Research and Development (ZonMw) (945-06-604). S. Middeldorp is Clinical Established Investigator of the Netherlands Heart Foundation (2008T056).

Disclosure of Conflict of Interests

The authors state that they have no conflict of interest.

References

1 Tapson VF. Acute pulmonary embolism. *N Engl J Med* 2008; **358**: 1037–52.
2 Spencer FA, Gore JM, Lessard D, Douketis JD, Emery C, Goldberg RJ. Patient outcomes after deep vein thrombosis and pulmonary embolism: the Worcester Venous Thromboembolism Study. *Arch Intern Med* 2008; **168**: 425–30.
3 Pengo V, Lensing AW, Prins MH, Marchiori A, Davidson BL, Tiozzo F, Albanese P, Biasiolo A, Pegoraro C, Iliceto S, Prandoni P; Thromboembolic Pulmonary Hypertension Study Group. Incidence of chronic thromboembolic pulmonary hypertension after pulmonary embolism. *N Engl J Med* 2004; **350**: 2257–64.
4 Klok FA, Mos IC, Broek L, Tamsma JT, Rosendaal FR, de Roos A, Huisman MV. Risk of arterial cardiovascular events in patients after pulmonary embolism. *Blood* 2009; **114**: 1484–8.
5 Klok FA, Tijmensen JE, Haeck ML, van Kralingen KW, Huisman MV. Persistent dyspnea complaints at long-term follow-up after an episode of acute pulmonary embolism: results of a questionnaire. *Eur J Intern Med* 2008; **19**: 625–9.
6 Lamping DL, Schroter S, Kurz X, Kahn SR, Abenhaim L. Evaluation of outcomes in chronic venous disorders of the leg: development of a scientifically rigorous, patient-reported measure of symptoms and quality of life. *J Vasc Surg* 2003; **37**: 410–9.
7 Kahn SR, M'Lan CE, Lamping DL, Kurz X, Berard A, Abenhaim L. The influence of venous thromboembolism on quality of life and severity of chronic venous disease. *J Thromb Haemost* 2004; **2**: 2146–51.
8 van Korlaar I, Vossen CY, Rosendaal FR, Bovill EG, Cushman M, Naud S, Kaptein AA. The impact of venous thrombosis on quality of life. *Thromb Res* 2004; **114**: 11–8.
9 Kahn SR, Lamping DL, Ducruet T, Arsenault L, Miron MJ, Roussin A, Desmarais S, Joyal F, Kassis J, Solymoss S, Desjardins L, Johri M, Shrier I. VEINES-QOL/Sym questionnaire was a reliable and valid disease-specific quality of life measure for deep venous thrombosis. *J Clin Epidemiol* 2006; **59**: 1049–56.
10 Hedner E, Carlsson J, Kulich KR, Stigendal L, Ingelgard A, Wiklund I. An instrument for measuring health-related quality of life in patients with Deep Venous Thrombosis (DVT): development and validation of Deep Venous Thrombosis Quality of Life (DVTQOL) questionnaire. *Health Qual Life Outcomes* 2004; **2**: 30.
11 McKenna SP, Doughty N, Meads DM, Doward LC, Pepke-Zaba J. The Cambridge Pulmonary Hypertension Outcome Review (CAMPHOR): a measure of health-related quality of life and quality of life for patients with pulmonary hypertension. *Qual Life Res* 2006; **15**: 103–15.
12 Guyatt GH, Berman LB, Townsend M, Pugsley SO, Chambers LW. A measure of quality of life for clinical trials in chronic lung disease. *Thorax* 1987; **42**: 773–8.
13 Cohn DM, Nelis EA, Busweiler LA, Kaptein AA, Middeldorp S. Quality of life after pulmonary embolism: the development of the PEmb-QoL questionnaire. *J Thromb Haemost* 2009; **7**: 1044–6.
14 Ware JE Jr, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med Care* 1992; **30**: 473–83.
15 Kahn SR, Shbaklo H, Lamping DL, Holcroft CA, Shrier I, Miron MJ, Roussin A, Desmarais S, Joyal F, Kassis J, Solymoss S, Desjardins L, Johri M, Ginsberg JS. Determinants of health-related quality of life during the 2 years following deep vein thrombosis. *J Thromb Haemost* 2008; **6**: 1105–12.
16 Cronbach LJ. Coefficient alpha and the internal structure of tests. *Psychometrika* 1951; **16**: 297–334.
17 DeVellis RF. Scale Development: Theory and Applications (Applied Social Research Methods), 2nd Edition. Newbury, CA, Sage, 2003.
18 Ware JE. SF-36 Health Survey: Manual and Interpretation Guide. Boston: The Health Institute, New England Medical Center; 1993.
19 Lean ME, Han TS, Seidell JC. Impairment of health and quality of life using new US Federal guidelines for the identification of obesity. *Arch Intern Med* 1999; **159**: 837–43.
20 Kaptein AA, Scharloo M, Fischer MJ, Snoei L, Hughes BM, Weinman J, Kaplan RM, Rabe KF. 50 years of psychological research on patients with COPD – road to ruin or highway to heaven? *Respir Med* 2009; **103**: 3–11.
21 Newman S, Steed L, Mulligan K. Self-management interventions for chronic illness. *Lancet* 2004; **364**: 1523–37.
22 Guyatt GH, Bombardier C, Tugwell PX. Measuring disease-specific quality of life in clinical trials. *Can Med Assoc J* 1986; **134**: 889–95.

