

A Randomized Controlled Trial to Assess Adherence to Allergic Rhinitis Treatment following a Daily Short Message Service (SMS) via the Mobile Phone

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Key Words

Allergic rhinitis · Treatment · Adherence · Short message service

Abstract

Background: Short message service (SMS) has been suggested as an effective method to improve adherence to medical therapy in some chronic diseases. However, data on the effects of SMS interventions to allergic rhinitis (AR) treatment is limited at present. We aimed to assess whether a daily SMS reminder could improve AR patients' adherence to medication and treatment outcomes. **Methods:** Fifty outpatients with AR were randomized to either receive (SMS group) or not (control group) a daily SMS reminder on their cell phone to take intranasal corticosteroid treatment for 30 days. The primary study outcomes were self-reported adherence to medication, clinic attendance rate, and severity of AR symptoms using a visual analogue scale (VAS). Secondary outcomes were changes in nasal patency (minimum cross-sectional area, nasal cavity volume, and nasal airway resistance) and exhaled nasal nitric oxide levels. **Results:** Self-reported adherence to medication in the SMS group (15/25, 60%), was significantly higher than in the control group

(7/25, 28%, $p = 0.02$). Similarly, the clinic attendance rate in the SMS group (72%) was significantly higher than in the control group (40%, $p = 0.02$). Although the VAS score improved significantly from baseline in both study groups, the improvement in the SMS group was significantly greater than in the control group (4.38 ± 4.38 vs. 8.74 ± 6.54 , $p = 0.031$). No significant differences were observed between the two groups for the secondary outcomes. **Conclusions:** A daily SMS reminder may be an effective intervention to improve adherence to medication and treatment outcomes in AR patients.

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Introduction

Allergic rhinitis (AR) is a common chronic disease that has a significant negative impact on general health, productivity, and quality of life of the affected individuals [1, 2]. Despite great advances in guideline-based treatment algorithms, the level of AR control remains inade-

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quate for many patients [3, 4]. While up to 20% of AR patients do not respond satisfactorily to adequate medication treatment [5, 6], it is estimated that only about 50% of the patients seek medical care because they underestimate the disease or manage it with inadequate expectancy about the results of the treatment [5]. Thus, to achieve long-term control of AR, a variety of approaches are needed, including appropriate medication, patient education, and adequate adherence to medication [4, 7].

Adherence to medication, generally defined as the extent to which patients take medication as prescribed by their health care providers, is essential in achieving the full effectiveness and optimal outcomes of most treatment regimens [8]. Indeed, there is evidence that poor adherence or nonadherence to medication leads to worse treatment outcomes, higher hospitalization rates, and increased health care costs, particularly in the treatment of chronic diseases [9]. Studies have revealed that roughly 35% of nasal allergy patients were nonadherent at least some of the time during their treatment, and about 38% indicated they stopped taking their medications when they felt better [10]. While several factors, including variables related to the patient, the disease itself, the treatment, the physician-patient relationship, and the health-care system, account for nonadherence [9], evidence suggests that forgetfulness may be one of the main reasons for poor adherence in AR [7, 10, 11].

As modern technology has developed over the years, the use of the mobile phone short message service (SMS) has increased in the public health care system as a means of optimizing communication between health care providers and patients [12]. In particular, the SMS has been used in promoting adherence to treatment, reminding patients of appointments and acting as an educational tool in a broad range of chronic diseases, such as asthma [13, 14], diabetes [15], heart disease [16], and HIV [17–19]. However, to our knowledge, evidence for SMS interventions to improve AR treatment is limited at present. Given the importance of adherence to treatment in determining the effectiveness of the treatment, the aim of our study was to evaluate the impact of receiving a daily mobile phone SMS reminder on adherence to treatment and several treatment outcomes in patients with AR.

Patients and Methods

Study Population

A total of 50 patients (30 female and 20 male, 18–60 years of age) with AR were recruited in the trial. All patients had a history of physician-diagnosed AR and demonstrated the presence

