LYMPHATIC RESEARCH AND BIOLOGY
Volume 17, Number 3, 2019

DOI: 10.1089/lrb.2018.0025

Revision of the Lymphedema Functioning, Disability and Health Questionnaire for Upper Limb Lymphedema (Lymph-ICF-UL): Reliability and Validity

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Abstract

Background: Lymphedema is associated with significant physical and psychosocial problems. The Lymphedema Functioning, Disability and Health questionnaire for upper limb lymphedema is a valid and reliable tool quantifying the amount of problems in functioning in patients with breast cancer-related lymphedema. Patients suggested a revision of the scoring system to facilitate completion of the questionnaire. Therefore, adjustment of the questionnaire was carried out by implementing a numeric rating scale instead of the existing visual analog scale. Purpose of this study was to investigate reliability and validity of the revised Lymph-ICF, called the Lymph-ICF-UL.
Methods and Results: Reliability and validity of the Lymph-ICF-UL were examined in 56 participants with upper limb lymphedema. Intraclass correlation coefficients for test–retest reliability ranged from 0.79 to 0.95. Cronbach's alpha coefficients for internal consistency were higher than 0.80. Face and content validity were very good because the scoring system was clear for all participants (100%), questions were understandable for all participants (100%), and all complaints due to arm lymphedema were mentioned by 98% of the participants. Construct validity was good. Convergent validity was established since four out of five expected domains of the Lymph-ICF-UL showed a moderate correlation with expected domains of the 36-Item Short-Form Health Survey questionnaire. There was good divergent validity because seven out of nine hypotheses assessing divergent validity were accepted.
Conclusion: The Lymph-ICF-UL is a reliable and valid questionnaire using a simplified and clearer scoring procedure to assess impairments in function, activity limitations, and participation restrictions of patients with breast cancer-related arm lymphedema.

Keywords: breast cancer, breast neoplasms, lymphedema, Lymph-ICF-UL, reliability, validity

Introduction

Upper limb lymphedema is a debilitating morbidity affecting more than 16% of the women treated for breast cancer.[1] The swelling can be caused by destruction of the lymphatic vessels due to surgery or radiotherapy, resulting in a reduced lymphatic transport.[2]

Lymphedema can be assessed objectively with different assessment methods that all are valid and reliable.[3] Examples of assessment methods are different kinds of water displacement methods[4–7] and circumference measurements using a tapeline[7–9] or perimeter.[10] Subsequently, the calculated volume can be determined,[8] which is described as the most widely used calculation for lymphedema in common clinical

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practice.[11] However, objective assessment of the amount of lymphedema volume lacks the power to encounter the real burden of lymphedema. Besides swelling, patients can suffer from problems in physical, social, and mental functioning.[12] In addition, breast cancer-related lymphedema (BCRL) can cause a lower quality of life.[13–15] Therefore, the Lymphedema Functioning, Disability and Health questionnaire for the upper limb (Lymph-ICF) was developed.[10] This questionnaire aims to quantify impairments in function, activity limitations, and participation restrictions, which are related to lymphedema of the upper limb. In contrast to other lymphedema-related questionnaires it is based on terminology of the International Classification of Functioning, Disability and Health (ICF) as introduced by the World Health Organization.[16] According to a recently published systematic review, the Lymph-ICF is one of the most complete and accurate questionnaires available to asses quality of life in patients with BCRL.[17]

The quality and usefulness of a questionnaire are determined by its clinical properties, such as validity, reliability, and responsiveness. Reliability and validity of the Lymph-ICF have already been examined, and it has shown to be a valid and reliable Dutch questionnaire in patients with BCRL.[10] However, patients mentioned that the use of a scoring system with gradation like a numeric rating scale (NRS) would be an easier scoring method instead of the current scoring system which is a visual analog scale (VAS). Therefore, in 2014 when the Lymph-ICF-LL questionnaire for lower limbs was developed, the scoring mechanism was revised by implementing a NRS instead of a VAS.[18] This revision had not yet been extended to the Lymph-ICF questionnaire regarding upper limb lymphedema. As a result, revision of the Lymph-ICF questionnaire was established by implementing a NRS instead of the existing VAS. Although scores are not interchangeable, both VAS and NRS have proven to be valid, reliable, and sensitive.[19,20] Moreover, NRS showed to be the recommended scale based on a higher compliance, better responsiveness with lower error rate, and better applicability compared to VAS.[19] Clinimetric properties of this revised questionnaire have not been investigated yet. Therefore, the aim of this study was to examine different aspects of reliability and validity of the Lymph-ICF-UL with NRS in patients with BCRL.

