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REVIEW

Smoking cessation strategies for patients with asthma: improving patient outcomes

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Abstract: Smoking is common in adults with asthma, yet a paucity of literature exists on smoking cessation strategies specifically targeting this subgroup. Adverse respiratory effects from personal smoking include worse asthma control and a predisposition to lower lung function and chronic obstructive pulmonary disease. Some data suggest that individuals with asthma are more likely than their non-asthmatic peers to smoke regularly at an earlier age. While quit attempts can be more frequent in smokers with asthma, they are also of shorter duration than in non-asthmatics. Considering these asthma-specific characteristics is important in order to individualize smoking cessation strategies. In particular, asthma-specific information such as "lung age" should be provided and longer-term follow-up is advised. Promising emerging strategies include reminders by cellular phone and web-based interventions using consumer health informatics. For adolescents, training older peers to deliver asthma education is another promising strategy. For smokers who are hospitalized for asthma, inpatient nicotine replacement therapy and counseling are a priority. Overall, improving smoking cessation rates in smokers with asthma may rely on a more personalized approach, with the potential for substantial health benefits to individuals and the population at large.

Keywords: asthma, smoking cessation, asthma-COPD overlap syndrome, ACOS, lung function, patient outcomes

Introduction

Most smokers who consider quitting do so because of concerns about their physical health, which are most commonly related to the development of lung cancer and emphysema.[1] "Smokers with asthma" are a distinct subgroup of smokers. They have the propensity to poorer asthma control and the development of asthma–chronic obstructive pulmonary disease (COPD) overlap syndrome (ACOS), which results in lung function deficits similar to COPD. Despite these potential consequences, some evidence suggests that such smokers are less likely to quit smoking than smokers without asthma (Table 1).[2,3] Acknowledgment of these worse patient outcomes has given rise to an opportunity to improve current management practices.

We searched the full available range of articles written in English on PubMed using the search terms "asthma", "smoking cessation", and "patient outcomes" (search was last updated on December 2, 2015). Of the 38 articles identified, 23 were selected and 16 articles were included. Selection was based on review articles (narrative, systematic, and meta-analyses) and clinical studies addressing the lack, efficacy of, and emergent asthma-related smoking cessation strategies. References were also selected from a bibliographical search. They were excluded if primarily related to COPD and/or practice change, rather than to asthma patient outcomes (n=16).

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Table 1 Key points

Smoking is as common in those with asthma as in the general adult community, and even higher in adolescents with asthma. Smokers with asthma are predisposed to worse symptoms and greater deficits in lung function
As current asthma and personal smoking may interact to worsen lung function, the excess individual deficits provide another compelling reason to quit, ideally at the earliest possible age
Smoking cessation in people with asthma has been associated with positive outcomes such as better asthma control and improved lung function. The introduction of smoke-free environments has also improved asthma outcomes
Adult smokers with asthma may have greater difficulty in quitting than those who do not have a chronic illness, yet current smoking cessation strategies do not specifically target this subgroup, largely due to a lack of evidence
Smoking cessation and other strategies aimed at optimizing asthma control should be addressed at every opportunity, with early follow-up recommended in order to facilitate a sustained quit attempt
Emerging asthma-specific smoking cessation strategies include reminders by cellular phone and education via online, web-based, computer-delivered, and electronic systems. More research is needed with regard to the use of electronic nicotine delivery devices
For children with asthma, motivational interviewing with carers might be a useful approach to reduce asthma symptoms. For adolescents, training older peers to deliver asthma education is another promising strategy
Considering the specific needs of current smokers with asthma may facilitate a smoking cessation intervention that is more individualized and aimed at improving quit rates in the longer term

Asthma in adult and adolescent smokers

Prevalence of smoking in people with asthma

The prevalence of smoking in people with asthma is similar to, or even higher than the general community, being ~19% to 25% for European and Northern American countries prior to 2004.[4–6] In the European Community Respiratory Health Survey, a lower prevalence of continued smoking was seen for participants who also had asthma (26.3% vs 30.1%, P=0.018), although a greater attrition of smokers with asthma between the two surveys might have been a possible explanation.[7]

Several studies have shown that adolescents with asthma are more likely to smoke, especially at the more severe end of the spectrum.[8,9] Adolescents with or without asthma in the US Add Health Project were equally as likely to progress to heavier levels of smoking,[10] whereas in a Danish study, the odds for smoking at least 15 cigarettes per day were almost 1.5-fold higher for adolescents with asthma.[11]

