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Title: Living with asthma and chronic obstructive airways disease: using technology to support self-management – an overview

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Abstract

Long term respiratory conditions such as asthma and chronic obstructive pulmonary disease (COPD) are common, and cause high levels of morbidity and mortality. Supporting self-management is advocated for both asthma, and increasingly so for COPD and there is growing interest in the potential role of a range of new technologies, such as smartphone apps, the web, or telehealth to facilitate and promote self-management in these conditions. Treatment goals for both asthma and COPD include aiming to control symptoms, maintain activities, achieve the best possible quality of life, and minimise risks of exacerbation. To do this health professionals should be: a) helping patients to recognise deteriorating symptoms and act appropriately; b) promoting adherence to maintenance therapy; c) promoting a regular review where triggers can be established, and strategies for managing such triggers discussed, and d) promoting healthy lifestyles and positive self-management of symptoms. In particular, low uptake of asthma action plans is a modifiable contributor to morbidity and possibly also to mortality in those with asthma and should be addressed as a priority. Using technology to support self-management is an evolving strategy which shows promise. This review provides an overview of self-management support, and discusses how newer technologies may help patients and health professionals to meet key treatment goals.

Key words: asthma, self-management, inhaled corticosteroid, telehealth, digital, COPD.

INTRODUCTION

Long term respiratory conditions such as asthma and chronic obstructive pulmonary disease (COPD) are common, with reported worldwide prevalence rates of almost 5% for both.¹ COPD is associated with high morbidity and high rates of hospital admissions, and is the third leading non-communicable disease cause of death worldwide.² Asthma is also associated with a significant symptom burden, and worldwide, the number of disability-adjusted life years lost due to asthma has been estimated at 15 million per year, similar to that for diabetes.³ Both asthma and COPD are life-long and are associated with considerable morbidity, mortality and health resource use, along with higher than expected levels of comorbidity.⁴ While asthma and COPD are controllable with pharmacological and non-pharmacological treatment strategies, they are not curable; so many people live for many years with the consequences of these conditions and need to efficiently self-manage their illness in order to achieve optimal outcomes.

There is good evidence for effectiveness of self-management in asthma,⁵ and increasingly so for COPD, in improving outcomes.⁶⁻⁸ However, the challenges of implementing self-management into routine clinical practice are considerable,^{9, 10} with many patients lacking adequate self-management training and support, and many professionals lacking time, skills or motivation to support self-management in patients. Newer technologies such as telehealth and digital interventions are increasingly seen as potential modalities for providing self-management support in a more acceptable, efficacious and cost-effective way. Telehealth refers to healthcare provided 'at a distance' via the use of technology while "digital intervention" refers to any intervention delivered by digital technology which would

include web-based interventions on PC or mobile devices, apps on smart phones, and interventions delivered by text messages or interactive voice recognition (IVR).¹¹

This review provides an overview of self-management of these chronic respiratory conditions, and discusses strategies to support behaviour change, considering the potential role for digital interventions to promote this.

WHAT IS THE ROLE OF SELF-MANAGEMENT IN CHRONIC RESPIRATORY DISEASES?

The evidence base supporting self-management is compelling for asthma,⁵ and recent studies are clarifying the effectiveness in COPD.^{6, 8} As a result, supporting self-management is a crucial aspect of best care for those diagnosed with a chronic respiratory disease.^{7, 12}

The treatment goals for asthma and COPD are broadly similar, aiming to control symptoms, maintain activities and minimise risks of exacerbation.^{12, 13} Asthma is characterised by *reversible* airflow obstruction and variable symptoms, which are often underestimated by patients. Therefore optimising symptom control is a key goal, with the aim that patients should lead a full, active and unimpeded lifestyle. COPD, however, is characterised by *irreversible* airflow obstruction and associated lung damage, so persistent symptoms are usual, although slightly variable in severity. The aims of management are optimisation of symptoms and risk control, and improving quality of life. These treatment goals are not currently achieved in either condition, and care of patients with asthma and COPD is often suboptimal.^{3, 14-16}

