Asthma Management: Collaborative Strategies Between Pharmacists and Nurses

Aljehany, Hanan Ibrahim S[1] ،Almalki, Sharaf Mesfer M[2] ،Maha Ayed Al-Hazmi[3] ، Mona Hammad Awad Albalawi[4] ،Adel Khalofah Alahmary[5] ،Alenezi, Abdulmgid Mrwy T[6] ،Ashjan Ali Albishi[7] ،Saud Abdulrhman Aldubibi[8] ،Alshadidi, Khalid Ebrahim A[9] ، Mansour Sayeed Nouman Alshammari[10]

1. Nursing Senior Specialist, Branch of the Ministry of Health, Jeddah, Makkah Region, Kingdom of Saudi Arabia

2. Nursing Technician, Aseer Health Cluster, Abha, Aseer Region, Kingdom of Saudi Arabia

3. Nursing Technician, King Fahd Suburb Health Center, Arar, Northern Borders Region, Kingdom of Saudi Arabia

4. Nursing Technician, Maternity and Children Hospital, Tabuk Health Cluster, Tabuk, Tabuk Region, Kingdom of Saudi Arabia

5. Nursing Technician, Asir Central Hospital, Abha, Aseer Region, Kingdom of Saudi Arabia

6. Male Nursing Technician, North Medical Tower, Arar, Northern Borders Region, Ministry of Health, Kingdom of Saudi Arabia

7. Nursing Supervisor, Al Thagher Hospital, Jeddah, Makkah Region, Kingdom of Saudi Arabia

8. Pharmacist, Department of Pharmacy, Al-Jouf University, Sakaka, Al-Jouf Region, Kingdom of Saudi Arabia

9. Pharmacy Assistant, Aseer Health Cluster, Abha, Aseer Region, Kingdom of Saudi Arabia

10. Pharmacy Technician, Hail Health Cluster, Hail, Hail Region, Kingdom of Saudi Arabia

***Abstract*:** Asthma management requires a comprehensive approach, with collaborative strategies between pharmacists and nurses playing a pivotal role in optimizing patient outcomes. Pharmacists are uniquely positioned to provide medication therapy management, ensuring that patients adhere to their prescribed regimens and understand the proper use of inhalers and other medications. By conducting medication reviews and providing counseling, pharmacists can identify potential drug interactions, recommend adjustments, and support patients in recognizing their asthma triggers. Concurrently, nurses serve as essential care coordinators, often leading education initiatives to empower patients about self-management techniques, recognizing asthma symptoms, and understanding action plans. Together, pharmacists and nurses can develop tailored asthma management plans that are patient-centered and focused on improving quality of life while minimizing exacerbations. Effective communication and teamwork between pharmacists and nurses not only enhance individual patient care but also contribute to broader health system improvements. By collaborating on asthma education programs, these healthcare professionals can share their expertise, creating cohesive strategies that address both pharmacologic and non-pharmacologic aspects of asthma management. Regular interdisciplinary meetings and joint patient assessments can facilitate knowledge exchange, ensuring that both professions are aligned in their treatment goals. This synergistic approach can ultimately lead to better adherence rates, reduced hospitalizations, and an overall decrease in healthcare costs associated with asthma management, highlighting the importance of integrated care in chronic disease management.

***Keywords*:** Asthma management, pharmacists, nurses, collaborative strategies, patient outcomes, medication therapy management, adherence

Introduction:

Asthma, a chronic inflammatory disease of the airways, is characterized by recurrent episodes of wheezing, breathlessness, chest tightness, and coughing. Affecting approximately 235 million people globally, asthma represents a significant public health challenge, with increasing prevalence rates reported over the past decades. The complexity of asthma management includes pharmacological treatment, patient education, lifestyle choices, and the monitoring of symptoms, making it essential to adopt a multidisciplinary approach to care. Among the healthcare professions, pharmacists and nurses play pivotal roles in the effective management of asthma, each bringing unique skill sets and perspectives to enhance patient outcomes [1].

