Table 2. Instruments yielded by cluster analysis and their corresponding domains, with median/mean scores reported. Values in square brackets signify items no longer considered relevant to that disease.

Domain	Instruments	CTD-ILD Median/Mean	IPF Median/Mean
Dyspnea	Borg Dyspnea Index	7.0/6.9	7.0/7.0
	Dyspnea 12	[7.0/6.6]	7.0/6.7
	Medical Research Council (MRC) Breathlessness (Chronic Dyspnea) Scale or the Modified MRC Dyspnea Scale	7.0/7.0	7.0/7.1
	Borg Dyspnea Index, pre- and post-exercise	7.0/7.0	[7.0/7.1]
Health-related quality of life (HRQOL)	Medical Outcome Study Short Form-36 Questionnaire	7.0/7.3	7.0/7.3
	St. George's Dyspnea Respiratory Questionnaire	[7.0/6.6]	7.0/6.8
	Visual analog scale of patient assessment of disease activity	7.0/6.8	7.0/6.7
	Ability to carry out activities of daily living	7.0/6.8	Lost Tier 1
	Health Assessment Questionnaire Disability Index	7.0/7.0	Lost Tier 1
Lung imaging	Extent of honeycombing on HRCT	7.0/7.1	8.0/7.4
	Extent of reticulation on HRCT	[7.0/6.9]	7.0/6.9
	Extent of ground glass opacities on HRCT	7.0/7.2	[7.0/6.7]
	Overall extent of interstitial lung disease on HRCT	8.0/7.7	8.0/7.7
Lung physiology/function	Supplemental oxygen requirement	7.0/7.3	8.0/7.5
	Forced vital capacity on spirometry	8.0/8.3	9.0/8.3
	Diffusion capacity of lung for carbon monoxide	8.0/7.9	8.0/7.9
	6-MWT with maximal desaturation on pulse oximetry	7.0/6.8	7.0/7.0
	6-MWT for distance	[7.0/6.5]	7.0/7.0
Survival	Time to decline in forced vital capacity	7.0/7.3	7.0/7.0
	Progression-free survival	8.0/8.2	8.0/8.3
	Time to death	7.0/7.1	8.0/7.3

6-MWT: 6-minute walk test; CTD-ILD: connective tissue disease-related interstitial lung disease; IPF: idiopathic pulmonary fibrosis; HRCT: high-resolution computed tomography.

individually analyzed by 5 or more independent evaluators (one of whom was a patient research partner) with subsequent comparative analysis across transcripts. Throughout the process, the patient-research partner provided expert guidance in interpretation and theme development, and prioritization of themes.

Following the focus groups, patient partners completed a questionnaire to rate and prioritize the importance of a series of domains presented in lay terminology. The question was asked "On a scale from 1 to 7, how much do you care about the following item as it relates to your lungs?" Some examples included: "How much do you cough?" and "How good are the results of your chest x-ray or CT scan?"

At the time of OMERACT 11, data from 6 focus groups including 45 English-speaking participants were available. Two groups included patients with various underlying CTD: 1 with rheumatoid arthritis and ILD, 1 with idiopathic inflammatory myositis and ILD, and 2 with SSc and ILD. Moderation of focus groups necessitated knowledge of ILD, using both script and guiding discussions of lung disease as a primary topic or a comparator topic to the underlying disease. From these groups a preliminary set of congruent themes and issues important to inform synthesis with the HCP Delphi process for identifying domains and outcome measures emerged:

Cough. Cough, originally lost in HCP Delphi process, was found to (1) be central to the experience of patients with ILD; (2) impair physical functional, sleep, and social aspects of health-related quality of life (HRQOL); and (3) be well articulated by patients who could (i) describe its quality and distinguish between types of cough; (ii) recognize various triggers of cough; and (iii) identify changes in cough that are relevant to difficulty breathing (dyspnea).

Dyspnea. Dyspnea, a central experience to patients (although it had survived the HCP Delphi process) revealed important areas of discordance with concepts of "difficulty in breathing," i.e.: (1) It rarely referred to the act of breathing itself; (2) descriptors such as "shortness of breath" were rarely used to describe difficulty in breathing; rather descriptors such as "winded", "wind cut," trouble "getting a deep breath in," "can't catch a breath," "losing your breath" were used; (3) it was described in the context of the ability to carry out a central life activity, such as: (i) not being able to finish reading or singing a song to children/grandchildren; (ii) not being able to accomplish activities of daily living, care for others and surroundings; (iii) length of recovery time between tasks. The limitations arising from dyspnea generate (1) feelings of frustration, shame, anger, and isolation; (2) sleep disturbances; and (3) loss of connectedness/participation in family, employment, social, and pleasurable activities.

Distinct components of HRQOL affected were described, including mental health, fatigue, sleep, participation, etc. Such distinction had not been identified in the HCP Delphi

process. Cough, dyspnea, and HRQOL have been identified as important health areas for IPF[6].

"Cough" was clearly important to patients, although it did not survive as a domain in the HCP Delphi process. "Dyspnea," although included as a domain, revealed important areas of discordance between the language and concepts reflected in current instruments and those expressed by patients. Discrete areas of HRQOL were identified as important to patients. Additionally, patient participants identified previously unanticipated and important insights regarding the burden of these diseases: living with uncertainty, challenges in physician communication, struggle over new self, coping strategies, and self-efficacy.

OMERACT 11 Proceedings (Table 3)

At the CTD-ILD SIG at OMERACT 11, data from both the HCP Delphi exercise and the patient focus groups were presented. The main objectives of the meeting were to examine crucial issues arising from the preliminary comparative synthesis of data from both investigations. In addition, an in-depth analysis of data relating to psychosocial concepts that fell outside the primary goal of developing outcome measures in RCT was discussed by Drs. Frankel and Mittoo. Ms. LeSage and Ms. Sarver provided poignant summaries regarding the burden of their disease, issues pertaining to healthcare delivery for the patient with ILD, use of instruments, as well as unique interpretations of the data. This offered unanticipated and significant enhancements to the clinical knowledge of most of the attendees. Dr. Frankel presented results of the patient focus group analyses with interpretations based on careful reconstruction of patient-guided themes — this was expanded and corroborated by Ms. LeSage and Ms. Sarver. These presentations promoted understanding of patient response to the Delphi results and demonstrate lateralization of priorities between the 2 groups and thus an interim consensus.

Results of the patient perspective investigation revealed "cough" to be central to the patient experience, although it did not survive the HCP Delphi process. Patients were able to articulate subtleties indicating that "cough" in ILD is associated with distinct qualities not captured in currently available instruments, especially because current instruments of cough were not developed with patient participation nor specifically for patients with ILD. It was hypothesized by the group that "cough" may have been lost in the medical expert Delphi because of lack of an appropriate instrument. In view of these points, the following received 100% acceptance upon voting:

- Any domain important to either HCP or patient participants should be considered for inclusion in the core sets for CTD-ILD and IPF
- "Cough" should be included in the core sets for CTD-ILD and IPF
- Although appropriate instruments may be used in the interim, new instruments should be developed for "cough" specific for CTD-ILD and/or IPF with patient participation

"Dyspnea" was deemed important in both investigations, although there was important discordance between HCP and patient perspectives. In view of these points, the following received 100% acceptance upon voting:

- Although appropriate instruments may be used in the interim, new instruments should be developed for "dyspnea" specific for CTD-ILD and/or IPF with patient participation

Although HRQOL was collapsed into a single domain during the HCP Delphi process, patient participants identified the clearly defined importance of each of the discrete components of HRQOL. After discussion, the following was supported by an 82% vote for acceptance:

- Recognition of discrete components of HRQOL is essential; however, until these components can be

Table 3. Domains ratified during OMERACT 11 proceedings. Forging consensus between patients and physicians with special considerations.

