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# New and Emerging Technologies in the Management of Asthma: A Narrative Review

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**Abstract:** Millions of people worldwide suffer from asthma, a chronic inflammatory airway disease that results in frequent flare-ups, substantial morbidity, and a worse quality of life. Even with successful pharmaceutical treatments, poor medication adherence, improper inhaler technique, delayed symptom worsening awareness, and restricted access to continuous monitoring make it challenging to achieve optimal disease management. By providing individualized, proactive, and data-driven asthma care, recent technological advancements provide chances to solve these issues. The purpose of this narrative review is to provide an overview and assessment of new developments in asthma care, such as wearable technology, digital spirometry, telemedicine, smart inhalers, mobile health apps, and artificial intelligence (AI)-based tools. To find recent research on the creation, clinical use, and results of these therapies, a narrative literature search of PubMed, Scopus, and Google Scholar was carried out. The trends, advantages, and drawbacks of each technology were highlighted by synthesizing the chosen research. Research indicates that real-time feedback and reminders from smart inhalers and smartphone apps improve adherence and inhaler technique. Patient education, prompt professional care, and ongoing symptom tracking are all supported by telemedicine and remote monitoring. Digital spirometry and wearable technology make it possible to continuously evaluate lung function and physiological data, which makes it easier to spot decline early. AI and machine learning algorithms help identify patients who are more likely to experience exacerbations, enhance risk prediction, and provide individualized treatment plans. Conclusion: a proactive, patient-centered strategy to managing asthma is replacing a reactive, episodic one, thanks to developing technology. These developments have great potential to improve asthma management, lessen exacerbations, and improve patient quality of life despite obstacles with regard to cost, data privacy, technological integration, and accessibility.

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## INTRODUCTION

Asthma is a chronic inflammatory disorder of the airways characterized by recurrent episodes of wheezing, breathlessness, chest tightness, and coughing, particularly at night or in the early morning[1]. It affects individuals of all age groups and represents a major global public health problem.

Conventional asthma management relies on pharmacological therapies, including inhaled corticosteroids, bronchodilators, leukotriene receptor antagonists, and biologic agents for severe disease[3]. However, poor adherence, incorrect inhaler technique, and inadequate follow-up contribute to suboptimal asthma control in real-world practice[24].

Rapid advancements in healthcare technology have shifted asthma care from episodic, clinic-based management to continuous, patient-centered monitoring. Digital health innovations aim to improve adherence, enable early detection of exacerbations, and strengthen communication between patients and healthcare professionals[28].

## SMART INHALERS IN ASTHMA MANAGEMENT

Smart inhalers are conventional inhaler devices integrated with electronic sensors that record the date, time, and frequency of inhaler use. These data can be transmitted to digital platforms for real-time monitoring of adherence and inhaler use patterns[6].

Poor adherence to inhaled therapy is a leading cause of uncontrolled asthma and frequent exacerbations[4]. Smart inhalers provide reminders, alerts, and feedback that improve adherence and correct inhaler technique[5].

Objective inhaler usage data obtained from smart inhalers assist clinicians in distinguishing non-adherence from treatment failure, enabling informed treatment adjustments and reducing unnecessary medication escalation[6].

Increased use of short-acting beta-agonist inhalers may indicate worsening asthma control[4]. Smart inhaler systems can identify such trends early and alert patients and healthcare providers, facilitating timely intervention. A real-world observational study in severe asthma patients showed that using smart inhalers (with digital tracking and feedback via apps like Propeller Health) significantly improved adherence (>80% usage) and asthma control (measured by ACQ-6 scores), and reduced biomarkers like FeNO over 12 months. Patients with good adherence were less likely to need biologic therapy[29]. Smart inhalers with audio-visual reminders and clinician feedback increased adherence and reduced rescue use in pediatric and adult asthma populations compared to traditional or passive monitoring. Some RCTs show adherence rises significantly with smart features enabled (e.g., from 30% to ~84%), with correlated reductions in exacerbations[30].

## MOBILE HEALTH APPLICATIONS

Mobile health applications support asthma self-management by enabling patients to monitor symptoms, medication use, peak expiratory flow rates, and environmental triggers, thereby enhancing patient engagement[7].

Automated medication reminders, inhaler tracking features, and educational content within mobile applications improve adherence and inhaler technique, contributing to better asthma control[7].

Symptom tracking and trend analysis within mobile applications facilitate early identification of worsening asthma control and support personalized asthma action plans[8].

Integration of environmental monitoring features, such as air quality indices and pollen counts, helps patients reduce exposure to triggers and prevent exacerbations[9]. Machine learning models trained on electronic health record (EHR) data can identify risk patterns associated with future asthma exacerbations by integrating clinical features such as prior exacerbations, medication use, and biomarkers. These algorithms offer “risk scores” or prognostic predictions that outperform simple rule-based methods[31].