Pharmacists are highly trained in pharmacotherapy, with a deep understanding of medication mechanisms, interactions, and side effects. Their expertise allows them to play an integral role in patient education regarding inhaler techniques, medication adherence, and recognition of asthma exacerbations. Additionally, pharmacists can conduct Medication Therapy Management (MTM) sessions, wherein they assess a patient's medication regimen to ensure its efficacy and safety. By regularly reviewing a patient's current medications and addressing any issues related to adherence and understanding, pharmacists can significantly reduce the incidence of exacerbations and enhance the overall management of asthma [2].

On the other hand, nurses are often at the forefront of patient care, serving as primary points of contact within the healthcare system. They are equipped to conduct comprehensive assessments of patients' physical and psychological needs, develop individualized care plans, and provide ongoing education about lifestyle modifications and self-management strategies. Nurses can also facilitate communication between patients and other healthcare providers, ensuring that concerns are addressed promptly and effectively. By monitoring symptoms and educating patients about trigger avoidance and medication use, nurses empower individuals to take control of their asthma, fostering a collaborative partnership in their health management [3].

The synergy between pharmacists and nurses in the context of asthma management can lead to improved patient outcomes through better communication and coordinated care strategies. Research has indicated that when pharmacists and nurses work collaboratively, there is a marked reduction in asthma-related hospitalizations, emergency room visits, and overall healthcare costs. For example, integrated asthma management programs that include both pharmacists and nurses have shown promising results in enhancing adherence to asthma medications and promoting effective self-management behaviors among patients. Through mutual support and enhanced communication, the two professions can share insights and contribute to a holistic patient care approach that encompasses both medication management and lifestyle modification [4].

However, despite the evident benefits, challenges exist in implementing collaborative care strategies between pharmacists and nurses in asthma management. These can include professional silos, differing priorities within healthcare settings, and barriers to communication between providers. Additionally, there may be a lack of structured frameworks that define the roles and responsibilities of each profession in asthma care, leading to ambiguity in collaborative efforts. Addressing these challenges requires targeted training programs, policy initiatives, and institutional support aimed at fostering an environment conducive to interdisciplinary collaboration [5].

Roles of Pharmacists in Asthma Management

One of the primary roles of pharmacists in asthma management is patient education. Asthma is often misunderstood, both by patients and their caregivers. Pharmacists provide critical information regarding the disease process, the importance of medication adherence, and the proper use of inhalers. Proper inhaler technique is crucial for effective treatment delivery, yet studies indicate that many patients do not use their inhalers correctly. Pharmacists can conduct demonstrations and provide visual aids to ensure patients understand how to use their medications effectively. They can also offer tailored education regarding triggers, lifestyle modifications, and asthma action plans—documents outlining how to manage asthma day-to-day as well as in emergencies [6].

Another key role of pharmacists is medication management. Asthma treatment typically involves a

combination of quick-relief (rescue) and long-term control (maintenance) medications, which can include inhaled corticosteroids, bronchodilators, and leukotriene modifiers. Pharmacists can collaborate with healthcare providers to optimize medication regimens by reviewing patient profiles, assessing medication appropriateness, and identifying potential drug interactions. Their expertise in pharmacotherapy allows them to provide recommendations on switching medications, adjusting dosages, or considering alternative therapies based on evidence-based guidelines. Additionally, pharmacists can help patients manage side effects, ensuring that they maintain adherence to their prescribed regimens [7].

A personalized asthma action plan is essential for effective self-management of the disease. Pharmacists can assist in developing these plans by working with patients to document daily management strategies, recognize warning signs of exacerbations, and establish protocols for managing asthma-related emergencies. These plans empower patients, facilitating better self-monitoring and enhancing their overall disease management [8].

Pharmacists are also pivotal in the medication refill process. They can conduct medication therapy management (MTM) sessions that help identify patients overdue for refills or those experiencing poor control of their symptoms. By utilizing pharmacy management systems, they can track refill patterns and communicate with patients who may require additional counseling or support, thus promoting continuity of care [9].

