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IMPLEMENTATION SCIENCE & OPERATIONS MANAGEMENT

Development and Utilization of a Diagnostic Support Tool for Asthma within the Electronic Medical Record

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Abstract

Asthma in childhood is a common and costly chronic disease. Quality asthma care can lead to better control of asthma thus decreasing use of health services. The gold standard for pediatric asthma diagnosis and management is the National Heart, Lung and Blood Institute (NHLBI) guidelines for Diagnosis and Management of Asthma which center on precisely establishing the severity of asthma, as this precise classification delineates appropriate therapy. However, navigating these guidelines is a challenge for primary care providers that creates a barrier to providing quality care. We aim to improve precision in asthma severity classification in the community healthcare setting through the development of an electronic asthma decision support tool (eADST) incorporating NHLBI guidelines embedded within the electronic health record system. We developed an algorithm for the eADST to guide the health care provider to the appropriate classification and subsequent therapy. We engaged our health system's electronic health record informatics team and together developed and revised the tool. We launched the tool in three academic community clinics and measured precision in asthma classification in the twelve months prior to the availability of the tool and the twelve months following the launch. We found a significant improvement in precision of asthma severity classification following the launch, a necessary first step in improvement of asthma care. The next step will be to evaluate the impact of the tool on asthma outcomes.

Keywords Electronic health record · Asthma management · Decision support tool

Abbreviations

NHLBI	National Heart, Lung and Blood Institute
GINA	Global Initiative for Asthma
Eadst	Electronic Asthma Decision Support Tool
HCP	Healthcare provider
ABPI	Asthma Best Practice Initiative
EMR	Electronic medical record

Introduction

Childhood asthma accounts for significant morbidity, healthcare utilization and economic burden across the United States. Asthma is one of the top five conditions for which children are hospitalized and ranks within the top ten most costly pediatric inpatient conditions [1]. Children with asthma incur close to three times the yearly healthcare expenditure of those without asthma [2]. There are significant racial and income disparities for asthma prevalence in the US, with prevalence in African American children twice that of Caucasian children, and prevalence in children living in lower income families 50% higher than the those not living in poverty [3, 4]. Moreover, hospitalizations and emergency department visits are three times higher among African American children than among Caucasian children [5]. This pattern is also evident on the local level in the nation's capital where the prevalence of pediatric asthma in the District of Columbia remains higher in the underserved predominantly African American areas of the district with further stratification showing that emergency department visits for asthma exacerbations follow geographic distribution of

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poverty within the district [6]. These disparities are seen despite evidence that asthma may in fact be underdiagnosed in minority populations due to limited access to quality care and treatment [7, 8].

Evidence shows that quality asthma care, as defined by appropriately diagnosed and treated asthma inclusive of regular long term follow up, can lead to better control of asthma symptoms and in turn decrease utilization of health services and lower impact on family resources [9, 10]. Despite treatment advances, awareness and education, and a slight decrease in overall prevalence over the last few years, asthma diagnosis and management continue to be a challenge for health care providers and disparities persist [11]. The gold standard for pediatric asthma diagnosis and management remains the National Heart, Lung and Blood Institutes (NHLBI) guidelines for Diagnosis and Management of Asthma (Expert Panel Report-3) initially published in 2007 with an updated Quick Reference Guide based on the guidelines published in 2012 [12]. The Global Initiative for Asthma (GINA) also has published guidelines that are updated regularly [13]. GINA guidelines focus on children 6 years of age and older as well as adults. Quality management outlined in these guidelines centers on precisely establishing and tracking the severity of asthma, as this precise classification informs appropriate controller therapy in order to reduce impairment and reduce risk. These therapeutic classifications are grouped into six therapeutic steps and may change based on intercurrent asthma control. For health care providers (HCP) in primary care settings, these guidelines can be cumbersome to navigate effectively and efficiently for individual patients often resulting in poor precision, subsequent poor asthma management, increased asthma impairment and risk [14, 15]. As an academic community pediatric practice delivering primary care to low income, high-risk communities, our aim is to improve asthma management and outcomes, ultimately decreasing asthma disparities. Our study aimed to identify if there is a relationship between using an electronic asthma decision support tool embedded in the electronic health record system and precision in asthma severity classification. As a first step, our goal was to improve the precision of asthma severity classification in the community healthcare setting through the development of an electronic asthma decision support tool (eADST) incorporating NHLBI and GINA guidelines embedded within the electronic health record system.