Materials and Methods

Study design

Included subjects were participants of the EFforT-BCRL trial ($n=42$)[21] and were recruited in the University Hospitals of Leuven and the Antwerp University Hospital in Belgium. To shorten the inclusion period, also a small group of participants ($n=14$) was recruited in the Lymphovenous Center of the University Hospitals of Leuven. Approval for this trial was obtained by the Ethics Committee of the University Hospitals of Leuven (main Ethics Committee) and received positive advice from the Ethics Committees of all other participating centers (CME reference S58689, EudraCT 2015-004822-33).

This cross-sectional study is reported following the COSMIN (COnsensus-based Standards for the selection of health Measurement INstruments) guidelines.[22]

Participants

Fifty-six participants with BCRL were included between December 2016 and August 2017. Eligibility criteria were as follows: (1) subjects diagnosed with unilateral lymphedema of the arm and/or hand, developed after treatment for breast cancer, (2) chronic lymphedema stage I to IIb (duration of >3 months), and (3) at least 5% difference between both arms and/or between both hands at start of the treatment (in case of participation in EFforT-BCRL trial) or at the day of the consultation at the Lymphovenous Center, adjusted for limb dominance. Participants were excluded when (1) they had edema of the upper limb from other cause than breast cancer treatment or (2) when they were not native Dutch speaking or able to read and fully understand the Dutch language.

Procedure

To analyze the clinimetric properties of the revised version of the Lymph-ICF questionnaire, called the Lymph-ICF-UL (Supplementary Appendix S1), the same methodology was applied as for the investigation of the clinimetric properties of the original questionnaires.[10,18]

Lymph-ICF-UL questionnaire

In the introduction of the Lymph-ICF-UL questionnaire, the scoring system is explained. Then the patient is asked to score his/her average impairments in function, activity limitations, and participation restrictions during the past 2 weeks. Furthermore, the patient is asked not to discuss the questions with anyone to maintain the self-assessment characteristics of the questionnaire. The Lymph-ICF-UL questionnaire takes about 5–10 minutes to complete.

Different scores are obtained from the questionnaire. Each of the 29 questions has to be scored on a 11-point Likert scale between 0 and 10 (instead of a VAS between 0 and 100). The total score of the Lymph-ICF-UL is equal to the sum of the scores on the questions divided by the total number of answered questions and multiplied by 10. In addition, a score is determined for each of the five domains of the Lymph-ICF-UL: (1) physical function, (2) mental function, (3) household activities, (4) mobility activities, and (5) life and social activities. Thus, the total score on the Lymph-ICF-UL and the score on the five domains range between 0 and 100.[10] Table 1 describes how to interpret the Lymph-ICF-UL scores in clinical practice.[16] The Lymph-ICF-UL has already been translated into the English and French language according to established international guidelines described by the World Health Organization.[23,24] For more details about the

Table 1. Interpretation of Scores of the Lymph-ICF-UL Questionnaire

According to the World Health Organization taxonomy,[16] impairments in function, activity limitations, and participation restrictions can be quantified with the following scale	
0%–4%	No problem
5%–24%	Small problem
25%–49%	Moderate problem
50%–95%	Severe problem
96%–100%	Very severe problem

establishment of the original version of the Lymph-ICF questionnaire, we refer to Devoogdt et al.[10]

Reliability

To analyze test–retest reliability, patients completed the adapted questionnaire twice, once at the hospital and once at home with an interval of 24–48 hours after the first test. This time interval was chosen given the fact that problems related to arm lymphedema may change from one day to another. Since the questionnaire consists of 29 questions, the risk for recall bias is negligible. This second questionnaire was needed to be returned by mail.

