

Preview of highlighted presentations from the European Respiratory Society' clinical assembly

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This paper highlights a selection of abstracts that will be presented at the 2018 European Respiratory Society (ERS) International Congress in Paris. The abstract were submitted through the five different groups of our society largest assembly, the clinical assembly (assembly 1).

The different groups of the ERS' clinical assembly are: (I) Clinical Problems; (II) Rehabilitation and Chronic Care; (III) Imaging; (IV) Interventional Pulmonology; and (V) General Practice and Primary Care.

Aim of this article is to give readers an opportunity to identify outstanding clinical & scientific abstracts before the start of the ERS International Congress in Paris this year. It is our hope that this publication will raise interest in the sessions organized by our assembly and help delegates to navigate the conference's vast program.

Group 1: Clinical Problems

The Clinical Problems group of assembly 1 is by far the largest compared to any other group in the society's assembly system. By definition this group addresses a wide range of topics and it is impossible to summarize or review all highly rated and noteworthy abstracts submitted through this group. We decided to highlight two outstanding abstracts each in the categories "Severe Asthma" and "COPD", knowing that we cannot do justice to the many interesting topics this group will

cover during the ERS International Congress.

Asthma

Abstract: evaluation in a severe asthma (SA) expert center improves asthma outcomes

Patients with severe and difficult-to-treat asthma comprise a small proportion (5–10%) of all asthmatic patients but are responsible for a disproportionate degree of asthma morbidity and costs (1). Previous analyses have concluded that SA patients benefit in terms of asthma control when systematic assessment and multidisciplinary treatment of patients in expert centres are involved in their care (2,3).

Focusing on this increasingly recognised, major unmet need, Prof. Taillé (Paris, France) and her group will present their single expert centre data on the evaluation of SA patients (4) during this year ERS International Congress. Their assessment consists of an outpatient visit with an asthma specialist, followed by a one-day in hospital evaluation, including evaluation of asthma diagnosis, and educational and environmental assessment by a multidisciplinary team. Of initial 201 patients assessed by the centre from 2014 to 2016, the diagnosis of SA was only confirmed in 102 patients, consistent with the literature (5). The majority of patients were referred by a pulmonologist; one third of them received daily oral steroids and 20%

previously failed to improve after an omalizumab trial. After the initial assessment of these patients, further improvement of care was achieved by implementation of individualized therapeutic approaches including pulmonary rehabilitation, nocturnal ventilation for obstructive sleep apnoea, inclusion in a therapeutic trial, prescription of omalizumab, or thermoplasty. After a follow-up period of 12 months after the initial assessment, a significant improvement in asthma control (mean ACT score changed from 13 ± 5 to 16 ± 5.3) was observed, underscoring the importance of dedicated asthma expert centres and care for this vulnerable patient entity.

Abstract: increased sputum FKBP51 gene expression following azithromycin (AZM) add-on therapy in asthma
The macrolide antibiotic AZM has been shown to have a beneficial effect on asthma symptoms on adult patients with uncontrolled asthma under therapy with medium-to-high dose inhaled corticosteroids (6).

Prof. Simpson's group out of Newcastle, Australia went on to further test the hypothesis that AZM would increase gene expression for FKBP51 and that this increase would be associated with a reduction in sputum eosinophils (7). FKBP51 is highly expressed in patients with asthma taking inhaled corticosteroids and one of four immunophilins involved in glucocorticoid receptor translocation (8).

Induced sputum was collected from adults with symptomatic asthma ($n=106$) in a randomized double-blind placebo controlled trial of oral AZM. Gene expression analysis revealed that at baseline, higher sputum FKBP51 expression was significantly associated with a higher ICS total daily dose and lower sputum eosinophils in the whole study population. In those participants who were prescribed AZM, Sputum FKBP51 gene expression was significantly increased following AZM therapy ($P=0.018$).

The authors conclude that an increased expression of FKBP51 may be one pathway by which AZM reduces eosinophilic airway inflammation, possibly through increasing/restoring corticosteroid responsiveness.

This study is an important step in elucidating the mechanisms of action of this pleiotropic drug and will hopefully help in the development of biomarkers that predict the therapeutic response to macrolides and facilitate optimal patient selection for treatment with AZM.