Pharmacists play an essential role in the collaborative healthcare model. Effective asthma management often requires a team approach, particularly for patients with comorbid conditions such as allergic rhinitis or obesity, which can exacerbate asthma symptoms. Pharmacists can work closely with physicians, nurses, respiratory therapists, and dietitians to share crucial patient information, contribute to treatment planning, and ensure a cohesive approach to care. Interprofessional communication enhances the level of care, allowing for more personalized and effective asthma management strategies. [10]

Beyond the individual patient level, pharmacists can also contribute to community outreach and public health initiatives aimed at asthma prevention and management. Asthma prevalence can be higher in certain populations, particularly children and individuals living in urban settings. Pharmacists can spearhead community education campaigns, provide free asthma screenings, or organize workshops focusing on asthma awareness. They can also engage in advocacy efforts to promote policies that support better asthma management in underserved communities and contribute to research initiatives aimed at understanding the environmental determinants of asthma exacerbations [11].

Health disparities in asthma management and outcomes are a significant public health concern. Pharmacists are uniquely positioned to address these disparities by providing culturally competent care. They can tailor their educational materials and counseling techniques to meet the diverse needs of the populations they serve. By understanding the cultural, social, and economic factors that affect asthma management, pharmacists can facilitate better engagement and empower patients to take control of their health [12].

The Role of Nursing Care in Asthma Management

Nursing care in asthma management encompasses a broad range of activities aimed at supporting patients in achieving optimal asthma control. Nurses are often at the forefront of patient education, medication management, and holistic support, bridging the gap between clinical care and patient engagement [9].

1. Patient Education and Self-Management

One of the essential roles of nurses in asthma management is patient education. Evidence suggests that informed patients are more likely to engage in effective self-management behaviors, leading to improved asthma control and reduced emergency visits. Nurses provide education on the proper use of inhalers, the significance of adherence to prescribed medication regimens, and the importance of recognizing early warning signs of asthma exacerbation [3].

By developing individualized asthma action plans, nurses empower patients to monitor their symptoms, use rescue medications effectively, and make informed decisions about when to seek further medical help. Research has demonstrated that tailored education programs, often facilitated by

nurses, can lead to significant improvements in asthma outcomes, including reduced symptoms and decreased hospitalization rates [12].

2. Assessing and Monitoring Asthma Symptoms

Regular assessment and monitoring of asthma symptoms are crucial for effective management. Nurses are trained to conduct thorough assessments of a patient's respiratory status, including the frequency of symptoms, peak flow measurements, and the impact on daily activities. By utilizing standardized assessment tools, nurses can identify patterns of control or exacerbation, which can inform treatment adjustments and interventions [5].

Furthermore, ongoing monitoring allows nurses to provide timely interventions when patients are at risk for worsening asthma control. By recognizing the need for medication adjustments or additional interventions, nursing care can preemptively address potential complications and improve overall care quality [4].

3. Coordination of Care

Coordinating care among various healthcare providers is another vital function of nurses in asthma management. Asthma often requires a collaborative approach involving pulmonologists, allergists, primary care physicians, and other health professionals. Nurses play a critical role in facilitating communication between these parties, ensuring that the patient's needs are met during the treatment process [12].

This coordination becomes especially important when addressing comorbid conditions, such as allergies and obesity, which can complicate asthma control. Effective nursing care ensures that all aspects of a patient's health are considered, leading to comprehensive management plans that address both asthma and its associated conditions [13].

Chronic conditions like asthma can have profound psychosocial effects on patients and their families. Anxiety, depression, and stress are common among individuals with asthma, potentially exacerbating their symptoms and complicating management. Nursing care extends beyond physical assessments and interventions; it encompasses emotional and psychosocial support that is essential for holistic patient care [14].

By establishing trusting relationships with patients, nurses can provide a safe space for individuals to express their concerns and fears regarding their asthma management and impact on life. Emotional support, such as counseling and coping strategies, can empower patients to manage their condition better and adhere to treatment plans. Additionally, community resources and support groups can be organized by nurses to promote shared experiences and reduce feelings of isolation among patients [15].

