

EXHALE

A Technical Package to Control Asthma (Resource Document)

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Executive Summary

The EXHALE technical package represents a group of strategies, which, based on the best available evidence, can improve asthma control and reduce health care costs. It is intended as a resource to inform decision-making in communities, organizations, and states.

This table summarizes the strategies in this technical package, as well as specific ways (i.e., approaches) to advance these strategies.

EXHALE		
	Strategy	Approach
E	Education on asthma self-management	<ul style="list-style-type: none"> Expanding access to and delivery of asthma self-management education (AS-ME)
X	X-tinguishing smoking and secondhand smoke	<ul style="list-style-type: none"> Reducing tobacco smoking Reducing exposure to secondhand smoke
H	Home visits for trigger reduction and asthma self-management education	<ul style="list-style-type: none"> Expanding access to and delivery of home visits (as needed) for asthma trigger reduction and AS-ME
A	Achievement of guidelines-based medical management	<ul style="list-style-type: none"> Strengthening systems supporting guidelines-based medical care, including appropriate prescribing and use of inhaled corticosteroids Improving access and adherence to asthma medications and devices
L	Linkages and coordination of care across settings	<ul style="list-style-type: none"> Promoting coordinated care for people with asthma
E	Environmental policies or best practices to reduce asthma triggers from indoor, outdoor, and occupational sources	<ul style="list-style-type: none"> Facilitating home energy efficiency, including home weatherization assistance programs Facilitating smokefree policies Facilitating clean diesel school buses Eliminating exposure to asthma triggers in the workplace whenever possible Reducing exposure to asthma triggers in the workplace (if eliminating exposures is not possible)

These strategies are complementary and intended to work in combination to reinforce each other.

The hope is that multiple sectors, including public health, health care, education, social services, and non-governmental organizations, will use this technical package to improve asthma control in all age groups. Commitment, collaboration, and leadership from numerous sectors can maximize the impact of this technical package.

This technical package is ready for implementation now; it reflects the mature evidence base about how to control asthma effectively. Monitoring and evaluation play a key role in implementing EXHALE and identifying additional effective programs, policies, or practices. As new evidence becomes available, this technical package can be refined to reflect the current state of the science.

This technical package is not a guideline or recommendation.

Fast Facts about Asthma in the United States

- One in 13 people has asthma (more than 24 million Americans)¹
- In the United States, 50% of adults with asthma and 40% of children with asthma do not have control of their disease²
- Each year, asthma accounts for approximately:
 - 439,000 hospitalizations¹
 - 1.6 million emergency department visits¹
 - 10.5 million physician office visits¹
 - 13.8 million missed school days³
 - 14.2 million missed work days⁴
- The estimated cost of treating asthma in the United States is \$62.8 billion every year⁵

Overview of EXHALE

The EXHALE technical package represents a select group of strategies based on the best available evidence to control asthma. It is a resource to inform decision-making in communities, organizations, and states, by identifying strategies with the greatest potential impact on controlling asthma.

This table summarizes the strategies in this technical package, as well as each strategy’s associated approach(es).

EXHALE		
	Strategy	Approach
E	Education on asthma self-management	<ul style="list-style-type: none"> Expanding access to and delivery of asthma self-management education (AS-ME)
X	X-tinguishing smoking and secondhand smoke	<ul style="list-style-type: none"> Reducing tobacco smoking Reducing exposure to secondhand smoke
H	Home visits for trigger reduction and asthma self-management education	<ul style="list-style-type: none"> Expanding access to and delivery of home visits (as needed) for asthma trigger reduction and AS-ME
A	Achievement of guidelines-based medical management	<ul style="list-style-type: none"> Strengthening systems supporting guidelines-based medical care, including appropriate prescribing and use of inhaled corticosteroids Improving access and adherence to asthma medications and devices
L	Linkages and coordination of care across settings	<ul style="list-style-type: none"> Promoting coordinated care for people with asthma
E	Environmental policies or best practices to reduce asthma triggers from indoor, outdoor, and occupational sources	<ul style="list-style-type: none"> Facilitating home energy efficiency, including home weatherization assistance programs Facilitating smokefree policies Facilitating clean diesel school buses Eliminating exposure to asthma triggers in the workplace whenever possible Reducing exposure to asthma triggers in the workplace (if eliminating exposures is not possible)

These strategies are complementary and intended to work in combination to reinforce each other.

Similarly, commitment, collaboration, and leadership from numerous sectors, including public health, health care, education, social services, and non-governmental organizations, can maximize the impact of this technical package.

Additional details on these strategies and approaches are available in the [Appendix](#), along with summaries of supporting evidence and relevant sectors well positioned to lead implementation efforts.

What Is a Technical Package?

A technical package is a compilation of a core set of strategies to achieve and sustain substantial reductions in a specific risk factor or outcome.⁶ Technical packages help communities, organizations, and states prioritize prevention activities based on the best available evidence.

This technical package has three components.

- 1) The **strategies** are the actions to achieve the goal of improved asthma control.
- 2) The **approaches** are specific ways (e.g., programs, policies, or practices) to advance each strategy.
- 3) The **evidence** is the scientific basis for each strategy or approach.

This technical package is a resource to guide and inform decision-making in communities, organizations, and states. This technical package is not a guideline or recommendation.

Controlling Asthma is a Priority

Asthma is a disease that affects the lungs.⁷ It can cause wheezing, trouble breathing, chest tightness, and coughing.⁷ These symptoms increase during asthma attacks. Asthma attacks can require life-saving treatment in an emergency department (ED) or hospital.⁷

Asthma is common and costly.

- More than 24 million Americans have asthma, affecting 1 in 12 children and 1 in 14 adults.¹
- Each year, asthma accounts for more than 439,000 hospitalizations, 1.6 million emergency department (ED) visits, and 10.5 million physician office visits.¹
- About 10 people die of asthma each day.¹
- Asthma has been linked to 13.8 million missed school days and 14.2 million missed work days annually.^{3,4}
- The estimated cost of treating asthma in the United States is \$62.8 billion every year.⁵

The burden of asthma is unequally distributed.

- People disproportionately affected by asthma include Black Americans, Puerto Ricans, and those with low income.¹
- Black Americans are approximately 2 times more likely to die from asthma than white Americans.⁸

Asthma burden can be reduced by controlling asthma.

- In the United States, 50% of adults with asthma and 40% of children with asthma do not have control of this disease.²
- By taking appropriate medicine and avoiding triggers that can cause asthma attacks, asthma can be controlled and many asthma attacks can be prevented.⁷

More About Asthma Control

According to national guidelines⁷, controlling asthma consists of:

1. **Reducing impairment**, which includes preventing asthma symptoms, reducing rescue medication use, maintaining lung function, and maintaining normal physical activity levels and attendance at work or school
2. **Reducing risk**, which includes minimizing the need for ED visits and hospitalizations and preventing repeated asthma attacks

In other words, controlling asthma:

- Prevents symptoms like wheezing or coughing
- Prevents ED visits and hospitalizations for asthma
- Prevents missed work or school because of asthma
- Helps people take part in all physical activities

Assessing the Evidence

Assessing the evidence for this technical package included identifying impact on asthma control and characterizing the strength of evidence.

- Evidence included in this technical package had to show a beneficial impact on asthma control.
- Priority was given to meta-analyses or systematic reviews, followed by randomized controlled trials, and then quasi-experimental designs. If these study designs were unavailable because of feasibility or ethics, pre–post comparisons were acceptable (e.g., interventions implemented by a state or health insurance plan).
- Impact on asthma control and strength of evidence are summarized in the text descriptions of the strategies, as well as in the Appendix.
- In addition, priority was given to evidence from the United States. Regarding evidence from another country, consideration was given to the feasibility of implementation in a U.S. context.

The examples provided in this technical package are not a comprehensive list of evidence-based programs, practices, or policies for each approach.

- These are examples of success in improving asthma control.
- Not all programs, practices, or policies that implement the same approach (e.g., home visits) are successful or equally effective; even those that are effective might not work across all populations.⁹

In practice, the effectiveness of the programs, practices, and policies identified in this package will vary.

