

Screening for inhalation technique errors with electronic medication monitors



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Clinical Implications

- The therapeutic efficacy of inhaled medications in asthma is commonly hindered by errors in the inhalation technique. Using digital sensors to quantify the time between 2 actuations as a screening test for the appropriate inhalation technique, we detected a high prevalence of errors in the inhalation technique.

TO THE EDITOR:

To achieve full therapeutic efficacy of an inhaled asthma medication, several specific steps are required as discussed in asthma guidelines and the patient information leaflets for these medications. Guidelines state that training is required with a follow-up observation of the inhalation technique. A recent meta-analysis described deficient knowledge by health care providers (HCPs) of the appropriate steps required for the maximum deposition of these medications in the airways.¹ Criteria to evaluate inhalation technique are subjective, and therefore assessment can be challenging.

Following the required steps needed for maximal therapeutic benefit has been discussed for decades. Shim and Williams² decades ago reported the difficulty of training and knowledge retention of the inhalation technique in patients. This issue was described as inhaled corticosteroids were introduced into asthma pharmacotherapy in the 1980s. Although most providers agree that inhalation technique is important, they may not be taking an active role to regularly assess the inhalation technique. As such, improvements in the inhalation technique have not been observed.³

For many rescue and controller medications, 2 inhalations are required for a dose. Both US and global asthma guidelines have explicit recommendations regarding patient education training, observation, and retraining for metered dose inhalers (MDIs).^{4,5} In addition, patient information leaflets (PILs) provide instructions on appropriate use that is consistent across medication types and brands. More than 30 to 60 seconds are required between inhalations to achieve effective MDI use including shaking the canister, exhaling completely before inhalation, inhaling slowly, and breath-holding after inhalation. Therefore, objective assessment of the interval between the 2 actuations may be a useful measure to screen for the inadequate technique. This study aimed to screen for inhalation error by quantifying the time between 2 consecutive actuations using electronic medication monitors (EMMs).

Data were analyzed from patients ≥ 4 years old with self-reported asthma. Their rescue and/or controller inhalers had

EMMs attached to determine the exact time and date of each actuation (± 3 -second error). Patients using 2 actuations within 120 seconds were included, as most consecutive actuations occur within this time period.⁶ The interval between actuations was quantified and conservatively classified as acceptable (>30 seconds), fair ($15 \leq 30$ seconds), or poor (≤ 15 seconds) based on the available PILs and guideline criteria.^{4,5} The change in the interval between actuations over time was assessed using the Akaike and Bayesian information criteria and linear mixed effects models that allowed for within- and between-patient variability.⁷ This study was determined as exempted from institutional review board approval by the Copernicus Group IRB (PRH1-18-132).

The study included 278,374 patient-days from 7558 patients, of whom 6616 were rescue medication users on 120,882 patient-days and 3220 were controller medication users on 157,492 patient-days. The median (interquartile range) interval between actuations was 9 (16) seconds. Figure 1 shows that 67% of multiple inhalations were separated by ≤ 15 seconds (poor), 17% by 15 to 30 seconds (fair), and 16% by >30 seconds (acceptable). The results were similar when stratified by rescue versus controller and MDI versus dry powdered inhaler (DPI) use but varied by age (see Figure 2). Patients 4 to 11 years of age had the highest level of “acceptable” inhaler use, whereas those 18 to 29 years of age had the lowest (22% vs 12%, $P < .001$). There was little variability in the interval between actuations over time within and between patients.

Our data suggest that the majority of patients using inhaled medications are deficient in technique for both rescue and controller medications based on current device recommendations. A recent systematic review of HCP proficiency on using MDIs and DPIs demonstrated that only 15.5% were using the correct technique.¹ The implications of these findings are that HCPs may not have the knowledge base, training, or time to assure that the required steps of the medications are followed. Two common issues identified by Plaza et al¹ were not exhaling completely and not breath-holding appropriately. Both parameters would be detected by EMM-measured duration between inhalations.