Recent advancements in nursing practice are integrating innovative technologies to further enhance asthma management. Telehealth and remote monitoring solutions enable nurses to provide real-time support and education to patients in their own homes. Such approaches facilitate continuous care, ensuring that patients receive timely guidance and interventions without the barrier of frequent clinic visits [2].

Moreover, utilizing smartphone applications for asthma management can empower patients with immediate access to educational resources, medication reminders, and symptom tracking. By leveraging technology, nurses can help patients engage actively in their asthma management, leading to improved outcomes and increased patient satisfaction [13].

Communication Strategies Between Pharmacists and Nurses in Asthma Control

To devise effective communication strategies, it is imperative to recognize the distinct yet complementary roles that pharmacists and nurses play in asthma management. Pharmacists are primarily responsible for medication management, which includes reviewing prescriptions, counseling patients about their medications, monitoring for potential drug interactions, and providing education on the proper use of inhalers and other delivery devices. They serve as medication experts who can advise not only patients but also their colleagues on how to adhere to treatment protocols effectively and manage side effects or complications [16].

On the other hand, nurses have a broader role in patient care that encompasses assessment, education, and overall management of the patient's condition. This often includes performing physical assessments, educating patients about lifestyle modifications, and teaching self-management skills, such as recognizing early signs of asthma

exacerbations. Nurses typically spend more time with patients than pharmacists, allowing them to build stronger relationships and gather vital information about patient adherence, attitudes, and understanding of their condition [17].

Effective communication between pharmacists and nurses enhances the quality of asthma care by fostering a team-based approach that ensures all aspects of patient management are covered. When pharmacists and nurses are aligned in their objectives, there is a lower risk of miscommunication that can lead to medication errors, patient confusion, and ultimately, suboptimal health outcomes. Moreover, clear communication strategies enhance efficiency in workflows, minimize redundancy, and ensure that patients receive consistent messaging regarding their treatment plans [18].

Several studies have shown that improvements in communication between healthcare disciplines can lead to better disease management, increased patient satisfaction, and reduced hospitalization rates. In the context of asthma, where patient education and adherence to medication are paramount, the synergy between pharmacists and nurses can significantly improve adherence levels [4].

Strategies for Effective Communication

1. **Regular Interdisciplinary Meetings**: Scheduling routine meetings between pharmacists and nurses can facilitate open dialogue regarding patient care strategies. This platform can be utilized to discuss patient progress, share concerns, and brainstorm solutions to common challenges faced in asthma management. Regular meetings also foster professional relationships and enhance mutual understanding of each other's roles [19].

2. **Shared Electronic Health Records (EHRs)**: Implementing shared EHRs where pharmacists and nurses have access to the same patient information can streamline communication. This shared data ensures that both parties are informed about medication changes, allergy information, and the patient's clinical status. EHR systems can also include flags for adherence monitoring, allowing pharmacists to identify patients who may require intervention and to alert nursing staff accordingly [20].

3. **Interprofessional Education (IPE)**: Engaging in interprofessional education initiatives can be an effective strategy to cultivate mutual respect and understanding. Physicians, pharmacists, and nurses can learn together about asthma management, the importance of medication adherence, and the roles each member plays in the patient's care. This shared learning experience helps break down silos and fosters teamwork [11].

4. **Utilization of Standardized Communication Tools**: Implementing standardized communication tools, such as SBAR (Situation, Background, Assessment, Recommendation), can improve clarity and ensure that important information is conveyed concisely and effectively. This approach can be particularly useful during handoffs or when discussing patient cases during team meetings [4].

5. **Patient-Centered Communication**: Both pharmacists and nurses should adopt a patient-centered approach to communication that emphasizes empathy and active listening. Understanding each patient's perspective, including their socioeconomic barriers to accessing medications or understanding treatment plans, can enhance communication strategies and lead to better-tailored interventions [21].

6. **Utilization of Technology**: Technology can serve as a formidable ally in enhancing communication. Telehealth options allow for real-time communication if either party has questions regarding patient management or treatment adjustments. Various apps can also facilitate communication pathways, enabling quicker responses to patient inquiries and updates on treatment plans.