- Factors affecting these programs, practices, and policies include the quality of their implementation and the communities in which they are implemented.
- Tailoring and evaluating programs could improve understanding of program effectiveness across different communities.

This technical package is ready for implementation now.

- This technical package reflects the mature evidence base about how to control asthma.
- Progress will continue to be made into the future.
- As new programs, policies, or practices are identified, evaluated, and shown to be effective, this technical package can be updated and refined.
- Implementation guidance has been or will be developed separately. Examples of existing implementation resources are described or referenced in the text description of each strategy.

Contextual and Cross-Cutting Themes

An integrated approach to controlling asthma can achieve the greatest public health impact.

- Research indicates multifaceted interventions to control asthma are generally more effective than individual strategies in isolation.⁷
- The strategies in this technical package work in combination and reinforce each other to control asthma.
- Extensive, long-lasting improvements in asthma control are best achieved by a focus across individuals, families, communities, health care providers, and societal-levels and across all sectors, private and public.⁷

The social and cultural context of individuals and their communities is a critical consideration when implementing EXHALE.

- The example programs, practices, and policies provided in this technical package have been implemented within particular contexts.
- Practitioners in the field might be in the best position to assess needs and existing resources in their communities and to work with partners to implement EXHALE successfully.

Engagement is important for the successful implementation of this technical package.

- Engagement of people with asthma, their families, communities, and health care providers, among others, is vital to effective implementation of EXHALE. Thus, addressing barriers to engagement is valuable.^{10,11}
- Engagement and investment from multiple sectors are important for successful implementation of EXHALE. Public health agencies are well positioned to lead implementation efforts for selected EXHALE strategies and can serve as important collaborators for other EXHALE strategies. Leadership and commitment from other sectors (e.g., health care) are critical to implement strategies such as *Achievement of Guidelines-Based Medical Management*.
- The role of various sectors in implementing EXHALE is described further in the section on *Sector Involvement* (page 31).

The sections that follow describe the strategies and approaches with the best available evidence for improving asthma control.

Examples of Barriers to Engagement

- Among people with asthma, barriers to engagement include social determinants of health. These can affect availability of resources (e.g., time, money) to prioritize preventive behaviors to control their or their children's asthma.^{12,13} Relatedly, household chaos (overall physical, social, and environmental disorder in the household), has been linked to less patient engagement and control of chronic disease.¹⁴⁻¹⁸
- Among health care providers, engagement can be influenced by productivity expectations and burnout, which in turn can affect quality of care.¹¹

Education on Asthma Self-Management

Rationale for this Strategy

- Asthma self-management education (AS-ME) is an important strategy for controlling asthma, according to national guidelines.⁷
- Key educational messages of AS-ME include basic facts about asthma, roles of medications, how to use asthma medications correctly, what to do when asthma symptoms worsen, and how to reduce exposures to asthma triggers (i.e., environmental allergens and irritants).⁷
- Local, state, and federal factors (e.g., availability of AS-ME providers or provider reimbursement mechanisms) can limit access to and delivery of AS-ME.^{9,19-21}
- Improving access to and delivery of AS-ME can improve asthma control and reduce health care costs.^{7,9}

Approach for this Strategy

Expanding access to and delivery of asthma self-management education

- Effective AS-ME can be delivered in a variety of settings (e.g., individual, family, or group education in a clinic, school, pharmacy, or community) by a variety of providers (e.g., nurses, respiratory therapists, certified asthma educators, or community health workers).^{7,9,22}
- National standards exist for providing AS-ME and training asthma educators.^{19,23}
- AS-ME requires repetition and reinforcement.⁷
- Proven models and potential pathways for sustainable delivery of AS-ME are discussed at <http://www.cdc.gov/sixeighteen/asthma> and in other public resources.^{9,24,25}

Evidence for this Strategy

Expanding access to and delivery of asthma self-management education

- Many studies have shown that AS-ME can improve asthma control and medication adherence while reducing ED visits, hospitalizations, and missed work or school days.^{7,9,22,26}
- Over 25 U.S. programs have shown that AS-ME often can reduce health care costs within 1 to 3 years, by preventing asthma-related ED visits, hospitalizations, or urgent care visits⁹, including:
 - ❖ Adult and pediatric patients of community health centers (i.e., federally qualified health centers) who received 5 AS-ME lessons experienced fewer ED and urgent care visits.^{9,27,28} Their health insurance plan observed cost savings of 22% for adult patients and 39% for pediatric patients.^{9,27,28}
 - ❖ When school nurses at 61 schools received training and supplies to provide AS-ME to their students, participating students experienced better asthma control and saved Medicaid an average of \$1,431 per student over 1 year.²⁹
- U.S. health insurance plans have engaged in approximately 20 AS-ME programs reporting return on investment or other cost savings data, including at least 15 home-based AS-ME programs and 4 programs providing AS-ME in other settings such as clinic.^{9,30,31} Additional

information on home visits is available in the section *Home Visits for Trigger Reduction and Asthma Self-Management Education* (page 17).

Additional details on the evidence for this strategy and its approach are available in the Appendix.

What Is a Certified Asthma Educator?

- A certified asthma educator typically is a licensed health care professional (e.g., nurse, respiratory therapist) with an additional certification in asthma education, but non-health care professionals also can become certified if they have at least 1,000 hours of relevant experience and pass the National Asthma Educator Certification Board Exam.²³
- Multiple effective, economically sustainable programs implementing EXHALE strategies (e.g., AS-ME, home visits for trigger reduction and AS-ME) have involved certified asthma educators.^{9,32-34}
- Additional information regarding certified asthma educators is available online.²³

What Is a Community Health Worker?

- A community health worker is a frontline public health worker who is a trusted community member or has a deep cultural understanding of the community served. This person serves as a liaison between health and social services and the community to facilitate access to services and to improve the quality and cultural competence of service delivery.
- Multiple effective, economically sustainable programs implementing EXHALE strategies (e.g., AS-ME, home visits for trigger reduction and AS-ME, coordination of care) have involved community health workers.^{9,33,35,36}
- Additional information regarding community health workers, including asthma-specific training tools, is available at <http://www.cdc.gov/stltpublichealth/chw> and in other public resources.³⁷⁻

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X-tinguishing Smoking and Secondhand Smoke

Rationale for this Strategy

- Tobacco smoke is a known trigger of asthma attacks.^{7,43} National asthma guidelines recommend people with asthma avoid smoking and exposure to secondhand smoke.⁷
- About 1 in 5 of U.S. adults with asthma smoke cigarettes and about 9% of adult asthma-related ED visits are related to smoking.^{44,45}
- Approximately half of children with asthma (54%) are exposed to secondhand smoke in the home; this exposure is linked to a 63% increase in asthma-related ED visits among low-income, urban children.^{46,47}
- Secondhand smoke exposure before birth is a risk factor for childhood asthma and wheezing.⁴⁸⁻⁵² Thus, national asthma guidelines recommend pregnant women avoid both smoking and exposure to secondhand smoke.⁷
- Interventions to reduce smoking and secondhand smoke exposure can improve asthma control and reduce health care costs.^{7,43,53-56}

Approaches for this Strategy

Reducing tobacco smoking

- National guidelines for reducing tobacco smoking recommend interventions such as cessation counseling (individual, group, or telephone-based) and cessation medications approved by the Food and Drug Administration (FDA).⁵⁷⁻⁶³
- Proven approaches include focused tobacco cessation interventions as well as those provided in combination with other asthma-related interventions (e.g., self-management education).^{58-60,64} Additional information on reducing tobacco smoking is available in national tobacco cessation guidelines⁵⁷ and at <http://www.cdc.gov/tobacco>.