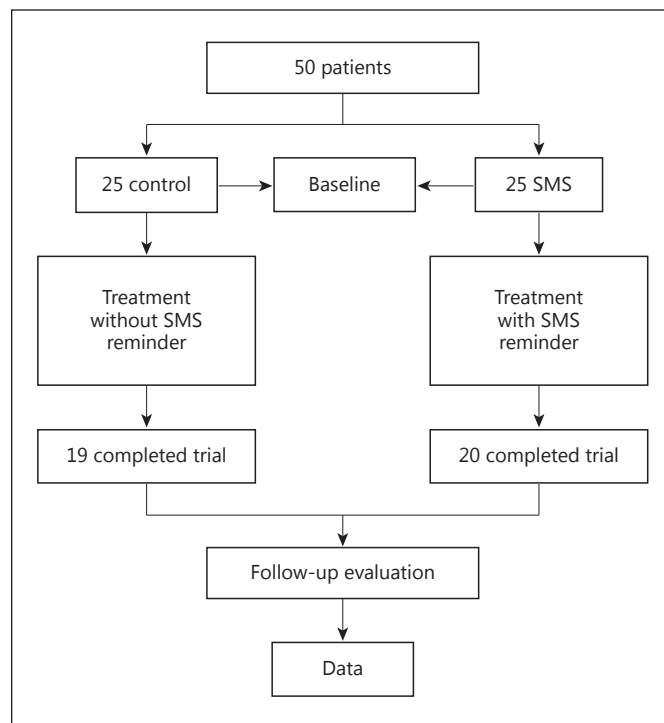


Fig. 1. Trial profile.

of persistent or intermittent symptoms of anterior rhinorrhea, continuous sneezing, nasal obstruction, and itching. All patients were additionally required to demonstrate a positive skin prick test to a panel of common allergens (Allergopharma, Reinbeck, Germany) and/or positive serum antigen-specific IgE, measured by the ImmunoCAP 100 system (Pharmacia, Uppsala, Sweden). The tested antigens included house dust mite (Der f and Der p), seasonal grass pollens (giant ragweed, mugwort, lamb's quarters, *Humulus*, and *Chenopodium album*), animal hair (especially dog and cat), molds (indoor and outdoor mustiness or floricultural environment), and cockroaches. Diagnosis of AR was further confirmed by the presence of symptoms induced by exposure to an allergen shown to produce a strong positive skin test response. All eligible patients were also required to own a mobile phone and be able to read and understand an SMS. Patients who had been treated with corticosteroids during the previous 2 weeks or who had experienced any respiratory infection within the previous 4 weeks (or any other lung disease) were excluded.

Study Design

This was a prospective controlled investigation conducted from December 2011 to March 2012. Eligible AR patients were randomized to either the SMS group (receiving a daily SMS to take their medication) or the control group (not receiving an SMS reminder) (fig. 1), according to a computer-generated random allocation sequence. A laboratory technician, who was not directly involved with the study, blinded the investigators to the study groups to which each patient was randomized and the pa-

tients were not made aware whether other patients would be messaged or not. All patients were provided with information regarding the mechanisms underlying the symptoms and treatment of AR with intranasal corticosteroids, and demonstrated the correct technique for using Rhinocort Aqua Nasal Spray (AstraZeneca, Shanghai, China). The patients were assessed for severity of symptoms, nasal patency [nasal airway resistance (NAR), minimum cross-sectional area (MCA), and total nasal cavity volume (NCV)], and exhaled nasal nitric oxide (nNO) levels. All patients were provided with intranasal budesonide (Rhinocort Aqua Nasal Spray) 256 µg per day, administered as two sprays per nostril once daily in the morning, for 30 days, and they were instructed to keep a record of adherence to medication over the course of treatment. The participants in the SMS group additionally received a daily SMS reminder, sent by the technician at 7 a.m. on Monday to Friday, and at 9 a.m. on Saturday and Sunday. The SMS reminder stated, 'Good morning! Budesonide aqueous nasal spray once daily is effective for allergic rhinitis. Please do not forget to take your medication.' All patients were asked to visit the clinic at the end of the 30-day treatment and were reassessed for severity of symptoms, nasal patency, and exhaled nNO. Data regarding adherence to medication was collected from each patient, and patients failing to attend the clinic were contacted to attend. Self-reported adherence to medication, change in severity of AR, and attendance rate were assessed as primary outcome measures, while changes in nasal patency and exhaled nNO levels were assessed as secondary outcome measures.

The study protocol was approved by the ethics committee of Beijing Institute of Otolaryngology, and all patients provided informed consent before participation in the study.

Adherence to Medication

Adherence to medication was assessed based on patients' self-reported adherence, which can simply and effectively measure adherence [8]. The patients were instructed to record the number of days they missed to take medication over the 30-day treatment period, and this was noted for each patient at the follow-up visit. Patients were classified as adherent if they reported that they had taken the medication for more than 95% of the study period [17]. The reasons for nonadherence to medication were also recorded at follow-up.