7. **Development of Joint Guidelines and Protocols**: By developing joint practice guidelines, pharmacists and nurses can create a unified approach to asthma management. Such documents can clarify roles, optimize medication management, and outline procedures for patient education and follow-up, thereby promoting consistency in care across disciplines [22].

8. **Feedback Mechanisms**: Establishing processes for providing and receiving feedback can enhance interprofessional communication. Constructive feedback allows nurses and pharmacists to reflect on their practices, learn from

each other, and identify areas for improvement in their communication methods [5].

Measuring Outcomes of Collaboration:

The integration of pharmacists and nurses has proved beneficial in various aspects of asthma control. Studies have demonstrated that collaborative care involving these two healthcare professionals can lead to improved asthma outcomes, including better symptom control and reduced emergency department visits. This is largely attributed to enhanced medication adherence, increased patient education, and more comprehensive management strategies [23].

For example, when pharmacists and nurses collaborate, they can conduct medication reviews together, ensuring that patients are following complex medication regimens and understanding their treatment plans. Such cooperative interactions help bridge the communication gap between prescribers and patients, ultimately leading to improved adherence and, consequently, better asthma control [24].

One significant area where collaborative care has shown efficacy is in asthma education. Asthma requires patients to manage their condition actively, which includes recognizing warning signs, understanding the use of inhalers, and knowing when to seek help. Nurses, with their emphasis on patient education and support, can work alongside pharmacists to create tailored educational interventions that resonate with patients' understanding and experiences. By involving both professionals in the education process, patients receive a reinforced and cohesive message regarding their asthma management, which is essential for effective self-management [25].

To assess the efficacy of collaborative care models involving pharmacists and nurses, it is essential to measure relevant health outcomes. Common metrics include changes in asthma control, frequency of asthma exacerbations, the number of emergency department visits or hospitalizations, and patient's quality of life—these can all indicate how well a patient's asthma is being managed [26].

Moreover, adherence to asthma medications is a critical outcome measure. Studies have shown that when pharmacists and nurses work together, patients are more likely to adhere to their prescribed regimens. Tools such as the Asthma Control Test (ACT) can effectively quantify patients' perceptions of control over their asthma, while objective measures, such as peak flow readings, can provide concrete data regarding lung function [27].

Implementing these measures involves the need for consistent data collection and analysis. Collaborative care models should include systematic screening, documentation of interventions, and ongoing evaluation of outcomes. It is crucial for healthcare organizations to invest in training and technology that facilitate data collection and enable robust evaluation of collaborative practices [28].

While the concept of collaborative care appears promising, various challenges and barriers may impede its implementation. One significant issue is the integration of services across different healthcare disciplines. Effective communication and collaboration can be hampered by hierarchical structures within healthcare settings. Furthermore, reimbursement models often do not accommodate collaborative care, specifically in terms of recognizing the contributions of pharmacists and nurses [29].

Additionally, establishing standardized protocols for communication and cooperation among these professionals can be difficult. Ensuring that both pharmacists and nurses are adequately trained in collaborative practices is essential to promoting smoother interactions and achieving successful outcomes. There is also a need for ongoing professional development to ensure that both parties remain abreast of the latest evidence-based practices in asthma management [30].

Conclusion:

In conclusion, effective asthma management necessitates a collaborative approach that harnesses the expertise of both pharmacists and nurses. By working together, they can create comprehensive care plans that address both the pharmacological and non-pharmacological aspects of asthma treatment. The potential benefits of such collaborations are numerous, including improved patient adherence, better chronic disease management, and decreased healthcare utilization. As healthcare continues to evolve toward integrated models of care, this research aims to identify and document the strategies that enhance collaboration between pharmacists and nurses in asthma management,

ultimately providing a framework that can be adopted more broadly to improve asthma outcomes across diverse populations. Through this exploration, we hope to contribute to the ongoing discourse surrounding interdisciplinary collaboration in healthcare and its role in enhancing patient care.