Methods

We convened a multidisciplinary team inclusive of physicians from the divisions of Community Pediatrics and Pediatric Pulmonology and formed a working group called Asthma Best Practice Initiative (ABPI). The team reviewed current guidelines and discussed practical considerations of a community-based clinical practice. The team developed a blueprint algorithm for the eADST based on NHLBI and GINA guidelines, with main focus areas of Asthma History, Risks, Initial Asthma Severity and Asthma Control, that guides the HCP to the appropriate severity classification and subsequent therapeutic step and follow up recommendations based on NHLBI guidelines. The tool integrates algorithms from multiple age groups, each of which has a separate diagnostic and management algorithm. The established algorithm obtains user input in the form of asthma risk and impairment before providing output as diagnosis and treatment (Fig. 1). During subsequent patient visits, the tool auto-populates with the previously recorded most recent asthma severity classification as well as risk factors. After updating current impairment, interim history and risks,

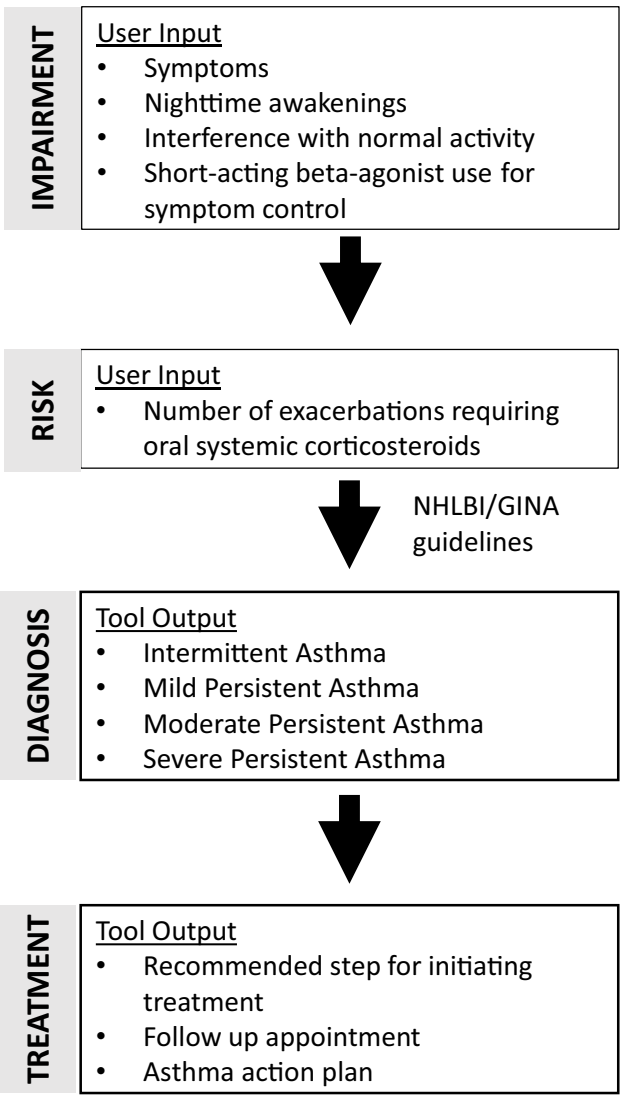

Fig. 1 Electronic Asthma Decision Support Tool (eADST) diagnostic and treatment algorithm

the tool guides the HCP to decide current level of control, update severity classification and therapeutic step if indicated, and provide guidance for recommended appropriate treatment.