Validity

To analyze construct validity, patients also completed the Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36) once at the hospital. The SF-36 is a valid, reliable, and commonly used questionnaire to measure a person's health related quality of life.[25,26] It is a generic health status instrument, consisting of 36 questions, divided into eight domains. Scores range between 0 and 100; the higher the score on the SF-36, the better is one's quality of life.[26]

Furthermore, to analyze face and content validity of the Lymph-ICF-UL questionnaire, an additional questionnaire developed by one of the authors (N.D.) in the original investigation[10] was completed. This questionnaire consisted of the following questions: (1) Was the scoring system clear? (yes/no), (2) Was each question of the Lymph-ICF-UL understandable? (yes/no), and (3) Were all complaints related to your lymphedema mentioned in the questionnaire? (yes/no). If a participant answered ''no'' to any of these questions, an explanation was asked.

Descriptives were collected by interviewing the participants and by consulting their medical records. Circumference measurements of both affected and nonaffected arms were performed using a perimeter, after which the volume of the arm was calculated using following truncated cone formula: $4\times(C_1{}^2 + C_1C_2 + C_2{}^2)/12\pi$, where C_1 is the upper circumference and C_2 is the lower circumference of each segment.[8] Measurements were performed by one of three physical therapists specialized in edema therapy (N.D., L.V., T.D.V.).

Data analysis

Statistical analyses were performed using the software SPSS for Windows version 24.0. The 0.05 level of significance was applied. Descriptive analyses were applied to describe the participants.

Reliability

Intraclass correlation coefficients (ICCs) were used to determine test–retest reliability of the total score of the Lymph-ICF-UL, of the scores on the five domains, and of the score on each question separately.[27] ICC estimates and their 95% confidence intervals were calculated based on a single rating, absolute agreement, two-way mixed-effects model.[28,29] Cronbach's alpha coefficients were used to determine internal consistency of the entire questionnaire, as well as of each domain.[30] The ICCs and Cronbach's alpha coefficients were interpreted as follows: <0.40 was weak, 0.40 to 0.74 was moderate, 0.75 to 0.90 was strong, and >0.90 was very strong.[31]

To calculate significant changes in the mean between the two test occasions, Wilcoxon-signed rank tests were performed since the One-Sample Kolmogorov–Smirnov test revealed non-normal distribution of data.

To interpret the magnitude of the within-subjects variation of the two scores, the standard error of measurement (SEM) was calculated using following formula: $\mathrm{SEM} = \mathrm{SD}\sqrt{(1-ICC)}$, where SD was the average standard deviation of the two ratings.[27] To evaluate clinically important changes, we calculated the smallest real difference (SRD) using the formula: $\mathrm{SRD} = 1.96\times\mathrm{SEM}\times\sqrt{2}$.[27] To obtain a reference range for the mean difference of the scores of the two test occasions, we calculated 95% SRD as the mean difference between the two test occasions ± SRD.

Validity

Face, content, and construct validity were examined. Face validity was examined by asking participants whether the scoring system was obvious and whether the questions in the Lymph-ICF-UL were understandable. Content validity was examined by analyzing the answers given by participants to the question about the comprehensiveness of the questionnaire. First, the number of positive answers on each of the three questions was counted. Next, the participants' explanations on the negative answers were discussed.

To investigate construct (convergent, divergent) validity of the Lymph-ICF-UL, the relationship between scores on domains of the Lymph-ICF-UL and scores on domains of the SF-36 was examined. Spearman rank correlation coefficients were used since data were non-normal distributed. To determine convergent and divergent validity and based on the content of the questions of each domain of Lymph-ICF-UL and SF-36, we used the same hypotheses as formulated in the validation study of the original Lymph-ICF.[10] In case of agreement between the questions in a specific domain of the Lymph-ICF-UL and SF-36, these domains were included in a hypothesis for assessing convergent validity. In case of disagreement, they were included in a hypothesis for assessing divergent validity. Table 2 shows an overview of the hypotheses for determining convergent and divergent validity and the rationale for the hypotheses. Correlation coefficients were interpreted as follows: <0.4 was weak, 0.4–0.74 was moderate, 0.75–0.9 was strong, and >0.9 was very strong.[31] If a moderate to very good correlation was found between two corresponding domains, the hypothesis for convergent validity was accepted. In case of a weak correlation between two disagreeing domains, the particular hypothesis for divergent validity was accepted. Construct validity was defined as very good if more than 90% of all 14 hypotheses were confirmed, as good if between 75% and 90% of the hypotheses were confirmed, and as moderate if between 40% and 74% of the hypotheses were confirmed.