Cochrane reviews have shown that optimum self-management for individuals with asthma should include a combination of regular health professional review with provision of self-management

education and an agreed written action plan, (

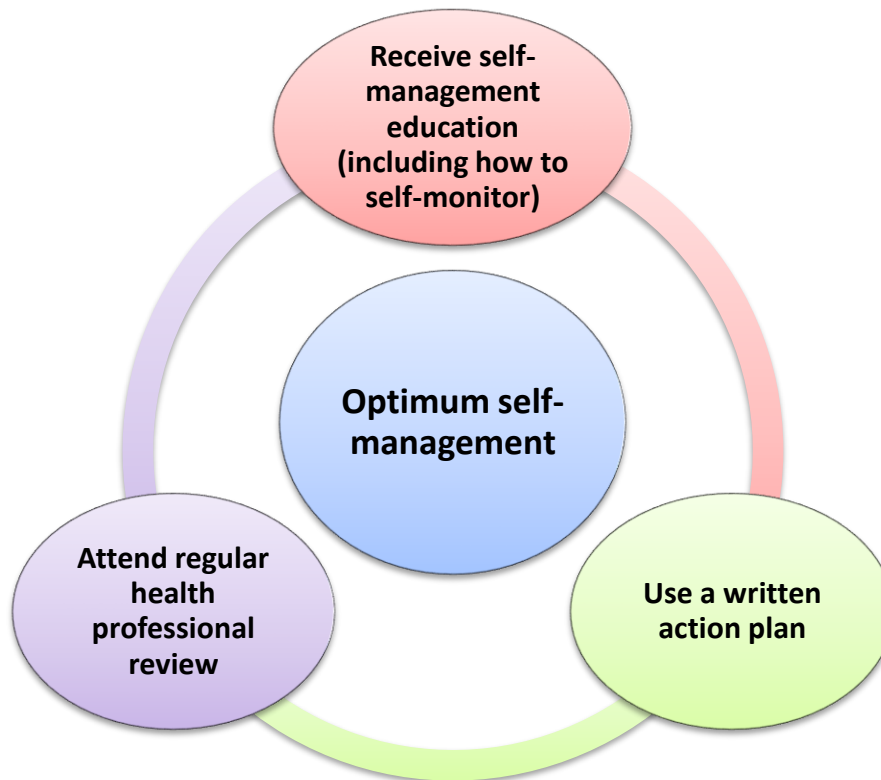


Figure 1) as this will improve outcomes for both patients (fewer symptoms, less limitation in activity, fewer days off school/work, improved quality of life) and for health services (fewer contacts, less hospitalisation).^{6, 17, 18}