Smoking-related beliefs and knowledge in those with asthma

Even 20 years ago, substantially more Australian smokers with asthma "believed that smoking has had at least a moderately bad effect on their own health" than smokers without asthma (58% vs 38%, P<0.001).[12] The perception of higher health risks from smoking can contribute to motivation to quit, but these perceptions are balanced against the perceived benefits to an individual of continued smoking and ability to resist the smoking influences from parents and close friends.[13] Asthma diagnosis is associated with earlier age of regular smoking onset, higher number of quit attempts, and reasons for quitting related to self-control, suggesting that smokers with asthma may have more difficulty quitting and unique reasons for quitting.[14] Anxiety sensitivity, the fear of aversive internal anxiety states, might offer some explanation as to why sustained quitting can be more difficult for smokers with asthma compared with non-asthmatics.[3]

Quitting and smokers with asthma

Asthma-specific reasons for quitting can include heightened health concerns and need for self-control.[14] Smokers with asthma have increased odds of reporting high or very high nicotine addiction compared with smokers without asthma (adjusted odds ratio [OR], 1.57; 95% confidence interval [CI], 1.16–2.10), with their doctors more likely to advise the participants to quit smoking (adjusted OR, 2.22; 95% CI, 1.35–3.65).[5] US primary care physicians more frequently provided counseling to smokers with COPD than smokers without chronic diseases (46% vs 25%, P<0.001) or to smokers with asthma (31%).[15] Adults enrolled in the telephone counseling service, Quitline, were only a small fraction of all smokers attempting to quit, but those with asthma and/or COPD were found to be less likely to have quit smoking after 30 days.[2] This contrasts similar abstinence rates at a smoking cessation clinic in Greece, which considered individual asthma, COPD, and overlap subgroups separately.[16]

Smoking abstinence is particularly important in adolescence, as nicotine exposure from cigarette experimentation during this period may be more likely to lead to sustained dependence and progression to regular smoking.[17,18] Some evidence suggests that dependence and progression develop more quickly in adolescents with asthma, corresponding with greater difficulty quitting and more quit attempts.[19] As

an interaction between the adverse effects of current asthma and personal smoking on post-bronchodilator (BD) airflow obstruction in mid-adult life is likely,[20,21] smoking abstinence at the earliest opportunity is key to maintaining optimal lung function in later life.

Lung function measurement in smokers in general

Although intuitively one might expect that providing smokers with evidence of smoking-related damage to their lungs might increase quit rates, a Cochrane review providing feedback of personal biomarkers including spirometry failed to find evidence that this improved quit rates in smokers.[22] Measurement of lung function in conjunction with telling smokers their lung age and providing a graphical representation of lung function decline in the form of the Fletcher-Peto diagram (the age of the average person who has an forced expiratory volume in 1 second [FEV_1] equal to the individual) significantly improved quit rates in a UK study in general practice.[23] This applied whether the lung function was abnormal or not. However, the mechanism by which this intervention achieved its effect was unclear.

Adverse health effects

Continuous smokers have been estimated to die at least one decade earlier than nonsmokers, with approximately a 90% reduction in the risk of death if an individual quits before the age of 40 years.[24] From the perspective of asthma, the main adverse outcomes include new and poorly controlled asthma, increased chronic airflow limitation, and possibly the coexistence of COPD. Relevant studies have been summarized in Table 2.

Poorly controlled adult asthma

Current active smokers who also have asthma report poorer symptom control than nonsmokers with asthma.[25–27] Adverse clinical and health care outcomes have been shown in smokers with both mild-to-moderate[28] and severe asthma.[29]

Poor asthma control in current smokers may relate to reduced efficacy of inhaled corticosteroids (ICSs),[30] leading to inadequately controlled airway inflammation and increased bronchial hyperreactivity.[31] In the meta-analysis of ten studies that examined ICS therapy in people with asthma, smoking was associated with reduced ICS efficacy (Table 2).[32] Com-