Attendance Rate

The attendance rate is the percentage of scheduled appointments attended on a scheduled date and time [20]. In our study, the patients were considered to have attended posttreatment visit if they returned within 1 day before or after the scheduled 30-day visit. Patients who failed to return at follow-up were contacted by phone and considered as lost to follow-up if they did not return despite being contacted.

Severity of AR

The severity of clinical symptoms of AR (rhinorrhea, sneezing, nasal itching, and nasal obstruction) was self-assessed by the patients at baseline and after 30 days of treatment using the visual analogue scale (VAS) [21]. The patients scored their individual symptoms on a VAS of 0–10 cm (0 = minimum severity and 10 = maximum severity), and the results were expressed as a total score for the four symptoms.

Table 1. Baseline characteristics of the randomized study groups

Characteristic	Control group (n = 19)	SMS group (n = 20)	p
Males	8 (50.0)	12 (60.0)	0.343
Age, years	31.0 ± 10.88	35.7 ± 8.87	0.151
Duration of AR, years	2.07 ± 1.09	1.8 ± 1.41	0.505
Education level			
Less than high school	8 (42.1)	11 (55.0)	0.421
More than high school	11 (57.9)	9 (45.0)	
Family income per month			
<5,000 (RMB)	7 (36.8)	9 (45.0)	0.605
≥5,000 (RMB)	12 (63.2)	11 (55.0)	
Health insurance (yes)	14 (73.7)	13 (65.0)	0.557
VAS	23.1 ± 8.4	26.6 ± 6.5	0.155
NAR, Pa·cm ⁻³ ·s ⁻¹	0.27 ± 0.22	0.21 ± 0.06	0.302
MCA, cm ²	0.85 ± 0.65	1.05 ± 0.33	0.623
NCV, cm ³	8.41 ± 1.17	9.44 ± 2.58	0.258
nNO, ppb	208.9 ± 145.6	187.1 ± 76.3	0.559

Data are means ± SD values or n (%).

Nasal Patency

EcoVision acoustic rhinometry (Hood Labs, Pembroke, Mass., USA) was performed to measure the MCA and total NCV in the distance of 0–5 cm in the nostril. An ATMO 300 Rhinomanometer (ATMOS Medizin Technik GmbH & Co., Feldkirch, Germany) was used to measure unilateral NAR at 75 Pa point (R₇₅) by anterior active rhinomanometry. Total NAR, R_{75T}, was calculated using the formula: $R_t = R_l \cdot R_r / R_l + R_r$. All measurements were performed in a quiet examination room at 24 ± 1 °C, and with humidity of 70 ± 1% [22].

Exhaled nNO

A nitric oxide analyzer (Niox; Aereocrine, Solna, Sweden) was used to measure exhaled nNO. Briefly, NO-free air was aspirated through the nasal cavity at a flow rate of 50 ml/s. The patient exhaled against resistance resulting in an intraoral pressure of approximately 10 cm H₂O to close the velum and prevent mixture of oral and nasal gas. Nasal gas from this circuit was continuously routed in part directly into the analyzer for determination of nNO, and the level of nNO was calculated from a plateau lasting for at least 3 s. The procedure was repeated three times and a mean concentration of nNO (ppb) was calculated for the three readings.

Statistical Analysis

All statistical analyses were performed using the SPSS version 11.5 (SPSS Inc., Chicago, Ill., USA) statistical package. Differences between the groups were assessed by independent samples t tests and Mann-Whitney tests for normally and not normally distributed data, respectively. Paired samples t tests and Wilcoxon signed-rank tests were performed to compare baseline and posttreatment data within each group, and categorical data were compared using χ^2 and Fisher's exact tests. $p < 0.05$ was considered to be statistically significant.