Appendix: the PEmb-QoL Questionnaire

Questionnaire

After having a pulmonary embolism

Instructions how to answer:

Answer every question by marking the answer as indicated. If you are unsure about how to answer a question, please give the best answer you can.

These questions are about your **lungs.** The information you give should describe how you feel. You can also indicate how capable you are of carrying out your normal activities.

1. During the past 4 weeks, how often have you had any of the following symptoms from your lungs? *(Circle 1 answer on each line)*

	Every day	**Several times a week**	**About once a week**	**Less than once a week**	**Never**
Pain behind or between the shoulder blades?	1	2	3	4	5
Pain on or in the chest?	1	2	3	4	5
Pain in the back?	1	2	3	4	5
Sensation of pressure?	1	2	3	4	5
Feeling that there is 'still something there"?	1	2	3	4	5
'Burning sensation' in the lungs?	1	2	3	4	5
'Nagging feeling' in the lungs?	1	2	3	4	5
Difficulty in breathing or breathlessness?	1	2	3	4	5

2. At what time of day are your **lung symptoms** most intense? (circle *one answer*)
   1. On waking
   2. At mid-day
   3. At the end of the day
   4. During the night
   5. At any time of the day
   6. Never

3. Compared to 1 year ago, how would you rate the **condition** of your **lungs** in general now? *(circle one answer)*
   1.Much better now than 1 year ago
   2. Somewhat better now than 1 year ago
   3. About the same now as 1 year ago
   4. Somewhat worse now than 1 year ago
   5. Much worse now than 1 year ago
   6. I did not have any problems with my lungs

4. The following items are about activities that you might do in a typical day. Do your lung symptoms now limit you in these activities? If so, how much? *(Circle one answer on each line)*

	I do not work	**YES, Limited A Lot**	**YES, Limited A Little**	**NO, Not Limited At All**
a. **Daily activities at work**	0	1	2	3
b. **Daily activities at home** (e.g. housework, ironing, doing odd jobs/repairs around the house, gardening, etc.…)		1	2	3
c. **Social or activities** (such as travelling, going to the cinema, parties, shopping)		1	2	3
d. **Vigorous activities**, such as running, lifting heavy objects, participating in strenuous sports		1	2	3
e. **Moderate activities**, such as moving a table, hoovering, swimming or cycling		1	2	3
f. Lifting or carrying groceries		1	2	3
g. Climbing **several** flights of stairs		1	2	3
h. Climbing **one** flight of stairs		1	2	3
i. Bending, kneeling, or squatting		1	2	3
j. Walking **more than half a mile**		1	2	3
k. Walking **a couple of hundred yards**		1	2	3
l. Walking **about one hundred yards**		1	2	3
m. Washing or dressing yourself		1	2	3

5. During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your lung symptoms? *(Circle one answer on each line)*

	YES	**NO**
a. Cut down the **amount of time** you spent on work or other activities	1	2
b. **Accomplished less** than you would like	1	2
c. Were limited in the **kind** of work or other activities	1	2
d. Had **difficulty** performing the work or other activities (e.g. it took extra effort)	1	2

6. During the past 4 weeks, to what extent have your **lung symptoms** interfered with your normal social activities with family, friends, neighbours or groups? (Circle one answer)

1. Not at all
2. Slightly
3. Moderately
4. Quite a bit
5. Extremely

7. How much pain around your shoulder blades/pain in your chest have you experienced during the past 4 weeks? (Circle one answer)

1. None
2. Very slight
3. Slight
4. Quite a bit
5. Serious
6. Very serious

8. How much breathlessness have you experienced in the past 4 weeks? (Circle one answer)

1. None
2. Very slight
3. Slight
4. Quite a bit
5. Serious
6. Very serious

9. These questions are about how you feel and how things have been with you during the past 4 weeks as a result of your lung symptoms. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks *(Circle one answer on each line)*

	All of the Time	**Most of the Time**	**A good Bit of the Time**	**Some of the Time**	**A Little of the Time**	**None of the Time**
Were you worried about having another pulmonary embolism?	1	2	3	4	5	6
Did you feel irritable?	1	2	3	4	5	6
Would you have been worried if you had to stop taking anticoagulant medication?	1	2	3	4	5	6
Did you become emotional more readily?	1	2	3	4	5	6
Did it bother you that you became emotional more quickly?	1	2	3	4	5	6
Were you depressed or in low spirits?	1	2	3	4	5	6
Did you feel that you were a burden to your family and friends?	1	2	3	4	5	6
Were you afraid to exert yourself?	1	2	3	4	5	6
Did you feel limited in taking a trip?	1	2	3	4	5	6
Were you afraid of being alone?	1	2	3	4	5	6

Thank you very much for your co-operation.

Please return the questionnaire in the enclosed prepaid envelope or give it to your doctor.

Legend to the Appendix: Higher scores indicate worse outcome. Scores for all dimensions are calculated by the sum of the scores for each item of the dimension divided by the number of the items. Questions 1, 4, 5 and 9 are reversed scored. Questions 2 and 3 provide descriptive information.