Table 2 Key studies that examined personal smoking and adverse asthma outcomes

References	N	Participants	Findings
Thomson et al[29]	760	BTS Severe Asthma Registry with severe refractory asthma: 69 (9%) current smokers 210 (28%) ex-smokers 461 (62%) never smokers	Compared with never smokers, current smokers had poorer asthma control (ACQ 4.1 vs 2.9, $P<0.001$), more unscheduled health care visits (6 vs 4, $P=0.008$), more rescue oral steroids (6 vs 4 courses, $P=0.04$), higher anxiety (13 vs 8, $P<0.001$), and depression (10 vs 6, $P<0.001$), but no differences in spirometry
To et al[28]	519	From eight Canadian primary care practices, 137 of 519 with physician-diagnosed, mild-to-moderate asthma were smokers at baseline; after 12 months, 11% (n=15/137) quit, and 4% (n=16/382) of those not smoking at baseline commenced	Compared with continuous smokers (within a 12 month period), individuals who quit had less chest tightness (OR, 0.21; 95% CI, 0.06, 0.82) and fewer nocturnal symptoms (OR, 0.24; 95% CI, 0.07, 0.85), but no difference in acute health care utilization. Those who became smokers had increased chest tightness, nighttime symptoms, and ≥1 asthma attack within 6 months
Cerveri et al[7]	9092	ECRHS I (n=17,840 from 28 centers) and II (n=10,296), where 1,045 of 9,092 participants in the current analysis had asthma at baseline	26% of current smokers with asthma (n=949) continued to smoke despite significantly more having chronic cough and sputum production than never and ex-smokers (52% vs 42% and 43%). There was no difference in FEV_1% of predicted or FEV_1/FVC between smoking subgroups with asthma
Boulet et al[27]	893	Telephone survey of Canadian adults: 108 (12%) current smokers 268 (30%) past smokers 514 (58%) nonsmokers	Current smokers were more likely to have daytime asthma symptoms (30% vs 17% nonsmokers and 18% ex-smokers), and report asthma symptoms as a reason for absenteeism ($P<0.01$)
Zheng et al[32]	4070	Meta-analysis of ten controlled studies in smokers vs nonsmokers with asthma using inhaled corticosteroids	Compared with nonsmokers with asthma, smoking was associated with an attenuated inhaled corticosteroid response, reduced mean change in FEV_1, reduced posttreatment FEV_1, and increased use of concomitant medication

Notes: FEV_1/FVC, the ratio between FEV_1 and forced vital capacity as a measure of airflow limitation/obstruction.
Abbreviations: ACQ, Asthma Control Questionnaire; BTS, British Thoracic Society; ECRHS, European Community Respiratory Health Survey; FEV_1, forced expiratory volume in 1 second; FVC, forced vital capacity; OR, odds ratio.

pared with nonsmokers, smoking at least five cigarettes per day was associated with a reduced post-ICS treatment in pre-BD FEV_1 (standardized mean difference, –0.19; 95% CI, –0.33 to –0.06) and increased use of concomitant medications (standardized mean difference, 0.054; 95% CI, 0.17–0.91). This reduction in corticosteroid sensitivity can occur even in light smokers with mild asthma.[30] While dose escalation of ICS might hypothetically alleviate this corticosteroid resistance,[33] the addition of long-acting β-agonist (LABA) to low-to-medium dose ICS may be preferable to increasing ICS dose.[34] However, more evidence is needed to assess the relative effectiveness of different treatment options that include extra-fine ICS particle formulations and leucotriene receptor antagonists.[35]

Many studies have shown a reduction in asthma symptoms in people who quit smoking,[36] although a large Danish population-based cohort showed an increase in the odds for incident asthma over a decade, especially for "new quitters".[37]

Worse asthma control has also been associated with exposure to second-hand smoke (SHS) in young adults.[38] During the first 3 years following the implementation of smoke-free legislation in England, emergency admissions for asthma decreased by 4.9% (95% CI, 0.6–9.0) for those 16 years and older.[39]

Asthma morbidity and poorer quality of life have been linked to depression and risk-taking behaviors such as smoking.[40] Asthma symptoms might also be a result of poor treatment adherence,[41] and this is particularly relevant to those with difficult-to-treat asthma and major psychiatric illness.[42]

Asthma and lung function deficits

In addition to "reversible airflow obstruction", the hallmark of asthma, the occurrence of "irreversible" airflow obstruction from long-standing and/or severe asthma in adult life, is well recognized.[21,43] Childhood asthma as a potential predictor of reduced peak lung function in adulthood has been illustrated by the Melbourne Asthma Study in which 10-year-old participants with severe asthma were recruited in 1967 before ICSs were available.[44] Compared with participants with mild asthma, the severe subgroup already had a decrement in lung function at study entry, without further deficits over the next four decades, despite ongoing symptoms.[45] In terms of lung function decline, adults with asthma from the Copenhagen City Heart Study had an approximately twofold higher rate of pre-BD FEV_1 decline compared with those without asthma (38 mL/year vs 22 mL/year).[46]

There has been recent interest in the potential for interactions between the effects of smoking and asthma on post-BD lung function. In one study of middle-aged adults, a multiplying effect was seen for current asthma and personal smoking with regard to "fixed" airflow obstruction, where the combined association was more than the sum of individual estimates.[20,21] This observation may in part reflect the entity of ACOS.