Domains from Combined Investigations	Special Considerations
Dyspnea	Unexpected language and contextual factors
	Consider need for disease-specific instrument development
Cough	Pervasive effect on dyspnea and HRQOL
	Core set inclusion received 100% endorsement
	Consider need for disease-specific instrument development
Health-related quality of life (HRQOL; also captures patient global assessment)	Consider need for disease-specific instrument development
	HRQOL is affected by uncertainty surrounding disease outcome
	HRQOL may be affected by physician-patient communication
Lung physiology/function	Important to patients and physicians
	Patients are anxious about performance-related results (re: poor result of spirometry because of "effort" or a "bad day")
Lung imaging	Patients and physicians care about this domain
Survival	Important to both groups
	Patients want to communicate about prognosis and handling episodic exacerbations
Medications	Important to both groups
	Incremental increase/decrease may be useful as a disease activity marker but depends on targeted therapy

supported by validated instruments for CTD-ILD and/or IPF, interim instruments designed to measure generic and disease-specific HRQOL may be utilized

Strong support in the HCP Delphi for results led to the proposal that strategies in the handling of adjuvant immunosuppressant agents be decided depending on the targeted therapy. It was acknowledged that, in the present state of uncertainty about the benefits of the medication and management of ILD, this is a complex concept. However, after discussion, the following was supported by an 82% vote for acceptance:

- Both strategies: (a) dichotomous treatment failure/success defined by increase or decrease in immunosuppressive agents and (b) incremental increases or decreases in immunosuppressive agents over time be considered as outcome measures, on a protocol specific basis.

At OMERACT 10, discussions during the CTD-ILD SIG included consideration of cohort enrichment, as well as alternative models of efficacy and clinically meaningful endpoints, particularly in a condition that typically results in irreversible damage[5]. Subsequent discussions during OMERACT 11 resulted in 100% voting for acceptance:

- "Lack of progression" should be considered a clinically meaningful endpoint in RCT in CTD-ILD and IPF
- Definitions of "progression free survival" should be a goal of the CTD-ILD Working Group for use in RCT

These points were important for future efforts of this CTD-ILD Working Group.

Future Directions

The next step in the process is a meeting of HCP and patient participants, using nominal group technique (NGT), to identify currently available instruments most appropriate to measure the domains selected from the HCP Delphi process and patient participant focus groups, examine the degree to which they meet the "OMERACT filter"[7], and to outline the research agenda.

The selected domains, which include the reinstatement of "cough," "dyspnea" as voted upon in the OMERACT proceedings, as well as "patient global assessment of disease activity," will be evaluated by a panel of experts: patients, as well as pulmonary, rheumatology, and radiology specialists in the fields of IPF and CTD-ILD. A domain to capture the above called "signs and symptoms" is under consideration.

"Domain teams" including representation from each expert group according to expertise will be assigned to present the most updated information regarding the instruments and how well they fulfill the OMERACT filter; each team will also be responsible for ensuring that patient perspective results are included. As an example, a concept central to the OMERACT Filter 2.0, a core domain of "survival" or death will be considered. Importantly it encompasses not only the length of time a patient lives, but also the concept of "progression free survival." Additional discussion and voting will include addressing whether and how "lung physiology/function" measures should be part of the core set. For each accepted instrument, experts will determine whether they should be considered primary or secondary endpoints and whether a preliminary threshold of change (e.g., > 10% decline in DLCO regarded as significant) can be assigned.

In addition to the pre-meeting endeavors of the "domain teams," pre-meeting educational sessions on the meeting process and OMERACT methodology[7] are planned, allowing for clarification and review of the combined results. A subsequent meeting in San Francisco in May 2012 was dedicated to review the NGT content and process review for the pulmonary experts on the panel. This meeting also provided a forum to discuss the results of these OMERACT proceedings. Patient experts will attend a pre-meeting teleconference/Web series that deconstructs domains and potential instruments' importance as perceived by medical experts as well as a forum devoted to reviewing the patient-centered data, with continual open discussion of experiences and perceptions related to the instruments.

Future directions necessitate a priority-tiered research agenda to guide inclusion and testing of non-core set items that did not survive the Delphi tier-filtered exercise but may nonetheless be considered important for examination within the context of randomized clinical trials, clinical practice, and registry studies. Continued work will necessarily involve non-physician HCP such as nurse specialists in ILD and pulmonary rehabilitation therapists, who provide useful insights into the disease process and care of these patients.

Summary

Perspectives from and results of the HCP Delphi process and patient perspective focus groups will be reconciled in the evaluation of domains and instruments appropriate for their assessment in 1 year RCT in CTD-ILD and IPF at an upcoming NGT meeting. Following this and on completing an outline of the research agenda, the CTD-ILD group will work over time to develop a responder analysis using the core set of domains and recommended and validated instruments.

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APPENDIX 1

List of study collaborators: The OMERACT CTD-ILD Working Group: Robert P. Baughman, Kevin K. Brown, Romy B. Christmann, Paul Dellaripa, Christopher P. Denton, Oliver Distler, Aryeh Fischer, Kevin Flaherty, Dörte Huscher, Dinesh Khanna, Otylia Kowal-Bielecka, Peter A. Merkel, Chester V. Oddis, David Pittrow, Nora Sandorfi, James R. Seibold, Jeffrey Swigris, Athol Wells, Katerina Antoniou, Flavia V. Castelino, Lisa Christopher-Stine, Harold R. Collard, Vincent Cottin, Sonye Danoff, Robert Hedlund, Kristin B. Highland, Laura Hummers, David A. Lynch, Dong Soon Kim, Jay H. Ryu, Lisa Christopher-Stine, Frederick W. Miller, Karen Nichols, Susanna M. Proudman, Luca Richeldi, Ami A. Shah, Pieter van den Assum.