Results

Fifty-six volunteers with objective BCRL participated in this study. All participants had undergone breast surgery with axillary dissection (sentinel lymph node biopsy and/or axillary lymph node dissection). For more details about the participant characteristics, see Table 3.

Table 2. Fourteen Hypotheses and Rationale for Hypotheses for Assessing Construct Validity

Hypothesis	*Rationale*
Convergent validity	Considering all correlation coefficients for various domains of the Lymph-ICF-UL and the SF-36, at least moderate correlation coefficients would occur between:
1. Lymph-ICF-UL physical function and SF-36 bodily pain	Lymph-ICF-UL physical function: Does your arm: feel heavy, feel stiff, feel swollen, feel like it has lost strength, tingle, hurt, or have a tensed skin? SF-36 bodily pain: How much bodily pain have you had during the past 4 weeks? During the past 4 weeks, how much did pain interfere with your normal work?
2. Lymph-ICF-UL mental function and SF-36 mental health	Lymph-ICF-UL mental function: Due to your arm problems, do you feel sad, do you feel discouraged, do you have a lack of self-confidence, do you feel stressed? SF-36 mental health: How much time during the last 2 weeks have you been a very nervous person, have you felt so down in the dumps that nothing would cheer you up, have you felt calm and peaceful, have you felt downhearted and low, and have you been a happy person?
3. Lymph-ICF-UL household activities and SF-36 physical functioning	Lymph-ICF-UL general tasks/household activities: How well are you able to: clean (scrub, vacuum, mop), cook, iron, and work in the garden? SF-36 physical functioning: Does your health limit you in the following activities: vigorous activities, such as lifting heavy objects; moderate activities, such as moving a table, pushing a vacuum, lifting or carrying groceries, climbing several flights of stairs, climbing 1 flight of stairs, bending, kneeling, stooping, walking more than a mile, walking half a mile, walking 100 yd (91.44 m), and bathing or dressing yourself?
4. Lymph-ICF-UL mobility activities and SF-36 physical functioning	Lymph-ICF-UL mobility activities: How well are you able to: perform tasks with the arm elevated (e.g., hang out the laundry), lift or carry heavy objects (e.g., a filled bucket or shopping bags), sleep on the affected side, perform computer work (>30 minutes), sunbathe, drive a car, walk (>2 km), ride a bike? SF-36 physical functioning: Does your health limit you in the following activities: vigorous activities, such as lifting heavy objects; moderate activities, such as moving a table, pushing a vacuum, lifting or carrying groceries, climbing several flights of stairs, climbing 1 flight of stairs, bending, kneeling, stooping, walking more than a mile, walking half a mile, walking 100 yd, and bathing or dressing yourself?
5. Lymph-ICF-UL life and social activities and SF-36 social functioning	Lymph-ICF-UL life domains/social life: How well are you able to: go on vacation, perform your hobbies, practice sports, wear your clothes of choice, do your job, do social activities (e.g., going to parties, concerts, restaurant)? SF-36 social functioning: During the past 2 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, neighbors, or groups? During the past 2 weeks, how much of the time has your physical health or emotional problems interfered with your social activities?
Divergent validity	Considering all correlation coefficients for various domains of the Lymph-ICF-UL and the SF-36, weak correlation coefficients would occur between:
6–7. Lymph-ICF-UL physical function and SF-36 role-emotional and mental health	Lymph-ICF-UL physical function: Does your arm: feel heavy, feel stiff, feel swollen, feel like it has lost strength, tingle, hurt, or have a tensed skin? SF-36 role-emotional: During the past 4 weeks, for how much time have you had problems with your work or other regular daily activities as a result of emotional problems? SF-36 mental health: How much time during the last 2 weeks have you been a very nervous person, have you felt so down in the dumps that nothing would cheer you up, have you felt calm and peaceful, have you felt downhearted and low, and have you been a happy person?
8–9. Lymph-ICF-UL mental function and SF-36 physical functioning and role-physical	Lymph-ICF-UL mental function: Due to your arm problems, do you feel sad, do you feel discouraged, do you have a lack of self-confidence, do you feel stressed? SF-36 physical functioning: Does your health limit you in the following activities: vigorous activities, such as lifting heavy objects; moderate activities, such as moving a table, pushing a vacuum, lifting or carrying groceries, climbing several flights of stairs, climbing 1 flight of stairs, bending, kneeling, stooping, walking more than a mile, walking half a mile, walking 100 yd, and bathing or dressing yourself? SF-36 role-physical: 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 physical health; cut down the amount of time you spent on work or other activities, accomplished less than you would like, were limited in the kind of work or other activities, had difficulty performing the work or other activities (e.g., it took extra effort)?