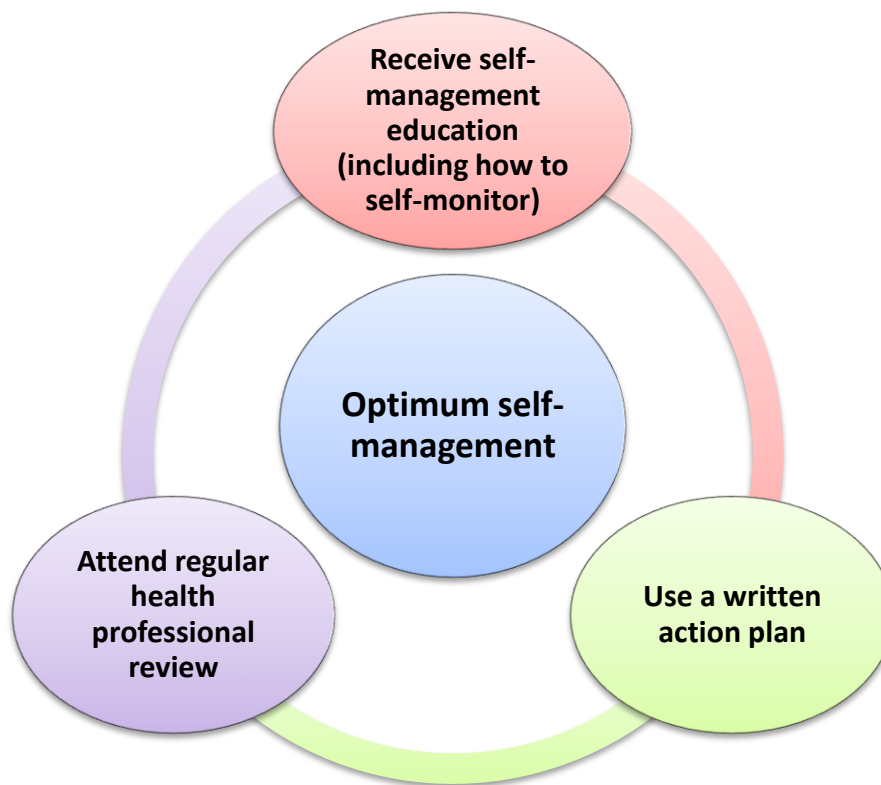


Figure 1 Components of optimum self-management in asthma

Focussing on COPD, a recent Cochrane systematic review has demonstrated that self-management improves health related quality of life (QOL), reduces respiratory-related hospital admissions, and improves levels of dyspnoea.⁸ However due to heterogeneity they were unable to be specific about what was the most effective form and content of self-management in COPD and it is clear that the evidence supporting self-management in COPD is more mixed than for asthma.¹⁹ At present guidelines advise that optimum self-management in COPD focuses on the importance of smoking cessation, reducing exposure to indoor and outdoor pollution, promoting physical activity and healthy diet, adherence to pharmacological therapies, and improving uptake of vaccinations. Pharmacological action plans are sometimes recommended in specific contexts such as supported discharge and exacerbation self-treatment with patient-held antibiotics and/or oral steroids, because

evidence for their widespread use has not been established and there is no evidence that altering inhaled regimes in response to worsening symptoms can prevent exacerbations.^{8 12,}

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IMPLEMENTING SELF-MANAGEMENT – WHAT IS IMPORTANT?

Common to both asthma and COPD is a need to improve knowledge and understanding of the condition as part of the package of self-management education. Broadly this involves promoting the following behaviours: ^{7, 12, 21}

1. Recognising a deterioration in symptoms (self-monitoring) and reacting appropriately
2. Adhering to maintenance therapies
3. Stopping smoking, avoiding triggers
4. Health professional review
5. Healthy lifestyle promotion (exercise, diet, stress reduction, relaxation etc.)

As part of promoting these behaviours, health professionals should focus on empowering patients to take control of their illness and manage their symptoms, emphasising that improved quality of life can be the resultant outcome.

However, many people with chronic respiratory disease underplay their symptoms in order to avoid accepting their diagnosis, mistakenly attribute symptoms to other causes, adopt

sedentary lifestyles or believe that their symptoms are normal for them or cannot be improved.^{22, 23} It is therefore understandable that when people do not attribute their symptoms to an underlying disease process, they are more likely to consider that the advice provided to them is irrelevant. Facilitating a shared understanding of what symptoms a person is experiencing and what is realistic for them to achieve with regular therapy is an important place to start.

Recognising deterioration in symptoms

Recognising deterioration in symptoms is important as timely intervention can potentially avert progression to a severe exacerbation.^{6, 24, 25} The evidence for effectiveness of self-monitoring of symptoms is more evident for asthma patients than those with COPD.^{6, 18, 25-27} It is interesting to note that the latest UK BTS-SIGN Asthma guideline⁷ has moved away from the term 'self-monitoring', using the term 'recognition of deteriorating symptoms' instead. An analysis of exacerbations (n = 425) within a large RCT of asthma treatments found that participants displayed evidence of deteriorating asthma control (a decline in PEF, increase in symptom scores or increase in reliever use) occurring gradually and progressively for 5-7 days followed by a more rapid change over the 2-3 days before the exacerbation.²⁸ Other studies have found similar results, implying that there is a 'window of opportunity' to initiate treatment to prevent progression to a severe exacerbation.²⁹ Unfortunately most patients lack action plans and an effective way of improving uptake of self-monitoring remains elusive.^{25, 30, 31} New technologies, such as smartphone and tablet computer apps could be used to address these issues, but the evidence for effectiveness remains unclear.³² Additionally, even when self-management occurs, the resulting behaviour is sometimes not

appropriate or in accordance with the prior agreed action plan,³³ even in the context of asthma clinical trials when presumed exemplary education on self-monitoring is provided.²³

Provision of an asthma action plan can support patients to self-monitor by providing written advice about recognising deteriorating symptoms and instructions on how to alter medications appropriately or when to seek help.^{27, 34} Discussing and agreeing an action plan is a collaborative activity between a patient and a clinician and so takes time. Unfortunately the evidence is clear that they are not being used regularly, with the majority of patients lacking an action plan, which in some cases leads to potentially preventable deaths.³⁰ A systematic review focussing on barriers and facilitators of asthma plan use found that patients and carer's often perceive that health professionals do not acknowledge the experience they have of managing their own condition already, and that the action plans provided were sometimes felt to be irrelevant to their own illness.³⁵ Additionally, health professionals may not offer action plans to all individuals with asthma, selecting those they believe capable of understanding an action plan, or those with milder asthma.³⁵