Chronic obstructive pulmonary disease (COPD) and comorbidities

COPD is considered a complex, heterogeneous, and

multicomponent condition (9). Indeed, comorbidities and extrapulmonary manifestations are common in COPD and do impact on morbidity and mortality (10,11). The underlying mechanisms, leading to the co-existence of comorbidities in COPD, and their relations to the pathophysiology of COPD, are poorly understood. Multiple pathophysiological pathways have been suggested that lead to the co-existence of multiple comorbidities in COPD patients, as e.g., systemic inflammation, endothelial dysfunction or accelerated ageing. Not everyone exposed to cigarette smoke develops COPD or cardiovascular disease, or other smoking-related disorders, such that these conditions are part of a spectrum of smoking-related pathology that occurs in those with an underlying genetic susceptibility. This genetic susceptibility is complex, and polygenic (aside from the specific example of alpha-1 antitrypsin deficiency in emphysema). In this way, it is generally thought that at a given genetic background, chronic diseases may develop and progress at different speeds in various combinations in response to a variable mix of common risk factors, such as smoking, alcohol, diet, pollution and physical inactivity (12). Adding knowledge to this context, in this year ERS conference an Meteran *et al.* (13) (Copenhagen, Denmark) will present their study on the association of COPD with 8 different common comorbidities studied in 12,449 twins, aged 40–80 years from the Danish Twin Registry that participated in a nationwide survey. The participants performed spirometry, completed a questionnaire including questions on lifestyle factors, self-reported physician-diagnosed diseases and respiratory symptoms. The authors aimed to examine whether the assumed associations between COPD and comorbidities could be explained by shared genetic or environmental factors. The authors found that the presence of COPD was associated with heart failure and pulmonary embolism, whereas respiratory symptoms alone were associated with 7 out of 8 comorbidities. Conditional logistic regression showed no significant difference in risk of comorbidities in monozygotic and dizygotic twins discordant for respiratory symptoms. The authors acknowledged the association of COPD with heart failure and pulmonary embolism, and stressed that respiratory symptoms are a much stronger predictor for the presence of comorbid disease than the presence of COPD. Then again, the associations seemed not to be influenced by genetic factors. The role of heredity in COPD and multimorbidity remains to be unraveled.

Early clinically important improvement in lung function and symptoms after therapy initiation might predict reduced exacerbation risk

The natural history of COPD can be punctuated by acute deteriorations in symptoms, which we call exacerbations. Exacerbations, especially hospitalised ('severe') exacerbations drive most of the health-care cost associated with COPD, are associated with a small increase in lung function decline rate and are a major driver to impaired quality-of-life. Different people with COPD have different susceptibility to exacerbation, and whilst these are more common in those with more severe disease, exacerbations are very unpredictable. The current best predictor of future exacerbation risk is past exacerbation history (14). There are currently no tools available that helps to estimate the early effect of treatment on future exacerbation risk. In this year ERS meeting, a post-hoc analysis of the 52-week FLAME study (15) addressing the "Early Clinically Important Improvement" after treatment with either indacaterol/glycopyrronium or salmeterol/fluticasone, the two drug combinations patients were randomized to in that study (16). The authors predefined ECII as achievement of minimal clinically important difference (MCID) in trough FEV1 (≥ 100 mL increase) AND one patient reported outcome: reduction in e-Diary score ≥ 0.6 points; reduction in COPD Assessment Test (CAT) ≥ 2 points or reduction in Saint George's Respiratory Questionnaire (SGRQ) ≥ 4 points at 4 or 12 weeks. Approximately 18–21% of patients achieved ECII at weeks 4 or 12 post randomisation according to the different definitions. Patients who achieved ECII experienced lower rates of subsequent exacerbations and longer time to first exacerbation. The ECII is a novel composite outcome measure that could help to predict the response to therapy in terms of future exacerbation risk. The value and reproducibility of this prediction needs to be evaluated.

Group 2: Rehabilitation and Chronic Care

Abstract: pericyte coverage of skeletal muscle capillaries is impaired during training-induced angiogenesis in COPD patients

Skeletal muscle dysfunction is common in patients with COPD, affects the patient's prognosis, exercise tolerance and health-related quality of life (17), and has been related to reduced physical activity. Interestingly, even though exercise training is the most efficient treatment for the peripheral muscle impairment in these patients, this

impairment is never fully reversed (18).

Exercise training and physical activity significantly increases muscle capillarisation in these patients (19,20), however it may be hypothesised that the angiogenic response of muscle to training is present but blunted in COPD, as it happens in other chronic conditions with similar skeletal muscle impairment.