(*continued*)

TABLE 2. (CONTINUED)

Hypothesis	*Rationale*
10–11. Lymph-ICF-UL household activities and SF-36 role-emotional and mental health	Lymph-ICF-UL general tasks/household activities: How well are you able to: clean (scrub, vacuum, mop), cook, iron, work in the garden? SF-36 role-emotional: During the past 4 weeks, how much time have you had problems with your work or other regular daily activities as a result of emotional problems? SF-36 mental health: How much time during the last 2 weeks have you been a very nervous person, have you felt so down in the dumps that nothing would cheer you up, have you felt calm and peaceful, have you felt downhearted and low, and have you been a happy person?
12–13. Lymph-ICF-UL mobility activities and SF-36 role-emotional and mental health	Lymph-ICF-UL mobility activities: How well are you able to: perform tasks with the arm elevated (e.g., hang out the laundry), lift or carry heavy objects (e.g., a filled bucket or shopping bags), sleep on the affected side, perform computer work (>30 minutes), sunbathe, drive a car, walk (>2 km), ride a bike? SF-36 role-emotional: During the past 4 weeks, how much time have you had problems with your work or other regular daily activities as a result of emotional problems? SF-36 mental health: How much time during the last 2 weeks have you been a very nervous person, have you felt so down in the dumps that nothing would cheer you up, have you felt calm and peaceful, have you felt downhearted and low, and have you been a happy person?
14. Lymph-ICF-UL life and social activities and SF-36 physical functioning	Lymph-ICF-UL life domains/social life: How well are you able to: go on vacation, perform your hobbies, practice sports, wear your clothes of choice, do your job, do social activities (e.g., going to parties, concerts, restaurant)? SF-36 physical functioning: Does your health limit you in the following activities: vigorous activities, such as lifting heavy objects; moderate activities, such as moving a table, pushing a vacuum, lifting or carrying groceries, climbing several flights of stairs, climbing one flight of stairs, bending, kneeling, stooping, walking more than a mile, walking half a mile, walking 100 yd, and bathing or dressing yourself?

TABLE 3. CHARACTERISTICS OF THE INCLUDED SUBJECTS ($N=56$)

Variable	*Outcome*
Age (years)	62 (10)
Body mass index (kg/m^2)	27 (4)
Lymphedema volume arm (mL)	410 (351)
Duration lymphedema (months)[a]	34.5 (13.5, 79.5 [66])
BCRL stages, *n* (%)	
I	10 (17.9)
IIa	33 (58.9)
IIb	13 (23.2)
Breast surgery, *n* (%)	
Mastectomy	36 (58.1)
Breast-conserving surgery	20 (32.3)
Axillary lymph node clearance,[a] *n* (%)	
SLNB alone	4 (7.1)
SLNB + ALND	49 (87.5)
Surgery on the dominant side, *n* (%)	29 (46.8)
Radiotherapy,[b] *n* (%)	54 (87.1)
Chemotherapy,[b] *n* (%)	50 (80.6)
Antihormonal therapy,[b] *n* (%)	45 (72.6)
Target therapy (Herceptin),[b] *n* (%)	13 (21)

[a] $n=52$ since medical data of three patients are unknown due to surgery in different hospitals in the past ($n=2$) or due to previous treatment abroad ($n=1$).

[b] $n=55$ since medical data of one patient are unknown due to previous treatment abroad; BCRL stages as described by the International Society of Lymphology; descriptives are presented as ''mean (standard deviation)'' except when indicated with [a]where ''median (25th, 75th percentile [interquartile range])'' is shown.

Reliability

Table 4 gives an overview of the ICCs, Cronbach's alpha coefficients, SEMs, and SRDs for the total score on the Lymph-ICF-UL and for the scores on each domain separately. Test–retest reliability of the total score and of the mental function and mobility activity scores was very strong (ICC >0.90). The other scores were found strong (ICC >0.75). Test–retest reliability of the scores on 26 questions (90%) was strong to very strong (data not shown). Reliability of scores on the other three questions (about the abilities to cook, to iron, and to wear clothes) was moderate (ICC = 0.60–0.74).

