

# Inhalation technique with hand-held inhalers in patients with obstructive airway diseases: a systematic review with meta-analysis

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## INTRODUCTION

The inhaled route of administration is widely accepted as optimal for administering drugs, such as bronchodilators and corticosteroids, for the treatment of patients with asthma and COPD. Compared with systemic administration, the inhalation route offers a faster onset of action and high in situ drug concentrations, resulting in a lower required drug dose and subsequent lower rates of side effects. Pressurised metered-dose inhalers (pMDIs) and dry-powder inhalers (DPIs) are the most widely used inhalation devices because of their effectiveness, low cost and relative simplicity of use. However, up to 80% of patients do not use their inhalers, either pMDIs or DPIs, correctly, despite having received comprehensive instructions. Incorrect use of inhalers may lead to insufficient drug delivery and deposition thus reducing their clinical effectiveness. We conducted a systematic review and meta-analysis to establish which of two hand-held inhalers (pMDI and DPI) is more frequently associated with a correct inhalation technique in patients with asthma and COPD. We also evaluated the observed errors in inhalation technique using these inhalation devices.

## METHODS

Identification and selection of trials. We identified studies published from 1966 to 2006 by means of a computerised search (Science Citation Index, Embase, Medline, Web of Science, individual respiratory journal websites), and a hand search of 15 relevant respiratory journals (from 2000 to 2006) with the following keywords: “mishandling” or “errors” or “incorrect use” or “incorrect technique” or “improper technique” or “improper use” in conjunction with “pressurised metered-dose inhaler” and “dry-powder inhaler”. We included parallel-group studies performed in adult patients with either asthma or COPD and aimed at comparing, by using standardised checklists scoring systems, the correct use of pMDI (with or without spacers) compared with DPIs, regardless of the drug being inhaled. We included in the review laboratory, hospital or community based trials, published in English, Spanish, French, Italian, German or Portuguese. Commentaries, cost-analyses, and letters to the editor were excluded. Titles and abstracts of articles identified using the above search strategy were scanned and articles that appeared potentially to fulfil the inclusion criteria were retrieved in full. Two reviewers independently selected trials for inclusion and exclusion; disagreement between reviewers was resolved with discussion. Data abstraction and analysis. We combined data from all trials using Review Manager 4.2 (Cochrane Collaboration software). For each included study, the association between the presence of a correct inhalation technique (categorical dependent variable) and the use of the pMDI or DPIs was evaluated by calculating the odds ratio (OR) with 95% confidence intervals. For the meta-analysis, mean ( $\pm$ 95% confidence interval, CI) OR values obtained from all considered studies were pooled and evaluated by means of Forrest plots. Heterogeneity between trials was evaluated by using both  $\chi^2$  and I<sup>2</sup> tests. In all instances,  $P < 0.05$  was taken as significant.

## RESULTS

Trial searches and study characteristics. The electronic search yielded 56 citations; manual search yielded an additional 3 articles. Sixteen articles met the inclusion criteria and proved to have usable data (Figure 1). The reviewers completely agreed on trial inclusion. Six studies were performed in patients with asthma, 4 in patients with COPD and 6 in both. The pMDI was compared against Turbuhaler in 12 studies, Rotahaler in 6, Diskhaler in 6, Diskus in 3, Aerolizer in 2, and Handihaler in one (Table 1). Data synthesis. The frequency of a correct inhalation technique ranged from 24 to 73% of patients (mean value 52.1%, 95%CI, 43.1-61.1), irrespective of the inhalation device. Notably, as many as 25% patients had never received instruction on correct use of their inhaler. As reported in Figure 2, we found that the use of DPIs was significantly ( $P < 0.01$ ) more often associated with correct inhalation technique than pMDIs. The errors in inhalation technique described with the use of either the pMDI or DPIs are reported in table 2 and 3, respectively.

## CONCLUSION

This systematic review confirms that incorrect use of inhalers is common among patients with asthma or COPD. Furthermore, our results indicate that a correct inhalation technique is more frequently associated with the use of DPIs than pMDIs. The fact that up to approximately 70% of patients misuse their inhaler may have detrimental consequences for clinical efficacy of inhaled drugs and disease management. Regular assessment and reinforcement of correct inhalation technique are to be considered by health care professionals as an essential step in the management of patients with obstructive airway diseases.