Reducing exposure to secondhand smoke

- Providing tobacco cessation counseling or FDA-approved cessation medications to parents or caregivers of children with asthma is effective, especially when combined with other asthma-related interventions (e.g., self-management education).⁶⁵⁻⁷³
- Many successful programs have delivered these interventions through home visits.⁶⁵⁻⁷³ Additional information on home visits is available in the section *Home Visits for Trigger Reduction and Asthma Self-Management Education* (page 17).
- Proven interventions to reduce smoking among pregnant women could reduce secondhand smoke exposure before birth, a recommendation of national asthma guidelines.^{7,62,74-76}
- Smokefree policies are effective in reducing exposure to secondhand smoke and improving asthma control. Additional information is available in the section *Environmental Policies or Best Practices to Reduce Asthma Triggers from Indoor, Outdoor, and Occupational Sources* (page 26).⁷⁷

Evidence for this Strategy

Reducing tobacco smoking

- Research shows that tobacco cessation can improve asthma control and lung function while reducing rescue medication use, ED visits, and urgent office visits.^{58-60,78} Significant improvements in lung function have been observed as early as 24 hours after quitting smoking.⁷⁹
- For example, a controlled study that provided nicotine replacement therapy (chewing gum or oral inhaler) to adults with asthma found significant improvements in asthma symptoms, quality of life, rescue medication use, and lung function. Individuals who quit smoking also needed 25% less inhaled steroid medication to control their asthma.⁵⁸

Reducing exposure to secondhand smoke

- Research shows that providing tobacco cessation treatments to parents or caregivers of children with asthma can reduce ED visits, hospitalizations, and missed school days; these treatments can also reduce health care costs.^{65-69,71,80} These studies include multiple randomized controlled trials^{66-69,71} and also include populations with high asthma burden (e.g., Medicaid-eligible, African American, or Puerto Rican).^{65-69,71,80}
- For example, a program providing 3 home visits for tobacco cessation counseling and asthma self-management education to Medicaid-enrolled parents or caregivers of children with asthma significantly reduced asthma-related ED visits, hospitalizations, and office visits among these children, as well as associated health care costs.⁶⁹

Additional details on the evidence for this strategy and its approaches are available in the Appendix.

Home Visits for Trigger Reduction and Asthma Self-Management Education

Rationale for this Strategy

- Home visits to reduce environmental asthma triggers and provide asthma self-management education (AS-ME) can improve asthma control (e.g., when asthma is not controlled despite guidelines-based medical management and AS-ME outside the home).^{7,9,81,82}
- Home visits can reveal barriers to patient engagement, adherence, or asthma control not previously recognized or fully appreciable in the outpatient, ED, or hospital setting (e.g., housing conditions, social stressors, work and family obligations that affect individuals' or families' abilities to manage asthma).⁸³
- Home visit programs for asthma remain limited. Local, state, and federal factors play a role (e.g., availability of home visit programs, infrastructure to pay for home visit services or providers).^{7,9,10,81,82,84}
- Improving access to and delivery of home visits for selected people with asthma can improve asthma control and reduce health care costs.^{7,9,81,82}

Approach for this Strategy

Expanding access to and delivery of home visits (as needed) for asthma trigger reduction and AS-ME

- Home visits might be necessary to improve asthma control among some individuals with asthma (e.g., those whose asthma is not controlled despite guidelines-based medical management and AS-ME outside the home).^{7,9,81,82}
- These home visit programs can serve as care management programs for people at high risk for asthma attacks.⁸⁵
- Effective home visit programs provide both multifaceted asthma trigger reduction and AS-ME.^{7,9,81,82}
- A variety of providers can effectively deliver home visits for asthma, including nurses, respiratory therapists, certified asthma educators, and trained community health workers.^{7,9,81,82}
- To reduce asthma triggers in the home (e.g., cockroaches, dust mites, mold, secondhand smoke), successful programs have provided, at a minimum, education on how individuals or families can decrease their exposure to asthma triggers.^{7,9,81,82} Some programs help participants even further, e.g., through integrated pest management, providing supplies (e.g., bedding encasements, cleaning supplies), or communicating with health care providers, schools, or social services. The importance of these linkages is further described in the section *Linkages and Coordination of Care Across Settings* (page 23).⁹
- Relevant implementation guidance is available in CDC's *Strategies for Addressing Asthma in Homes*⁸⁶ and other public resources.^{40,87,88} Proven models and potential pathways for sustainable delivery of home visit programs for asthma are discussed at <http://www.cdc.gov/sixteen/asthma> and elsewhere online.^{9,24,87,89}

- Addressing barriers that prevent people with asthma from participating in home visit programs (e.g., trust or scheduling concerns) could improve program efficiency.^{10,13}

Evidence for this Strategy

Expanding access to and delivery of home visits (as needed) for asthma trigger reduction and AS-ME

- Many studies, including a systematic review and multiple randomized controlled trials, have shown that home visits can improve asthma control and medication adherence while reducing ED visits, hospitalizations, and missed work or school days.^{7,9,35,81,82,90-95}
- Over 40 U.S. programs have shown that home visits can reduce health care costs.^{9,96} Among these programs, the median estimated time to achieve return on investment was 3 years.⁹
- For example, a randomized controlled trial found that a program offering Medicaid-enrolled children up to 4 home visits by a community health worker for trigger reduction and AS-ME (over a 4 month period) significantly reduced urgent asthma-related health care utilization (e.g., ED visits, hospitalizations) and achieved a return on investment of \$1.90 per \$1 spent within 2 years.³⁵
- U.S. health insurance plans have engaged in at least 15 asthma-related home visit programs reporting return on investment or other cost savings data.^{9,30,31}

Additional details on the evidence for this strategy and its approach are available in the Appendix.

Selected State Success Stories

Michigan: Managing Asthma Through Case-management in Homes (MATCH) Programs

- Nurses or respiratory therapists (all certified asthma educators) providing home visits for case management, AS-ME, and trigger reduction have reduced ED visits and hospitalizations by ~60%, while also reducing missed school and work days.^{9,32,97}
- Multiple Medicaid health insurance plans have reimbursed providers for these services.
- These services have been replicated across the state.
- Return on investment is an estimated as \$2.10 per \$1 spent.^{9,32,34,97}

Montana: Montana Asthma Home Visiting Program (MAP)

- Nurses providing home visits for trigger reduction and AS-ME have reduced asthma symptoms, ED visits, and missed school and work days.^{97,98}
- This program also has improved asthma control, inhaler technique, and self-management among participants.^{95,97}

Rhode Island: Home Asthma Response Program (HARP)

- Certified asthma educators and community health workers teamed up to provide home visits for AS-ME and trigger reduction (including environmental supplies); these home visits reduced ED and hospital costs by 76%, an average of \$1,606 per program participant over the following year. Overall return on investment was \$1.33 per \$1 spent.³³
- Even greater cost savings were seen among the subset of 'high utilizers' (participants with at least 2 asthma-related ED visits or 1 hospitalization prior to program enrollment). For high

utilizers, ED and hospital costs decreased 80%, an average of \$2,708 per person over the following year. Among high utilizers, return on investment was \$2.26 per \$1 spent.³³

- Quality indicators also improved, with asthma medication ratio HEDIS scores increasing from 32% to 46%, use of asthma action plans rising from 20% to 80%, and participants with well-controlled asthma growing from 20% to 52%.³³

For more information on certified asthma educators and community health workers, please see the text box on page 14.

Achievement of Guidelines-Based Medical Management

Rationale for this Strategy

- Evidence-based recommendations for medical management of asthma are provided in national asthma guidelines (i.e., Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma [EPR-3] from the National Asthma Education and Prevention Program).⁷
- However, guidelines-based medical management of asthma is not routine, leading to inadequate asthma control.⁹⁹⁻¹⁰²
- Increased use of guidelines-based medical management can improve asthma control and reduce health care costs.¹⁰¹⁻¹⁰⁶
- Evidence-based opportunities to increase use of guidelines-based medical management of asthma among populations include strengthening system supports and improving access and adherence to asthma medications and devices (e.g., spacers).^{26,101-110}

Approaches for this Strategy

Strengthening systems supporting guidelines-based medical care, including appropriate prescribing and use of inhaled corticosteroids

- Effective interventions providing clinical support or feedback include:
 - ❖ Focused training of health care providers including physicians, nurses, and pharmacists.^{99,104,105,111}
 - ❖ Audit and feedback systems implemented by health care organizations or health insurance plans, which analyze medical records to identify patients who could benefit from asthma control interventions.^{99,104,112,113}
 - ❖ Decision support tools (electronic or paper-based) designed to promote guidelines-based medical management (e.g., pocket-sized guidelines summaries, system reminders, treatment algorithms).^{99,114}
- Other interventions shown to support access to or delivery of guidelines-based medical care include:
 - ❖ School-based health centers, which provide primary health care on-campus or off-site. More information about school-based health centers is available online.¹¹⁵⁻¹¹⁹
 - ❖ Coordinated care for people with asthma. Additional information on coordinated care is available in the section *Linkages and Coordination of Care Across Settings* (page 23).
- Quality improvement projects and initiatives are examples of ways to implement these types of interventions.^{99,106}
- Relevant implementation guidance is available in several publications produced by the National Asthma Education and Prevention Program, which is coordinated by the National Institutes of Health.^{100,120}