Gouzi *et al.* (21) compared the muscle functional responses and angio-adaptations after training in COPD patients and sedentary healthy subjects. They concluded that the skeletal muscle in COPD patients showed a blunted response to training in terms of muscle capillarisation response, which was linked with lower functional improvements. Skeletal muscle capillarisation and angiogenesis impairments may limit the benefit of exercise training and furthermore the capillary maturation, which is strongly linked to angiogenesis, may also be impaired.

In this year ERS Congress (22), Blervaque *et al.* will present their investigation on the skeletal muscle angiogenesis and the capillary maturation in response to exercise training in COPD. Seven control subjects and 14 COPD patients (FEV₁: 75% $\pm$ 19% pred) were recruited. COPD patients trained at an intensity matched on relative or absolute level of the training intensity of the controls. Capillarisation indexes (capillary-to-fiber ratio, capillary to fiber perimeter exchange index), pericyte coverage and skeletal muscle mRNA expression of angiogenic factors were assessed on vastus lateralis muscle biopsies, before and following 5 and 10 weeks of exercise training. Controls showed better quadriceps endurance benefits compared to both absolute and relative intensity training. This is the first study to show a defective maturation during the muscle angiogenesis in COPD in response to exercise training, involving pericyte impairment, as previously reported in other chronic diseases.

Abstract: effectiveness of pulmonary rehabilitation for patients with asthma: EPRA-RCT

The risk of asthma flares may be reduced by implement regular physical activity in individuals with asthma (23). Even though increased physical activity is beneficial for asthma patients, routine referral to pulmonary rehabilitation is not recommended (24).

A proportion of asthma patients may avoid physical activity due to exertional dyspnoea and/or fear of worsening their asthma symptoms. In fact, it has been shown that adults with asthma have reduced levels of physical fitness

comparing to match controls and additionally they have reduced capacity to undertake daily activities. This increases the psychological distress and consequently reduces the health-related quality of life (25,26).

It is clear that pulmonary rehabilitation may help these patients in improving the management of their symptoms including the breathlessness on exertion and thus improving their quality of life. Unfortunately, the data are still scarce. Two randomized controlled trials reported that exercise training improves asthma symptoms, anxiety, depression, and quality of life in patients with moderate to severe, persistent asthma (27,28). These data are in favour of the rationale for inclusion of patients with persistent asthma in structured pulmonary rehabilitation programs.

Schultz *et al.* (29) set out to investigate the effectiveness of pulmonary rehabilitation versus usual care for patients with uncontrolled asthma in regards to asthma control. They conducted a single-centre randomized controlled waiting-list trial. Asthma patients with uncontrolled asthma were included. The patients of the intervention group underwent a 3-week inpatient pulmonary rehabilitation. Asthma control test and asthma quality of life questionnaire were measured. They showed that pulmonary rehabilitation improves asthma control and quality of life with clinically relevant effect sizes. This is the first randomised control trial demonstrating the effectiveness of pulmonary rehabilitation in patients with uncontrolled asthma. Although it has long been the assumption that pulmonary rehabilitation improves physical fitness in asthma, these new data suggests that structured inpatient pulmonary rehabilitation may have important effects on psychosocial outcomes and symptoms.

Abstract: MCID in 30 second sit-to-stand test after pulmonary rehabilitation in patients with COPD

Various tests of peripheral muscle strength have been developed to assess function. Quadriceps muscle force is typically reduced compared with age-matched control subjects in COPD. Much less is known about limb muscle function in community or primary care settings (30).

Measuring lower body strength is crucial in the assessment of functional performance in older people. The 30s sit-to-stand-test is an assessment of the lower body strength where the number of repetitions within 30 seconds is recorded (31). It provides a reasonably reliable and valid indicator of lower body strength in generally active, community-dwelling older adults. Its clinical significance is that it may predict falls (32). There is a potential of using

this test in pulmonary rehabilitation programs, especially in the community settings where sophisticated lower limb force assessment devices are not widespread available, however its MCID has not been previously calculated.

