

Systematic Review of Errors in Inhaler Use Has Patient Technique Improved Over Time?



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BACKGROUND: Problems with the use of inhalers by patients were noted shortly after the launch of the metered-dose inhaler (MDI) and persist today. We aimed to assess the most common errors in inhaler use over the past 40 years in patients treated with MDIs or dry powder inhalers (DPIs).

METHODS: A systematic search for articles reporting direct observation of inhaler technique by trained personnel covered the period from 1975 to 2014. Outcomes were the nature and frequencies of the three most common errors; the percentage of patients demonstrating correct, acceptable, or poor technique; and variations in these outcomes over these 40 years and when partitioned into years 1 to 20 and years 21 to 40. Analyses were conducted in accordance with recommendations from Preferred Reporting Items for Systematic Reviews and Meta-Analyses and Strengthening the Reporting of Observational Studies in Epidemiology.

RESULTS: Data were extracted from 144 articles reporting on a total number of 54,354 subjects performing 59,584 observed tests of technique. The most frequent MDI errors were in coordination (45%; 95% CI, 41%-49%), speed and/or depth of inspiration (44%; 40%-47%), and no postinhalation breath-hold (46%; 42%-49%). Frequent DPI errors were incorrect preparation in 29% (26%-33%), no full expiration before inhalation in 46% (42%-50%), and no postinhalation breath-hold in 37% (33%-40%). The overall prevalence of correct technique was 31% (28%-35%); of acceptable, 41% (36%-47%); and of poor, 31% (27%-36%). There were no significant differences between the first and second 20-year periods of scrutiny.

CONCLUSIONS: Incorrect inhaler technique is unacceptably frequent and has not improved over the past 40 years, pointing to an urgent need for new approaches to education and drug delivery.

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KEY WORDS: aerosol therapy; aerosols; inhalation errors; inhalers

ABBREVIATIONS: BAMDI = breath-actuated MDI; DPI = dry powder inhaler; MDI = metered-dose inhaler; MDI+IC = MDI with inhalation chamber

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Current clinical evidence suggests that although contemporary inhaled therapy for asthma has the potential to control disease in most patients,^{1,2} control is often not achieved in practice. One prominent reason for poor control is poor inhaler technique, because no matter how good a drug is, it cannot be effective if it does not reach the targeted airways.^{3,4}

Problems with technique were recognized shortly after the launch of pressurized metered-dose inhalers (MDIs) in the 1960s,⁵ and later reports suggested that the problems persisted despite elaborate initiatives to reduce them.⁶⁻¹¹ Initiatives trying to improve the situation have included regular training programs for patients and health-care professionals; printed instructional material, videos, and software; and measures and devices to make inhalation easier, such as the development of a

breath-actuated MDI (BAMDI) and an MDI with inhalation chamber (MDI+IC); and the design of various dry powder inhalers (DPIs) that require an easier inhalation maneuver. A reasonable question that arises, therefore, is to what extent these initiatives have improved problems with inhaler technique over the past 4 decades.

We examined articles published between 1975 and 2014 in which inhaler technique demonstrated by patients with asthma and COPD was assessed by trained observers who classified the errors according to established recommendations and then assessed the overall technique as correct, acceptable, or poor. We also documented the most common errors noted for each inhaler type. Finally, we divided this 40-year period into early and late periods of use and compared the outcome variables to look for time trends.

Materials and Methods

Eligibility, Literature Search, and Selection Process

Full details of the protocol followed are available from http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42014009347.

Data were extracted from papers assessing the extent and prevalence of incorrect inhaler use in children (minimum age, 5 years) and adults who were receiving inhaled therapy for either asthma or COPD. Articles published in English, French, or Spanish between 1975 and 2014 were evaluated. To be included in the analysis, a study had to meet the following criteria: (1) include an evaluation of inhaler use and technique in its main objective, and (2) contain a description of the assessments made that was based on direct observation of the patients' technique by trained personnel using an inhaler-specific checklist of steps. The recommended maneuvers¹²⁻¹⁴ that had to be observed directly and assessed are listed in Table 1. We classified their assessments in rough groupings for analysis. We recorded technique as correct if observers thought all maneuvers were performed in accordance with the recommendations; acceptable (fair or good but suboptimal) if observers thought roughly three-quarters of the maneuvers were as recommended, including all critical aspects; and poor or very poor if fewer than one-half of the maneuvers were correct and/or one or more critical errors were present. The concept of critical error refers to its influence on the generation and lung deposition of aerosol rather than whatever changes it might induce in terms of clinical or therapeutic effects.¹⁵

Papers providing insufficient information about the maneuvers were excluded. If a study presented data on technique before and after an educational or instructional intervention, we only extracted data prior to the intervention.

MEDLINE (PubMed) was searched using search terms related to inhalers and their use as follows: *inhaler* AND *technique* AND *errors*; *inhaler* AND *education*; *inhaler* AND *technique*; *spacers* AND *asthma*; *metered dose inhaler* AND *utilization* OR *dry powder inhaler* AND *utilization*. We also searched for the brand names of DPIs: Turbuhaler (AstraZeneca), Diskhaler (GalxoSmithKline), Diskus/Accuhaler (GlaxoSmithKline), Rotahaler (GlaxoSmithKline), Novolizer (Meda), Cyclohaler/Aerolizer (Novartis), Handihaler (Boehringer-Ingelheim), Clickhaler (Innovata Biomed), Swinghaler (Otsuka Pharmaceutical), Jethaler (Radiopharm), Benosid N

TABLE 1] Essential Inhalation Maneuver Steps

MDI and BAMDI
1. Prepare the device: Both: uncap, shake, hold inhaler (canister vertical, mouthpiece horizontal) BAMDI: raise valve lever
2. Breathe out completely
3. Place teeth and lips around the mouthpiece and fire the device while beginning a slow inhalation
4. Breathe in slowly and deeply, without stopping
5. Hold the breath for 5 to 10 seconds or as long as possible
MDI+IC
1. Prepare the device: remove cap, shake the inhaler while holding it vertically with mouthpiece on the bottom, and connect it to the chamber
2. Exhale gently and then place teeth and lips around the chamber's mouthpiece to form a seal
3. Firing and breathing: fire the MDI and take 4 to 5 slow breaths, ^a inhaling from the chamber; hold the last breath for 5 to 10 seconds or as long as possible
DPI
1. Prepare the device: uncap, load the inhaler
2. Turn away from the inhaler and breathe out completely
3. Place teeth and lips around the mouthpiece to form a seal
4. Breathe in with one brisk, deep inhalation
5. Hold the breath for 5 to 10 seconds or as long as possible

The list of steps for the different devices is based on the early descriptions of Newman et al¹² and Dolovich et al¹³ and later endorsed by the recommendations of international bodies.^{1,2,14} The open mouth technique was also accepted. BAMDI = breath-actuated MDI; DPI = dry powder inhaler; MDI = metered-dose inhaler; MDI+IC = MDI with inhalation chamber.

^aTidal breaths (4-5) in small children. A single, long deep expiration outside the chamber and long deep inspiration (small chambers) or several tidal breaths in older children or adults using large chambers were also accepted.

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