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# Evaluation of health-care providers' knowledge in the science of aerosol drug delivery: Educational sessions are necessary

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## Abstract:

**BACKGROUND:** Aerosolized drugs are widely used to treat and control a variety of pulmonary diseases. However, there is increasing evidence that patients are unable to use their drug delivery device correctly. The failure of aerosolized treatment is usually the result of poorly communicated instructions. The aim of this investigation was to evaluate the knowledge of health-care providers in the science of aerosol drug delivery (ADD) and assess the impact of further education on their knowledge.

**MATERIALS AND METHODS:** One hundred and seventeen health-care providers attended a 4-hour educational course on ADD science. The course was conducted from June to August 2018 in Jeddah, Riyadh, and Dammam. Pre-course assessment done with a 12-item multiple-choice questionnaire. Post-course assessment was conducted after the end of course in which participants were asked to rate their knowledge of ADD on a scale of 1–10 (before and after the course).

**RESULTS:** Sixty-six health-care providers (physicians, pharmacists, respiratory therapists, and health educators) completed the course. The participants' clinical experience, on average ( $\pm$ standard deviation), was  $7.6 \pm 7.3$  years. Clinical experience favored physicians over other groups. The precourse score for all participants was  $3.2 \pm 1.9$  out of 12 and the postcourse score was  $6.97 \pm 2.7$ . There was a significant statistical difference between pre- and postcourse assessment scores ( $P < 0.05$ ). Differences between the four specialties were insignificant ( $P = 0.216$ ), without a correlation between clinical experience and preassessment scores ( $P = 0.202$ ).

**CONCLUSION:** The present data indicate that health-care providers' knowledge of ADD is completely inadequate. There is an urgent need to introduce an ADD educational package in the curricula. An annual competency-based evaluation for health-care providers is critical as well.

## Keywords:

Aerosol therapy, educational package, nebulizer, pressurized metered-dose inhalers

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## Introduction

Aerosolized drugs are widely used to treat and control a variety of pulmonary diseases.<sup>[1,2]</sup> However, there is increasing evidence of patients' inability to use their drug delivery device correctly.<sup>[3-7]</sup> The failure of aerosolized treatment usually

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results from poorly communicated instructions arising out of suboptimal patient counseling by health-care providers, which may, in turn, be the result of a lack of knowledge of aerosol therapy.<sup>[6]</sup> Indeed, it has been shown that the knowledge health-care providers require to optimally teach patients is largely absent.<sup>[8,9]</sup> It is reasonable to assume that the health-care providers' lack of proper knowledge and skills to teach patients' treatment delivery

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will inevitably reflect in patients' ability to properly use aerosol devices.

A single-center study with different specialties reported that the majority of health-care providers lack fundamental knowledge in aerosol drug delivery (ADD).<sup>[10]</sup> It was also reported that this might be related to the absence of formal training in its use. The authors recommended the introduction of ADD training in all relevant residency programs.<sup>[11]</sup> Others have found that a simple lecture and demonstration has resulted in good outcomes in the understanding of ADD. A well-structured course could have an even greater impact on their performance in ADD counseling.<sup>[12]</sup>

The primary aim of this study was to evaluate health-care providers' knowledge of ADD as well as the impact of educational programs on their work; our aim was also to evaluate the knowledge of the different specialties working with ADD systems.

## Materials and Methods

A convenience sampling method was used to recruit participants who were all invited to attend 4-hour courses on ADD, conducted in three different cities: Jeddah, Riyadh, and Dammam on three different dates from June to August 2018. Physicians, health educators, pharmacists, and respiratory therapists (RTs) were invited from almost all hospitals in each of the three cities. Invitations were concomitantly sent to relevant departments in all hospitals, both government and private, to ensure that no hospital was excluded. Participants were not aware of the pre- and postcourse assessments. Before the course, a 12-item multiple-choice precourse assessment questionnaire was given to all participants to complete in 20 min. The first page of the assessment tool was a survey, with data about participants' gender, specialty, and clinical experience; they were asked to rate their perceived knowledge of ADD on a scale of 1–10, with 1 indicating a lack of knowledge and 10 indicating ample knowledge. Evaluation of participants' perceived knowledge was conducted twice, both before and after the ADD course.