Internal consistency of the Lymph-ICF-UL also ranged between strong and very strong. The Cronbach's alpha coefficient for all questions was 0.98 and ranged for the different domains between 0.89 and 0.98.

There were no statistical differences between the means of the total score, as well as of the separate domain scores, between the two test occasions which were calculated with Wilcoxon-signed rank analyses (Table 4).

The total score on the Lymph-ICF-UL had a variation from one test occasion to the other of 4.9. A decrease or an increase in score of 10 or more is considered (with 95% certainty) as a statistically significant change. Furthermore, a decrease or increase in score of 14 or more is considered as a clinically relevant change (Table 4).

Validity

The questionnaire regarding face and content validity of the Lymph-ICF-UL was completed by all participants. All participants (100%) found the scoring system clear, and all

Table 4. Reliability on the Total Score of the Lymph-ICF-UL and the Scores on the Five domains

		Mean			Test–retest		Internal	Variability		Clinically important changes	
Score	N	*X1*	*X2*	p	*ICC*	*95% CI*	*consistency*[a]	*SEM*	*95% CI*	*SRD*	*95% CI*
Lymph-ICF-UL total score	56	27.50	27.45	0.98	0.95	0.91–0.97	0.98	4.89	−9.57 to 9.61	13.56	−13.54 to 13.58
Physical function score	56	24.30	22.76	0.26	0.90	0.83–0.94	0.92	6.76	−11.70 to 14.78	18.73	−17.19 to 20.27
Mental function score	56	18.97	19.69	0.67	0.93	0.88–0.96	0.98	6.31	−13.09 to 11.65	17.49	−18.21 to 16.77
Household activity score	56	33.02	34.60	0.71	0.79	0.66–0.87	0.89	12.31	−25.71 to 22.55	34.13	−35.71 to 32.55
Mobility activity score	56	30.68	31.03	0.84	0.91	0.85–0.95	0.89	7.63	−15.31 to 14.61	21.16	−21.51 to 20.81
Life and social activity score	55	28.30	30.65	0.22	0.88	0.80–0.93	0.92	8.28	−18.58 to 13.88	22.96	−25.31 to 20.61

p-value is resulting out of Wilcoxon signed rank analyses.
[a]Cronbach's alpha coefficient.
CI, confidence interval; ICC, Intraclass correlation coefficient; SEM, standard error of measurement; SRD, smallest real difference; X1, mean at time point 1; X2, mean at time point 2.

participants (100%) mentioned that the questions were understandable. Forty-three participants (77%) mentioned that all complaints were addressed in the questionnaire. Complaints not covered in the questionnaire are shown in Table 5. After discussion with a team of experts (N.D., L.V., T.D.V.), only one missing complaint mentioned by one participant was considered to be relevant (2%).

Table 6 provides an overview of the Spearman rank correlation coefficients between the different domains of the Lymph-ICF-UL and the SF-36. All participants completed both questionnaires. Concerning convergent validity, four out of five domains of the Lymph-ICF-UL correlated at least moderately with the expected corresponding domains of the SF-36 and were accepted. Correlation coefficients of these four ranged from −0.42 to −0.66 (moderate correlations). Concerning divergent validity, seven out of nine domains of the Lymph-ICF-UL showed a weak correlation with the expected corresponding domains of the SF-36. The correlation coefficients of these seven ranged from −0.19 to −0.37 (no to weak correlation). Consequently, seven out of nine hypotheses for assessing divergent validity were accepted, resulting in an overall good construct validity of the Lymph-ICF-UL (79%).

Discussion

In 2011, the original version of the first Dutch questionnaire based on terminology of the ICF to assess the impairments in function, activity limitations, and participation

Table 5. Overview of Mentioned Missing Complaints ($N = 12$) and Reason Why No Inclusion in Lymph-ICF-UL

Lymph-ICF-UL domain	*Complaint*	*Argumentation (see Table Notes)*
Physical function domain	Pain in the breast	A
	Hypersensitivity of the skin	B
	Presence of paresthesia	B
	Number of episodes of erysipelas[a]	
Mental function domain	Feeling annoyed/embarrassed about wearing compression garment ($n = 3$)	C
Mobility activity domain	Ability to perform more powerful activities	C
	A delayed onset of complaints after performing a task (i.e., not at the moment itself)	C
Life and social activity domain	The possibility of wearing any kind of bra	A
	The ability to meet the former (presurgery) sports/activity level	C
One participant found that the distinction between limb dominance within the questions was not covered		D
One participant found that the two questions about the ability to sport and to work were too vague		