Levy et al and Price et al found that the inadequate inhalation technique was associated with decreased levels of asthma control⁸ and increased exacerbations risk.⁹ The association of these critical errors and diminished outcomes demonstrates the importance of the inhalation technique. The use of EMMs to assess the time taken to complete several of these parameters including preparing the device, exhalation, inhalation, and breath-holding may help screen for the appropriate technique in clinical practice.

Marketed inhalers for asthma contain PILs for rescue and controller medications, and the majority of rescue MDIs have comparable instructions. GlaxoSmithKline and Merck MDI controllers have recommendations for 10-second breath-holding and a 30-second wait before the second inhalation. The Symbicort PIL does not have this wait time period, but as with the other MDIs, a minimum of 30 seconds would be required between inhalations. Comparable recommendations are made for DPIs with the exception of shaking the device before use. Both US and global asthma guidelines give recommendations that are consistent with the PILs, but less prescriptive on the specific times for these steps for inhalation.^{4,5}

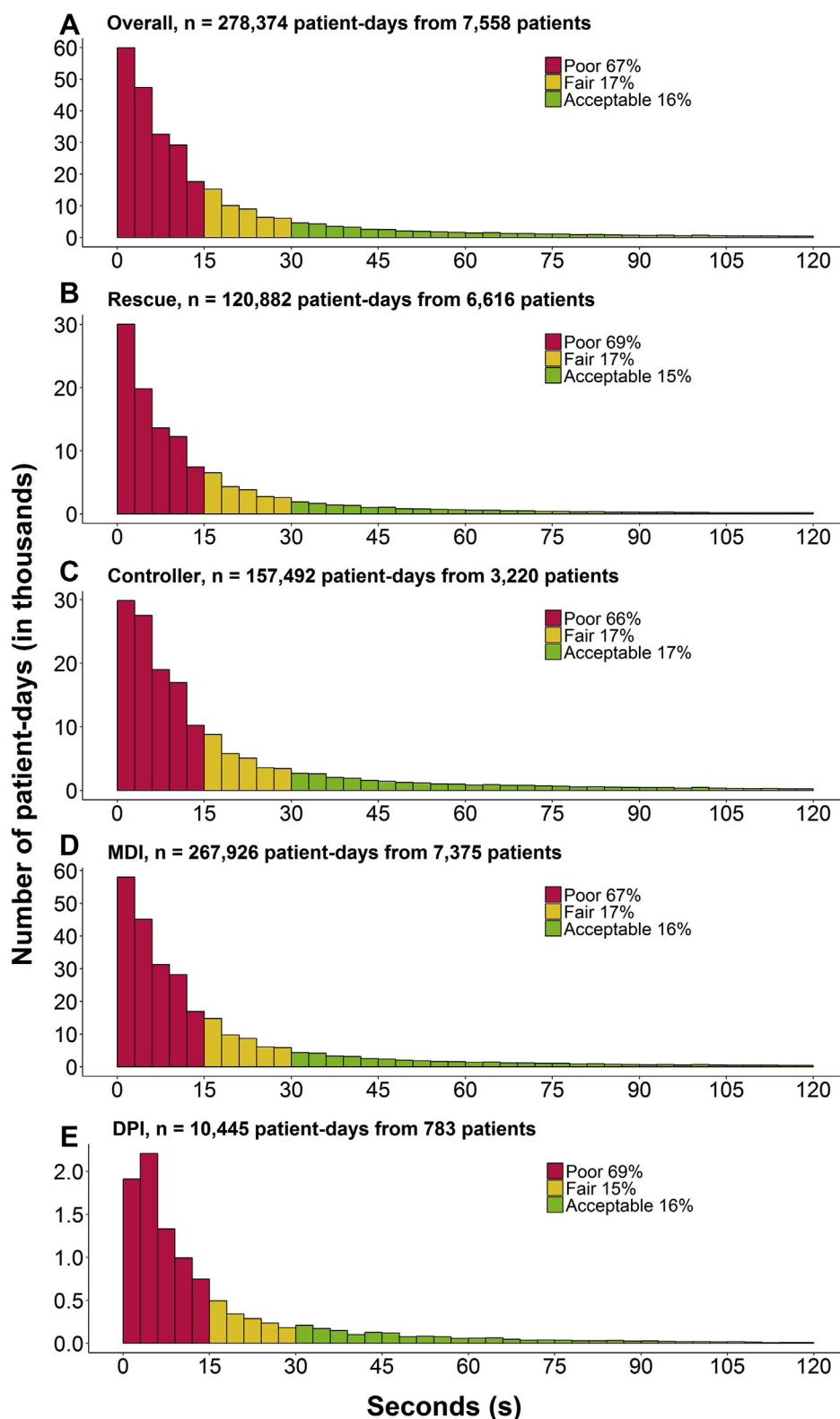


FIGURE 1. Distribution of interval between actuations measured over patient-days. *DPI*, Dry powdered inhaler; *MDI*, metered dose inhaler.

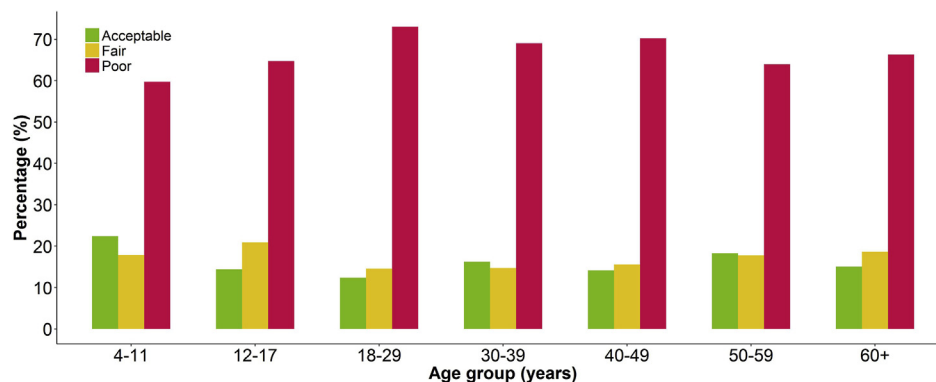


FIGURE 2. Inhaler technique classification based on the interval between actuations by age.