Delphi Process Collaborators: Rohit Aggarwal*, University of Pittsburgh School of Medicine, USA; Gillian Ainslie, University of Cape Town & Groote Schuur Hospital, South Africa; Firas Alkassab, University of North Carolina-Chapel Hill, Charlotte, USA; Yannick Allanore*, Université Paris Descartes, France; Marina E. Anderson, University of Liverpool, UK; Andrew P. Andonopoulos, University of Patras School of Medicine, Greece; Danielle Antin-Ozerkis, Yale University School of Medicine, USA; Katerina Antoniou*, University of Crete, Greece; Ana Arrobas, Centro Hospitalar de Coimbra, Portugal; Dana P. Ascherman*, University of Miami Miller School of Medicine, USA; Shervin Assassi, University of Texas Health Science Center at Houston, USA; Murray Baron, Jewish General Hospital, McGill University, Canada; Joan M. Bathon*, Columbia University College of Physicians and Surgeons, USA; Robert P. Baughman*, University of Cincinnati, OH, USA; Juergen Behr, Ludwig-Maximilians University, Munich, Germany; Lorenzo Beretta, Referral Center for Systemic Autoimmune Diseases-Milan, Italy; Clifton O. Bingham III, Johns Hopkins University, USA; Matthew Binnie, St. Michael's Hospital, Toronto, Canada; Surinder S. Birring, King's College Hospital, UK; Francesco Boin, Johns Hopkins University; USA; Tim Bongartz*, Mayo Clinic College of Medicine, USA; Arnaud Bourdin, Département de Pneumologie et Addictologie INSERM U1046, Université Montpellier, France; Demosthenes Bouros, Democritus University of Thrace, Greece; Richard Brasington, Washington University, St. Louis, USA; Paul Bresser, Onze Lieve Vrouwe Gasthuis, Netherlands; Kevin K. Brown*, National Jewish Health; Denver, CO, USA; Maya H. Buch, University of Leeds, UK; P. Sherwood Burge, Birmingham Heartlands Hospital, UK; Loreto Carmona, Universidad Camilo José Cela and Institute for Musculoskeletal Health, Spain; Flavia V. Castelino*, Massachusetts General Hospital, Boston, MA, USA; Patricia E. Carreira, Hospital Universitario, Spain; Carlos R.R. Carvalho, University of Sao Paulo Medical School, Brasil; Luis J. Catoggio, Hospital Italiano de Buenos Aires, Argentina; Kevin M. Chan, University of Michigan Health Systems, USA; Jeffrey Chapman, Cleveland Clinic, USA; Soumya Chatterjee, Cleveland Clinic, USA; Romy B. Christmann*, Boston University School of Medicine, Boston, MA, USA; Lisa Christopher-Stine*, Johns Hopkins University, Baltimore, MD, USA; Felix Chua*, St. George's Hospital NHS Trust, UK; Lorinda Chung, Stanford University School of Medicine, USA; Matthew Conron, St Vincent's Hospital, Australia; Tamera Corte, University of Sydney, Australia; Gregory Cosgrove, National Jewish Health, USA; Ulrich Costabel, University of Duisburg-Essen, Germany; Vincent Cottin*, Claude Bernard University, Lyon, France; Gerard Cox, McMaster University, Canada; Bruno Crestani, Centre de Compétences Maladies Rares Pulmonaires, Paris, France; Leslie J. Crofford, University of Kentucky College of Medicine, USA; Mary E. Csuka, Medical College of Wisconsin, USA; Pablo Curbelo, Universidad de la República, Montevideo, Uruguay; László Czirják, University of Pécs, Hungary; Zoe Daniil, University of Thessaly, Larissa, Greece; Sonye Danoff*, Johns Hopkins University, Baltimore, MD, USA; Christine L. D'Arsigny, Queen's University, Canada; Gerald S. Davis, College of Medicine University of Vermont, USA; Joao A. de Andrade, University of Alabama at Birmingham, USA; Paul F. Dellaripa*, Brigham and Womens Hospital, Boston, MA, USA; Paul De Vuyst, Hopital Erasme, Université Libre de Bruxelles, Belgium; Owen J. Dempsey, Aberdeen Royal Infirmary Foresterhill, Scotland, UK; Christopher P. Denton*, Royal Free Hospital, London, UK; Chris T. Derk, University of Pennsylvania, USA; Jörg Distler, University of Erlangen-Nuremberg, Germany; Oliver Distler*, University Hospital Zurich, Switzerland; William G. Dixon*, University of Manchester, UK; Gregory Downey, National Jewish Health, USA; Mittie K. Doyle, Alexion Pharmaceuticals Inc., Cambridge, MA, USA; Marjolein Drent, Maastricht University, Maastricht, Netherlands; Lakshmi Durairaj, Carver College of Medicine, University of Iowa, USA; Paul Emery, University of Leeds, UK; Luis R. Espinoza, Louisiana State University Health Sciences Center, New Orleans, USA; Dominique Farge, St. Louis Hospital, Paris, France; Maryam Fathi, Karolinska Institutet, Sweden; Charlene D. Fell, University of Calgary, Canada; Barri J. Fessler, University of Alabama at Birmingham, USA; Aryeh Fischer*, National Jewish Health; Denver, CO, USA; John E. Fitzgerald, University of Texas Southwestern Medical Center, USA; Kevin R. Flaherty*, University of Michigan, USA; Ivan Foeldvari, University of Hamburg, Germany; George A. Fox, Memorial University of Newfoundland, Canada; Tracy M. Frech, University of Utah, USA; Sara Freitas, Coimbra Hospital and University Center, Portugal; Daniel E. Furst*, University of California Los Angeles, USA; Armando Gabrielli, Università Politecnica delle Marche, Ancona, Italy; Rosario García-Vicuña, Hospital Universitario de la Princesa IISP, Spain; Ognian B. Georgiev, University Hospital Alexandrovska, Sofia, Bulgaria; Anthony Gerbino, Virginia Mason Medical Center, USA; Adrian Gillisen, General Hospital Kassel, Germany; Dafna D. Gladman, University of Toronto, Canada; Marilyn Glassberg, University of Miami Miller School of Medicine, USA; Bernadette R. Gochuico, National Human Genome Research Institute, National Institutes of Health, USA; Athena Gogali, University Hospital of Ioannina, Greece; Nicole S. Goh*, Alfred Hospitals, Melbourne, Australia; Avram Goldberg, Hofstra North Shore LIJ School of Medicine, USA; Hilary J. Goldberg, Brigham and Women's Hospital, Harvard Medical School, USA; Mark F. Gourley*, National Institutes of Health, USA; Leroy Griffing, Mayo Clinic College of Medicine, USA; Jan C. Grutters, University Medical Center Utrecht, Netherlands; Ragnar Gunnarsson, Oslo University Hospital, Norway; Eric Hachulla, Claude Huriez Hospital, University of Lille, France; Frances C. Hall, University of Cambridge, UK; Sergio Harari, U.O. di Pneumologia Ospedale San Giuseppe MultiMedica, Milan, Italy; Ariane L. Herrick, University of Manchester, UK; Erica L. Herzog, Yale University School of Medicine, USA; Roger Hesselstrand, Lund University, Sweden; Kristin Highland*, Cleveland Clinic, Cleveland, OH, USA; Nikhil Hirani, University of Edinburgh, UK; Ulla Hodgson, Helsinki University Hospital,