Notes
A: May indicate myofascial pain or pain due to breast edema.[28] The Lymph-ICF-UL is aimed to quantify the amount of problems in functioning in patients with BCRL of the arm; however, this questionnaire has not yet been validated in patients with breast edema. This needs to be further investigated.
B: Complications related to the treatment of breast cancer (i.e., due to lesions of sensory nerves after axillary lymph node dissection and/or radiotherapy) and not due to the arm lymphedema.[29,30]
C: Can be scored with corresponding questions of the questionnaire. The patient has to give the mean score on his/her problems in functioning during the past 2 weeks, as reported in the introduction of the questionnaire.
D: Limb dominance is an item that is collected separately from the lymph-ICF-UL.
[a]After discussion, only one complaint (2%) was considered relevant; nevertheless, it was not included in the questionnaire.

Table 6. Correlation Between the SF-36 and the Lymph-ICF-UL to Determine Convergent and Divergent Validity (Spearman Rank Correlation Coefficient; $N=56$)

	Spearman rank correlation coefficient ($r_{s\ (p\text{-}value)}$) for: Lymph-ICF-UL domains				
	Impairments in function		*Activity limitations and participation restrictions*		
SF-36 domain	*Physical function*	*Mental function*	*Household activities*	*Mobility activities*	*Life and social activities* (n = 55)
	Correlation coefficient (sign.)				
Physical functioning	–0.249 (0.640)	**–0.311 (0.020)**	–0.244 (0.070)	**–0.415 (0.001)**	–0.426 (0.001)
Role-physical	–0.266 (0.470)	–0.526 (≤0.001)	–0.400 (0.002)	–0.428 (0.001)	–0.495 (≤0.001)
Bodily pain	**–0.440 (0.001)**	–0.292 (0.029)	–0.454 (≤0.001)	–0.437 (0.001)	–0.586 (≤0.001)
General health	–0.390 (0.003)	–0.388 (0.003)	–0.511 (≤0.001)	–0.471 (≤0.001)	–0.541 (≤0.001)
Vitality	–0.265 (0.045)	–0.542 (≤0.001)	–0.375 (0.004)	–0.384 (0.003)	–0.558 (≤0.001)
Social functioning	–0.399 (0.002)	–0.599 (≤0.001)	–0.522 (≤0.001)	–0.534 (≤0.001)	**–0.607 (≤0.001)**
Role-emotional	**–0.191 (0.158)**	–0.488 (≤0.001)	**–0.306 (0.022)**	**–0.369 (0.005)**	–0.419 (0.001)
Mental health	**–0.195 (0.150)**	**–0.661 (≤0.001)**	**–0.234 (0.083)**	**–0.341 (0.010)**	–0.431 (0.001)

Values with bold frame = hypotheses for expected moderate correlations assessing convergent validity; Values with double frame = hypotheses for expected moderate correlations assessing divergent validity; Bold values = accepted hypotheses regarding convergent validity (correlation coefficient ≥0.4) or regarding divergent validity (correlation coefficient ≤0.4).

restrictions of patients with BCRL was shown to be valid and reliable. The revised version, the Lymph-ICF-UL questionnaire, is also found appropriate and useful in clinical practice by showing very good (reliability) to good (validity) clinimetric properties.

Reliability of the Lymph-ICF-UL was very good. The ICCs of the total score on the Lymph-ICF-UL and the different domain scores varied between strong and very strong, showing over all higher ICC values than those shown in the original study, except for the household activity score.[10] However, this ICC value is still high enough to speak of good test–retest reliability. Moreover, the ICC value of life and social activities improved remarkably. Consequently, the test–retest reliability of this domain improved from moderate to strong. Compared to the original version of the Lymph-ICF-UL, also Cronbach's alpha coefficients are increased for both the total score as for the scores on the different domains, with exception of the household activity score where Cronbach's alpha remained stable. If we look at the differences in SEMs and SRDs between this revised version and the original version, we found similar SEMs and SRDs for the total score as for the different domains. Except for the household activity domain we found a higher SEM and SRD, and for the mental function domain, as well as the life and social activity domain, we found remarkably lower SEMs and SRDs in the present study.