Self-monitoring by individuals with COPD is recommended, although less emphasised in guidelines, due to less evidence of effectiveness.¹² This is particularly true of action plans which are often only recommended in the immediate post discharge situation as part of more extensive case management. However, they are also sometimes provided to patients at risk of exacerbations in conjunction with self-held antibiotic and oral steroid courses, despite the absence of a firm evidence base.¹² Self-monitoring in COPD, if used as an aid to self-management, should be symptom based, as changes in physiological variables (i.e. lung function) do not allow differentiation between an exacerbation and normal variability in the condition.^{24, 26}

Technological advances have been employed in recent trials to promote self-monitoring in asthma. One example is using a sensor on a reliever inhaler to detect increasing use, communicating via Bluetooth to a smartphone to trigger alerts.³⁶ It seems plausible that this type of 'passive' monitoring may be acceptable to patients in the future and may lessen the treatment burden associated with self-management and self-monitoring, thus potentially increasing adherence.³⁷

Therefore although the evidence quoted above shows that asthma self-monitoring, in association with a written action plan, is best practice, it is clear that new strategies to increase uptake are needed. Several systematic reviews have highlighted that for such interventions to be effective they have to consider patient, professional and organisational issues, a feature which is not commonly found in published interventions to date.³⁸⁻⁴⁰

Promoting adherence to maintenance therapies.

Non-adherence with maintenance therapy is common in people with long-term conditions, including lung disease. When faced with patients with chronic respiratory diseases it is important to consider whether they are taking medications as prescribed, and to try and assess levels of adherence and understand reasons for non-adherence in a non-judgemental way.⁴¹

Taking medicines as prescribed in asthma and COPD is crucial to avoid exacerbations, improve day-to-day control, and reduce the risk of hospitalisations and death.^{42, 43} For example, in asthma falling levels of adherence to inhaled corticosteroids ICS is associated with progressively poorer outcomes, with evidence that for every 25% increase in time without ICS, the rate of asthma related hospitalisation doubles.⁴⁴ Population mean

adherence rates to ICS are low, usually reported at 30-50%, with marked variability between patients.⁴⁵

Not taking medications as prescribed can be intentional or unintentional. Common reasons for unintentional non-adherence are poor inhaler technique and forgetting to take medication.⁴¹ Electronic reminder systems show promise in the case of unintentional non-adherence due to forgetfulness, but seem unlikely to be effective in those intentionally non-adherent and as yet there is no robust evidence relating to their benefits, in terms of long term adherence or improvements in clinical outcomes.⁴⁶⁻⁴⁸ Inhaler technique problems are compounded by an ever increasing array of inhalers,^{49, 50} with evidence that health professionals can be as confused as patients.⁵⁰ Checking inhaler technique is an essential part of any review. Instructional videos have been shown to be an effective way of improving correct inhaler use, particularly in those with limited health literacy,⁵¹ and may be a useful option particularly where placebo inhalers are unavailable.

A qualitative synthesis by Pound et al,⁵² provides a detailed exploration of 'why' people do not take medicines as prescribed. Many prefer not to take medicines at all where possible, with contributory factors being: 1) doubts about the need for the medications in the first place (in asthma specifically, this is compounded by a reluctance to accept the diagnosis); and 2) concerns about potential side effects of treatments. Actively establishing underlying concerns during a review is essential to address adherence issues.

Lifestyle advice & triggers

Typical triggers for inducing symptoms in those with asthma or COPD are cigarette smoke, other environmental irritants such as air pollution, allergens, infections, exercise and certain medications (for example non-steroidal anti-inflammatory drugs, beta-blockers and aspirin).

The benefits of stopping smoking and achieving a smoke free environment are clear in both asthma and COPD, and for those with COPD, smoking cessation influences the natural history of the disease.⁵³⁻⁵⁵ Despite this, 1/3 or more of patients with COPD continue to smoke, and smoking rates in people with asthma are similar to those of the general population. Documentation of smoking status and provision of smoking cessation support is a vital component of clinical care in asthma and COPD. Going forward technology supported interventions such as txt2Stop may be increasingly considered.⁵⁶ Infections are a well recognised trigger for both asthma and COPD, and promoting uptake of vaccinations is considered best practice. While handwashing to reduce spread of infection has always been advocated, there is now firm evidence that this does reduce spread of respiratory infections.⁵⁷ Advice on avoidance of other triggers is less clear cut.⁷ For example, UK asthma guidelines discuss the potentially paradoxical effects of removing a pet from the home: it may improve symptoms, however removal of the allergen source also reduces the opportunity for tolerance developing, which itself may reduce symptoms.⁷ House dust mites are a trigger for some individuals, however both chemical or physical methods of reducing house dust mites have been shown to be ineffectual, and therefore advice to these individuals may revolve more around promoting adherence to ICS. Regarding exercise, appropriate pharmacological therapy, in particular using beta agonists before exertion, should allow most of those with asthma to continue to exercise. While exercise training has

