



ERS | *monograph*

# Pulmonary Rehabilitation

Edited by Anne E. Holland,  
Simone Dal Corso and  
Martijn A. Spruit

# Pulmonary Rehabilitation

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Anne E. Holland, Simone Dal Corso  
and Martijn A. Spruit

Editor in Chief  
John R. Hurst

This book is one in a series of *ERS Monographs*. Each individual issue provides a comprehensive overview of one specific clinical area of respiratory health, communicating information about the most advanced techniques and systems required for its investigation. It provides factual and useful scientific detail, drawing on specific case studies and looking into the diagnosis and management of individual patients. Previously published titles in this series are listed at the back of this *Monograph*.

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# Preface

John R. Hurst 

PR is an astonishingly effective intervention for improving the health of people living with chronic respiratory disease. It sounds so simple: exercise and education. Deceptively so. But underpinning widely recognised recommendations on how to establish, manage and evaluate PR classes sits a significant body of rigorous research, delivered through the diligence, patience and efforts of multi-professional clinical academics in the PR community. We owe them a great debt of thanks. We now know more about the science of PR than we ever have. And PR clinicians have risen to the challenge of delivering PR in evermore innovative ways following the reduced capacity for face-to-face classes during the COVID-19 pandemic.



This issue of the *Monograph* is therefore both welcome and timely. It covers the topic comprehensively, from service set-up, through outcome measures, to patient experience. And this isn't all about COPD or high-income settings: the evidence basis for PR is now much wider in both a disease-indication and geographical sense.

As the Guest Editors note, for the benefits of PR to be fully realised, every clinician working in respiratory disease must understand how to recommend and refer people to PR, and to advocate strongly for widespread global provision. That task will be made much easier by understanding the evidence for PR, and this *Monograph* provides that state-of-the-art summary.

I congratulate Anne E. Holland, Simone Dal Corso and Martijn A. Spruit on delivering this excellent collection, and the chapter authors for their authoritative summaries. Like all peer-reviewed publications, the efforts of reviewers often go unseen yet their role is vital. To you all, thank you. And to the reader: thank you for your support, enjoy the collection.

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**Disclosures:** J.R. Hurst reports receiving grants, personal fees and non-financial support from pharmaceutical companies that make medicines to treat respiratory disease. This includes reimbursement for educational activities and advisory work, and support to attend meetings.





# Guest Editors

Anne E. Holland

Anne E. Holland is Professor of Physiotherapy and Head of Respiratory Research at Monash University and Alfred Health (Melbourne, Australia). Over the last 20 years she has had the privilege of working in PR and witnessing the important outcomes it delivers for patients. Anne's research programme investigates new models of rehabilitation for people with chronic respiratory disease. Her recent clinical trials have tested novel models of PR to improve access and uptake, including low-cost home-based models and telerehabilitation. She led the first randomised controlled trial of PR for people with pulmonary fibrosis, a treatment that is now considered the standard of care.



Anne has published over 300 peer reviewed journal articles and her publications have been cited over 16000 times, including in 27 clinical guidelines for PR, COPD, pulmonary fibrosis, skeletal muscle dysfunction, oxygen therapy and respiratory management. She has been an Editor for *Cochrane Airways* since 2009, providing editorial oversight for *Cochrane Reviews* of non-drug treatments for respiratory disease.

In 2016, Anne received the American Thoracic Society (ATS) Pulmonary Rehabilitation Assembly Award, in recognition of a career serving the field of PR. She is a Fellow of the Thoracic Society of Australia and New Zealand (TSANZ), and in 2021 was awarded the TSANZ Society Medal, the first allied health professional to be afforded this honour.

Simone Dal Corso

Simone Dal Corso is Professor of the Graduate Program in Rehabilitation Science at the Universidade Nove de Julho (Sao Paulo, Brazil). In 2012, she received a Research Productivity Fellowship from the Brazilian National Council for Scientific and Technological Development (CNPq).



Currently, Simone is leading a research group into Evaluation and Intervention in Cardiorespiratory Diseases, registered as part of the CNPq. Her research mainly focuses on PR in patients with chronic respiratory diseases.



## Martijn A. Spruit



Martijn A. Spruit completed a bachelor in physiotherapy in Amsterdam (the Netherlands), and obtained his MSc and PhD degrees in Rehabilitation Sciences at KU Leuven (Leuven, Belgium).