Finland; Helen M. Hollingsworth, Pulmonary Center, Boston University School of Medicine, USA; Robert J. Homer, Yale University School of Medicine Department of Pathology, USA; Rachel K. Hoyles, Oxford Centre for Respiratory Medicine, UK; Vivien M. Hsu, University of Medicine and Dentistry of New Jersey, USA; Richard B. Hubbard, University of Nottingham, UK; Laura Hummers*, Johns Hopkins University, Baltimore, MD, USA; Nicolas Hunzelmann, Department of Dermatology, University of Cologne, Germany; Dörte Huscher*, German Rheumatism Research Centre, Berlin, Germany and Charité Universitaetsmedizin, Berlin, Germany; Maria Eloisa Isasi, Hospital Maciel, Montevideo, Uruguay; Elida Susana Isasi, Hospital Maciel, Montevideo, Uruguay; Soren Jacobsen, Rigshospitalet, Copenhagen University Hospital, Denmark; Sergio A. Jimenez, Jefferson University, USA; Sindhu R. Johnson, University of Toronto, Toronto, Canada; Christine H. Jones, University of Vermont College of Medicine, Fletcher Allen Health Care, USA; Bashar Kahaleh, University of Toledo Medical Center, USA; Ronaldo A. Kairalla, Heart Institute (InCor), University of São Paulo Medical School, Brazil; Meena Kalluri, University of Alberta, Canada; Sanjay Kalra, Mayo Clinic, USA; Robert J. Kaner, Cornell University School of Medicine, USA; Dinesh Khanna*, University of Michigan, USA; Dong Soon Kim*, Asan Medical Center University of Ulsan, Korea; Brent W. Kinder, University of Cincinnati College of Medicine; USA; Goksel Kiter (Kiter G.), Pamukkale University, Turkey; Ross C. Klingsberg, Tulane University School of Medicine, USA; Maria Kokosi, Sismanoglio General Hospital; Martin R.J. Kolb, McMaster University, Canada; Otylia M. Kowal-Bielecka*, Medical University of Bialystok, Poland; Joanna Kur-Zalewska, Military Institute of Medicine, Warsaw, Poland; Masataka Kuwana*, Keio University School of Medicine, Japan; Fiona R. Lake, University of Western Australia; Edward V. Lally, Brown University, USA; Joseph A. Lasky, Tulane University School of Medicine, USA; Ileda M. Laurindo, University of Sao Paulo, Brasil; Lawrence Able, Sanjay Gandhi Postgraduate Institute of Medical Sciences, India; Peter Lee, University of Toronto, Canada; Colm T. Leonard, University Hospital of South Manchester NHS Foundation Trust, UK; Dale C. Lien, University of Alberta, Canada; Andrew H. Limper, Mayo Clinic College of Medicine, USA; Stamatis-Nick C. Liossis, University of Patras Medical School, Greece; Kristine M. Lohr, University of Kentucky College of Medicine, USA; James E. Loyd, Vanderbilt University, USA; Ingrid E. Lundberg*, Karolinska Institutet, Sweden; Yolanda N. Mageto, University of Vermont, USA; Toby M. Maher, Royal Brompton Hospital, UK; Tafazzul H. Mahmud, Shaikh Zayed Medical complex, Lahore, Pakistan; Helene Manganas, CHUM (Notre-Dame Hospital), Canada; Isabelle Marie, Rouen University, France; Theodore K. Marras, University Health Network, Mount Sinai Hospital and the University of Toronto; José Antônio Baddini Martinez, Faculdade de Medicina de Ribeirao Preto, Brasil; Fernando J. Martinez, University of Michigan, USA; Alessandro Mathieu, Università degli Studi di Cagliari, Italy; Marco Matucci-Cerinic*, University of Florence, Italy; Maureen D. Mayes*, University of Texas Health Science Center at Houston, USA; Kevin M. McKown, University of Wisconsin School of Medicine and Public Health, USA; Thomas A. Medsger Jr., University of Pittsburgh School of Medicine, USA; Richard T. Meehan, National Jewish Health, USA; Ana Cristina Mendes, Serviço de Pneumologia 1, CHLN-Hospital de Santa Maria, Portugal; Peter A. Merkel*, University of Pennsylvania, Philadelphia, PA, USA; Keith C. Meyer, University of Wisconsin School of Medicine and Public Health, USA; Ann B. Millar, University of Bristol, UK; Frederick W. Miller*, National Institutes of Health, Bethesda, MD, USA; Nesrin Moğulkoç, Ege University, Izmir, Turkey; Jerry A. Molitor, University of Minnesota, USA; António Morais, Pneumology Department, Centro Hospitalar São João, Portugal; Luc Mouthon, Hôpital Cochin, Paris, France; Veronika Müller, Semmelweis University, Hungary; Joachim Müller-Quernheim, University of Freiburg, Germany; Oleg Nadashkevich, Lviv National Medical University, Ukraine; Roland Nador, University of Alberta, Canada; Peter Nash, University of Queensland, Australia; Steven D. Nathan, Inova Fairfax Hospital, USA; Carmen Navarro, Instituto Nacional de Enfermedades Respiratorias, Mexico; Sofia Neves, Centro Hospitalar Vila Nova de Gaia/Espinho, Portugal; Imre Noth, University of Chicago, USA; Hilario Nunes, Avicenne Hospital, Paris, France; Chester V. Oddis*, University of Pittsburgh, Pittsburgh, PA, USA; Amy L. Olson, National Jewish Health, USA; Christian F. Opitz, DRK Kliniken Berlin-Köpenick, Berlin, Germany; Maria Padilla, Mount Sinai School of Medicine, New York, USA; Dimitrios Pappas, Columbia University College of Physicians and Surgeons, USA; Helen Parfrey, University of Cambridge and Papworth Hospital, UK; José M. Pego-Reigosa, Meixoeiro Hospital, Spain; Carlos A.C. Pereira, Federal University of São Paulo, Brasil; Rafael Perez, University of Kentucky College of Medicine, USA; Kristine Phillips*, University of Michigan, USA; David Pittrow, University of Dresden, Germany; Janet E. Pope*, Western University, Canada; Joanna C. Porter, University College London, UK; Susanna M. Proudman*, University of Adelaide, Australia; Elisabeth A. Renzoni, Interstitial Lung Disease Unit, Royal Brompton Hospital, UK; Luca Richeldi*, University Hospital of Modena, Modena, Italy; Gabriela Riemekasten, Charité Universitätsmedizin Berlin, Germany; David J. Riley, University of Medicine and Dentistry of New Jersey, USA; Maureen Rischmueller, The Queen Elizabeth Hospital and University of Adelaide, Australia; Tatiana S. Rodriguez-Reyna, Instituto Nacional de Ciencias Médicas y Nutrición, Mexico; J. Rojas-Serrano, Instituto Nacional de Enfermedades Respiratorias, Mexico; Jesse Roman, University of Louisville Health Sciences Center, USA; Glenn D. Rosen, Stanford University School of Medicine, USA; Milton Rossman, University of Pennsylvania, USA; Naomi Rothfield, University of Connecticut Health Center, USA; Jay H. Ryu*, Mayo Clinic College of Medicine, Rochester, MN, USA; Steven A. Sahn, Medical University of South Carolina, USA; Nora Sandorfi*, University of Pennsylvania, USA; Alessandro Sanduzzi, Università degli Studi di Napoli "Federico II", Italy; Mary Beth Scholand, University of Utah, USA; James R. Seibold*, Scleroderma Research Consultants LLC, Avon, CT, USA; Moises Selman, Instituto Nacional de Enfermedades Respiratorias, Mexico; Jean-Luc Senécal, University of Montreal, Canada; Philip Seo, Johns Hopkins University, USA; Ami Shah*, Johns Hopkins University, USA; Richard M. Silver*, Medical University of South Carolina, USA; Joshua J. Solomon, National Jewish Health, USA; Virginia Steen*, Georgetown University, USA; Wendy Stevens, St. Vincent's Hospital, Melbourne, Australia; Charlie Strange, Medical University of South Carolina, USA; Robert Sussman, Pulmonary and Allergy Associates, Summit, NJ, USA; Evelyn D. Sutton, Dalhousie University, Canada; Nadera J. Sweiss, University of Illinois, Chicago, USA; Jeffrey Swigris, National Jewish Health; Denver, CO, USA; Göran Tornling, Karolinska Institutet, Sweden; George E. Tzelepis, University of Athens Medical School, Greece; Alvaro Undurraga, Thorax National Institute, Santiago, Chile; Allessandra Vacca, University and A.O.U. of Cagliari, Italy; Carlo Vancheri, University of Catania, Italy; Janos Varga, National Koranyi Institute of TB and Pulmonology, Hungary; Douglas J. Veale, University College Dublin, Ireland; Suncica Volkov, University of Illinois, Chicago, USA; Ulrich A. Walker, Basel University Dept. of Rheumatology, Felix Platter-Spital, Switzerland; Athol U. Wells, Royal Brompton Hospital and National Heart and Lung Institute; London, UK; Mark Wencel, Via Christi Clinic, University of Kansas Medical Center – Wichita, USA; Lewis J. Wesselius, Mayo Clinic Arizona, USA; Melissa Wickremasinghe, St. Mary's Hospital, London, UK; Pearce Wilcox, University of British Columbia, Canada; Margaret L. Wilsher, Auckland District Health Board and University of Auckland, New Zealand; Frank A. Wollheim, Lund University, Sweden; Wim A. Wuyts, University Hospitals Leuven, Netherlands; Gordon Yung, University of California-San Diego, USA; Pietro Zanon, Ospedale di Circolo di Busto Arsizio, Italy; Christopher J. Zappala, Royal Brisbane and Women's Hospital, Brisbane QLD Australia; Pathology Advisory Team: Steve D. Groshong, National Jewish Health, USA; Kevin O. Leslie, Mayo Clinic College of Medicine, USA; Jeffrey L. Myers, University of Michigan, USA; Robert F. Padera, Brigham and Women's Hospital, USA; Radiology Advisory Team: Sujal R. Desai, King's College Hospital, London, UK; Jonathan Goldin, David Geffen School of Medicine, UCLA, USA; Ella A. Kazerooni, University of Michigan, USA; Jeffrey S. Klein, Fletcher Allen Health Care, University of Vermont, USA; David A. Lynch, National Jewish Health, Denver, USA; Additional Statistical Support: Kevin J. Keen, University of Northern British Columbia, Prince George, Canada. *Disease Committee Member