References:

1. Buhl R, FitzGerald JM, Busse WW. Tiotropium add-on to inhaled corticosteroids versus addition of long-acting β2-agonists for adults with asthma. Respir Med. 2018;143:82–90. [DOI] [PubMed] [Google Scholar]
2. Centers for Disease Control and Prevention. 2017 National Health Interview Survey (NHIS) Data. Table 5-1. Compiled March 18, 2019. Accessed June 24, 2019.
3. Dima AL, de Bruin M, Van Ganse E. Mapping the asthma care process: implications for research and practice. J Allergy Clin Immunol Pract. 2016;4(5):868–876. [DOI] [PubMed] [Google Scholar]
4. Yancey SW, Ortega HG, Keene ON, et al. Meta-analysis of asthma-related hospitalization in mepolizumab studies of severe eosinophilic asthma. J Allergy Clin Immunol. 2017;139(4):1167–1175.e2.
5. Barnes PJ. Similarities and differences in inflammatory mechanisms of asthma and COPD. Breathe. 2011;7(3):229–238. [Google Scholar]
6. Scott MA, Heck JE, Wilson CG. The integral role of the clinical pharmacist practitioner in primary care. N C Med J. 2017;78(3):181–185. [DOI] [PubMed] [Google Scholar]
7. Global Initiative for Asthma. Pocket guide for asthma management and prevention. Updated 2019. Accessed April 25, 2019.
8. Kerstjens HA, Engel M, Dahl R, et al. Tiotropium in asthma poorly controlled with standard combination therapy. N Engl J Med. 2012;367(13):1198–1207. [DOI] [PubMed] [Google Scholar]
9. National Heart, Lung, and Blood Institute. Expert panel report 3: Guidelines for the Diagnosis and Management of Asthma, Clinical Practice Guidelines 2007. Published August 28, 2007. Accessed November 4, 2019.
10. Loss GJ, Depner M, Hose AJ, Genuneit J, Karvonen AM, Hyvärinen A, Roduit C, Kabesch M, Lauener R, Pfefferle PI, Pekkanen J, Dalphin JC, Riedler J, Braun-Fahrländer C, von Mutius E, Ege MJ., PASTURE (Protection against Allergy Study in Rural Environments) Study Group. The Early Development of Wheeze. Environmental Determinants and Genetic Susceptibility at 17q21. Am J Respir Crit Care Med. 2016 Apr 15;193(8):889-97.
11. McEvoy CT, Shorey-Kendrick LE, Milner K, Schilling D, Tiller C, Vuylsteke B, Scherman A, Jackson K, Haas DM, Harris J, Schuff R, Park BS, Vu A, Kraemer DF, Mitchell J, Metz J, Gonzales D, Bunten C, Spindel ER, Tepper RS, Morris CD. Oral Vitamin C (500 mg/d) to Pregnant Smokers Improves Infant Airway Function at 3 Months (VCSIP). A Randomized Trial. Am J Respir Crit Care Med. 2019 May 01;199(9):1139-1147.
12. Crump C, Sundquist J, Sundquist K. Preterm or early term birth and long-term risk of asthma into midadulthood: a national cohort and cosibling study. Thorax. 2023 Jul;78(7):653-660.
13. Pate CA, Zahran HS, Qin X, Johnson C, Hummelman E, Malilay J. Asthma Surveillance - United States, 2006-2018. MMWR Surveill Summ. 2021 Sep 17;70(5):1-32.
14. Leps C, Carson C, Quigley MA. Gestational age at birth and wheezing trajectories at 3-11 years. Arch Dis Child. 2018 Dec;103(12):1138-1144.
15. Fishe JN, Labilloy G, Higley R, Casey D, Ginn A, Baskovich B, Blake KV. Single Nucleotide Polymorphisms (SNPs) in PRKG1 & SPATA13-AS1 are associated with bronchodilator response: a pilot study during acute asthma exacerbations in African American children. Pharmacogenet Genomics. 2021 Sep 01;31(7):146-154.
16. Dhuper S, Chandra A, Ahmed A, Bista S, Moghekar A, Verma R, Chong C, Shim C, Cohen H, Choksi S. Efficacy and cost comparisons of bronchodilatator

administration between metered dose inhalers with disposable spacers and nebulizers for acute asthma treatment. J Emerg Med. 2011 Mar;40(3):247-55.