In this year ERS conference, Crisafulli *et al.* (33) will present the evaluation of the MCID of 30s sit-to-stand-test following pulmonary rehabilitation in COPD patients. Stable inpatient COPD patients undergoing 30s sit-to-stand-test and 6-minute walk test before and after PR were recruited. Ninety-six moderate-to-severe COPD patients were included. At baseline, 30s sit-to-stand-test was significantly related to the distance of the 6-minute walk test. They concluded that, in COPD patients 30 s sit-to-stand-test is a sensitive tool to assess pulmonary rehabilitation efficacy. A Delta 30s sit-to-stand-test of 2 repetitions represents the MCID and this is related also to chronic dyspnoea and lung hyperinflation.

Abstract: regular extended release morphine for chronic breathlessness: a multi-centre double-blind RCT

Systemic administration of opioid agonists is the most well-established pharmacological treatment strategy for the symptomatic management of dyspnoea in patients with advanced illness (34). Abernethy *et al.* (35) conducted a randomised, double blind placebo control crossover study to investigate the efficacy of oral morphine in relieving the sensation of breathlessness in patients in whom the underlying aetiology is maximally treated. A significant change in dyspnoea was identified when subjects were treated with morphine comparing to placebo. Additionally, while patients were on morphine an improvement on sleep quality was reported. However, most patients reported distressing constipation while on morphine despite of using regularly laxatives.

The effect of opioids on improving the exertional dyspnoea is not so clear. Current literature regarding administration of exogenous opioids in exertional dyspnoea comes from a variety of phase 2 feasibility or pilot studies with great inhomogeneity in terms of duration, doses, medications, exercise strategy, underlying disease, and outcomes (36). Recently, a randomized crossover trial assessed the effect of immediate-release oral morphine versus placebo on cycle ergometer exercise testing in 20 adults with advanced COPD (37). They showed that morphine reduced breathlessness and increased exercise endurance time, but the effects varied among individuals and almost one-half derived no benefit.

In this year ERS Congress, Currow *et al.* (38) will present the efficacy and safety of regular, low dose, extended release (ER) morphine orally on chronic breathlessness intensity. The design of their study was a national, multi-site, parallel arm, fixed dose (20 mg ER morphine daily; docusate with sennosides), double-blind, randomised, placebo-controlled study ran in 14 inpatient and outpatient respiratory, cardiology, and palliative care services. Both arms were allowed up to six 2.5 mg doses of 'rescue' immediate release morphine per day. They found that the placebo arm used more prn morphine. In COPD patients, chronic dyspnoea (mMRC 3 or 4) was significantly improved. In accordance with the rest of the literature, the morphine group had more constipation and nausea/vomiting. They concluded that there was no overall affect in patients with more severe breathlessness, especially in COPD patients. A clinically significant reduction in worst breathlessness was identified.

Group 3: Imaging

Abstract: comparison of inhaled ^{19}F -C3F8 and hyperpolarized ^{129}Xe lung ventilation MRI

Hyperpolarized helium-3 (^3He) and xenon-129 (^{129}Xe) contrast agents are being utilized in magnetic resonance imaging (MRI) to provide high quality structural and functional images of the lungs (39,40). The high costs involved with the reliable hyperpolarized isotopes production, however, may impede the MRI for wide-scale clinical implementation. Fluorine-19 (^{19}F) MRI of the lungs using inhaled inert fluorinated gases has been suggested as a cost-effective alternative option to hyperpolarized noble MRI contrast agents for high-quality imaging of pulmonary ventilation (41). It is an attractive choice as ^{19}F isotope is naturally abundant and can visualize through a safe and well-tolerate technique the distribution of ventilation in human lungs detecting ventilation impairments in patients with COPD, in a manner similar to ^3He and ^{129}Xe (42).

Maunder *et al.* conducted a pilot study comparing the qualitative agreement in ventilation patterns by using ^{19}F -C3F8 and ^{129}Xe gas ventilation MRI in the lungs. They recruited five healthy volunteers who underwent MRI of the lungs sequentially using: (I) ^{19}F -C3F8 (perfluoropropane: $^{79}\text{F}_3\text{C}_3\text{F}_8/_{21}\text{O}_2$) performed at 3 T (Philips Ingenia) with a birdcage coil; and (II) ^{129}Xe at 1.5 T (GE HDx) with a vest coil; 4 breaths of the gas mixture were inhaled prior to breath-hold. The anatomical ^1H images were registered to ventilation images and segmented to calculate the

percentage lung ventilated volume (%VV) from the imaging data. Investigators reported lower spatial resolution in fluorinated gas technique resulting in more blurred images, lower relative signal in major airways, and systematically slightly lower %VV using ^{19}F -C3F8 compared to ^{129}Xe . Overall, they detected a qualitative agreement in ventilation patterns of healthy subjects with slight differences in the global lung ventilation metric and the %VV.