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ORIGINAL ARTICLE

Connective tissue disease related interstitial lung diseases and idiopathic pulmonary fibrosis: provisional core sets of domains and instruments for use in clinical trials

Lesley Ann Saketkoo,[1] Shikha Mittoo,[2] Dörte Huscher,[3,4] Dinesh Khanna,[5] Paul F Dellaripa,[6] Oliver Distler,[7] Kevin R Flaherty,[5] Sid Frankel,[8] Chester V Oddis,[9] Christopher P Denton,[10] Aryeh Fischer,[11] Otylia M Kowal-Bielecka,[12] Daphne LeSage,[13] Peter A Merkel,[14] Kristine Phillips,[5] David Pittrow,[15] Jeffrey Swigris,[11] Katerina Antoniou,[16] Robert P Baughman,[17] Flavia V Castelino,[18] Romy B Christmann,[19] Lisa Christopher-Stine,[20] Harold R Collard,[21] Vincent Cottin,[22] Sonye Danoff,[20] Kristin B Highland,[23] Laura Hummers,[20] Ami A Shah,[20] Dong Soon Kim,[24] David A Lynch,[11] Frederick W Miller,[25] Susanna M Proudman,[26] Luca Richeldi,[27] Jay H Ryu,[28] Nora Sandorfi,[14] Catherine Sarver,[29] Athol U Wells,[30] Vibeke Strand,[31] Eric L Matteson,[28] Kevin K Brown,[11] James R Seibold[32]

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For numbered affiliations see end of article.

Correspondence to
Dr Lesley Ann Saketkoo, Department of Medicine, Sections of Rheumatology and Pulmonary Medicine and Critical Care, Louisiana State University Health Sciences Center—New Orleans, LSU Scleroderma and Sarcoidosis Patient Care and Research Center, 1542 Tulane Avenue, New Orleans, LA 70112, USA; ctd.ild@gmail.com, lsake1@lsuhsc.edu

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ABSTRACT

Rationale Clinical trial design in interstitial lung diseases (ILDs) has been hampered by lack of consensus on appropriate outcome measures for reliably assessing treatment response. In the setting of connective tissue diseases (CTDs), some measures of ILD disease activity and severity may be confounded by non-pulmonary comorbidities.

Methods The Connective Tissue Disease associated Interstitial Lung Disease (CTD-ILD) working group of Outcome Measures in Rheumatology—a non-profit international organisation dedicated to consensus methodology in identification of outcome measures—conducted a series of investigations which included a Delphi process including >248 ILD medical experts as well as patient focus groups culminating in a nominal group panel of ILD experts and patients. The goal was to define and develop a consensus on the status of outcome measure candidates for use in randomised controlled trials in CTD-ILD and idiopathic pulmonary fibrosis (IPF).

Results A core set comprising specific measures in the domains of lung physiology, lung imaging, survival, dyspnoea, cough and health-related quality of life is proposed as appropriate for consideration for use in a hypothetical 1-year multicentre clinical trial for either CTD-ILD or IPF. As many widely used instruments were found to lack full validation, an agenda for future research is proposed.

Conclusion Identification of consensus preliminary domains and instruments to measure them was attained and is a major advance anticipated to facilitate multicentre RCTs in the field.

Key messages

Why is the key question?
- Can a core set of outcome measures that are reliable and feasible be identified by experts for use in future clinical trials in connective tissue disease associated interstitial lung disease (CTD-ILD) and idiopathic pulmonary fibrosis (IPF)?

What is the bottom line?
- Using established Delphi and nominal group techniques supplemented by patient input, a preliminary core set of outcome measures in CTD-ILD and IPF have been identified.

Why read on?
- To learn the core set of clinically meaningful and feasible measures in CTD-ILD and IPF that were identified and the gaps remaining.

BACKGROUND

The diffuse idiopathic interstitial pneumonias describe a spectrum of parenchymal lung diseases sharing clinical, physiological, radiological and pathological similarities, including varying degrees of fibrosis, inflammation and vascular injury.[1] Idiopathic pulmonary fibrosis (IPF) is associated with usual interstitial pneumonia (UIP), poor survival and limited treatment options.[2] Interstitial lung disease (ILD), most typically presenting as non-specific interstitial pneumonitis, is a leading cause of death in systemic sclerosis (SSc)[3] and a prominent clinical feature of other connective tissue diseases (CTDs), including idiopathic inflammatory myopathy (IIM) and Sjögren syndrome. UIP is also found in rheumatoid arthritis (RA) and IIM.[4 5]

Current evaluations of therapies focus on patient survival or markers of chronic disease progression,

for example, change in forced vital capacity (FVC).[6–8] Measures of patient function, for example, 6 min walk test (6MWT), and health-related quality of life (HRQoL) have been variably applied with inconsistent results.[6] Therapeutic research has been hampered by lack of consensus on and validation of outcome measures that reliably assess the likelihood of treatment response. Furthermore, extra-pulmonary CTD manifestations may confound measures of ILD activity/severity. Patient-reported dyspnoea is demonstrated to predict time to death, yet a satisfactory dyspnoea instrument for ILD has not yet been identified.[7 8] Clinically relevant, patient-reported outcome measures (PROMs) exist for obstructive lung disease and, in the absence of disease-specific measures, have been utilised in trials of ILD.