not been shown to specifically improve asthma outcomes, it does improve cardiovascular fitness, and should be advocated as part of general healthy lifestyle measures.⁷ New technologies that promote physical activity monitoring such as 'Fitbit' and 'JawboneUP', may prove useful as a means to promote activity, but this remains an evolving area.⁵⁸ For those with COPD there is good evidence that pulmonary rehabilitation classes relieve symptoms such as dyspnoea and fatigue, and improve emotional functioning and their uptake should be promoted at every opportunity⁵⁹ and in recent times pulmonary rehabilitation via telecare has been increasingly advocated as a potential way to deliver such services.⁶⁰ With asthma, stress and anxiety can be a trigger for some individuals and there is higher prevalence of psychological problems in those with asthma.^{4, 61} Those with anxiety and depression tend to have poorer outcomes, so establishing the presence of these comorbidities and discussing management strategies is an important aspect of asthma care.⁶¹ A similar link between depression and COPD is well recognised, and worth exploring during consultations.^{4, 62} As web based Cognitive Behavioural Therapy (CBT) or Apps become increasingly available this provides another therapeutic option to offer, which might be particularly useful for those for whom lack of time is a significant barrier to accessing such services.^{63, 64}

Establishing triggers with patients with asthma or COPD at a review, and discussing person specific strategies for reducing their impact is an important part of self-management education, but must be tailored to the individual.

Health professional review

Self-management support should be provided by clinicians in addition to regular clinical review, and self-management advice reviewed and reinforced at regular (e.g. annual) checks. In asthma, provision of an action plan is only shown to be effective in conjunction with a regular health professional review.^{6, 65} At present, regular professional review often means a face to face, pre-arranged appointment. However not all patients are willing or able to attend, particularly given most people perceive themselves as being well, so attendance is variable. In the UK National Review of Asthma Deaths published in 2014, only 57% of those who died had evidence of a routine asthma review in the preceding year. As well as patient barriers to the asthma review, professional barriers also exist. Health care professionals (HCP) report only providing asthma action plans to select groups of patients e.g. those who are well educated, or already well controlled, potentially missing the majority with potential to benefit.³⁵ Lack of time, and confidence in own ability to discuss action plans and self-management education have been identified as important issues for health professionals.⁴⁰

One aspect of the health professional review which is difficult to quantify is the impact of the quality of the clinician-patient relationship on outcomes. Improving the patient professional relationship may be a modifiable factor influencing whether a person self manages effectively or not. A recent qualitative study of adults with asthma in the USA,⁶⁶ reported widespread over reliance on reliever inhalers across those with uncontrolled and controlled asthma. However, those who were uncontrolled described a poorer relationship with their health care providers, feeling that their provider did not listen to them and this patient group rejected self-management advice. This group were also more likely to

attribute effects such as weight gain to a side effect of ICS. In contrast, the controlled group reported feeling engaged with their health provider. The importance of this relationship is a strong theme generated from a comprehensive systematic review on barriers to self-management in asthma, which also demonstrated that patients with positive relationships with health care providers have less emergency department attendances, and are more likely to adhere to self-management advice in general.⁴⁰

CAN TECHNOLOGY IMPROVE SELF-MANAGEMENT?

Self-management in chronic respiratory diseases improves outcomes but how best to improve uptake on a day to day basis remains unclear. The traditional method of self-management support and education during face to face reviews only works in a proportion of individuals and the lack of support between reviews may be a barrier to sustained engagement with self-management.²¹ There is increasing interest in using technology to improve uptake of self-management behaviours. This might work by facilitating alternatives to face-to-face reviews (such as via telephone),⁶⁷ or as a way of providing ongoing tailored information and support between reviews, such as with digital interventions, as illustrated in Figure 2 below. Digital interventions to promote self-management behaviours may work completely independently from health professionals through the provision of automated tailored advice generated by the intervention based on information provided by the patient.⁶⁸ More commonly, digital interventions are used as telehealth interventions, where patients provide clinical data to a health professional in a different location, who reviews it and provides tailored advice back (via the intervention), for example based on oxygen saturation levels or peak flows.^{25, 69} The majority of digital

interventions published to date include a telehealth component, with completely standalone digital interventions in the minority.⁶⁸⁻⁷⁰