Recently, the ^{19}F MRI has unveiled new research avenues in molecular and cellular imaging and, thus, the comparison of ^{19}F -C3F8 and ^{129}Xe in patients with obstructive airways disease may be the next step as authors suggested. Indeed, a quantification of regional lung ventilation by using dynamic ^{19}F gas washout MR imaging in free breathing is feasible at 1.5 T even in obstructed lung segments (43). It is anticipated that ^{19}F -C3F8 as a cost-effective gas would increase the number of structural and physiological lung measurements in clinical settings as well as the opportunity to test treatment efficacy of various obstructive airways diseases.

Abstract: assessing regional lung ventilation with ^{19}F -MRI of inhaled perfluoropropane

Hyperpolarized noble gas of MRI is cost-intensive requiring a polarizer to prepare and process the gases that may limit its broader application (39-41). An alternative option in lung imaging is the functional MRI performed by inert fluorinated gases such as perfluoropropane (PFP: ^{19}F -C3F8) (42). Although the quality of imaging derived from inert fluorinated gases appears to be sufficient to obtain functional and/or physiologic information (44), the short T2 relaxation times in ^{19}F -MRI may limit the duration of the diffusion gradients and, thus, the achievable diffusion weighting (45).

Pippart *et al.* conducted a study assessing the utility of ^{19}F -MRI to distinguish ventilation properties in healthy volunteers and patients with respiratory disease. They recruited 28 healthy volunteers (aged: 23–61 years; 43% females) and 4 patients (2 asthmatic, 2 COPD), who underwent a single MRI session on a 3 T scanner, involving periodic inhalation of a 79% PFP/21% oxygen gas mixture. The inhalation sessions typically comprised 3 deep breaths of the gas followed by a breath-hold, during which ^{19}F -MR images were acquired. During the procedure, heart rate and blood oxygen saturation were monitored. In total, 126 inhalation sessions were performed and the investigators reported that gas mixture was well-tolerated, with no adverse events. They detected a homogeneous gas distribution throughout the lungs in healthy volunteers, whilst a

heterogeneous gas distribution was seen in the asthmatic and COPD patients that reflects impaired regional ventilation. Investigators demonstrated the ability to assess regional ventilation in healthy volunteers and patients with respiratory disease by ^{19}F -MRI of inhaled PFP gas.

Nevertheless, the reproducibility of this technique to quantify ventilation defects in asthmatic and COPD patients need to be determined by future research. Reproducibility is of great importance in longitudinal monitoring as measurements of ventilation properties by ^{19}F -MRI of inhaled PFP gas may be repeated at regular time intervals and the measured values can be compared amongst the subjects and in-between subject's different time points. Considering the epidemiologic and economic importance of asthma and COPD, inhaled PFP gas for functional lung imaging in these patients would be also highly appreciated as biomarker (46).

Group 4: Interventional Pulmonology

Various abstracts in the field of "Interventional Pneumology" that will be presented at this year European Respiratory Congress will focus on endoscopic therapeutic approaches in patients with severe COPD, emphysema and uncontrolled asthma.

Abstract: twelve-month positive outcomes of zephyr endobronchial valves in severe emphysema patients: LIBERATE trial

So far, numerous randomized controlled trials demonstrated endoscopic valve therapy to improve lung function parameters, exercise capacity and quality of life in selected patients with advanced emphysema and absent interlobar collateral ventilation. Based on this knowledge, valve therapy is mentioned as additional therapeutic approach in the GOLD recommendations. The 12-month results of the randomized controlled LIBERATE trial that will be presented at this year's international Congress confirm the current evidence of valve therapy (47). Patients with heterogeneous emphysema and absent collateral ventilation were randomly assigned to valve treatment or standard medical care. At 12-month follow-up, 84.2% of the patients treated by valves experienced a target lobe volume reduction ≥ 350 mL. Between group differences for mean changes from baseline in exercise capacity, health-related quality of life and BODE Index were significant. Furthermore, responder

rates significantly favored valve therapy over standard medical care.