The Outcome Measures in Rheumatology (OMERACT) filter[9] (see online supplement) is a dynamic and iterative process/structure through which an instrument's performance can be evaluated under three criteria or points of examination: *truth* (face, content, construct and criterion validity), *discrimination* (reliability, sensitivity to change) and *feasibility* (cost, interpretability, accessibility, safety, time). The ideal instrument satisfies all three while instruments incompletely satisfying the filter may still be immediately useful but require additional study.

The Connective Tissue Disease associated Interstitial Lung Disease (CTD-ILD) working group of the OMERACT international consensus initiative convened to define outcome measures for use in randomised controlled trials (RCTs) in CTD-ILD. Given the major clinical overlap, the same process was used in parallel for IPF. We report the results of a three-component process: medical expert Delphi exercise, patient perspective investigations and a combined medical expert and patient participant nominal group technique (NGT) meeting leading to identification of preliminary core sets of domains with corresponding instruments that are clinically meaningful and feasible in the context of a 1-year multi-centre RCT for each CTD-ILD and IPF. These sets of instruments are proposed as the minimum outcome measures to be used in future RCTs and registries.

METHODS

Medical expert Delphi process

Delphi

International experts (n=270) were identified by authorship in peer-reviewed journals, specialty society membership and peer recommendations, and invited to participate in the web-based Delphi process.[10–12] This began with an 'item-collection' stage called Tier 0, wherein participants nominated an unrestricted number of potential domains (qualities to measure) and instruments (specific tools for use as a measure) perceived as relevant for inclusion in a hypothetical 1-year RCT. This exercise produced a list of >6700 items—reduced only for redundancy, organised into 23 domains and 616 instruments and supplemented by expert advisory teams of pathologists and radiologists. The results of Tier 0 provided the content for sequential web-based surveys: Tiers 1, 2 and 3 which progressively reduced the number of voting items as the items with the lowest ratings were dismissed. Survey items for each CTD-ILD and IPF were aligned in parallel and rated along a nine-point Likert scale from 1 ('not at all important') to 9 ('absolutely important'), with 'insufficiently familiar' a voting alternative. An extensive online repository of item-related journal articles was available to participants throughout the process.

Analysis

A cut-off of <4 (median rating) was applied to ratings from the large number of voting items in Tier 1. Cluster analyses were applied to the ratings in Tiers 2 and 3 avoiding the use of an arbitrary cut-off, thus allowing items to aggregate independently providing an unbiased analysis of agreement among raters.[12] A nine-cluster analysis was initially applied and reduced to three clusters for all items during both tiers.

Patient perspective investigation

Patient participation is recognised as integral to development of outcome measures by OMERACT, the US Food and Drug Administration and European Medicines Agency.[9 13] To investigate the patient perspective in CTD-ILD, a set of qualitative studies were conducted: focus groups (60–90 min) of 8–12 consented participants with CTD-ILD were selected by convenience sampling and asked 1) how their life has changed since the diagnosis of their lung disease? and 2) how their lung disease has changed over time? Patient perspective data in 20 English-speaking patients with IPF were previously available.[14] Content was extracted from verbatim transcripts and inductive analysis was applied to minimise investigator bias.[15] Following each focus group, CTD-ILD participants (study patients with IPF were not available) rated on a seven-point Likert scale the importance of the domains identified in Tier 0 of the medical expert Delphi process.

NGT meeting

At the 2012 OMERACT 11 conference and the 2012 American Thoracic Society (ATS) International Conference, data from the Delphi and the patient perspective investigations were reviewed by medical and patient experts. Following this, a face-to-face meeting was held to apply NGT to the overall results.

At the NGT, evaluation of each domain was led by assigned teams of medical and patient participants who presented evidence-based reviews focusing on instrument validation in accordance with the OMERACT filter.[9 12] Several weeks prior to team assembly, interactive educational sessions with the patient participants examined each domain and instrument. The teams served as a resource for evidence-based information during the discussion phases.

After each team presentation, all participants engaged in a 'round-robin' discussion allowing equal speaking time per participant[10–12] over two to three rounds examining acceptance or rejection of an item, potential clinical endpoint assignment, and determination for new instrument development within that domain. Each round of discussions was followed by group voting.

All participants were requested to register a vote for each item. With participants' full knowledge, responses from all physicians and patients with CTD-ILD were tabulated for CTD-ILD, with only those from pulmonologists and patients with IPF for IPF. All votes were recorded. (The radiologist voting was tabulated as a pulmonologist.) A priori, acceptance was agreed upon as ≥70% affirmative votes.[16] Voting addressed inclusion/exclusion of items based on the OMERACT filter and whether the patient perspective and evidence-based data warranted the need for new instrument development for that corresponding domain.

RESULTS

Medical expert Delphi

A total of 254 (137 pulmonologists, 113 rheumatologists and 4 cardiologists) engaged in the Delphi process. Seventy-four per cent reported their primary field of interest being ILD. Participation through all stages exceeded 97%. Six domains identified were: *Dyspnoea*, *HRQoL*, *Lung Physiology/Function*,

Lung Imaging and Survival, and *Medications* for each CTD-ILD and IPF. Eighteen instruments were identified for each CTD-ILD and IPF (tables 1–4).

Focus groups

Focus groups were conducted with patients (n=45) in IIM-ILD (n=11), RA-ILD (n=13), SSc-ILD (n=17) and other CTD diagnoses (n=4) (table 5). Patient participants attributed importance to cough, dyspnoea, fatigue, participation (in family, social and leisure activities, work within and outside the home), physical function, self-care and sleep in the questionnaire and the focus groups. Changes in cough were perceived as reflecting potential worsening ILD. Dyspnoea largely carried descriptors different from current instruments. Patients with IPF identified cough, dyspnoea and HRQoL effects as central symptoms.[14]

OMERACT 11/ATS 2012/Domain Team meetings

Discussions and voting at the OMERACT 11/ATS 2012/Domain Team meetings resulted in the following changes based on the patient perspective data or strong evidence in recent literature (detailed in online supplement):

- *Cough* was reintroduced, discussed and voted upon at the NGT.
- To satisfy the reintroduction of *Cough*, Leicester Cough Monitor (LCM) was introduced as an interim instrument to assess *Cough*.
- The Mahler Dyspnea Index (MDI) and University of California San Diego Shortness of Breath Questionnaire (UCSD-SBQ) were reintroduced under *Dyspnoea* for use in CTD-ILD and IPF, respectively, based on substantive findings in an updated literature review.
- For feasibility, *HRQoL* would capture 'fatigue', 'participation', 'physical function', 'self-care' and 'sleep' until disease-specific investigations into these components were conducted.
- NGT voting would include whether development of new instruments for *Dyspnoea*, *Cough* and *HRQoL* are needed.
- Owing to variability of therapies, concern regarding *Medications* as a core domain was expressed. However, being identified as important in the Delphi, a statement of clarification would be constructed at the NGT.
- 'All-Cause Mortality' was introduced as an assessment of 'Survival'.