The 12-item multiple-choice questionnaire prepared by a senior respiratory therapy clinical instructor comprised three main categories. The first category included the characteristics and physical properties of therapeutic aerosol which included appropriate aerosol particle size and deposition sites of these particles. The second category included the operational principles of ADD systems with the proper operational instructions and certain features of ADD devices. The third category included the selection of the appropriate ADD device. The 12-item questionnaire was then revised and approved by two university professors who specialized

in respiratory therapy. The professors recommended no major changes in the content but had several suggestions for correcting grammar and structure.

No precourse assessment was permitted once the ADD course started. At the end of the course, participants were asked to complete the same assessment. None of the participants knew they would have an assessment after the course, and none knew it would be the same one. Participants had 20 min to complete the postcourse assessment. For analysis, on average, any score on the pre- or postcourse assessment of <40% was considered poor.

The ADD course comprised two oral presentations and three workshop sessions. Each presentation was 45 min long and the workshops were 40 min long. The first oral presentation on the science of aerosol delivery described the physical characteristics of aerosol and therapeutic indications for each treatment. It also discussed factors influencing aerosol particle deposition. The second presentation was on a variety of drug delivery devices. The advantages, disadvantages, and relevant factors affecting the performance of all nebulizers, pressurized metered-dose inhalers (pMDIs), and dry-powder inhalers (DPIs) were discussed. Workshops focused on patient education, drug delivery devices, and turbuhaler devices, using a demonstration and a hands-on approach.

Ethical approval from the Institutional Review Board was obtained and informed written consent taken from all participants in the study. Data were anonymized by removing any personal information for the purpose of confidentiality.

Participant demographics were calculated with descriptive statistics. Reliability analysis was applied to check the internal consistency of the tool (the 12-item multiple-choice questionnaire). A *t*-test was used to evaluate the significance between pre- and postcourse scores and between precourse perceived knowledge and postcourse knowledge scores. An independent *t*-test was used to determine the differences between males and females in the pre- and postcourse assessment. One-way ANOVA was used to evaluate the significance between the four groups: physicians, health educators, pharmacists, and RTs in pre- and postcourse scores. A correlation coefficient evaluated clinical experience and perceived knowledge against pre- and postassessment scores. *P* < 0.05 was considered statistically significant. All statistical analyses were conducted with SPSS version 22 (IBM, Armonk, NY, USA).

## Results

Of the 117 participants who attended the course, only 66 (56%) completed the pre- and postcourse assessments.

Participants for whom there was no demographic data or incomplete pre- and/or postcourse questionnaires were excluded. Participants representing 4 main specialties: pharmaceutical care, respiratory therapy, medicine, and health education. Figure 1 illustrates the distribution of specialties as a percentage of the number of participants. Most were pharmacists, but physicians and health educators were well-represented.

The clinical experience of the participants ranged from 0 to 30 years, with an average ( $\pm$ standard deviation) of  $7.6 \pm 7.3$  years. Clinical experience favored physicians in comparison to other groups. The precourse score for participants was  $3.2 \pm 1.9$  out of 12 on average, while the average postcourse score was  $6.97 \pm 2.7$ .

Table 1 presents the pre- and postcourse scores for each specialty, as well as the perceived knowledge of all groups before and after the course.

The Cronbach's alpha shows the value of more than 0.6 for all variables and overall. This indicates a high level of internal consistency. A *t*-test comparing the total pre- and postcourse scores indicates a statistically significant difference. On the other hand, the independent *t*-test shows no significant difference between males and females in pre- or postcourse scores. Yet, a comparison of pre- and postcourse perceived knowledge shows a statistically significant difference.