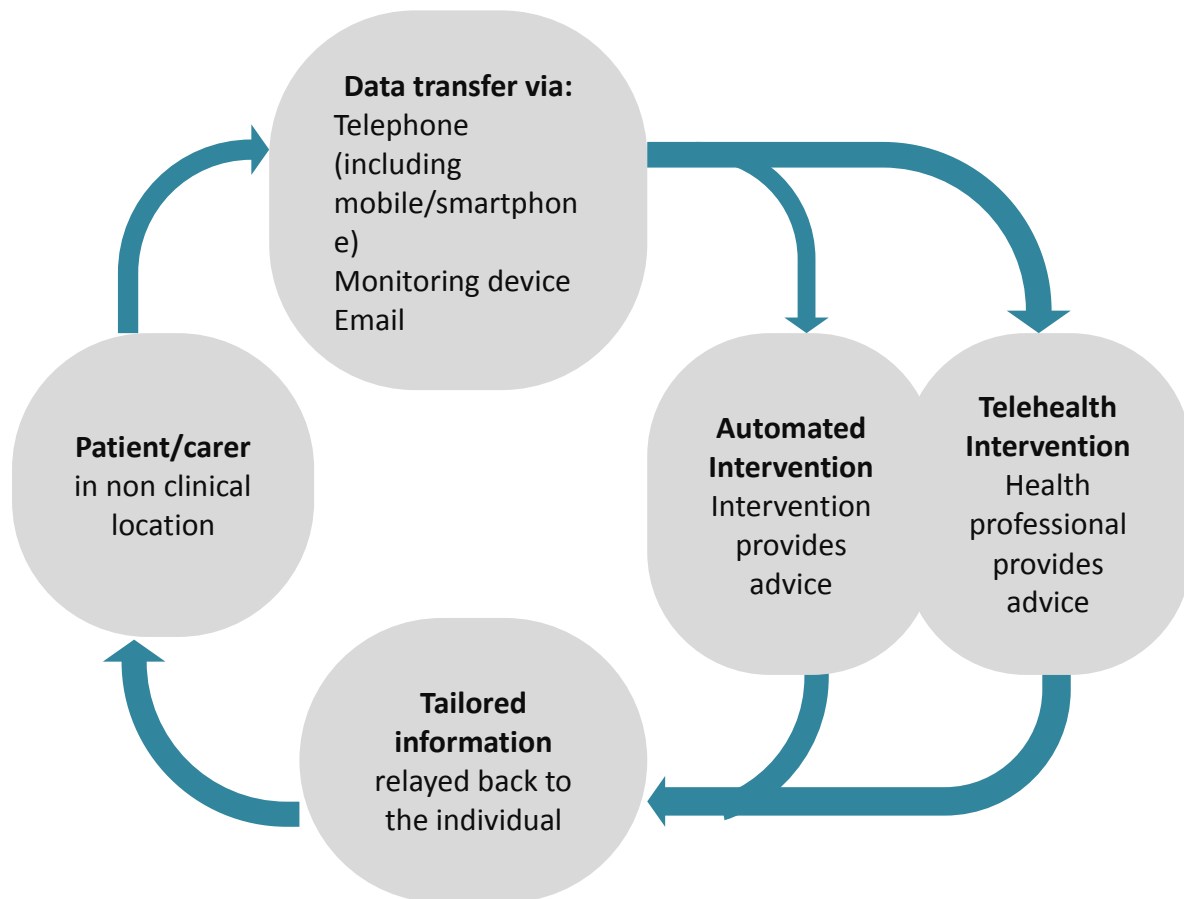


Figure 2 Difference between digital interventions that provide automated tailored advice and telehealth interventions

There appears to be a divergence in the use of technology when investigating its' role in supporting self-management of chronic respiratory diseases, with telehealth being the most popular modality for COPD, but with asthma digital interventions generally including automated advice, often supplemented with additional health professional input.⁶⁸ This is possibly driven by the increased evidence and experience of using action plans in asthma, which lend themselves well to algorithm based digitally generated advice.

