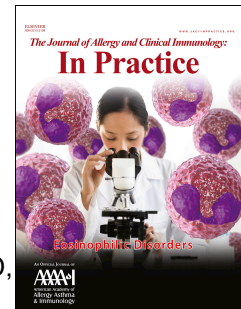


Journal Pre-proof

Digital Assessment of Medication Utilization by Age and Diagnosis of Asthma or COPD

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PII: S2213-2198(20)31222-8

DOI: <https://doi.org/10.1016/j.jaip.2020.10.065>

Reference: JAIP 3245

To appear in: *The Journal of Allergy and Clinical Immunology: In Practice*

Received Date: 14 July 2020

Revised Date: 27 October 2020

Accepted Date: 31 October 2020

Please cite this article as: Anderson WC III, Gondalia R, De Keyser HE, Kaye L, Szeffler SJ, Stempel DA, Digital Assessment of Medication Utilization by Age and Diagnosis of Asthma or COPD, *The Journal of Allergy and Clinical Immunology: In Practice* (2020), doi: <https://doi.org/10.1016/j.jaip.2020.10.065>.

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Funding Sources: Data and analysis were provided by Propeller Health, an affiliate of ResMed.

Declaration of Interests: W. Anderson has served as a consultant for GlaxoSmithKline; received a loan repayment grant from HRSA; and received study funding from the Colorado Medicaid Upper Payment Limit Program. R. Gondalia, L. Kaye report compensation from their employer, ResMed. D. Stempel reports compensation from his employer, Propeller Health, an affiliate of ResMed. H. De Keyser has served as a consultant for Astra Zeneca; has received EMMS from Propeller Health for other research studies; received a loan repayment grant and K award from the NIH; and received study funding from the Colorado Department of Public Health and Environment, as well as Children's Hospital Colorado. S. Szeffler has served as a consultant for

Boehringer-Ingelheim, Genentech, GlaxoSmithKline, AstraZeneca, Propeller Health, Sanofi, and Regeneron; and received a grant from Propeller Health.

Clinical Implications: 39 words

Manuscript Word Count: 1003 words

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Clinical Implications: Electronic medication monitors were used to assess patterns of controller and rescue medication use by age, providing potential insight into the need for age-specific strategies to improve medication management in patients with asthma or chronic obstructive pulmonary disease (COPD).

Remote monitoring technology gives providers the ability to trend adherence patterns¹, to assess medication administration technique², and to supplement patient care with real-time information, with increasing importance in the age of social distancing.³ Further refinement of care may be gained by examining disease control, burden, and medication adherence by age cohort.⁴ This information is important given the differences in respiratory-related morbidity and mortality by age and disease.⁵

The objective of this study was to evaluate age-specific patterns of controller adherence, rescue medication use, and disease status in patients with asthma and chronic obstructive pulmonary disease (COPD).

This analysis used retrospective data collected from patients aged ≥ 4 years with self-reported asthma or COPD and were utilizing the Propeller Health platform (Propeller Health; Madison, WI) from January 2017 to September 2019. Eligible patients included in this analysis were enrolled through a number of managed and self-enrolled programs, including health fairs, mailed pamphlets and social media campaigns. The platform has been previously described.⁶ Patients attached electronic medication monitors (EMMs) to their controller and rescue

inhalers to passively record the date and time of each actuation. The EMMs are part of an FDA 510(k) cleared digital health platform. Inclusion required 97-days of continuous EMM data for any controller medication with a sensor. Patients were prompted to complete an Asthma Control Test (ACT), childhood ACT (c-ACT), or COPD Assessment Test (CAT) through the Propeller smartphone application at baseline and monthly thereafter. Patients who did not take an ACT, c-ACT, or CAT were excluded from the analyses. Baseline disease status was determined by the first ACT, c-ACT, or CAT taken. Daily controller adherence and short-acting beta-agonist (SABA) use was assessed from days 8-97, with data from the onboarding week excluded to account for acclimation to the device or potential Hawthorne effect. Daily adherence was calculated at the patient-level as the total number of controller actuations recorded by the EMM (numerator) divided by the number of prescribed actuations (denominator), which were self-reported in the app. Adherence was capped at 100%. Mean daily controller adherence and SABA use were compared by age groups using linear regressions and differences in disease status was compared using logistic regressions.

This study was determined to be exempt of institutional review by the Copernicus Group Board (PRH1-18-132).

A total of 8385 patients were included in the study, 6474 with asthma and 1911 with COPD (Table 1). The mean age of patients with asthma was 34.4 years. ACT or c-ACT were completed in 80.3% of patients with asthma, with 20.4% being well-controlled (ACT/cACT >19). COPD patients had a mean age of 62.2 years and 80.2% completed a CAT, of whom 60.7% had higher burden COPD (CAT >20).