Table 2 Domain results of Tier 0

Tier 0 results of 23 domains	
Survival	Mental health
Biomarkers	Sleep
Imaging	Global assessment
Lung physiology/function	HRQoL
Lung parenchyma	Physical function
Lung vascular	Participation
Cardiac function	Employment/work productivity
Composite scores	Medication
Gastroesophageal reflux	Extra-pulmonary CTD features
Cough	Comorbidities
Dyspnoea	Barriers to care
Fatigue	

CTD, connective tissue disease; HRQoL, health-related quality of life.

NGT results

The final NGT panel included 10 pulmonary experts, 12 rheumatology experts and 1 radiology expert, with 5 patient partners (tables 6–8, and see online supplement).

Table 6 displays the voting results on instruments for CTD-ILD and IPF with striking concurrence in all domains except for *HRQoL*, for which Patient Global Assessment (PtGA) was not accepted by the pulmonary experts for IPF.

Tables 7 and 8 present the content of the NGT discussions in the context of the OMERACT filter with items of special interest highlighted below.

It was agreed that 'Medications' (ie, the incremental increase/decrease of glucocorticoid and/or immunosuppressive therapy) should be viewed as protocol specific rather than a core domain. Depending on study design, 'Medications' may be either a dichotomous interpretation of treatment efficacy/failure or a reflection of changes in disease activity.

The lack of validated biomarkers was fully discussed. No items for bio-specimen evaluation emerged from the Delphi exercise but the importance of future biomarker research was planned for during the meeting. Consensus is required to define the minimal standards for investigation-related bio-banking and systematic access to samples by investigators.[17]

Table 1 Reduction of domains and instruments in the Delphi process

Phase yielded	Analysis method	Domains CTD-ILD/IPF	Instruments CTD-ILD/IPF	Participant Dropout (%)
Tier 0	Intense review	133 nominations >>23	>6700 nominations >>616/616	0
Tier 1	<4 median cut-off	21	71/71	2
Tier 2	cluster analysis	13	58/61	<1
Tier 3	cluster analysis	5/5	18/18	0

CTD-ILD, connective tissue disease associated interstitial lung disease; IPF, idiopathic pulmonary fibrosis.

Table 3 Results of the Delphi Tier 3 cluster analysis of domains with median/mean reported

Five domains identified for each CTD-ILD and IPF		
Domain name	CTD-ILD (median/mean) ratings on a 9-point scale	IPF (median/mean) ratings on a 9-point scale
Dyspnoea	(8.0/7.8)	(8.0/8.1)
Health-related quality of life	(8.0/7.7)	(8.0/7.8)
Lung imaging	(9.0/8.3)	(9.0/8.3)
Lung physiology/function	(9.0/8.7)	(9.0/8.7)
Survival	(8.0/8.2)	(9.0/8.4)
Medications	(8.0/7.2)	(7.0/7.3)

CTD-ILD, connective tissue disease associated interstitial lung disease; IPF, idiopathic pulmonary fibrosis.

Table 4 Results from Tier 3 of Delphi

Domain	Instrument	Acceptance in	
Dyspnoea	Borg Dyspnea Index	CTD-ILD	IPF
	MRC Breathlessness (Chronic Dyspnea) Scale or the Modified MRC Dyspnea Scale	CTD-ILD	IPF
	Borg Dyspnea Index pre and post exercise	CTD-ILD	–
HRQoL	Medical Outcomes Trust Short Form 36 health survey	CTD-ILD	IPF
	St George's Dyspnoea Respiratory Questionnaire	–	IPF
	Visual analogue scale of Patient Assessment of Disease Activity	CTD-ILD	IPF
	Ability to carry out activities of daily living	CTD-ILD	–
	Health Assessment Questionnaire Disability Index	CTD-ILD	–
Lung imaging	Extent of honeycombing on HRCT	CTD-ILD	IPF
	Extent of reticulation on HRCT	–	IPF
	Extent of ground glass opacities on HRCT	CTD-ILD	–
	Overall extent of ILD on HRCT	CTD-ILD	IPF
Lung physiology/ function	Supplemental oxygen requirement	CTD-ILD	IPF
	FVC on spirometry	CTD-ILD	IPF
	Diffusion capacity of lung for carbon monoxide	CTD-ILD	IPF
	6MWT with maximal desaturation on pulse oximetry	CTD-ILD	IPF
	6MWT for distance	–	IPF
Survival	Time to decline in FVC	CTD-ILD	IPF
	Progression-free survival	CTD-ILD	IPF
	Time to death	–	IPF
Medications	Increase or decrease in glucocorticoids	CTD-ILD	IPF
	Increase or decrease in concomitant immune suppressive agents	CTD-ILD	IPF

6MWT, 6 min walk test; CTD-ILD, connective tissue disease associated interstitial lung disease; FVC, forced vital capacity; HRCT, high-resolution CT; IPF, idiopathic pulmonary fibrosis; HRQoL, health-related quality of life; MRC, Medical Research Council.

DISCUSSION

These comprehensive international investigations are the first to identify core sets of domains in each CTD-ILD and IPF along with a *provisional* consensus on a minimum cadre of feasible and clinically meaningful outcome measures/instruments. The proposed measures are intended to be a common denominator across future RCTs, longitudinal observational studies and natural history registries until work can be done that substantiates a truly durable framework. The rigorous consensus methodologies of OMERACT outline the overall status of the field. Importantly, this is the first study in ILD to incorporate patient participants in panel meetings or guidelines. From the synergy of these investigations, domains which require development of new instruments were also identified, thus providing guidance for imminent research.

Based on the current data, FVC (100% acceptance) was the measure that the group favoured most for each CTD-ILD and IPF. Again, we emphasise that the overarching construct of this exercise was limited to that of a hypothetical RCT of 1-year duration. FVC has been shown to be a consistently reliable serial variable in IPF. Declines in FVC correlate with increased risk of subsequent mortality,[4 7 8 18–22] although no data exist demonstrating that improvement in FVC correlates with improved survival. Thus, utilising FVC as an endpoint requires consideration of the clinically meaningful magnitude of change independent of potential impact on mortality. This is particularly relevant in studies of short duration.

While changes in FVC have been shown to be reproducible in SSc-ILD, there are insufficient RCT-derived data to evaluate this in other forms of CTD-ILDs.[3–5 20] There are confounding issues of vasculopathy, pulmonary hypertension, cardiac involvement, chest wall impairment and systemic disease activity that are often coexistent in CTD-ILDs. Nonetheless, FVC may most reliably and sensitively reflect the contribution of parenchymal disease above other endpoints.

Though a relative change from baseline predicted is preferred to absolute change from normal values, these changes are recognised as non-parametric in FVC. Thus a discrete clinically relevant threshold of minimal change was not able to be agreed upon in either IPF or CTD-ILD. Further, efforts to validate serial variables are challenged by variations in the rate of disease progression, with interval changes of FVC[20 22] more likely to represent a true change in rapidly progressive disease than in less progressive disease that crosses the same threshold. Extrapolation between two value points will provide less reliable information than continuous variables; therefore, identification of a minimal clinically important difference (MCID) would be misleading without accommodating for these non-parametric changes. Panel discussions surrounding Diffusion Capacity of Lung for Carbon Monoxide (DLCO) reflected the multiple confounders for this instrument, with ranking of FVC as being the favoured marker above DLCO. A threshold of clinically meaningful change was not determined for DLCO.