Improving access and adherence to asthma medications and devices

- Copayment amounts for asthma medications and devices can influence whether people with asthma obtain prescribed treatments.¹⁰⁸⁻¹¹⁰

- A proven method of improving adherence is shared treatment decision-making, in which patients with asthma and their health care providers collaborate to decide on treatment.^{26,107} This process provides opportunities to discuss patient goals, preferences, or concerns.^{26,107}

Evidence for this Strategy

Strengthening systems supporting guidelines-based medical care, including appropriate prescribing and use of inhaled corticosteroids

- Many studies, including a systematic review and multiple randomized controlled trials, have shown interventions providing asthma-related clinical support or feedback to health care providers can improve patients' asthma symptoms and controller medication use while reducing ED visits, hospitalizations, and missed school days.^{10,94,99,104-106,114,121}
- For example, a large randomized controlled trial found that a 2-session interactive training for primary care physicians led to a 45% decrease in asthma-related ED visits and a 46% decrease in days limited by asthma symptoms among patients of physicians who received this training (the Physician Asthma Care Education curriculum).^{105,121}
- Audit and feedback systems (e.g., using claims data) also can reduce asthma-related ED visits by up to 55% and hospitalizations by up to 56%. Return on investment for these systems is an estimated \$2 to \$4 per \$1 spent.^{10,103,104,106}
- A systematic review found fewer asthma-related ED visits and hospitalizations occurred among students of schools with school-based health centers, compared to schools without school-based health centers.¹¹⁵⁻¹¹⁹

Improving access and adherence to asthma medications and devices

- Studies have linked access to prescribed asthma treatments to improved asthma control, increased controller medication use, reduced rescue medication use, fewer ED visits and hospitalizations, and lower health care costs.^{26,107-110,122,123}
- Effects of out-of-pocket medication costs on medication adherence and health outcomes have been studied in over 51,000 people with asthma.¹⁰⁸⁻¹¹⁰ Two of these studies showed that higher copayment costs affected whether people obtained prescribed asthma treatments.^{109,110} An additional study demonstrated that higher out-of-pocket costs for asthma medications were associated with less medication use and more asthma-related hospitalizations.¹⁰⁸
- Shared treatment decision-making between people with poorly controlled asthma and their health care providers led to improved asthma control, fewer asthma-related medical visits, decreased rescue medication use, and better lung function, in a large randomized controlled trial of more than 600 participants.¹⁰⁷

Additional details on the evidence for this strategy and its approaches are available in the Appendix.

State Success Story

Missouri: Drug Utilization Review of Medicaid Pharmacy Claims Data

- This quality improvement intervention analyzed Medicaid pharmacy claims data to identify people with asthma whose medication use did not follow guidelines-based medical management; these individuals' health care providers were then notified by mail.¹²⁴
- In one year, this audit and feedback system improved controller medication adherence, decreased overutilization of rescue inhalers, and resulted in Medicaid savings on pharmacy costs.¹²⁴
- Medicaid savings on asthma-related medications were \$5.92 per patient per month (compared to a control group), leading to a total estimated savings of more than \$430,000 for the 6-month post-intervention period.¹²⁴

Linkages and Coordination of Care Across Settings

Rationale for this Strategy

- Coordinated care includes promoting linkages within and across the health care system and community services to address patients' needs (e.g., medical, social) and improve health.^{10,125,126}
- Improved coordination of care could reduce total U.S. health care expenditures by \$240 to \$310 billion annually.¹²⁷
- Improving access to coordinated care for people with asthma can improve asthma control and reduce health care costs.^{9,36,128-138}

Approach for this Strategy

Promoting coordinated care for people with asthma

- Health care provider organizations, health insurance plans, schools, and community organizations can emphasize coordinated care through interventions such as patient-centered medical homes, disease management, case management, and school- or community-based programs.^{9,36,128-138}
- A variety of providers can successfully coordinate care and facilitate linkages across settings, including nurses, community health workers, social workers, and case managers.^{9,10,36,128-138}
- Successful coordination of care can:
 - ❖ Be facilitated by partnerships and health information exchange (e.g., using health information technology) between organizations or sectors such as health care, education, and non-governmental organizations.^{10,113,129-131,139-141}
 - ❖ Involve or support other strategies in this technical package (e.g., AS-ME, home visits for trigger reduction and AS-ME, achievement of guidelines-based medical management)^{9,36,128-133}; these strategies are described further in their respective sections of this document.
- Relevant implementation guidance is available at <http://pcmh.ahrq.gov>, <http://bphc.hrsa.gov/qualityimprovement/clinicalquality/accreditation-pcmh/selection.html>, and in other public resources.^{142,143}

What Is a Patient-Centered Medical Home?

A patient-centered medical home, also known as a primary care medical home, is a model of health care that puts patients at the forefront of care.^{125,142} Its priorities include:

- Coordinated, team-based, patient-centered care
- Linkages among care providers
- Health care quality

Studies have shown this model can improve health care quality, patient experiences and staff satisfaction while reducing health care costs.¹⁴²

Evidence for this Strategy

Promoting coordinated care for people with asthma

- Many studies, including several randomized controlled trials, have shown that coordinated care can improve asthma control and controller medication use while reducing ED visits, hospitalizations, and missed school and work days.^{9,36,94,128-136,144}
- Multiple programs have shown that coordinated asthma care can reduce health care costs.^{133,134,138} Return on investment has been reported as \$1.33 per \$1 spent within 3 years.¹³³
- A wide variety of providers and organizations have improved asthma control by expanding access to coordinated care for people with asthma, including:
 - ❖ **Numerous health insurance plans across the country** have improved asthma control and reduced health care costs by coordinating asthma care using trained staff members (e.g., case managers or community health workers) or contracts with community organizations to provide these services, often through home visits.^{9,10} Additional information on home visits is available in the section *Home Visits for Trigger Reduction and Asthma Self-Management Education* (page 17).
 - ❖ **A state chapter of the American Academy of Pediatrics**, supported by state and federal funding, implemented patient-centered medical homes in 92 pediatric practices and improved asthma control within 100 days, including an 18% reduction in missed school days and a 21% reduction in ED visits and acute care visits.¹²⁸
 - ❖ **A hospital-run, community-based program** emphasizing coordinated asthma care through services including nurse case management, linkage to primary care providers, and home visits for trigger reduction and AS-ME reduced ED visits by 68% and hospitalizations by 85%,¹³² Return on investment was \$1.33 per \$1 spent within 3 years.¹³³
 - ❖ **School-based programs** providing coordinated asthma care (including increased communication between schools and primary care providers) through school nurses or other staff have improved asthma control and reduced ED visits, urgent care visits, and missed school days.^{130,131} These successful programs have also provided AS-ME to children or families.^{130,131} Additional information on school-based strategies to address asthma is available in CDC's *Strategies for Addressing Asthma in Schools*.¹⁴⁵

Additional details on the evidence for this strategy and its approach are available in the Appendix.

State Success Story

Indiana: Parkview Health's Emergency Department Asthma Call Back Program

- A registered nurse or registered respiratory therapist contacts (via phone or email) people with asthma who visit Parkview Health's emergency department (ED) within 7–14 days of the visit.^{146,147} These staff provide various services, including discussing the status of asthma control, assessing whether people can afford prescribed asthma medications, offering home visits, linking people to primary care physicians and patient-centered medical homes, encouraging people to make and keep regular medical appointments, and providing AS-ME and mitigation resources as needed.^{146,147}
- This program has effectively reduced asthma-related ED visits and missed school and work days.^{146,147}
- Return on investment is >\$1 per \$1 spent.^{147,148}
- Collaboration between the local health care system, local school districts, and the local and state health department helped this program succeed.^{146,147,149,150}

Environmental Policies or Best Practices to Reduce Asthma Triggers from Indoor, Outdoor, and Occupational Sources

This section has three parts.