Asthma–COPD overlap syndrome

It is widely acknowledged that adult smokers with asthma and atopic individuals with COPD are two populations who have largely been excluded from clinical trials in the past. These "overlap" individuals have recently been highlighted as a subgroup which may show a greater benefit from ICS therapy given their relative corticosteroid responsiveness.[47] The combined Global initiative for chronic Obstructive Lung Disease (GOLD) and Global Initiative for Asthma (GINA) strategy has now formally labeled this clinical entity as ACOS.[48]

ACOS is estimated to account for ~15%–25% of obstructive airway diseases. Compared with patients with COPD, patients with ACOS are generally younger with the combined risk factors of smoking and atopy, and have higher rates of exacerbations without more severe chronic airways obstruction.[49,50]

Smoking from a public health perspective

Antismoking campaigns and the general population

A number of public health programs followed the release of the 1964 US Surgeon General's "report on smoking and health", including mass media campaigns, increasing the federal cigarette tax, restrictions on tobacco advertizing,[51] and most recently, the introduction of plain cigarette packaging in Australia in 2012. The Surgeon General's 1986 and 2006 reports documented links between parental smoking, childhood respiratory illness, and reduced lung function growth.[52] The 1986 report led to the first successful implementation of a smoke-free environment in a US medical facility.[53]

Between 2001 and 2010 in Australia, regular smoking decreased from 25% to 19% for adult males, compared with 21% to 16% for adult women.[54] While Australia and other high-income countries have made major progress to control tobacco consumption, the highest levels of preventable and premature death can be still attributed to personal smoking,[55] and this is still rising in low- and middle-income countries.

Parental smoking and childhood asthma

A causal link has been established between early childhood exposure to SHS and the incidence of new-onset wheeze and asthma,[56] suggesting that SHS exposure may unmask clinical symptoms of asthma in those otherwise susceptible. Maternal smoking during pregnancy has been shown to be most closely related to incident asthma,[57] and persistent asthma among Mexican, Puerto Rican, and black children.[58] It has been documented that children with respiratory illness can be aware of the negative consequences of smoking and exposure to SHS.[59]

Smoking cessation strategies

As smoking is a modifiable risk factor for poorer asthma control and greater symptom severity, smoking cessation in asthmatic individuals is a clinical strategy likely to improve patient outcomes. However, only few studies have assessed evidence-based treatments for nicotine dependence in people with asthma.[60] As a result, many of the following strategies relate to smokers in general, unless otherwise specified. While still relevant to the smoker who has asthma, the integration of these smoking cessation strategies into asthma care is important and has been addressed by subsequent sections.

Brief interventions for smoking cessation in those with asthma can involve opportunistic advice,[61] such as when individuals present for a review of their asthma and/or lung function testing. Public education, resources, and advice could be more heavily targeted toward this more susceptible group.

Advice from a health professional

Health professionals have the potential to assist people to give up smoking through giving advice, encouragement, and support, regardless of asthma status. It is best practice to ask smokers if they are ready to quit using the "five As" approach, originally proposed by the US Clinical Practice Guideline, and is summarized in Table 3.[62] Even if people appear not to be ready to quit, advice from a health professional can still be a trigger to quit, particularly in the context of adverse health problems.[63] Thus, there is benefit in urging all smokers to think about quitting whenever the opportunity arises.

The current evidence does not support restricting quitting advice and encouragement only to those smokers perceived to be "ready to quit", and thus guidelines now recommend that all smokers are advised to quit regardless of readiness.[61] If a smoker is ambivalent, then motivational interviewing can be used to resolve ambiguity and facilitate commitment to quitting. The rationale of this new approach is based on other aspects of medical care where patients can usually "opt out" by declining treatment.[64]

Telephone Quitlines are an essential strategy for smoking cessation, as they provide a brief and minimally invasive intervention which can be particularly convenient for people with physical impairment from chronic diseases such as asthma and COPD.[62] A dose–response in effectiveness is apparent, with at least three calls increasing the chances of quitting smoking when compared with individual strategies that include standard self-help materials, brief advice, or pharmacotherapy alone.[65]

Cognitive and behavioral strategies

Behavioral counseling and motivational interviewing

Brief or intensive counseling has been shown to increase quit rates, with or without concurrent pharmacotherapy.[66] Behavioral support in person or via telephone increases the chance

Table 3 The "five As" strategic model for treating tobacco use and dependence, for the patient willing to quit