There is also burgeoning literature for digital interventions supporting lifestyle and behaviour change as part of optimum self-management, e.g. interventions supporting stopping smoking and increasing physical activity.⁷¹⁻⁷⁴

Technology and COPD

In 2011 McLean et al provided a clinical overview of telehealthcare for long term conditions (COPD, heart failure and diabetes), noting that telehealthcare interventions were proliferating rapidly, although underpinned by variable quality of evidence.⁷⁵ They reported some isolated examples of success, particularly in those with severe chronic diseases such as problematic asthma and diabetes that it could reduce hospital admissions, without increasing mortality, and suggesting that less complex interventions may be more cost-effective. They also detailed potential pitfalls associated with introducing telehealthcare such as enduring technical difficulties, safety concerns (data loss, confidentiality), potential adverse effects on workload and negative effects on patient-professional relationships. A Cochrane review focussing on COPD reported more convincing findings,⁶⁹ with evidence of improvements in quality of life and Emergency Department (ED) attendances, although noting that these telehealth interventions were often part of a larger complex intervention so that teasing out which elements were effective was not possible. These findings mirror that of the UK government funded Whole Systems Demonstrator (WSD) project which investigated the role of telehealth and telecare technologies in chronic disease management and included the world's largest RCT of telehealth involving 6191 patients with diabetes, COPD or heart failure. Across the three chronic diseases participants (disease specific data is not available for these outcomes), it showed some reductions in emergency admission rates, length of admission, markedly reduced mortality rates (4.6% vs 8.3%, $p < 0.001$),⁷⁶ but

overall was not found to be cost-effective.⁷⁷ While across the WSD study there was no improvement in QOL and psychological outcomes,⁷⁸ published COPD specific sub group data reports disease specific QOL and psychological outcomes showing that for those in the intervention arm there was a consistent trend to improved health related QOL, along with better emotional functioning and mastery, which improved over time.⁷⁹ This partly matches the earlier Cochrane review which while showing no benefit in mortality, did demonstrate improved QOL and reduced ED attendances.⁶⁹

Pinnock et al,⁸⁰ evaluated integrating a COPD telehealth intervention into existing clinical services with both control and intervention groups having care from the same clinical provider. They found no difference in their primary outcome, time to first admission, or in any secondary outcomes (including disease specific quality of life and length of admission). As well as the mixed results regarding effectiveness, the review by McLean et al,⁷⁵ highlighted potential negative implications on the patient-provider relationship, including reinforcement of historical power relationships with 'passive patients being monitored by a now distant medical professional'. However qualitative studies report that patients are mostly positive about their experiences, reporting that they felt safer and that they had learned more about their condition, and staff felt that the improved knowledge could be a useful long term benefit.⁸¹ Earlier qualitative work had also suggested that interacting with a telehealth intervention and receiving feedback from the health professional can increase satisfaction in relation to factors such as continuity of care, understanding of symptom variability, and encouragement of self-management behaviour.⁸² While participants were mostly positive about their role in telemonitoring, several were glad to hand their devices back at the end of this short (3-6 month) study, stating they were getting bored using it

every day. This raises the question about long term sustainability of such interventions requiring regular work by the patients that increase their overall treatment burden.³⁷

Qualitative studies suggest that COPD telehealth interventions should complement rather than replace current clinical care, supporting and encouraging self-management, and that interventions which are specifically developed to be intuitive and easy to use can overcome perceived barriers to using technology by those with little experience of it.⁸²

The uncertainties over telehealth in COPD are such that it is not clear how it would work in real life settings, and future research needs to be clear about the aims and structure of the telehealth interventions, and to consider implementation issues from the outset.⁸³ If telehealth is to be effective then it must not add to the burden of treatment that patients already endure.⁸⁴ There are suggestions from qualitative, but not quantitative studies, that there may be a group of patients for whom telehealth reduces the burden of disease and increases confidence.^{81, 82, 85} Strategies for establishing who is most likely to benefit from telehealth interventions is another important gap in the available evidence.

Other uses of technology in COPD include the provision of information or support online, for example via social media. Many disease based charities such as the British Lung Foundation or American Lung Association have a linked Facebook page or website, with forums where users can ask questions and hear about experiences of other others with similar problems. These may be useful for practical queries that users may have, for example, recommendations for a suitable back pack for carrying home oxygen. However a quick review of such sites shows evidence of potentially harmful advice being posted by other users. For example one user requesting advice due to experiencing increased shortness of

breath and cough, was advised to drink plenty of water to ‘thin the phlegm down’.

Following such advice would have detrimental effects if heart failure was the underlying pathology.

‘You Tube’ is another commonly used source of information and COPD is one of the few disease areas where the quality of information provided on You Tube has been formally evaluated.⁸⁶ Unsurprisingly they report the quality as mixed: 70% of the 223 patient education videos they evaluated demonstrated high scores providing quality and trustworthy health information, but 20% were very poor. This suggests that clinicians may want to find videos they have looked at themselves to ensure they are suitable, and be specific in recommendations. Regardless of the quality of these videos, the authors note that there was very little evidence of user engagement with them in the form of ‘likes’, marking as a ‘favourite’ or saving to their own accounts. This is not evidence that there is no demand, as further work by these authors provide evidence of unmet need in this area.⁸⁷ Importantly, it should be noted that “engagement” is unlikely to be accurately assessed by counting clicks on a “like” button and so it is clear that more research is needed in this area.