Part 1: Indoor sources of asthma triggers

Part 2: Outdoor sources of asthma triggers

Part 3: Occupational sources of asthma triggers

The approaches described in each part of this section represent the best available evidence to improve asthma control. As the evidence base grows for environmental policies or best practices to reduce asthma triggers, these approaches can be updated and refined.

Part 1: Indoor Sources of Asthma Triggers

Rationale for this Strategy (Part 1)

- Overall, people spend 90% of their time indoors and much of this time is spent in the home.¹⁵¹
- Indoor sources of asthma triggers include mold, secondhand smoke, dust mites, rodents, cockroaches, and furry household pets.¹⁵²
- Interventions to reduce indoor sources of asthma triggers can improve asthma control and be cost-saving.¹⁵³⁻¹⁶³

Approaches for this Strategy (Part 1)

Facilitating home energy efficiency, including home weatherization assistance programs

- Home improvement incentives (e.g., loans, grants, or tax credits) can help low-income families improve their homes' energy efficiency and simultaneously reduce or remove health hazards such as mold, moisture, or pests.^{164,165}
- Examples exist of incentives implemented at the local, state, or federal level.¹⁶⁵⁻¹⁷¹
- Some home weatherization improvements that can reduce indoor sources of asthma triggers include improving insulation, ventilation, and moisture control.^{165,170} These changes can complement home visit programs for asthma.^{13,172} Additional information on home visits is available in the section *Home Visits for Trigger Reduction and Asthma Self-Management Education* (page 17).

Facilitating smokefree policies

- Numerous U.S. communities, states, and other nations have implemented comprehensive smokefree policies, which prohibit smoking in all indoor spaces of workplaces, restaurants, and bars.^{153-160,173,174}
- Enforcement is easier and effectiveness of smokefree policies is greater when fewer policy exemptions exist (e.g., exemptions for designated smoking areas or certain types of restaurants or bars).¹⁷⁵⁻¹⁷⁷
- Smokefree policies for residences (e.g., houses, apartments) can be voluntary or mandatory; individuals, families, or property owners (public or private) can implement these policies.^{178,179}
- Smokefree policies reduce tobacco smoking and reduce nonsmokers' exposure to secondhand smoke. Additional information on tobacco use and secondhand smoke is available in the section *X-tinguishing Smoking and Secondhand Smoke* (page 15).

Evidence for this Strategy (Part 1)

Facilitating home energy efficiency, including home weatherization assistance programs

- Studies have shown improving the homes of low-income individuals or families (e.g., through home weatherization assistance programs) can reduce asthma-related ED visits, health care costs, missed work, or missed school days.¹⁶¹⁻¹⁶³
- The cost of weatherizing an entire house can be comparable to the cost of one hospitalization for asthma.^{170,180}
- A study from the state of Washington observed asthma-related Medicaid costs decreased an average of \$785 per person per year, among individuals participating in a weatherization assistance program to improve their homes.¹⁶²

Facilitating smokefree policies

- Multiple U.S. studies, including a systematic review, have found that smokefree policies can reduce asthma-related ED visits and hospitalizations.^{153-160,181}
- Besides improving asthma control¹⁵³⁻¹⁶⁰, smokefree policies have decreased hospitalizations for heart attacks, reduced health care costs, and lowered the cost of cleaning, repairing, or maintaining housing.¹⁸¹⁻¹⁸⁴
- Smokefree policies with fewer exemptions have been linked to larger reductions in hospitalizations for respiratory conditions (e.g., asthma), compared to smokefree policies with more exemptions.¹⁵⁷
- A systematic review of 179 studies showed that smokefree policies have not hurt the business activity of restaurants, bars, or companies catering to tourists.^{176,181,185}

Additional details on the evidence for this strategy and its approaches are available in the Appendix.

Part 2: Outdoor Sources of Asthma Triggers

Rationale for this Strategy (Part 2)

- Strong evidence links outdoor air pollutants (e.g., from vehicle exhaust, factory emissions, or smoke) to increased asthma-related ED visits and hospitalizations.^{186, 187, 188}
- Children with asthma can be especially vulnerable to negative health effects caused by air pollution.^{189, 190}
- Interventions to reduce outdoor air pollution can improve asthma control and be cost-saving for communities.^{191,192}

Approach for this Strategy (Part 2)

Facilitating clean diesel school buses

- Adopting clean diesel technology for school buses involves retrofitting or modifying school buses with older diesel engines to run more cleanly (e.g., by using diesel oxidation catalysts, crankcase ventilation systems, or ultralow-sulfur diesel fuel).¹⁹²
- States or local jurisdictions have obtained clean diesel school buses using voluntary incentives (e.g., grants or rebates) or mandatory regulation.¹⁹¹⁻¹⁹⁶
- Decreased diesel emissions from using clean diesel school buses can complement existing policies to reduce school bus idling in multiple states.¹⁹⁷⁻¹⁹⁹

Evidence for this Strategy (Part 2)

Facilitating clean diesel school buses

- U.S. school districts adopting clean diesel technology for some or all of their school buses have improved children's lung function, decreased asthma- or bronchitis-related hospitalizations by 23%, and reduced missed school days by 8%; some benefits can occur within one month of making these changes (e.g., missed school days).^{191,192}
- So far, switching to clean diesel school buses has prevented approximately 14 million missed school days in the United States.¹⁹¹
- Return on investment is an estimated \$7 to \$16 per \$1 spent on shifting to clean diesel school buses, because of savings from averted respiratory-related hospitalizations.¹⁹²
- Existing studies might underestimate the overall public health benefits of using clean diesel school buses, because other research has linked diesel emissions to other illnesses (e.g., pneumonia, heart disease, cancer).²⁰⁰⁻²⁰³ Over half of U.S. children (approximately 25 million) ride school buses to and from school.²⁰⁴ On average, these children spend nearly 45 minutes each day on the bus.¹⁹¹

Additional details on the evidence for this strategy and its approaches are available in the Appendix.

Part 3: Occupational Sources of Asthma Triggers

Rationale for this Strategy (Part 3)

- Workplace conditions can cause asthma (this is called “occupational asthma”). Approximately 1 in 6 cases of adult-onset asthma are attributable to occupation.²⁰⁵
- Workplace conditions also can worsen existing asthma (this is called “work-exacerbated asthma” or “work-aggravated asthma”). More than 1 in 5 adults with asthma experience this effect.²⁰⁶
- The overall estimated cost of work-related asthma (i.e., the combination of occupational asthma and work-exacerbated asthma) is at least \$1.6 billion annually.²⁰⁷ People with work-related asthma experience more long-term disability, frequent health care use, loss of income, and unemployment compared to people with asthma that is not work-related.²⁰⁸⁻²¹⁰
- Interventions to eliminate or reduce workplace triggers of asthma can prevent occupational asthma, improve control of work-related asthma, and reduce health care costs.^{208,211-213} Asthma medications complement but do not replace interventions in the workplace environment.²⁰⁸

Approaches for this Strategy (Part 3)

Eliminating exposure to asthma triggers in the workplace whenever possible

- Effective methods to eliminate workplace exposure to asthma triggers include engineering controls (e.g., in ventilation systems) or replacing workplace materials that can cause or trigger asthma with other materials without these effects.^{211,213}
- Another proven method is to change work responsibilities or jobs, but this option can result in unemployment or loss of income for the worker.²⁰⁸
- Avoiding use of powdered allergen-rich natural rubber latex gloves is recommended by national and international experts on work-related asthma.²¹³

Reducing exposure to asthma triggers in the workplace (if eliminating exposures is not possible)

- Reducing exposure to asthma triggers in the workplace (e.g., engineering controls such as ventilation, or administrative controls such as limiting the number of hours per week that workers are exposed to asthma triggers) is not the preferred approach based on current evidence, but a person’s income or employment might be less affected by reducing exposure instead of eliminating exposure.^{211,213}
- This approach requires careful medical monitoring to ensure that worsened asthma is detected quickly.²⁰⁸
- According to national and international experts on work-related asthma, respiratory protective devices do not reduce exposure to asthma triggers effectively, especially in the long term and in patients with severe asthma.^{208,213}