Strategy	"As"	Action
A1	Ask	Systematically identify all tobacco users at every visit
		Current | former| never
A2	Advise	Strongly urge all tobacco users to quit
		"Continuing to smoke makes your asthma worse, and quitting may dramatically improve your health"
		"Quitting smoking may reduce the number of ear infections (and asthma attacks) your child has"
A3	Assess	Determine willingness to make a quit attempt
		Determine stage of change[a]
		"How do you feel about your smoking at the moment?"
		"Are you ready to stop smoking now?"
A4	Assist	Aid the patient in quitting (provide medication and counseling)
		Help the patient with a quit plan
		Recommend the use of approved medication except when contraindicated or the evidence is insufficient
		Provide practical counseling (total abstinence, make the home smoke free, build positively on past quit experiences, avoid alcohol, and other triggers)
		Provide supplementary materials (National Quitline network)
A5	Arrange	Ensure follow-up contact, within a week of the quit date

Note: Adapted from Fiore MC, Jaén CR, Baker TB, et al. *Treating Tobacco Use and Dependence: 2008 Update. Clinical Practice Guideline*. Rockville, MD: U.S. Department of Health and Human Services. Public Health Service; 2008.[62] [a]The Australian Clinical Guidelines now emphasize the "stages of change", as opposed to "readiness to quit".[61]

of success by up to 25%, especially for those having at least four contact sessions.[67] Brief motivational advice from health professionals has been shown to be effective in encouraging smoking cessation in all current smokers,[68] and even a brief (<3 minutes) intervention can make a significant difference (relative risk, 1.66; 95% CI, 1.42–1.94). The interaction involves asking open-ended questions, reflective listening, and summarizing. The likes and dislikes of the smoking habit and the act of quitting can be listed, and inconsistencies in the smoker's beliefs and personal goals regarding health and fitness discussed. In the lead-up to the quit day, individuals can keep a smoking diary that may identify smoking triggers and high-risk environments, such that the risk of relapse can be lessened by avoiding such situations. The smoker can also list the benefits of quitting and the adverse consequences should smoking recommence. Thus, behavioral strategies can be individualized to help people cope with triggers and high-risk situations. Similarly, a range of cognitive and behavioral strategies such as acceptance and commitment therapy and mindfulness training could be applied to block thoughts about withdrawal symptoms and other perceived benefits of restarting smoking.

For carers of children with asthma, the effectiveness of parental education and counseling programs has not been proven.[69] Nonetheless, motivational interviewing or intensive counseling of parents toward quitting might be useful strategies to reduce asthma symptoms in children, particularly if the public health message conveys the children's concerns.[59]

Group behavior therapy

As distinct from social support from family and friends, for smokers in general, professional group therapy can offer more benefit than self-help and other less intensive interventions.[70] Pooled results from 55 studies showed group programs to be more effective than self-help (OR 2.04 [95% CI 1.6–2.6]) or no intervention (OR 2.17 [1.4–3.5]). Specifically, in the Lung Health Study, 22% of smokers who received 12 sessions of group behavior modification techniques and nicotine gum were sustained quitters with the fewest respiratory symptoms after 5 years, as compared with 5% of participants in the usual care group.[71] Such intensive therapy generally depends on a trained facilitator, and it is not clear whether these group therapies are more effective or cost-effective than intensive individual counseling.[70] No information about individuals with asthma was available in this review.

Pharmacotherapies

There are few studies of pharmacotherapy for smoking cessation in patients with asthma. For smokers in general, nicotine replacement therapy (NRT), sustained release bupropion, and varenicline may be considered as first-line smoking cessation medications.[61] Unlike NRT, bupropion and varenicline have not been shown to be effective without counseling and support. For each individual smoker, the choice of pharmacotherapy can be personalized depending on circumstances and preferences that include drug contraindications, adverse effects, previous experience from quit attempts, cost, and convenience. There are limited clinical data for adolescents <18 years of age, and varenicline has not been evaluated as a treatment modality in this group.[72]

Nicotine replacement therapy

Only one randomized controlled trial has addressed the efficacy of NRT in the subgroup of people with asthma.[6] Of 220 Danish smokers with asthma, participants were allocated to 1) complete cessation, 2) reduction to fewer than seven cigarettes daily, and 3) usual smoking, where loss to follow-up was greatest for those assigned to the intervention.[73] Subjects received short-acting NRT to curb acute cravings (chewing gum and/or inhaler), but neither long-acting nicotine patches nor counseling. Either 2 mg or 4 mg strengths of nicotine gum were prescribed depending on Fagerstrom score. At 4 months, compared with a 5% cessation rate for control subjects, abstinence rates were 15% for both reduction and cessation groups which equaled 12% for the entire group. A further 15% reduced their tobacco consumption to fewer than seven cigarettes per day. While this intervention only modestly improved asthma symptoms, there was a decrease in bronchial reactivity and reduction in ICS dose at the follow-up. Thus, NRT was effective in smokers with asthma in the absence of counseling, and statistically significant respiratory outcomes were achieved.