The health system's EMR informatics team was engaged, and together the clinical and informatics team developed and revised the eADST within the capacity and limitations of the health systems existing platform. The final product was reviewed and approved for by the health systems Pediatric EMR Committee.

Prior to launch of the eADST, primary care providers in the three clinics served by Division of Community Pediatrics received a one-hour training on best-practice guidelines for asthma management, as well as the use of the electronic asthma decision support tool (eADST). Providers also received a follow up e-mail correspondence reinforcing the educational and training materials.

We defined asthma classification precision by grouping of asthma related ICD-10 codes grouped as either "non-precise" or "precise" classification for the purposes of evaluation. Non-precise diagnosis codes included: Unspecified Asthma (*ICD-10 code: J45.909*), Unspecified Asthma Exacerbation (*J45.901*) and Other Asthma (*J45.998*). Precise diagnosis codes included: Mild Intermittent Asthma (*J45.20*), Mild Intermittent Asthma with Acute Exacerbation (*J45.21*), Mild Persistent Asthma (*J45.30*),

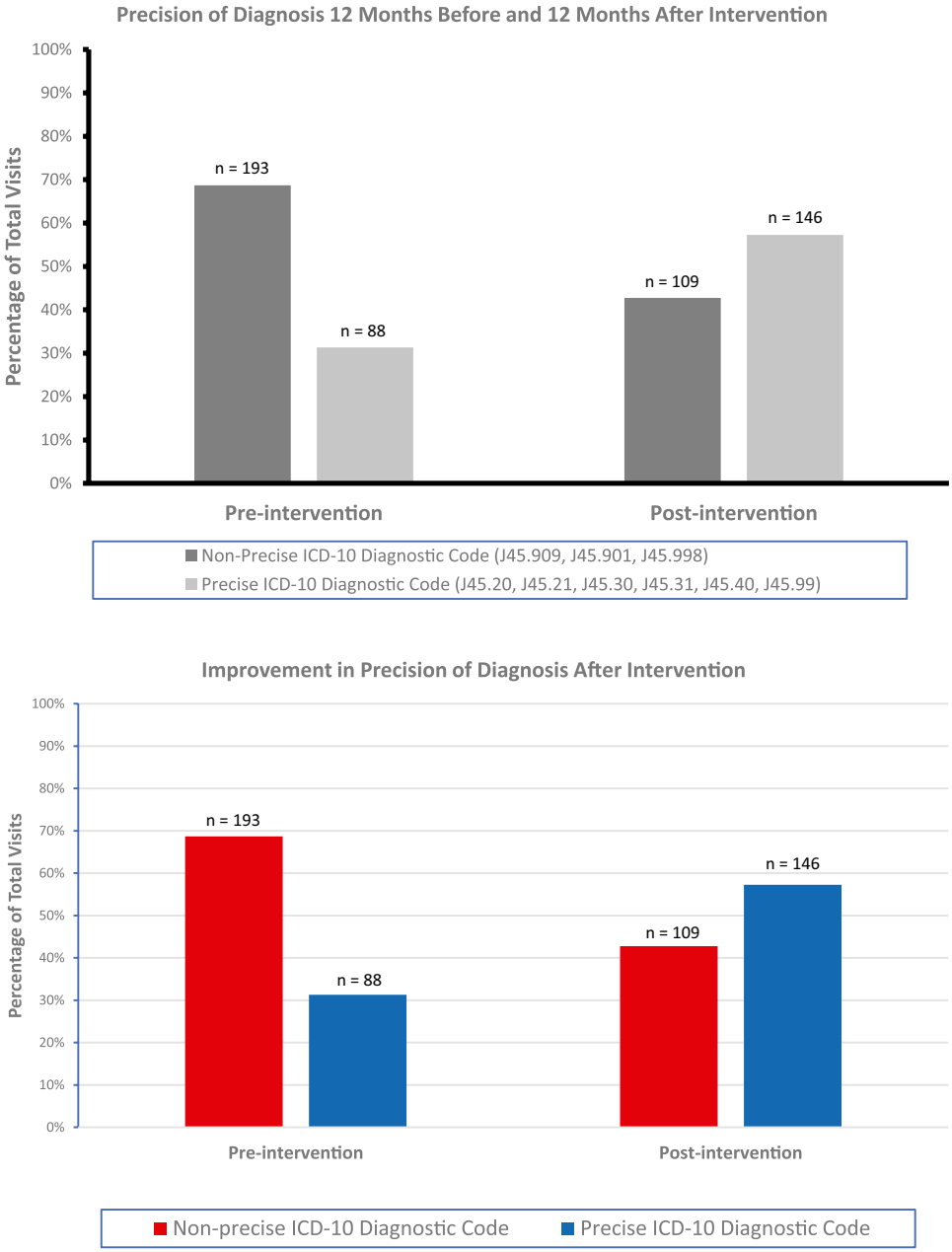

Fig. 2 Improvement in Precision of Diagnosis after Intervention

Mild Persistent Asthma with Acute Exacerbation (*J45.31*), Moderate Persistent Asthma (*J45.40*), Moderate Persistent Asthma with Acute Exacerbation (*J45.42*), and Exercise Induced Asthma (*J45.990*).

The eADST was launched in June 2018 simultaneously at three clinics in the Division of Community Pediatrics. We reviewed outcomes from the 12 months prior to eADST and training (July 2017—June 2018) and 12 months after launch (July 2018—June 2019) of the intervention.

Statistical analysis was performed using the Chi squared test. A p-value of less than 0.05 was considered statistically significant. This study was approved by the Institutional Review Board of MedStar Georgetown University Hospital.

Results

Patients in low-income communities were seen within 3 clinics by eight clinicians and monthly rotating residents. During the two-year study period, 2094 individual pediatric patients presented for a total of 5757 visits to any of the three clinics. Among individuals seen in the year prior to the intervention, 21.4% had an ICD-10 diagnosis of asthma. In the year following introduction of the electronic tool, 25.8% of unique patients had any ICD-10 diagnosis of asthma, including precise and non-precise classifications. Visits with an asthma related ICD-10 code varied seasonally with peaks in Spring and Fall. In the 12 months following the intervention, compared to the 12 months prior to the intervention, we saw improvement in precision of asthma classification, increasing from 31.3% to 57.3% and a decrease in non-precise classification from 68.7% to 42.7% (p-value < 0.001) (Fig. 2).