Evidence for this Strategy (Part 3)

Eliminating exposure to asthma triggers in the workplace whenever possible

- Multiple systematic reviews have shown that eliminating exposure to asthma triggers is the best preventive approach.²¹¹⁻²¹³ Benefits include fewer asthma symptoms and improved lung function.²¹¹⁻²¹³
- Another systematic review found that for persons with occupational asthma (asthma caused by workplace conditions), completely avoiding the cause of their occupational asthma maximizes chances for improvement but does not guarantee full recovery.²⁰⁸ However, ongoing exposure would likely worsen asthma.²⁰⁸
- The recommendation to avoid using powdered allergen-rich natural rubber latex gloves is based on a systematic review that found a high level of evidence for this intervention.²¹³

Reducing exposure to asthma triggers in the workplace (if eliminating exposures is not possible)

- A systematic review showed that reducing exposure to workplace asthma triggers improves asthma symptoms but has not clearly improved lung function.²¹¹
- Notably, this systematic review also found that reducing exposure to workplace asthma triggers did not improve asthma symptoms as much as eliminating or removing exposure to workplace asthma triggers.²¹¹
- Multiple systematic reviews have concluded that based on currently available evidence, respiratory protective devices cannot be considered a safe way to reduce exposure to asthma triggers in the workplace, especially in the long term, in patients with severe asthma, and in patients with occupational asthma (asthma caused by workplace conditions).^{208,212,213}

Additional details on the evidence for this strategy and its approaches are available in the Appendix.

Sector Involvement

Engagement and investment from multiple sectors are important for successful implementation of EXHALE. Collaboration across sectors can harness existing infrastructure and resources, reduce redundancy, and create synergy. Public health can be a leader in improving asthma control, but the public health sector cannot accomplish the strategies and approaches outlined in this technical package alone.

Below are examples of how individuals or organizations from various sectors can consider supporting the implementation of this technical package. These examples are not a comprehensive description of opportunities available to various sectors, nor are they a complete list of sectors that can consider implementation activities related to this technical package. Other key sectors include (but are not limited to) social services, housing, employers, media, and non-governmental organizations (e.g., national or community organizations).

Opportunities for federal, state, and local public health officials include:

- Promoting or implementing this technical package.
- Evaluating the impact of and progress in implementing this technical package.
- Bringing together different sectors, partners, or stakeholders to plan, prioritize, and coordinate implementation of this technical package.
- Continuing collecting and disseminating data on the burden of asthma.

Opportunities for other federal, state, and local government officials include:

- Establishing or supporting quality improvement initiatives or projects that implement one or more of the strategies in this technical package.
- Considering eliminating Medicaid or Medicare coverage requirements that could restrict access to evidence-based treatments for asthma or tobacco cessation (e.g., quantity limits, prior authorization, copayments, or requiring patients to obtain asthma devices such as spacers from durable medical equipment vendors instead of pharmacies).
- Allocating resources to improve access to AS-ME, smoking cessation, asthma-related home visits, and coordination of care. For example, states might consider “activating” Current Procedural Terminology (CPT) codes to pay for AS-ME or encourage their Medicaid managed care organizations to increase delivery of AS-ME and asthma-related home visits (e.g., through contractual agreements or quality-improvement projects). Relevant implementation guidance, including a list of relevant CPT codes, is available at <http://www.cdc.gov/sixteen/asthma>.
- Supporting workforce development for the delivery of AS-ME or home visits; relevant activities include building infrastructure for professional training, licensing, and reimbursement of certified asthma educators, community health workers, and other allied health professionals. Relevant implementation guidance is available at <http://www.cdc.gov/sixteen/asthma> and in other public resources.^{23,214-216}
- Promoting infrastructure for health information technology so that individuals are at the center of their care, health care providers have the ability to securely access and use health information from different sources, and asthma care quality can be measured and used to

provide feedback. Relevant implementation guidance is available at <http://www.healthit.gov/policy-researchers-implementers/interoperability>.

- Implementing or supporting policies and best practices proven to improve asthma control (e.g., home improvement incentives, smokefree policies, or clean diesel school buses). Additional information is available in the section *Environmental Policies or Best Practices to Reduce Asthma Triggers from Indoor, Outdoor, and Occupational Sources* (page 26).

Opportunities for health care providers or organizations include:

- Assessing asthma severity and regularly monitoring asthma control in patients.
- Prescribing inhaled corticosteroids according to national asthma guidelines.^{7,100}
- Using tools such as shared treatment decision-making or AS-ME to improve adherence to asthma medication. Additional information on shared treatment decision-making and AS-ME is available in the sections *Achievement of Guidelines-Based Medical Management* (page 20) and *Education on Asthma Self-Management* (page 13), respectively.
- Investigating and considering available payment mechanisms to support their or their staff's delivery of asthma self-management education (e.g., CPT codes). A list of relevant CPT codes is available at <http://www.cdc.gov/sixeighteen/asthma>.
- Referring patients to asthma-related home visit programs available through local health care systems, community organizations, or patients' health insurance plans, especially when asthma is not controlled despite guidelines-based medical management and AS-ME outside the home.
- Promoting coordination of care in their practices or health care organizations (e.g., through quality improvement projects or initiatives).^{125,142}
- Communicating and collaborating with local schools or health care organizations to share asthma treatment plans efficiently, effectively, and securely across places where individuals might seek help for their asthma.

Opportunities for health insurance plans include:

- Emphasizing national asthma guidelines^{7,100} in their clinical practice guidelines.
- Using pharmacy, ED, and hospital claims data to identify and engage individuals or families who could benefit from AS-ME, smoking cessation, asthma-related home visits, improved coordination of care, or increased adherence to guidelines-based medical management of asthma. Additional information on each of these EXHALE strategies is available in their respective sections of this document.
- Considering how their coverage requirements might affect access to evidence-based treatments for asthma or tobacco cessation. Potential barriers include quantity limits, prior authorization, copayments, or requiring patients to obtain asthma devices (e.g., spacers) from durable medical equipment vendors instead of pharmacies.
- Providing AS-ME or asthma-related home visits to patients using trained in-house staff (e.g., certified asthma educators or trained community health workers) or by contracting with health care providers or community organizations to provide these services. Relevant implementation guidance is available at <http://www.cdc.gov/sixeighteen/asthma> and in other public resources.^{10,13}

Opportunities for schools, school nurses, and school districts include:

- Communicating and collaborating with local health care providers to share important asthma information about students (e.g., asthma action plans, level of asthma control) efficiently and effectively. These partnerships can be supported by the development of consent forms or policies to promote communication while protecting student and patient privacy. Additional relevant information is available in the section *Linkages and Coordination of Care Across Settings* (page 23).
- Adopting clean diesel technology for school buses to reduce students' exposure to diesel emissions, a known asthma trigger. Additional information is available in the section *Environmental Policies or Best Practices to Reduce Asthma Triggers from Indoor, Outdoor, and Occupational Sources* (page 26).
- Supporting implementation of other EXHALE strategies such as *Education on Asthma Self-Management* and *Achievement of Guidelines-Based Medical Management*. Additional information on these strategies is available in their respective sections.
- Reviewing CDC's *Strategies for Addressing Asthma in Schools*.¹⁴⁵

Opportunities for employers include:

- Promoting healthy workplaces by eliminating or reducing known asthma triggers.
- Considering or requesting insurance coverage of preventive asthma services such as AS-ME or home visits when purchasing health insurance for employees.
- Reviewing resources that CDC offers employers to help employees stay healthy such as <http://www.cdcfoundation.org/businesspulse/health-costs-resources>.

Monitoring and Evaluation

Monitoring and evaluation are necessary components of the public health approach to prevention. Timely and reliable data can monitor the extent of the problem and evaluate the impact of prevention efforts. Data are essential for successful program implementation. Planning, implementation, and assessment all rely on accurate measurement.

Surveillance

Surveillance data (e.g., from surveys or health insurance claims) can provide information such as disparities or changes in the burden of asthma. Surveillance systems exist at the federal, state, and local levels.