Generally, provision of a combination of short- and long-acting NRT is recommended. Research has repeatedly shown that a combination of pharmacotherapy and behavioral support results in higher cessation rates than either approach alone. For example, West and Owen found 52-week follow-up abstinence rates of 7% for English smokers using single type of NRT alone, 10% for smokers using dual NRT alone, and 20% for smokers using combination NRT plus behavioral support.[74]

Other pharmacotherapy

The use of bupropion and varenicline combined with counseling is regarded as an appropriate smoking cessation strategy,[6] although trials of such strategies targeting smokers with asthma are lacking. In brief, bupropion was originally

developed as an antidepressant, and while it increases the quitting rate compared with placebo, it is not as effective as varenicline.[61] Varenicline is a nicotine receptor partial agonist, which can increase the odds of smoking abstinence at least twofold when compared with pharmacologically unassisted quit attempts.[75] It has been found to be more effective than bupropion, but the lack of efficacy over NRT may reflect the paucity of comparative studies. Serious adverse associations between varenicline, acute cardiovascular events, and suicidal ideation have not yet been excluded, and these possibilities should be discussed when considering which pharmacotherapy is most appropriate.[61] The increased risk of seizures from bupropion (1:1,000) is also an important consideration.[76]

Potential asthma-specific strategies for smoking cessation

Technologies and smoking cessation

Consumer health informatics applications provide health information via hardware, software, and web-based applications to facilitate health-related decisions made by the health care consumer.[77] Reviews have consistently demonstrated the effectiveness of online or web-based,[78] computer-delivered,[79] and electronic system[80] interventions for smoking cessation, compared with printed materials, emailed messages, and no intervention controls. In another review of 146 studies that looked at interventions such as interactive multimedia, web-based computer programs, and monitoring systems,[81] none had specifically targeted smokers with asthma.

For smokers in general, web-based internet programs have the potential for high cost-effectiveness as user acceptability is higher than for clinical, work-site, and/or telephone programs, and the costs per user are relatively low.[82] Interventions range from providing a list of smoking cessation websites, to moderately interactive and tailored programs, to high-depth tailored stories, and highly personalized message sources. In some cases, the individualization of one-to-one counseling can be effectively replicated.[83] Such innovative interventions are likely to be particularly useful for adolescents and young adults who are most familiar with the technology, and may be of more limited benefit for those who are older, have higher nicotine dependence, and/or are from a lower socioeconomic background.[82] An independent meta-analysis of 22 randomized controlled trials favored the use of web- and computer-based smoking cessation programs over no intervention (overall relative risk, 1.44; 95% CI, 1.27–1.64; n=29,549),[84] while the Cochrane review suggested that further studies that focused on interactivity and tailoring to subpopulations were needed.[83]

Text messages to cellular phones have been used successfully both to improve quit rates in the general population and to improve asthma symptoms in a small group of nonsmokers.[85,86] In the systematic review,[85] favorable results were reported by two randomized controlled trials, although generalizability of the findings may be limited to contemplative smokers and respondents to web-based advertisements.[87,88] While evidence for and against the use of text messaging in improving asthma symptoms or quit rates in smokers with asthma is still lacking, this form of intervention has the advantages of being personalized, affordable, and location independent.[87]

Potential barriers to consumer health informatics applications for all smokers include usability (technical plus limited literacy, language, and technological skills), limited clinician endorsement, lack of access, and concerns about data security and privacy.[81] Future studies that assess the acceptability, reach, efficacy, and cost-effectiveness of these strategies for smokers with and without asthma should clarify the role for consumer health informatics in this emerging field.

Electronic nicotine devices and smoking cessation

Electronic nicotine devices (ENDs; otherwise known as e-cigarettes) have been commercially available since 2006 with sales growing steadily, such that their use by American adolescents now exceeds that of conventional cigarettes.[89] Unlike combustible tobacco cigarettes, ENDs deliver nicotine in an inhalable form without the smoke, thereby minimizing exposure to non-nicotine constituents that can cause harmful health effects. As with traditional NRT, the provision of nicotine reduces withdrawal symptoms. ENDs additionally mimic the hand-to-mouth action and inhaling and exhaling of "smoke" or vapor.

Although using ENDs has been estimated to be ~95% safer than smoking combustible tobacco cigarettes,[90] the data regarding their use in smokers with asthma are lacking. In a small, retrospective study of 18 smokers with asthma who became regular END users for more than 12 months, the mean conventional cigarette consumption decreased from 22 to 1.7 daily, with a small increase in FEV_1 (3.30 L vs 3.40 L, P=0.005).[91] The null finding with regard to asthma exacerbations may have been due to limited power (P=0.15). These data have been included in a Cochrane systematic review,[92] where the bold suggestion was made that ENDs might be an option for individuals with asthma who are otherwise unable to quit smoking. While the change from conventional cigarettes to ENDs might offer potential harm minimization in asthma, nicotine exposure still has adverse effects especially

in pregnancy and cardiovascular disease, and more research is needed to clarify its safety profile.