Table 5 Characteristics of patients with CTD-ILD participating in the focus groups

Group	CTD type	Location	Participants	Gender	Age (years) Mean (SD)	Race
1	Various	Winnipeg, Manitoba, Canada	9 1 IIM, 2 RA, 4 SSc, 2 SLE	8 F, 1 M	53.6 (16.2)	8 C, 1 O
2	RA	Toronto, Canada	7	7 F, 0 M	64.3 (9.0)	4 C, 2 A, 1 AC
3	SSc	Baltimore, Maryland, USA	6	3 F, 3 M	58.2 (9.1)	6 C
4	IIM	Baltimore, Maryland, USA	7	4 F, 3 M	52.4 (10.5)	5 C; 2 AA
5	Various	New Orleans, Louisiana, USA	9 3 IIM, 4 RA, 1 SjS, 1 SLE	6 F; 3 M	53.8 (15.5)	4 C; 4 AA; 1 H
6	SSc	New Orleans, Louisiana, USA	7	5 F; 2 M	54.6 (5.7)	4 AA; 3 C

A, Asian; AA, African American; AC, African Caribbean; C, Caucasian; CTD-ILD, connective tissue disease associated interstitial lung disease; F, female; H, Hispanic; IIM, idiopathic inflammatory myopathy; M, male; O, other; RA, rheumatoid arthritis; SjS, Sjögren's syndrome; SLE, systemic lupus erythematosus.

Table 6 Results of nominal group proceedings with percentage for acceptance (see online supplement for expanded voting tables)

Instrument	CTD-ILD PULM+RHEUM+patients with CTD-ILD	IPF PULM+patient with IPF
Dyspnoea		
MRC Chronic Dyspnea Scale	7/9+9/12+2/3=75%	10/11+1/1=92%
Dyspnea 12	8/10+11/12+3/3=88%	6/9+1/1=70%
UCSD-SBQ	N/A	7/9+1/1=80%
Cough		
Leicester cough monitor	7/10+10/12+2/2=79%	8/10+1/1=82%
HRQoL		
Short Form 36	10/10+11/11+3/3=100%	8/10+1/1=82%
SGRQ	9/10+9/11+2/2=87%	8/10+1/1=82%
VAS-PtGA	10/10+11/12+2/2=96%	N/A
Lung imaging		
Overall extent of ILD on HRCT	11/11+9/11+3/3=92%	10/10+1/1=100%
Lung physiology		
Forced vital capacity	10/10+11/11+3/3=100%	10/10+1/1=100%
Diffusion capacity of lung	10/10+8/10+3/3=91%	10/10+1/1=100%
Survival		
All-cause mortality	Unanimous agreement	Unanimous agreement

CTD-ILD, connective tissue disease associated interstitial lung disease; HRCT, high-resolution CT; HRQoL, health-related quality of life; IPF, idiopathic pulmonary fibrosis; MRC, Medical Research Council; PtGA, Patient Global Assessment; PULM, pulmonary specialist; RHEUM, rheumatology specialist; SGRQ, St George's Respiratory Questionnaire; UCSD-SBQ, University of California San Diego Shortness of Breath Questionnaire; VAS, visual analogue scale.

Neither the 6MWT nor measures of oxygen desaturation survived the NGT process; although deemed feasible they were considered weak in discrimination in addition to construct and criterion validity. The need for supplemental oxygen was not accepted; changes in oxygenation, as judged partly by oxygen desaturation, are difficult to interpret since they do not correlate well with the sensation of dyspnoea or changes in disease progression in mild to moderate disease.[19 23]

The importance of patient-reported dyspnoea for assessing prognosis and disease progression are well recognised.[1 7 8] We identified the Dyspnea 12[24] and the Medical Research Council Dyspnea Scale[18 19] as the best currently available instruments in CTD-ILD and in IPF, yet data are essentially lacking in CTD-ILD. Though the MDI has some demonstrated validity in SSc-ILD[20], NGT panelists allocated this interviewer-administered instrument to the research agenda for CTD-ILD, voicing concerns of poor feasibility and uncertain reliability. The UCSD-SBQ was accepted for use in studying IPF.[21] It was agreed that development of new *Dyspnoea* instruments is warranted to specifically reflect the restrictive lung processes of CTD-ILD and IPF.

The Short Form 36 (SF-36) was recognised as a generic *HRQoL* instrument as anxiety, fatigue, participation, physical function, self-care and sleep are important to patients.[25] The St George's Respiratory Questionnaire, although endorsed, lacked specificity in CTD-ILD and IPF.[26 27] It was agreed that a new disease-specific instrument should be developed.

PtGA, previously validated across rheumatic and non-rheumatic diseases, correlates with dyspnoea in CTD-ILD[28 29] and was accepted as a measure in CTD-ILD with improvements greater than 10 mm agreed upon as an MCID. PtGA not being validated in IPF was allocated to the research agenda in IPF. PtGA may also serve as an 'anchor' to determine MCIDs for

Table 7 Relation of CTD-ILD preliminary core set instruments to aspects of OMERACT filter in CTD-ILD

CTD-ILD	Dyspnoea		Cough	HRQoL			Lung physiology		Lung imaging	Survival	
Instruments	D-12	MRC	LCM	SGRQ	SF-36	PtGA	FVC	DLCO	HRCT—overall extent of disease	All-cause mortality	Time to decline in FVC
Truth											
Face validity	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Content validity	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Construct validity	Y	Y	NT	Y	Y	NT	Y	±	Y	Y	NT
Criterion validity	NT	NT	NT	NT	NT	NT	No	No	Y	Y	NT
Discrimination											
Discriminatory	Y	Y	NT	Y	Y	NT	±	±	Yes, except± for GGO	No	Y
Reliable	Y	Y	NT	NT	Y	NT	Y	N	Yes, except± for GGO	Y	NT
Reproducible	NT	NT	NT	NT	NT	NT	Y	±	Y	N/A	NT
Sensitive to change	Y	Y	NT	NT	Y	NT	Y	±	Yes but relatively slow	N/A	Y
Feasibility											
Cost effective	Y	Y	Y	Y	Y	Y	Y	Y	Y	No*	Y
Interpretability	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Readily available	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Safe for patients	Y	Y	Y	Y	Y	Y	Y	Y	±	Y	Y
Patient-derived content†	Y	No	No	No	No	N/A	N/A	N/A	N/A	N/A	N/A

PtGA is adopted under HRQoL, though it is an independent instrument.
*Not cost effective as a primary efficacy endpoint but highly cost effective as a secondary endpoint to detect treatment toxicity—see text for discussion on 'survival'
†US Food and Drug Administration advocates patient-reported instruments be developed by qualitative data supplied by patients.[18 19]
±, ambiguous; CTD-ILD, connective tissue disease associated interstitial lung disease; D-12, Dyspnea-12; DLCO, diffusion capacity of lung for carbon monoxide; FVC, forced vital capacity; GGO, ground glass opacity; HRCT, high-resolution CT; LCM, Leicester Cough Monitor; MRC, Medical Research Council Dyspnea Scale; N/A, not applicable; NT, not yet tested; OMERACT, Outcome Measures in Rheumatology; PtGA, Patient Global Disease Activity; SGRQ, St George's Respiratory Questionnaire; SF-36, Short Form 36; Y, yes.