Sources of national asthma data include:

- National Health Interview Survey (<http://www.cdc.gov/nchs/nhis>)
- National Health and Nutrition Examination Survey (<http://www.cdc.gov/nchs/nhanes>)
- National Vital Statistics System (<http://www.cdc.gov/nchs/nvss>)

Sources of state or local asthma data include:

- Behavioral Risk Factor Surveillance System (BRFSS; <http://www.cdc.gov/brfss>)
- BRFSS Asthma Call-back Survey (<http://www.cdc.gov/brfss/acbs>)
- National Survey of Children's Health (<http://childhealthdata.org/learn/nsch>)

The systematic collection, evaluation, interpretation, and dissemination of asthma-related surveillance data at the federal, state, and local level can facilitate efficient implementation of this technical package (e.g., by identifying populations or areas with higher burden of disease). Additional information on available surveillance data and data systems for asthma is available at <http://www.cdc.gov/asthma/asthmadata.htm>.

Evaluation

It is important to track progress of activities to implement the strategies and approaches of this technical package and to evaluate the impact of those efforts. Routinely evaluating interventions as delivered in respective communities ensures programs are appropriately implemented and achieving expected results. In addition to increasing accountability, information generated from program evaluations can guide actions for program improvement and enhancement, as well as inform planning decisions. Understanding how strategies and approaches are implemented effectively and which implementation conditions result in the best outcomes can inform the refinement of asthma control activities over time.

In addition, evaluation findings shared with the broader asthma community will add to the evidence base and increase awareness of what works within community contexts. Collecting and sharing local evaluation data allows communities to make informed decisions when selecting intervention

opportunities with the highest potential impact, continually learn from experience, and build community support to sustain success.

In this way, collecting more data through evaluations of asthma-related programs, practices, and policies can enhance the effectiveness of asthma control initiatives, particularly across varied social and cultural contexts. Further, evaluation can help improve understanding of the synergistic effects that might occur within a comprehensive service system. Resources to assist these evaluation efforts are available at http://www.cdc.gov/asthma/program_eval.

Conclusion

The EXHALE technical package represents the best available evidence to improve control of asthma. It contains complementary strategies and approaches ideally used in combination in a multi-level, multi-sector approach to reduce the burden of asthma. The hope is that multiple sectors, such as public health, health care, education, social services, and non-governmental organizations, will find this technical package useful in improving asthma control.

This technical package is ready for implementation. It reflects the mature evidence base about how to control asthma. Monitoring and evaluation will play a key role in refining and maximizing implementation of the strategies in EXHALE. As new evidence becomes available, this technical package can be refined to reflect the current state of the science.

List of Abbreviations

AS-ME	Asthma self-management education
CPT	Current Procedural Terminology
ED	Emergency department
FDA	Food and Drug Administration
HEDIS	Healthcare Effectiveness Data and Information Set ¹
ICU	Intensive care unit
RCT	Randomized controlled trial

¹ Performance measurement tool used by many U.S. health plans²¹⁷

Appendix: Summary of Strategies and Approaches of EXHALE

Strategy	Approach	Lead Sectors ^a	Evidence ^b of Impact on Asthma	About this Evidence
Education on asthma self-management	Expanding access to and delivery of asthma self-management education (ASME)	Health care Public health (local, state, federal) Government ^c (local, state, federal) Non-governmental organizations	<p><i>General</i></p> <ul style="list-style-type: none"> Improved asthma symptoms^{9,218-228} Improved asthma control^{29,218-220,229} Improved quality of life^{22,29,218,230-232} <p><i>Asthma medication use</i></p> <ul style="list-style-type: none"> Increased medication adherence^{26,29,114,222,233} Increased controller medication prescriptions or use^{29,99} Decreased rescue medication prescriptions or use²³² <p><i>Health care utilization</i></p> <ul style="list-style-type: none"> Fewer ED visits^{9,22,99,114,134,144,221,224,226,227,229,231,232,234-237} Fewer hospitalizations^{9,22,219,224,226,227,229,231,237,238} Decreased urgent health care utilization (ED visit, hospitalization, or urgent office visit)²²⁸ <p><i>Impact on health care spending or society</i></p> <ul style="list-style-type: none"> Positive return on investment or other cost savings^{9,26,29,81,229,231,235} Fewer missed school days^{144,221,222,228,229} Fewer missed work days²³⁸ Fewer daycare absences²²⁴ 	<ul style="list-style-type: none"> Obtained from peer-reviewed journals^{9,22,26,29,99,114,134,144,218-228,230,233-236,238} and other sources^{229,231,232} Evaluated using systematic review^{22,26,99,218-222,237,238}, other literature review^{9,134}, RCT^{144,223,227,229,230}, non-randomized comparison group analysis^{29,225}, and pre-post analysis^{114,224,226,228,232-236}
X-tinguishing tobacco smoke and secondhand smoke	Reducing tobacco smoking	Health care Public health (local, state, federal) Government ^c (local, state, federal)	<p><i>General</i></p> <ul style="list-style-type: none"> Improved asthma symptoms^{58,78} Improved asthma control^{59,60,78} Improved quality of life^{58,64,78,239} <p><i>Asthma medication use</i></p> <ul style="list-style-type: none"> Increased controller medication prescriptions or use^{58,78} Decreased rescue medication prescriptions or use^{58,78} <p><i>Health care utilization</i></p> <ul style="list-style-type: none"> Decreased urgent health care utilization (ED visit or urgent office visit)²⁴⁰ <p><i>Impact on society</i></p> <ul style="list-style-type: none"> Fewer missed school days²³⁹ 	<ul style="list-style-type: none"> Obtained from peer-reviewed journals^{58-60,64,78,239-241} Evaluated using literature review^{78,241}, RCT^{58,64,239}, and non-randomized comparison group analysis^{59,60,240}

Strategy	Approach	Lead Sectors ^a	Evidence ^b of Impact on Asthma	About this Evidence
X-tinguishing tobacco smoke and secondhand smoke (continued)	Reducing exposure to secondhand smoke	Health care Public health (local, state, federal) Government ^c (local, state, federal)	<i>General</i> <ul style="list-style-type: none"> Improved asthma symptoms^{67,68} Improved asthma control⁸⁰ <i>Health care utilization</i> <ul style="list-style-type: none"> Fewer ED visits⁸⁰ Fewer hospitalizations^{66,68,69,80} Fewer outpatient visits^{66,69} Decreased urgent health care utilization (ED visit, hospitalization, urgent office visit, or prednisone use)^{65,71} <i>Impact on health care spending or society</i> <ul style="list-style-type: none"> Positive return on investment or other cost savings^{66,69} Fewer missed school days⁶⁸ 	<ul style="list-style-type: none"> Obtained from peer-reviewed journals^{65-69,71,80} Evaluated using systematic review²⁴², RCT^{67,68,71,80}, non-randomized comparison group analysis⁶⁵, and pre-post analysis^{66,69}
Home visits for trigger reduction and asthma self-management education	Expanding access to and delivery of home visits (as needed) for asthma trigger reduction and AS-ME	Health care Public health (local, state, federal) Government ^c (local, state, federal) Non-governmental organizations Social services	<i>General</i> <ul style="list-style-type: none"> Improved asthma symptoms^{35,82,91,98,134,243-247} Improved asthma control^{94,95,246,247} Improved quality of life⁹⁰ <i>Asthma medication use</i> <ul style="list-style-type: none"> Increased medication adherence^{135,243,245,246} Decreased rescue medication prescriptions or use^{247,248} <i>Health care utilization</i> <ul style="list-style-type: none"> Fewer ED visits^{9,30,31,94,135,243,244,246,248-250} Fewer ED return visits^{93,94} Fewer hospitalizations^{9,31,36,94,135,136,246,248-250} Fewer hospital readmissions^{94,135} Fewer outpatient visits^{82,244,246,248,251} Fewer ICU admissions^{9,252} Decreased urgent health care utilization (ED visit, hospitalization, or urgent office visit)^{35,82,247} <i>Impact on health care spending or society</i> <ul style="list-style-type: none"> Positive return on investment or other cost savings^{9,34-36,81,92,96,136,250,253} Fewer missed school days^{82,244,246-248,250} Fewer missed work days²⁴⁵⁻²⁴⁷ 	<ul style="list-style-type: none"> Obtained from peer-reviewed journals^{9,35,81,82,90,91,93-96,134,243-245,247,251-253} and other sources^{30,31,34,36,92,98,135,136,248-250} Evaluated using systematic review^{81,82}, other literature review^{9,93,134}, RCT^{35,90-92}, non-randomized comparison group analysis^{36,96,136}, and pre-post analysis^{30,31,34,94,95,98,135,243-253}