Smoking cessation and relapse

In general, many smokers make multiple attempts before successfully quitting. In addition to individual vulnerability to tobacco withdrawal symptoms, factors contributing to relapse include social situations when drinking alcohol, being around other smokers, as well as stress related to work, relationships, and finances.[1] A different drug or combination of smoking cessation medications may be trialed for smokers who have been unsuccessful in their quit attempt or, a combination of NRT can be repeated for a subsequent attempt.[93]

Depending on the pharmacotherapy used, 5%–25% of smokers who attempt to quit abstain at 6 months, but around half of those who are abstinent at 1 year, relapse within the next 7 years.[94] Thus, follow-up by a health professional is essential, preferably in the first week and month after quitting and thereafter for at least 5 years.[61]

Smoking cessation as a component of the Asthma management plan

People with asthma who smoke should be encouraged strongly to quit, as a successful attempt might effectively optimize the anti-inflammatory action of their prescribed ICSs.[33] Including this intervention within asthma self-management empowers people with asthma to act in their own best interests, while the health practitioner can act primarily as an educator and a facilitator.[95] Asthma-specific considerations for smoking cessation have been suggested in Table 4.

Opportunities for smoking cessation

During the inpatient admission

Hospitalization of a current smoker with an acute exacerbation or "attack" of asthma may be an ideal time to provide smoking cessation advice, being a so-called teachable moment. Not only is the patient prohibited from smoking as virtually all hospitals are now smoke-free environments, the admission will most likely highlight the individual's vulnerability to asthma exacerbation from smoking.[62] This hospital-enforced abstinence, as well as the obvious link between the admission and the underlying smoking behavior, provides a pressing opportunity to prescribe NRT to lessen the withdrawal symptoms, to be followed by motivational interviewing and prescription of other pharmacotherapy as appropriate. It is possible that a more positive experience of nicotine withdrawal during the admission might facilitate the maintenance of abstinence and/or success in a future quit attempt.[62] It is imperative that these individuals have short- as well as longer-term supportive contact from health professionals in order to minimize the likelihood of relapse.[96]

During the outpatient consultation

For individuals who smoke and present to ambulatory care with asthma symptoms, it is important to view this as an opportunity to optimize asthma medication and provide smoking cessation advice. This is relevant to all, but particularly for those with severe asthma,[29] and women who are pregnant.[97]

For young adolescents presenting for review of their asthma, establishing their smoking status in addition to their

Table 4 Asthma-specific considerations when quitting

Consideration		Asthma-specific action
1	Importance	Recommend to quit smoking at every opportunity Target adolescents and young adults for whom smoking cessation can have the greatest benefit
2	Information	Discuss "lung age" to illustrate the lung function deficit from smoking ± asthma Describe corticosteroid insensitivity as a mechanism of worsening asthma control Highlight that smokers with asthma often have repeated and more frequent attempts to quit and emphasize that the process is cumulative Offer written asthma-specific information that might be web based
3	Management	Optimize asthma management while planning to nominate the quit date, which might necessitate increasing doses of ICS and/or other add-on therapy Use the current standard approach for smoking cessation, until there is an evidence base that differs for smokers with asthma
4	Admission	Regard this opportunity as a "teachable moment" In the absence of contraindications, inpatient NRT and counseling can be given as a priority, and other pharmacotherapies can be commenced as appropriate
5	Follow-up	Close and longer-term follow-up is essential, given those with asthma have a tendency to relapse, have more quit attempts and not complete asthma educational programs. Consider reminder text messages and educational prompts by cellular phone for those interested

Abbreviations: ICS, inhaled corticosteroid; NRT, nicotine replacement therapy.

degree of asthma control is crucial. This can be often difficult unless this is discussed without the presence of their parent and/or guardian. Smoking cessation advice in addition to optimizing medication dosage, delivery, and adherence can then be provided.

Potential for improved patient outcomes

Smoking cessation and improved asthma control

In a community-based Canadian cohort of 519 people with asthma, smoking abstinence at 12 months was achieved by 11% and was associated with a significant reduction in chest tightness (OR, 0.21; 95% CI, 0.06, 0.82) and nighttime symptoms (OR, 0.24; 95% CI, 0.07, 0.085; Table 2).[28] Symptoms including chest tightness, nocturnal symptoms, asthma attacks, and clinic attendances for asthma increased for current smokers during the follow-up period.