Currently, Martijn is a member of the Executive Board of Ciro, a specialised PR centre in Horn (the Netherlands). He is also Professor of Rehabilitation Sciences at Maastricht University (Maastricht, the Netherlands).

Martijn has published >325 peer reviewed articles on PR, physical inactivity and treatable traits in patients with chronic organ failure, such as COPD, asthma, ILD and chronic heart failure. He was the lead author of the 2013 American Thoracic Society (ATS)/European Respiratory Society (ERS) Statement on PR.

Martijn was awarded the ERS COPD Research Award in 2013 and became a Fellow of ERS in 2016. He was the 2019 American Association of Cardiovascular and Pulmonary Rehabilitation's (AACVPR) Thomas L. Petty Distinguished Pulmonary Scholar awardee and the 2020 ATS PR Recognition awardee. In 2020, the Hungarian Respiratory Society (MTT) awarded him an honorary membership.

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# Introduction: Pulmonary rehabilitation – strong foundations, new science and opportunities for innovation

Anne E. Holland <sup>1,2,3</sup>, Simone Dal Corso<sup>4</sup> and Martijn A. Spruit <sup>5,6</sup>

 @ERSpublications

This edition of the *Monograph* details advances in the science and practice of #pulumrehab, including the patient groups who will benefit, the breadth of programme content, new methods of delivery and important outcomes. <https://bit.ly/2UM0srM>

PR is not new. It has long been a key component of best care for patients with COPD and its delivery is strongly encouraged in clinical care standards from around the world [1, 2]. This approach is supported by strong evidence that PR delivers meaningful improvements in exercise capacity, symptoms and QoL [3], as well as reductions in hospitalisations [4] and perhaps even improvements in survival [5]. More recently, PR has become the standard of care for patients with other chronic respiratory diseases, including bronchiectasis, pulmonary hypertension, ILD and lung cancer, underpinned by positive findings from clinical trials [6–9].

Whilst there is no question that PR generally “works”, we are still learning how to optimise its delivery and outcomes. In recent years, there have been substantial advances in the science underpinning PR, including the evaluation of novel exercise training methods, behaviour change approaches and physical activity promotion strategies. Many of these newer approaches are now ready for implementation in clinical practice. There has been increasing recognition of important traits that may influence the content, delivery and outcomes of PR for individual patients, including comorbidities, frailty and falls. We have also learnt much more about patient expectations and experiences of PR, and this is critical to inform patient-centred delivery.

For PR to realise its potential, these advances in science must be accompanied by improvements in referral, access and uptake. Prescribing a multicomponent intervention

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like PR is different to prescribing a pill, and is more complex for a patient to “take”. The barriers to uptake of PR have been well documented previously [10] but knowing why patients do not receive this effective treatment has not fixed the problem [11]. In recent years, scientists and clinicians have begun to explore the efficacy of alternative models for delivering PR in clinical trials, to address patient-related barriers such as the inability to travel due to disabling symptoms or geographical gaps in programme availability. Remotely delivered PR models have come into sharp focus during the COVID-19 pandemic, when social distancing and infection control measures resulted in temporary closure of centre-based programmes in much of the world [12].

This *Monograph* provides a comprehensive overview of best practice and new science in PR. Our aim is to provide HCPs and healthcare providers with the necessary tools to establish new PR programmes, to continually improve existing programmes, and to adopt and evaluate future innovations.

The *Monograph* begins by describing the rationale for PR, with a focus on the extrapulmonary consequences of chronic lung disease, such as skeletal muscle dysfunction, physical inactivity and psychosocial burdens, and how these may be addressed by a person-centred, individualised and multidisciplinary PR programme (chapter 1 [13]).

A key feature of this *Monograph* is a chapter on patient perspectives on PR, including suggestions for ways in which HCPs can enhance the patient experience to optimise uptake, engagement, enjoyment and outcomes (chapter 2 [14]).