Table 1. Characteristics of trials included in the meta-analysis

| Study reference             | Disease       | DPI             |
|-----------------------------|---------------|-----------------|
| Hilton S (1990)             | Asthma        | TBH, DH, RH     |
| Olaguibel et al (1996)      | Asthma        | Not specified   |
| Campos et al (1998)         | Asthma        | TBH,            |
| Van der Palen et al (1999)  | Asthma        | TBH, DH, RH, CH |
| Barthwal et al (2005)       | Asthma        | RH              |
| Van der Palen et al (1999)  | Asthma        | TBH, DH, RH, CH |
| Girodet et al (2003)        | COPD          | AR, TBH, D      |
| Van der Palen et al (1995)  | COPD          | TBH, DH, RH     |
| Dahl et al (2003)           | COPD          | HH              |
| Ho et al (2004)             | COPD          | Not specified   |
| Van Beerendonk et al (1998) | Asthma + COPD | TBH, DH, RH, CH |
| Carrion Valero et al (2000) | Asthma + COPD | TBH             |
| Hesselink et al (2001)      | Asthma + COPD | TBH, DH, RH, CH |
| Haro Estarriol et al (2002) | Asthma + COPD | TBH             |
| Lenney et al (2000)         | Asthma + COPD | TBH, D, CH      |
| Molimard et al (2003)       | Asthma + COPD | AR, TBH, D      |

TBH, Turbuhaler; DH, Diskhaler; RH, Rotahaler; CH, Cyclohaler; AR, Aerolizer; D, Diskus; HH, Handihaler

Figure 1: Results of search for trials and reasons for excluding studies

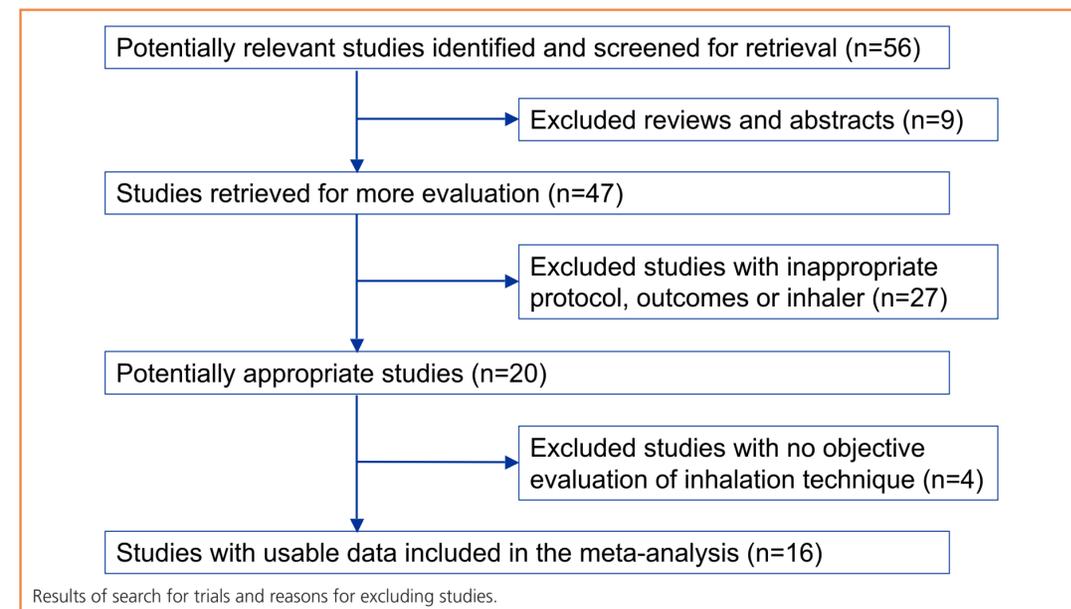


Table 2. Observed errors in pMDI inhalation checklist

| Actions  | % of patients performing action incorrectly |
|--|---|
| Remove protective cap                                  | 3.50 (0.30-6.69)                            |
| Shake inhaler  | 35.38 (22.29-48.46)                         |
| Hold inhaler upright                                   | 6.12 (0.17-12.08)                           |
| Exhale to residual volume                              | 42.25 (28.74-55.76)                         |
| Place mouthpiece between lips                          | 7.50 (1.37-13.63)                           |
| Inhale slowly and simultaneously activate the canister | 33.75 (18.01-49.49)                         |
| Continue slow and deep inhalation                      | 43.25 (20.89-65.61)                         |
| Hold breath for ~10 sec                                | 46.88 (33.30-60.45)                         |

Values are means  $\pm$  95%CI. pMDI, pressurised metered-dose inhaler.

Table 3. Observed errors in DPI inhalation checklist

| Actions                           | % of patients performing action incorrectly |
|-----------------------------------|---|
| Prepare the inhaler before use    | 11.90 (0.16-23.64)                          |
| Hold inhaler at correct angle     | 16.10 (6.42-25.78)                          |
| Exhale to residual volume         | 49.80 (32.57-67.03)                         |
| Place the mouthpiece between lips | 3.10 (0.19-6.01)                            |
| Inhale forcefully and deeply      | 20.60 (11.46-29.74)                         |
| Hold breath for ~10 sec           | 47.10 (32.36-61.84)                         |

Values are means  $\pm$  95%CI. DPI, dry-powder inhaler.

Figure 2: Association between correct inhalation technique and pMDI and DPI usage