Smoking cessation and improved lung function

While many studies support the observation that abstaining from smoking improves asthma symptoms,[36] few studies have measured the impact of quitting on spirometry. Improvements occurred after 6 weeks in a small study (n=20) in which the mean increase in pre-BD FEV_1 from baseline was 407 mL only in quitters (95% CI, 21, 793).[98]

The Lung Health Study randomized smokers with mild-to-moderate airflow obstruction to an intensive, long-term smoking cessation program or usual care more than 5 years.[99] Pre-BD lung function improved during the first year for sustained quitters (FEV_1 +47 mL), and mean (±SD) rate of FEV_1 decline for sustained quitters was 31±48 mL/year, compared with the rate for continuing smokers (62±55 mL/year). As asthma was not an exclusion criterion, the study may have included some individuals with the ACOS.

Personalized professional support

The GINA recommends for current and former smokers with asthma to be assessed for the coexistence of chronic airflow limitation, where the definition of this ACOS is still evolving.[43] Through the measurement of post-BD spirometry, the individual's lung age can be determined and airflow obstruction that meets the lung function criterion for COPD can be identified. In the absence of diagnostic uncertainty or atypical symptoms and signs, initial therapy would include low-to-moderate dose ICS for symptom control, and the avoidance of LABA monotherapy for safety reasons.[43]

For such smokers with asthma, ideally a tailored individualized approach should be taken to manage their both asthma and smoking habit. For smokers with poorly controlled asthma, optimizing asthma therapy, while simultaneously planning a suitable quit date, would seem appropriate. Within the GINA framework, higher-dose ICS may be needed to control symptoms, and smoke exposure that is either from personal use or environmental sources should be strongly discouraged. Other pharmaceutical options that have been studied include adding a LABA to ICS,[34] and further research is needed with regard to fine-particle ICS, and/or add-on antileukotriene therapy.[35] For smokers of at least 15 cigarettes per day who fulfill clinical criteria for ACOS,[48] the addition of bupropion to NRT and counseling may be considered based on the evidence for mild-to-moderate COPD.[100] Careful multidisciplinary management using mental health services is also appropriate for smokers with asthma and coexistent mental health issues.

For adolescents, asthma education delivered to 8–10-year-old Jordanian students by older peer leaders was also successful in teaching about asthma self-management and motivating students to avoid smoking.[101] Using the Arabic version of the self-efficacy subscale of the Self-Administered Nicotine Dependence Scale,[102] self-efficacy to resist smoking was significantly higher in the intervention group (mean score 11.5 vs 6.9), and the mean difference was statistically significant (mean difference 4.6; 95% CI, 2.9–6.4; P=0.03). This peer-led intervention was in part designed to assess the effectiveness of the Adolescent Asthma Action (Triple A) program on the capacity to resist smoking, which was originally developed in Australia to be implemented in a supportive school environment.[103] The National Asthma Council offers a website for adolescents with a link to this program: http://www.asthmahandbook.org.au/populations/adolescents/self-management. The following website: http://www.asthmahandbook.org.au/management/adults, may be appropriate for relatively well educated adults.

Future integration of smoking cessation strategies into asthma care

Quitting smoking can improve asthma symptoms and reduced lung function, but the relatively low rates of successful quitting places these smokers with asthma at greater risk of adverse health effects including poorly controlled asthma and the potential for the ACOS. For smokers with asthma, the integration of pharmacotherapy for smoking cessation with counseling is still best practice. Where appropriate, asthma medication can be intensified while planning a cessation date. A discussion around lung age and the provision of asthma-specific reading material can personalize management for individuals. For smokers, regardless of asthma status, com-

munication and web-based technologies based on consumer health informatics show some promise to aid smoking cessation over the course of the quitting process. Specifically for smokers with asthma, further studies that address the issue of acceptability, reach, efficacy, and cost-effectiveness will provide valuable information to tailor more optimal strategies for this more susceptible subgroup. The GINA strategy has provided updated guidelines for the management of asthma and the ACOS.[43]

As a health priority, the substantial benefits of smoking cessation should be emphasized to current smokers with asthma, through positive educational messages delivered by health practitioners and supported by Quitlines. Targeting adolescents and young adults before they become established smokers is vital because the earlier smokers quit, the easier cessation is to achieve and the health benefits are greatest. Considering the specific needs of current smokers with asthma may facilitate a smoking cessation intervention that is more individualized and aimed at improving quit rates in the longer term. Public education, resources, and advice could be more strongly focused toward this more susceptible group.

Disclosure

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