17. Gauvreau GM, O'Byrne PM, Boulet LP, Wang Y, Cockcroft D, Bigler J, FitzGerald JM, Boedigheimer M, Davis BE, Dias C, Gorski KS, Smith L, Bautista E, Comeau MR, Leigh R, Parnes JR. Effects of an anti-TSLP antibody on allergen-induced asthmatic responses. N Engl J Med. 2014 May 29;370(22):2102-10.

18. McEvoy CT, Schilling D, Clay N, Jackson K, Go MD, Spitale P, Bunten C, Leiva M, Gonzales D, Hollister-Smith J, Durand M, Frei B, Buist AS, Peters D, Morris CD, Spindel ER. Vitamin C supplementation for pregnant smoking women and pulmonary function in their newborn infants: a randomized clinical trial. JAMA. 2014 May;311(20):2074-82.

19. Aaron SD, Vandemheen KL, FitzGerald JM, Ainslie M, Gupta S, Lemière C, Field SK, McIvor RA, Hernandez P, Mayers I, Mulpuru S, Alvarez GG, Pakhale S, Mallick R, Boulet LP., Canadian Respiratory Research Network. Reevaluation of Diagnosis in Adults With Physician-Diagnosed Asthma. JAMA. 2017 Jan 17;317(3):269-279.

20. Been JV, Lugtenberg MJ, Smets E, van Schayck CP, Kramer BW, Mommers M, Sheikh A. Preterm birth and childhood wheezing disorders: a systematic review and meta-analysis. PLoS Med.

21. Sullivan PW, Ghushchyan V, Navaratnam P, et al. The national burden of poorly controlled asthma, school absence and parental work loss among school-aged children in the United States. J Asthma. 2018;55(6):659–667. [DOI] [PubMed] [Google Scholar]

22. Ye Q, He X-O, D'Urzo A. A review on the safety and efficacy of inhaled corticosteroids in the management of asthma. Pulmonary Ther. 2017;3(1):1–18. [Google Scholar]

23. Global Initiative for Asthma (GINA). Global strategy for asthma management and prevention. Updated 2018. Accessed May 31, 2019.

24. Pauwels RA, Löfdahl CG, Postma DS, et al. Effect of inhaled formoterol and budesonide on exacerbations of asthma. Formoterol and Corticosteroids Establishing Therapy (FACET) International Study Group. N Engl J Med. 1997;337(20):1405–1411. [DOI] [PubMed] [Google Scholar]

25. Ballas ZK. Asthma clinical practice guidelines: time for an update. J Allergy Clin Immunol. 2018;142(3):787. [DOI] [PubMed] [Google Scholar]

26. Henriksen DP, Bodtger U, Sidenius K, et al. Efficacy, adverse events, and inter-drug comparison of mepolizumab and reslizumab anti-IL-5 treatments of severe asthma – a systematic review and meta-analysis. Eur Clin Respir J. 2018;5(1):1536097. [DOI] [PMC free article] [PubMed] [Google Scholar]

27. Nurmagambetov T, Kuwahara R, Garbe P. The economic burden of asthma in the United States, 2008-2013. Ann Am Thorac Soc. 2018;15(3):348–356. [DOI] [PubMed] [Google Scholar]

28. Centers for Disease Control and Prevention. 2017 National Health Interview Survey (NHIS) Data. Table 3-1. Compiled March 18, 2019. Accessed June 24, 2019.

29. Bostantzoglou C, Delimpoura V, Samitas K, et al. Clinical asthma phenotypes in the real world: opportunities and challenges. Breathe (Sheff). 2015;11(3):186–193. [DOI] [PMC free article] [PubMed] [Google Scholar]

30. Peters SP, Busse WW. New and anticipated therapies for severe asthma. J Allergy Clin Immunol Pract. 2017;5(5S):S15–S24. [DOI] [PubMed] [Google Scholar]