Technology and Asthma

A Cochrane review focussing on telehealth in asthma concluded that the likelihood of clinically meaningful benefits in those with mild to moderate asthma was low, with more potential demonstrated in those with severe disease.²⁵ As alluded to above, there is more interest in the role of digital interactive interventions for supporting self-management in asthma, which are inexpensive to produce in comparison with professional care and so have the potential to be cost effective. The literature on asthma interventions is broader, with

interventions assessed including telehealth, but also other digital interventions including apps, simple reminders, and interactive voice response interventions to name a few. A systematic review of automated digital interventions to support self-management for adults with asthma concluded that there was some evidence of effectiveness, but that understanding of the active ingredients of such interventions was not possible due to lack of detail in the descriptions, particularly as there was little evidence that intervention development had been theory informed.⁶⁸ A later systematic review also found that the majority of interventions did not use any theoretical frameworks or guidelines to inform their design.⁸⁸ With increasing emphasis on the importance of theory informed development,⁹ it may be that the evidence picture becomes clearer over the next decade.

In 2012 Huckvale et al reviewed 72 freely available smart phone applications ‘apps’ looking at three domains: comprehensiveness of asthma information, consistency of advice with evidence and compliance with health information best practice principles.⁸⁹

Disappointingly, no apps were found to contain comprehensive evidence based advice, and in 32 of 72, advice provided was not supported by evidence, concluding that improvement was required before clinicians could recommend such apps. A recent update to that review has reinforced the message that questions about clinical quality and safety persist.⁹⁰ A Cochrane review focussing on the effectiveness of smartphone and tablet apps for asthma self-management in comparison to traditional methods of delivery found only two RCTs and inconclusive results.³² The disparity between the number of available apps (72) and the published evaluations (2) is an issue when discussing using such tools with patients. As with advice about websites or you tube videos clinicians would need to explore them individually

to ensure they are safe until such time as there are available apps which have been rigorously developed, and formally evaluated.

Other studies have investigated specifically the role of electronic medication reminders, which would seem to have particular utility when unintentional non adherence is the issue. Tao et al included four asthma studies; three used text messages and one used a pager like device with audio-visual reminder (green light and beep).⁹¹ Pooled results from these four asthma studies demonstrated a small but statistically significant positive effect on patient adherence to medication with the use of reminders. Overall, they also noted that trials with smaller sample sizes had larger effect sizes, and that given three of the four asthma trials were small (<100 participants) this effect needs to be interpreted with caution. Additionally the asthma studies also used additional self-management tools (information, advice, tailoring) so it is impossible to separate out the active ingredient. Their main conclusion was a call for more adequately powered good quality trials, which is the conclusion of most other systematic reviews in the field.^{32, 92}

There is little evidence of effectiveness or information about user experiences from asthma or COPD-related social media use, although the number of Facebook pages suggest they are well used. The UK patient charity Asthma UK has an active and well visited Facebook page, with the option of responding to clinical queries posted online by advising users to phone their helpline for advice.

FUTURE DIRECTIONS

Support for self-management aims to improve outcomes in a number of ways: improved recognition of deteriorating symptoms, more appropriate responses to exacerbations,

improving adherence (intentional and non-intentional) to medication, and empowering patients to take control of their illness.^{8, 79, 93, 94}

As a treatment strategy, self-management support is not offered enough by health professionals, or utilised enough by those with the potential to benefit.^{30, 35} Health professionals need to develop a more patient-centred approach, recognising the importance of a positive patient-provider relationship if outcomes are to improve.^{35, 39, 40, 65, 94, 95}

Technology has potential to facilitate effective self-management, particularly around ways of reducing the burden of self-management such as with passive monitoring, improving the delivery of self-management education, and the development of more sophisticated interactive interventions which can provide safe and clinically appropriate advice directly to the user 24 hours a day. Research into digital interventions to support self-management is still in its infancy, and previously evaluated interventions have not always been developed using best practice. The key will be ensuring future interventions are developed using best available evidence, are 'person-based' (i.e. developed with adequate attention to user experience), robustly evaluated, and with implementation issues considered from the beginning including at patient, professional and organisational levels.^{39, 40, 96, 97}

DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interests

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