Discussion

Ill-defined diagnosis of asthma increases the risk of poor asthma management and resulting impairment. We aimed to improve precision of asthma severity classifications through creation of an electronic decision support tool to distill complex asthma management guidelines into an existing electronic health record platform. This intervention significantly improved the precision of asthma severity classification in a high-risk pediatric population. This novel tool can be adapted into other electronic health record platforms to aid in the precision of asthma severity classification beyond this research setting.

The tool was developed for practical use in the community setting within the larger context of optimizing health care delivery, improving health outcomes and decreasing asthma disparities. The success of the tool was likely due to several factors:

1. Convening an inter-disciplinary group of primary care providers, pulmonary specialists and informaticists.
2. Forming internal consensus on applying best-practice guidelines with practical considerations of practice and health system technology.

The next step in this work is to study the association of the use of the eADST with prescription patterns, asthma-related morbidity, and health care utilization.

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Author Contributions Dr. Shukla conceptualized and designed the tool, analyzed and interpreted the data, drafted the initial manuscript, and approved the final manuscript as submitted. Dr. Sandel conceptualized and designed the tool, critically reviewed and revised the manuscript, and approved the final manuscript as submitted. Dr. Phull conceptualized and designed the tool, critically reviewed and revised the manuscript, and approved the final manuscript as submitted. Dr. Rethy conceptualized and designed the tool, coordinated and supervised data collection, drafted the initial manuscript, and approved the final manuscript as submitted. All authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Declarations

Ethics Approval MedStar-Georgetown University IRB ID: MODCR00000999.

Consent to Participate Exempt.

Conflict of Interest The authors have no conflict of interest to disclose.

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