## TELEMEDICINE AND REMOTE MONITORING

Telemedicine enables remote delivery of asthma care through video consultations, telephone follow-ups, and digital platforms, improving access to care for patients in remote or underserved areas[10].

Remote monitoring systems allow electronic transmission of symptoms, lung function measurements, and inhaler usage data to healthcare providers, supporting proactive asthma management[14].

Telemedicine has demonstrated effectiveness in improving adherence, continuity of care, and asthma outcomes, particularly during public health emergencies such as the COVID-19 pandemic[13].

Integration of telemedicine with smart inhalers and mobile health applications provides comprehensive data to support evidence-based clinical decision-making and multidisciplinary care[12].

## ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Artificial intelligence and machine learning technologies analyze large volumes of clinical, behavioral, and environmental data to predict asthma exacerbations and identify high-risk patients[15].

Machine learning models using data from electronic health records, digital inhalers, wearable devices, and environmental sources enable personalized treatment strategies and optimized asthma management[16].

AI-driven decision support systems show promise in precision-based asthma care, although challenges related to data quality, transparency, and ethical considerations remain[18]. A systematic review of AI/ML applied to pediatric asthma showed that models could accurately predict exacerbations and other clinical outcomes better than traditional approaches. Multimodal inputs (clinical, demographic, environmental) generally produced higher predictive accuracy. The review stresses strong performance but also highlights the need for *standardization and prospective validation* before clinical use[32].

## WEARABLE DEVICES AND DIGITAL SPIROMETRY

Wearable devices enable continuous monitoring of physiological parameters such as respiratory rate, heart rate, physical activity, and sleep patterns, facilitating early detection of asthma deterioration[19].

Digital spirometry allows home-based assessment of lung function parameters including forced expiratory volume in one second and peak expiratory flow, supporting remote monitoring and clinical decision-making[21].

Integration of wearable devices, digital spirometry, mobile health applications, and telemedicine platforms offers a comprehensive and personalized approach to asthma management[20]. A systematic evidence review of 14 RCTs showed that smart inhalers do increase maintenance drug adherence compared with devices without feedback. However, translation to clinical outcomes (e.g., exacerbations or hospitalizations) was inconsistent, and some evidence even showed trends favoring usual care over smart devices for severe outcomes — highlighting that increased adherence does not *always* automatically improve all clinical endpoints, especially when baseline adherence was high[20].

## ROLE OF INHALER TECHNIQUE AND CLINICAL PHARMACISTS

Correct inhaler technique is essential for effective asthma therapy, and poor technique is associated with inadequate disease control[22]. Advances in inhaler technology aim to address these challenges[24].

Clinical pharmacists play a vital role in asthma management by providing patient education, monitoring adherence, reinforcing inhaler technique, and supporting the use of digital health tools[26]. Pharmacist-led interventions have demonstrated improvements in asthma outcomes and patient satisfaction[25].

Emerging digital technologies, including smart inhalers, mobile health applications, telemedicine, artificial intelligence, wearable devices, and digital spirometry, have the potential to transform asthma management by improving adherence, enabling continuous monitoring, and supporting personalized care[29]. Integration of these technologies into routine clinical practice, supported by multidisciplinary collaboration and patient education, may lead to improved long-term asthma outcomes[28].

## CONCLUSION

Asthma management has evolved significantly with the introduction of new and emerging technologies, shifting the approach from symptom-based treatment to personalized and precision-based care. Advanced drug delivery systems such as smart inhalers, biologic therapies targeting specific inflammatory pathways, and digital health tools have improved disease monitoring, medication adherence, and overall treatment outcomes. These innovations help in early detection of exacerbations, reduce hospitalizations, and enhance patient quality of life.

Furthermore, the integration of artificial intelligence, mobile health applications, and telemedicine has strengthened patient–healthcare provider communication and enabled real-time assessment of asthma control. Biomarker-guided therapy and genotype-based treatment selection represent promising steps toward individualized asthma care, especially in patients with severe or refractory disease.

However, despite their clinical benefits, challenges such as high cost, limited accessibility, need for technical training, and lack of awareness may restrict widespread implementation, particularly in low- and middle-income settings. Therefore, future efforts should focus on cost-effective innovations, patient education, and incorporation of these technologies into routine clinical practice.

In conclusion, emerging technologies hold great potential to transform asthma management by improving control, reducing disease burden, and promoting patient-centered care. With proper implementation and supportive healthcare policies, these advancements can play a crucial role in achieving better long-term outcomes in asthma patients.

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