Mean daily controller adherence was 51.3% and 66.6% in patients with asthma and COPD, respectively. Adherence was lowest in adolescents and young adults, reaching a nadir of 39.5% in patients 18-29 years old (Figure 1). Only 13.0% of 18-29-year-olds had well-controlled asthma, the lowest of any age cohort. In contrast, well-controlled asthma and higher adherence was noted in children 4-11 years and adults ≥ 60 years. Adherence for patients aged ≥ 40 years was higher in older patient age groups but was consistent between asthma and COPD.

Mean daily SABA use was 0.81 puffs/day for patients with asthma at baseline. SABA use was higher with increasing age peaking in the 30-39-year-olds at 1.06 puffs/day and then progressively declining for patients ≥ 40 years (Figure 1). Daily SABA use in COPD patients was consistent across the age groups studied and nearly 2-fold than in asthma patients of the same age group.

For patients with asthma, the lower adherence to controller medications was paralleled with higher use of SABA and lower ACT/c-ACT scores. The controller adherence rates in children may reflect greater parental management that is not seen in adolescents. This pattern of low adherence is also seen in young adults.

Transition from pediatric to adult care is associated with increased morbidity. Prior studies have indicated that over half of adolescents and young adults (AYAs) had an asthma exacerbation in the prior year.⁷ Further, studies have shown that adolescents have difficulty identifying their medications and stating indication for their use, despite half of surveyed adolescents being responsible for taking their medications.⁸ Our findings are consistent with other studies that found 89% of AYAs having uncontrolled or partly controlled asthma per Global Initiative for Asthma guidelines.⁹ This study provides objective evidence of poor asthma

control in this age group and highlights the need for age-specific interventions to improve adherence.

There are several limitations to the present study. First, the patient population is based on those with self-reported asthma or COPD and lacks physician confirmation. Patients also self-reported the prescribed number of daily controller actuations, based on discussions with their personal healthcare provider. Patient disease severity, knowledge of whether they are receiving guidelines-appropriate step-level of care, and technique could not be ascertained. Moreover, patients may use multiple inhalers not all of which have a sensor. The Propeller Health platform offers audio and visual reminders which the patient can disable, and it is unclear how many patients utilized this feature. Selection bias may also limit our interpretation. Because patients self-enrolled to use EMMs, they may have characteristics that differ from the broader asthma and COPD populations, such as having access to a smartphone and/or having greater motivation to self-manage their disease.

In conclusion, this study highlights the age group-specific differences in adherence in both asthma and COPD, especially in adolescents and young adults with not well-controlled asthma. In contrast patients with asthma and COPD ≥ 40 years have similar and higher levels of controller adherence. These data illustrate the need to develop age-specific strategies to enhance adherence. Identifying patient goals of care and employing shared decision-making to determine therapy, schedule of dosing, and implication of therapy may advance progress in gaining better disease control. Using EMMs, providers can provide personalized therapy to their patients to enhance patient and clinician engagement in monitoring self-care and uniquely

address any barriers to asthma control that may not be identified through standard management alone.

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Table 1. Rescue use, adherence and disease status by age group

Age group	Overall	4 to 11	12 to 17	18 to 29	30 to 39	40 to 49	50 to 59	60+ (ref)
Asthma, n	6474	754	608	1182	1439	1160	795	536
Mean (SD) daily rescue use (puffs/day)	0.85 (1.62)	0.54 (0.84)*	0.64 (1.11)	0.88 (1.77)	1.06 (1.88)*	0.95 (1.84)	0.75 (1.40)	0.81 (1.59)
Mean (SD) daily adherence (%)	51.28 (32.18)	54.32 (30.15)*	43.37 (28.25)*	39.74 (31.23)*	47.72 (31.56)*	54.87 (32.16)*	61.54 (31.36)*	67.96 (30.66)
n (%) well-controlled, ACT>19	1059 (20.4)	172 (29.9)	78 (25.6)	132 (13.0)*	208 (16.2)*	182 (18.7)*	158 (25.0)*	129 (31.2)
COPD, n	1911					202	543	1166
Mean (SD) daily rescue use (puffs/day)	1.53 (2.21)					1.55 (2.27)	1.62 (2.36)	1.48 (2.13)
Mean (SD) daily adherence (%)	66.60 (31.47)					54.91 (33.94)*	64.39 (32.44)*	69.65 (30.00)
n (%) low burden, CAT<21	603 (39.3)					34 (26.6)*	171 (35.7)*	398 (43.0)

*P < 0.05, reference group for comparison = 60+ years age group

Figure 1. Mean (95% confidence intervals) rescue and adherence use trends in patients with asthma and COPD by age