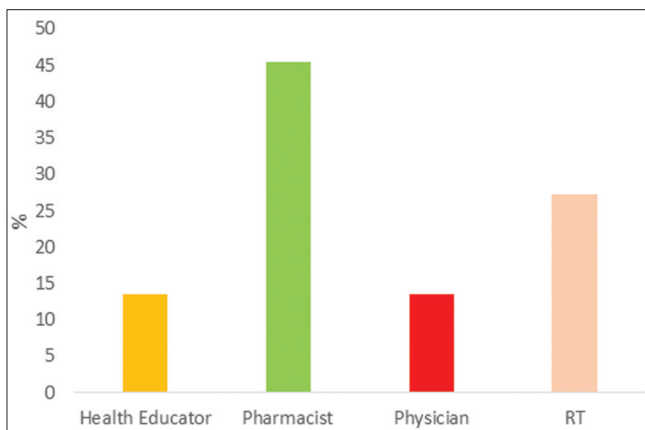


Figure 1: Distribution of participants by their specialty

Figure 2 illustrates the performance of all health-care providers in pre- and postcourse assessments on the 12-item, multiple-choice questions.

One-way ANOVA showed no statistically significant difference in the precourse scores of the pharmacists, RTs, health educators, and physicians ( $P = 0.216$ ), but the postcourse scores were significant ( $P = 0.000$ ).

Correlation between participants' clinical experience and precourse scores showed an insignificant relationship ( $P = 0.202$ ), but the correlation between the health-care providers' perceived knowledge scores and their precourse scores demonstrated a significant relationship ( $P = 0.001$ ). The correlation between postcourse scores and postcourse perceived knowledge scores showed a statistically significant correlation ( $P = 0.013$ ), as there was a statistically significant difference in pre- and postcourse perceived knowledge scores.

## Discussion

This study showed that health-care providers' knowledge of ADD was suboptimal, which was the same level as the four different specialties. More importantly, the knowledge of drug delivery science did not improve with cumulative clinical experience. The perception of health-care providers' competency in ADD was compatible with their actual performance, while a short educational course significantly improved their performance.

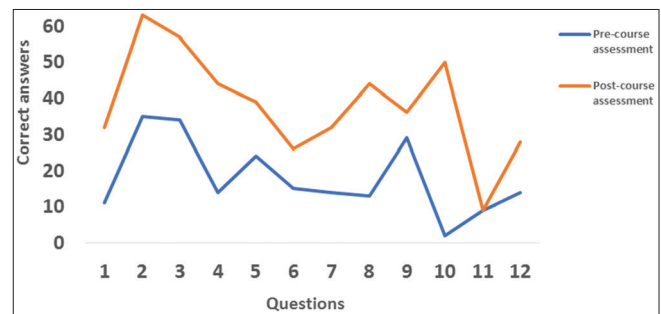


Figure 2: Performance of health-care providers in pre- and postcourse assessments

Table 1: Comparison of health-care providers' performance before and after the aerosol drug delivery course

	Pharmacists (n=30) Mean (SD)	RTs (n=18) Mean (SD)	Health educators (n=9) Mean (SD)	Physicians (n=9) Mean (SD)	Total Mean (SD)
Male/female	13/17	10/8	3/6	7/2	33/33
Clinical experience*	7.2 (5.7)	5.89 (6.8)	6.83 (6.2)	13.4 (11.6)	7.65 (7.3)
Precourse perceived knowledge score*	3.37 (2.0)	6.67 (2.3)	3.89 (2.6)	4.33 (3.5)	4.70 (2.7)
Postcourse perceived knowledge score*	4.4 (2.8)	7.28 (2.8)	5.22 (2.4)	6.22 (2.3)	5.55 (2.9)
Precourse score*	2.73 (1.5)	5.06 (1.4)	2.0 (1.6)	2.56 (1.9)	3.24 (1.9)
Postcourse score*	5.57 (2.7)	9.22 (1.5)	6.89 (2.5)	7.22 (2.2)	6.97 (2.7)

SD=Standard deviation, RTs=Respiratory therapists

It has been known since 1976 that inhalers were not being used correctly by patients.<sup>[13]</sup> Unfortunately, evidence shows that there is an increasing gap between the therapeutic effect of aerosolized drugs and the impact on patient quality of care.<sup>[3,14,15]</sup> Improper patient utilization of the available ADD systems is directly related to the lack of knowledge and skills. It is reasonable to attribute this improper use of the ADD systems to inadequate teaching and counseling of patients. The present data suggest a relationship between deficiencies in the knowledge and skill of the health-care providers and the teaching and counseling of patients. Those responsible for instructing and teaching patients how to use ADD systems have a significant deficiency in their own knowledge base. Four main categories of professionals, including physicians, pharmacists, RTs, and health educators, had very low scores. Consequently, patients still lack the essential skills to optimally utilize ADD systems.