Strategy	Approach	Lead Sectors ^a	Evidence ^b of Impact on Asthma	About this Evidence
Achievement of guidelines-based medical management	Strengthening systems supporting guidelines-based medical care, including appropriate prescribing and use of inhaled corticosteroids	Health care	<p><i>General</i></p> <ul style="list-style-type: none"> Improved asthma symptoms^{101,105,106,115,119} Improved asthma control⁹⁴ <p><i>Asthma medication use</i></p> <ul style="list-style-type: none"> Increased controller medication prescriptions or use^{99,113,124} Decreased rescue medication prescriptions or use^{124,235} <p><i>Health care utilization</i></p> <ul style="list-style-type: none"> Fewer ED visits^{94,99,103-106,115,116,119,235} Fewer ED return visits⁹⁴ Fewer hospitalizations^{94,103,106,115-119,235} Fewer hospital readmissions⁹⁴ Fewer outpatient visits^{103,235} <p><i>Impact on health care spending or society</i></p> <ul style="list-style-type: none"> Positive return on investment^{103,104,106,111} or other cost savings^{116,124,235} Fewer missed school days¹⁰⁶ 	<ul style="list-style-type: none"> Obtained from peer-reviewed journals^{94,99,101,103-105,111,113,116,117,119,235,254} and other sources^{106,115,124} Evaluated using systematic review^{99,115,119}, RCT^{101,105,113}, non-randomized comparison group analysis^{104,111,116,118,124}, and pre-post analysis^{94,103,106,117,235,254}
	Improving access and adherence to asthma medications and devices	Health care Government ^c (state, federal)	<p><i>General</i></p> <ul style="list-style-type: none"> Improved asthma symptoms^{26,107} Improved asthma control¹⁰⁷ Improved quality of life^{26,107} <p><i>Asthma medication use</i></p> <ul style="list-style-type: none"> Increased controller medication prescriptions or use^{107,109} Decreased rescue medication prescriptions or use¹⁰⁷ <p><i>Health care utilization</i></p> <ul style="list-style-type: none"> Fewer ED visits^{109,122} Fewer hospitalizations^{108,122} Fewer outpatient visits¹⁰⁹ Decreased overall health care utilization (ED visit, hospitalization, urgent care visit, or outpatient visit)^{26,107} Positive return on investment or other cost savings^{122,123} 	<ul style="list-style-type: none"> Obtained from peer-reviewed journals^{26,107-110,123} and other sources¹²² Evaluated using systematic review²⁶, RCT¹⁰⁷, non-randomized comparison group analysis¹⁰⁸⁻¹¹⁰, and pre-post analysis^{122,123}

Strategy	Approach	Lead Sectors ^a	Evidence ^b of Impact on Asthma	About this Evidence
Linkages and coordination of care across settings	Promoting coordinated care for people with asthma	Health care Public health (local, state, federal) Government ^c (local, state, federal) Education Non-governmental organizations Social services	<p><i>General</i></p> <ul style="list-style-type: none"> Improved asthma symptoms^{134,244,255} Improved asthma control^{94,130} <p><i>Asthma medication use</i></p> <ul style="list-style-type: none"> Increased medication adherence^{130,135} Improved HEDIS scores related to use of appropriate medications by people with asthma¹⁴⁰ Increased controller medication prescriptions or use¹¹³ Decreased rescue medication prescriptions or use^{130,134,244} Increased availability of asthma medication at school²⁵⁶ <p><i>Health care utilization</i></p> <ul style="list-style-type: none"> Fewer ED visits^{94,128,129,132,134,136,139,140,244,255,257-260} Fewer ED return visits⁹⁴ Fewer hospitalizations^{94,106,129,132,134-136,140,144,244,255,260} Fewer hospital readmissions^{94,135} Fewer outpatient visits²⁵⁷ <p><i>Impact on health care spending or society</i></p> <ul style="list-style-type: none"> Positive return on investment or other cost savings^{106,129,132,134-138} Fewer missed school days^{128,132,134,144,244,260} Fewer missed work days¹³² 	<ul style="list-style-type: none"> Obtained from peer-reviewed journals^{113,128,129,131,132,134,137,139,144,244,255-259} and other sources^{106,130,135,136,140,260} Evaluated using literature review¹³⁴, RCT^{113,144}, non-randomized comparison group analysis^{132,137,255}, and pre–post analysis^{106,128-131,134,136,139,140,244,256,257,259,260}
Environmental policies or best practices to reduce indoor, outdoor, and occupational asthma triggers	Facilitating home energy efficiency, including home weatherization assistance programs	Government ^c (local, state, federal — particularly agencies focused on housing or energy) Non-governmental organizations that assist with housing	<p><i>General</i></p> <ul style="list-style-type: none"> Improved asthma symptoms¹⁶¹ <p><i>Health care utilization</i></p> <ul style="list-style-type: none"> Fewer ED visits¹⁶³ <p><i>Impact on health care spending or society</i></p> <ul style="list-style-type: none"> Positive return on investment or other cost savings¹⁶² Fewer missed school days¹⁶¹ Fewer missed work days¹⁶¹ 	<ul style="list-style-type: none"> Obtained from peer-reviewed journal¹⁶¹ and other sources^{162,163} Evaluated using RCT¹⁶¹ and pre–post analysis^{162,163}

Strategy	Approach	Lead Sectors ^a	Evidence ^b of Impact on Asthma	About this Evidence
Environmental policies or best practices to reduce indoor, outdoor, and occupational asthma triggers (continued)	Facilitating smokefree policies	Government ^c (local, state, federal) Employers Housing	<i>General</i> <ul style="list-style-type: none"> Improved asthma symptoms^{154,160} <i>Health care utilization</i> <ul style="list-style-type: none"> Fewer ED visits^{153-155,158} Fewer hospitalizations^{153,156,157,159} Fewer outpatient visits¹⁶⁰ 	<ul style="list-style-type: none"> Obtained from peer-reviewed journals¹⁵⁴⁻¹⁶⁰ and other sources¹⁸¹ Evaluated using systematic review^{157,181}, non-randomized comparison group analysis^{154,159}, and pre-post analysis^{155,156,158,160}
	Facilitating clean diesel school buses	Public health (local, state, federal) Government ^c (local, state, federal) Education	<i>Health care utilization</i> <ul style="list-style-type: none"> Fewer hospitalizations¹⁹² <i>Impact on health care spending or society</i> <ul style="list-style-type: none"> Cost savings¹⁹² Fewer missed school days¹⁹¹ 	<ul style="list-style-type: none"> Obtained from peer-reviewed journals^{191,192} Evaluated using non-randomized comparison group analysis^{191,192}
	Eliminating exposure to asthma triggers in the workplace whenever possible	Employers Public health (state, federal) Government ^c (state, federal)	<i>General</i> <ul style="list-style-type: none"> Improved asthma symptoms²¹¹ 	<ul style="list-style-type: none"> Obtained from peer-review journals²¹¹⁻²¹³ Evaluated using systematic review²¹¹⁻²¹³
	Reducing exposure to asthma triggers in the workplace (if eliminating exposures is not possible)	Employers Public health (state, federal) Government ^c (state, federal)	<i>General</i> <ul style="list-style-type: none"> Improved asthma symptoms²¹¹ 	<ul style="list-style-type: none"> Obtained from peer-review journals²¹¹⁻²¹³ Evaluated using systematic review²¹¹⁻²¹³

^a This column refers to the lead sectors well-positioned to bring leadership and resources to implementation efforts. For each strategy, many other sectors can be instrumental to implementing relevant activities.

^b Evidence of impact for a strategy or a strategy's associated approach(es).

^c Government agencies other than public health agencies.

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