A thorough patient assessment is a critical component of PR. Chapter 3 includes an overview of assessment and outcome measurement, starting with the essential domains of exercise capacity, symptoms and HRQoL. Assessment tools for other important domains are also discussed, including limb and respiratory muscle function, mood, frailty, cognitive impairment and social support [15]. The principles of exercise training for patients with COPD are addressed in chapter 4, including the core components of aerobic and resistance training, with practical methods for exercise prescription and progression [16]. The *Monograph* then details novel and emerging exercise training strategies, including whole-body vibration training, respiratory muscle training, eccentric training and neuromuscular electrical stimulation (chapter 5 [17]).

Achieving optimal outcomes from PR requires a comprehensive intervention package delivered by a multidisciplinary team. The importance of occupational therapy, nutritional modulation and psychological support is detailed in chapter 6, including specific assessments and interventions that may be offered [18]. Education and self-management training are essential for PR participants to acquire knowledge, skills and strategies and facilitate sustained behaviour change. This *Monograph* describes approaches to the delivery of education that emphasise patient engagement and align with adult learning, and highlights factors that may influence patient engagement, including health literacy, psychological symptoms, cognitive impairment and social support (chapter 7 [19]).

Participants in PR have a range of coexisting medical conditions and a wide spectrum of disease severity. Modifications to PR programmes may be necessary to optimise uptake, adherence and benefits of PR for individual patients. In chapter 8, special considerations for patients with multimorbidity undergoing PR are presented [20]. Opportunities to optimise symptom control and address palliative care needs in PR are also discussed

(chapter 9 [21]), including management of chronic breathlessness, advance care planning, education, psychosocial support and partnership with palliative care teams.

Whilst the evidence for PR emerged in patients with stable COPD, a major development in recent years is our understanding of its benefits in patients with other respiratory diseases. Chapter 10 describes clinical considerations for implementation of PR in patients with ILD, asthma, bronchiectasis, lung cancer and pulmonary hypertension [22]. This *Monograph* also includes clinical cases describing the application of PR in patients with stable COPD, severe asthma, lung cancer and interstitial lung disease [23–26].

PR has important benefits in patients immediately following a COPD exacerbation, but is challenging to implement. Practical considerations for delivery of rehabilitation following COPD exacerbations, including programme timing and components, are provided in chapter 11 [27]. Chapter 12 goes on to discuss the burden of falls in people with COPD, and the potential to ameliorate this through balance training in PR [28].

Innovations in PR over recent years include new methods to measure and promote physical activity participation, and application of theory-informed behaviour change interventions. Practical strategies to integrate these new approaches into PR are presented in chapters 13 and 14 of this *Monograph* [29, 30]. Life after PR is also addressed, including strategies to maintain its benefits over time, and maintenance exercise training interventions (chapter 15 [31]).

Improving access to high-quality PR services is an enduring challenge for the respiratory community across the world. Practical aspects of establishing a new centre-based PR programme are addressed in chapter 16 [32], including staffing, space, equipment, infection control and programme components. Robust quality control and assurance processes for PR, allowing measurement of outcomes against evidence-based standards, are also described in chapter 17 [33]. The complex factors contributing to poor PR access and uptake are detailed in chapter 18 [34], along with potential solutions, including models suitable for low-resource settings (chapter 19 [35]) and emerging home-based or telerehabilitation models (chapter 20 [36]).

PR presents us with enormous opportunities to improve patient and health system outcomes over the coming years, using personalised approaches and innovative programme models (chapter 21 [37]).

Our aim in compiling this *Monograph* is to bring together innovations in science and practice in PR, with the aim of extending its benefits to patients across the globe.

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# List of abbreviations

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<b>6MWD</b>	6-min walk distance
<b>6MWT</b>	6-min walk test
<b>BMI</b>	body mass index
<b>COVID-19</b>	coronavirus disease 2019
<b>CPET</b>	cardiopulmonary exercise testing
<b>ESWT</b>	endurance shuttle walk test
<b>FEV<sub>1</sub></b>	forced expiratory volume in 1 s
<b>HCP</b>	healthcare professional
<b>HRQoL</b>	health-related quality of life
<b>ILD</b>	interstitial lung disease
<b>IPF</b>	idiopathic pulmonary fibrosis
<b>ISWT</b>	incremental shuttle walk test
<b>LMICs</b>	low- and middle-income countries
<b>MCID</b>	minimum clinically important difference
<b>PR</b>	pulmonary rehabilitation
<b>QoL</b>	quality of life