Face and content validity of the Lymph-ICF-UL was very good for participants with BCRL. All participants (100%) found the revised scoring system (NRS) clear, in contrast to the original version in which the scoring system (VAS) was clear for only 88% of the participants and whereby participants mentioned preferring a scoring system with gradation. Thus, revision of the scoring system resulted in an improved face validity of the questionnaire. Similar to the original version, all questions were understandable for all participants. Only one participant (2%) reported missing a complaint in the Lymph-ICF-UL which we considered relevant. This was the complaint ''number of episodes of erysipelas.'' However, it is not part of the questionnaire because during the development phase of the Lymph-ICF questionnaire, none of the patients reported erysipelas as complaint. Eleven other participants also mentioned missing a complaint in the Lymph-ICF-UL. However, after discussion we concluded that these complaints were irrelevant and, consequently, did not have to be included in the Lymph-ICF-UL (Table 5).

Construct validity of the Lymph-ICF-UL was tested in terms of convergent and divergent validity and gave good results. Concerning convergent validity, four out of five domains (80%) of the Lymph-ICF-UL correlated at least moderately with the expected corresponding domains of the SF-36 (r between –0.42 and –0.66). In the original study, all five hypotheses concerning convergent validity could be accepted. In current study, the household activity ($r=-0.24$) domain of the Lymph-ICF-UL did not show a moderate or strong correlation with the expected physical function domain of the SF-36. Noteworthy, this moderate correlation was also present between the life and social activity domain of the Lymph-ICF-UL and the social functioning domain of the SF-36, although this correlation was weak in previous version ($r=-0.61$ vs. $r=-0.33$, respectively).

Concerning divergent validity, seven out of nine hypotheses (78%) were accepted in current study, whereas three out of five hypotheses (60%) were accepted in the original study. Unexpected, the mental function domain of the Lymph-ICF-UL showed a moderate correlation with the role physical ($r=-0.53$) domain of the SF-36, in contrast with the previous version where this correlation was weak ($r=-0.25$).

Strengths and study limitations

Our study consisted of several strengths. First, different aspects of reliability and validity of the Lymph-ICF-UL

were investigated. However, our study did not investigate responsiveness of the Lymph-ICF-UL. Research to determine this clinimetric property is ongoing. Second, the sample size of this study consisted of 56 participants. As stated by Shrout and Fleiss, researchers should try to obtain at least 30 heterogeneous subjects for reliability studies.[29] The sample of our study is heterogeneous since participants with BCRL stage I, IIa, or IIb, with a broad range of duration in months and lymphedema volume, were enrolled to accommodate this.

A limitation of our study is that testing of face and content validity occurred with an author-developed questionnaire. However, we are unaware of an available valid questionnaire to investigate these clinimetric properties.

Conclusion

In conclusion, the Lymph-ICF-UL is a reliable and valid Dutch questionnaire using a simplified and clearer scoring procedure to assess problems in functioning of patients with arm lymphedema developed after breast cancer treatment. This tool enables a better understanding of the quality of life of a patient. Based on the outcome of the Lymph-ICF-UL, treatment goals for patients with upper limb lymphedema can be set. Thereafter, the questionnaire may be used to monitor long-term results of this treatment and self-care. For the interpretation of follow-up assessments with the Lymph-ICF-UL, a decrease or increase of 14 or more of the total score should be considered as clinically relevant.

Acknowledgments

The authors are very grateful to the hospitals collaborating in this study. The authors also extend their very grateful thanks to the study participants. All authors critically revised the article for important intellectual content and approved the final article. This study is financed by the Agency for Innovation by Science and Technology, applied Biomedical Research (IWT 150178). To arrange such financing a separate collaboration agreement has been signed by the University Hospitals of Leuven and the beneficiaries.

Clinical Trial

The study makes part of a double-blind, multicenter, randomized controlled trial (EFforT-BCRL trial), which is registered in clinicaltrials.gov (NCT02609724). CME reference S58689, EudraCT No. 2015-004822-33.

Author Disclosure Statement

No competing financial interests exist.

Supplementary Material

Supplementary Appendix S1

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