Abstract: a double-blind, randomized, sham-controlled study of targeted lung denervation (TLD) in patients with moderate to severe COPD

Besides endoscopic lung volume reduction, TLD presents a novel bronchoscopic therapy that aims at persistent bronchodilation by ablation of parasympathetic pulmonary nerves. In a double-blind, randomized, sham-controlled trial, Slebos and colleagues investigated the safety and efficacy of TLD compared to sham bronchoscopy whereby patients of both arms received additional anticholinergic medication (48). Eighty-two patients with stable COPD were enrolled and randomly assigned. During a 6-month follow-up, there were no deaths or treatment related adverse events requiring therapeutic interventions. TLD demonstrated a significant reduction in respiratory adverse events and trends toward improved quality of life, dyspnea, and pulmonary function testing when compared to sham control.

Abstract: airway smooth muscle (ASM) mass reduction after bronchial thermoplasty (BT) in asthmatics correlates with FEV₁

BT is an endoscopic treatment that impacts airway remodelling in patients with asthma. Randomized controlled trials have shown BT to be safe and effective in reducing severe exacerbations and improving quality of life. However, the mechanism of action is incompletely understood. Bonta *et al.* correlated the BT-induced ASM mass reduction with change in forced expiratory volume in 1 second (FEV₁) in 16 patients with SA (49). Before and after BT, pre- and post-bronchodilator FEV₁ was measured and bronchial biopsies were taken. Histological results demonstrated a significant ASM mass reduction by BT, that correlated negatively with baseline pre- and post-bronchodilator FEV₁.

Group 5: General Practice and Primary Care

Abstract: inhalation corticosteroids (ICS) withdrawal and exacerbation risk by GOLD 2017 Report: post hoc analysis of the WISDOM trial

ICS have traditionally had a large role in the treatment of COPD. In the last decade, it has become clear that for COPD patients that do not suffer from exacerbations and do not have an asthma component this may not be the most

optimal treatment (50). Studies on the de-implementation of ICS have been published (51). Important in the de-implementation process is the risk of exacerbations.

Prof. Watz *et al.* have investigated this via a post hoc analysis of the WISDOM trial (52). In this study, the effect of ICS withdrawal was followed for 12 months in a double-blind, parallel-group study. Special attention was paid to the risk per GOLD group. They showed that there were no differences between exacerbations in the group that did and did not withdraw their ICS and that the patients in GOLD A and B suffered from less exacerbation than the patients in GOLD groups C and D. Affirming that the GOLD 2017 classification was a good exacerbation predictor.

Abstract: more household air pollution (HAP) and COPD at higher altitude—a population-based, observational FRESH AIR study in rural Kyrgyzstan

COPD in the western world has traditionally been ascribed mainly to smoking tobacco. It has become increasingly clear over the last years that especially in the low and middle income countries (LMIC) HAP plays a major role. Smoke from burning solid fuels used for cooking and heating with inefficient combustion in poorly-ventilated areas forms a major risk for the development of lung diseases (53).

Brakema and her colleagues point out that the association between HAP-exposure, altitude and COPD is still unclear (54). To shed a light on this subject they conducted a study in the high altitude country of Kyrgyzstan. In both a lowland and a highland setting they measured particulate matter, performed spirometry, and administered a questionnaire. They found that highlanders were more exposed to HAP and particulate matter and suffered from COPD more often than the lowlanders. Even though this latter group also suffered from high levels of both, they conclude that interventions, most notably prevention, seem of particular importance.

Abstract: investigating the feasibility of a mobile mindfulness-based digital intervention for patients with asthma

Mobile interventions in disease management have taken flight in the recent years with the rise of mobile phone use. A well-known problem is that often they are not well developed or tested. There are indications that meditation may be beneficial for improving quality of life in asthma patients (55). In daily life, it may be difficult for asthma

patients to follow classes. Mobile interventions might increase access for less mobile patients.

Dr. Ben Ainsworth evaluated an existing mindfulness intervention 'headspace' in 160 patients from 16 GP practices in the UK (54). Patients were randomized to either the headspace group or to the control group. In addition patients completed questionnaires. Use of the intervention was monitored. They found that the use of the intervention was very high and that the Asthma Quality of Life increased in the intervention group at 6 weeks and 3 months. Qualitative outcomes indicated that the app was considered accessible and helped the patients focus on quality of life. The study shows that this intervention might be useful for asthma patients.

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Footnote

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