There are many reports of evaluations of the knowledge and skills of health-care providers with ADD, but the majority focus on pMDIs and DPIs because of the complexity of instructions, compared to a simple nebulizer. In 1983, the knowledge of physicians on the use of bronchodilators administered via canister nebulizer was evaluated.<sup>[16]</sup> The authors concluded that the role of physicians as aerosol inhalation educators might be affected by their deficient knowledge. It was consequently reported that health-care providers lacked the essential knowledge and skills on the use of the available inhalers as well.<sup>[9]</sup> The authors found that RTs scored better than both physicians and nurses in theoretical knowledge and practical skills. They concluded that those responsible for instructing and teaching patients how to use the inhalers lacked "rudimentary skills." The present data are consistent with those findings. The performance of health-care providers has been disappointing, although the performance of the RTs seemed superior to other specialties. A multicenter study compared the performance of patients, nurses, and physicians and found that physicians were superior to nurses in the teaching of correct inhaler techniques. The authors concluded that the nurses displayed severe deficiencies in their knowledge and skills.<sup>[6]</sup> A large Spanish study sample including 1514 physicians had similar findings. Only 14% of physicians had adequate knowledge of ADD.<sup>[17]</sup> The present investigation did not aim to evaluate one specialty over others. Rather, its aim was to evaluate general knowledge of all health-care providers who teach patients about ADD. The results were consistent with previous reports. Inadequate knowledge of ADD has existed since 1976, which might explain patients' chronic incorrect use of inhalers.<sup>[18]</sup> Improper inhalers use has the potential to reduce the general clinical therapeutic efficacy of aerosolized medications.<sup>[19]</sup>

Given the deficiency in the knowledge about ADD skills, required for instructing patients, it is necessary to develop a simple educational package to help improve health-care providers' performance. Several educational sessions of almost 1 h each were able to improve the knowledge and skills of pediatric residents,<sup>[20]</sup> while a session led by a nurse educator (for postgraduate physicians) created significant improvement in these skills: this has been sustained for at least 8 months.<sup>[21]</sup> In addition, the improvement in health-care providers' knowledge and skills would translate to better patient outcomes.<sup>[22]</sup> Our data agree with previous reports, as simple educational sessions have significantly improved health-care providers' knowledge and resulted in similar improvement in confidence; their perceived knowledge of ADD correlates with their postassessment scores. This would also translate into improved teaching and counseling sessions for patients. Thus, it is recommended that health-care providers be regularly included in ADD educational sessions in continuous medical education. Health-care providers must undergo annual competency-based assessments for the benefit of both patients and providers.

One limitation of the present study was the small sample size and the moderate response rate. A larger sample size with a higher response rate would definitely improve the generalizability of the findings. Second is the finite level of health-care providers' skills. Only the theoretical knowledge was evaluated. Although psychomotor skills were discussed during the workshop sessions, they were not measured. However, the 12-item multiple-choice assessment partially examined these skills. The addition of a control group to the experimental group would add a great deal of strength to the study design. Nevertheless, the present data indicate the critical deficiency in knowledge and significant improvement achievable after a short educational course. Moreover, not all categories of health-care providers were represented. These four categories were chosen because of their possible greater exposure to ADD systems.

## Conclusion

The current ADD knowledge of health-care providers is alarming. Inadequate/incorrect patient use of the ADD systems seems to be related to inadequate knowledge. There is, therefore, an urgent need to integrate ADD educational sessions into the curricula. Moreover, an annual competency-based assessment would be most valuable for health-care providers responsible for teaching ADD systems to patients.

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## Conflicts of interest

There are no conflicts of interest.

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