The use of EMMs in screening for errors in the inhalation technique is limited in its specificity of several critical criteria for errors. For example, they do not assess whether the patient has removed the medication cap, taken a slow deep inhalation, used a spacer, or shaken the MDI before use. Further limitations include not identifying priming of MDIs nor the use of spacing device. Most prior studies have been performed in research environments where patients are more likely to be careful with their technique.^{1,3} However, EMMs can objectively and longitudinally measure temporal parameters related to medication use in the real world and have the ability to electronically deliver these daily observations to patients and providers. This study demonstrates the value of EMM-derived measurements to screen for errors in the inhalation technique. The better technique observed in younger children compared with adolescents may suggest the need for greater parental supervision, especially for adolescents. The large frequency of timing errors that we observed—less than 15% have an acceptable duration between consecutive inhalations—indicates the critical need for patient-level retraining and observation of medication use.

The present study digitally screened for errors in the inhalation technique by quantifying the time between 2 consecutive inhalations recorded by EMMs. Objective monitoring may help identify patients who have inadequate parameters of the technique that can limit the effectiveness of treatment and increase cost through higher medication use.¹⁰ Digital application-based interventions that rapidly disseminate educational instructions and target at-risk subgroups and/or their providers may allow for efficient, cost-effective, and scalable solutions to counter widespread misuse of inhaler medication.¹¹ Providers and pharmacists should also emphasize and evaluate the inhalation technique before prescribing and dispensing medications, respectively.

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