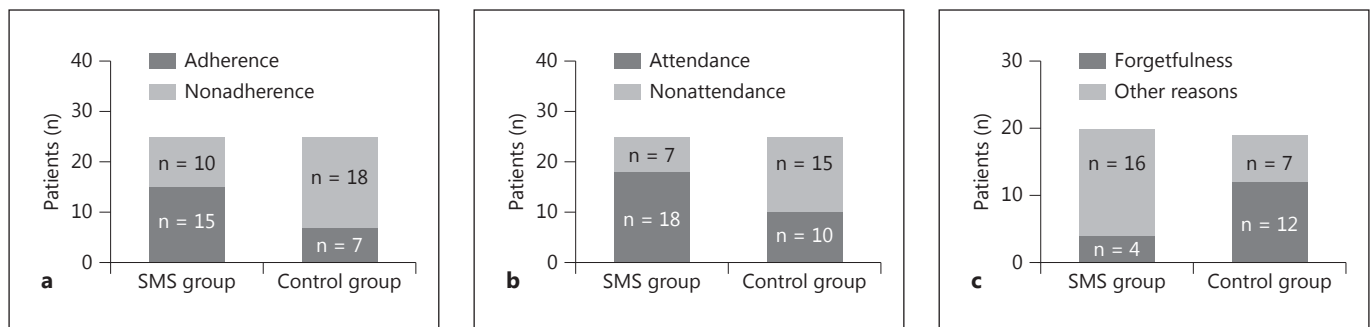


Fig. 2. Primary outcomes in the two randomization groups: **a** self-reported adherence rate (OR = 3.85, 95% CI: 1.18–12.61, $p = 0.02$), **b** attendance rate (OR = 3.85, 95% CI: 1.18–12.61, $p = 0.02$), and **c** typical reasons for non-adherence (OR = 6.85, 95% CI: 1.63–28.91, $p = 0.009$).

Table 2. Reasons for medication nonadherence

	Control group (n = 19)	SMS group (n = 20)
Forgot to take the medication	12 (63.2%)	4 (20%)
Fear of side effects	6 (31.5%)	5 (25%)
Belief that the medication was no longer needed	7 (36.8%)	5 (25%)
Belief that the medication was not effective	2 (10.5%)	1 (5%)
Inconvenience	1 (5.26%)	1 (5%)
Other reasons	2 (10.5%)	1 (5%)

Results

A total of 39 subjects completed the study ($n = 20$ for the SMS group and $n = 19$ for the control group), of whom 28 patients ($n = 18$ in the SMS group and $n = 10$ in the control group) returned for the scheduled follow-up visit on their own and 11 ($n = 2$ in the SMS group and $n = 9$ in the control group,) returned after being contacted. Overall, 2 patients dropped out of the study due to pregnancy, 3 due to moving to another place, and 6 due to poor adherence. Although there were more females than males, the two study groups were not significantly different concerning demographic and clinical characteristics (table 1).

Primary Outcomes

At the end of the treatment period, significantly more patients in the SMS intervention group (15/25, 60%) reported >95% adherence to medication than patients in the control group (7/25, 28%; OR = 3.85, 95% CI: 1.18–12.61, $p = 0.02$; fig. 2a). Similarly, the attendance rate at the fol-

low-up visit was also significantly higher in the SMS group (18/25, 72%) than that in the control group (10/25, 40%; OR = 3.85, 95%CI: 1.18–12.61, $p = 0.02$; fig. 2b).

At the end of the 30-day treatment period, the VAS score improved significantly in both the control group (23.2 ± 8.4 vs. 8.74 ± 6.54 , $p = 0.000$) and the SMS group (26.6 ± 6.5 vs. 4.38 ± 4.38 , $p = 0.000$) from baseline. Moreover, the mean VAS score for the SMS group (4.38 ± 4.38) at the end of treatment was significantly lower than the mean VAS score for the control group (8.74 ± 6.54 , $p = 0.031$; fig. 3a). During follow-up, 19 (95.0%) of the 20 patients in the SMS group reported they would like the SMS program to continue.

Assessment of the typical reasons for nonadherence to medications was analyzed in the subjects who completed the follow-up visit (table 2). The top three reasons cited by patients for nonadherence to medication in our study were (1) ‘forgot to take the medication’, (2) ‘fear of side effects’, and (3) the ‘belief that the medication was no longer needed’. Overall, 63.2% (12/19) of the patients in the control group reported ‘forgot to take the medication’ as the main reason for nonadherence to medication, compared to 20% (4/20) of the patients in the SMS group (OR = 6.85, 95% CI: 1.62–28.91, $p = 0.009$; fig. 2c).

Secondary Outcomes

By the end of treatment, NAR was improved significantly in both the control group (0.27 ± 0.22 vs. 0.19 ± 0.10 , $p = 0.015$) and the SMS group (0.21 ± 0.06 vs. 0.17 ± 0.07 , $p = 0.033$) compared to baseline (fig. 3b); however, the improvement in NAR was not significantly different between the control and SMS groups. Although MCA, NCV, and nNO were also improved in both groups by the end of treatment, these were not significantly different compared to baseline (fig. 3c–e).

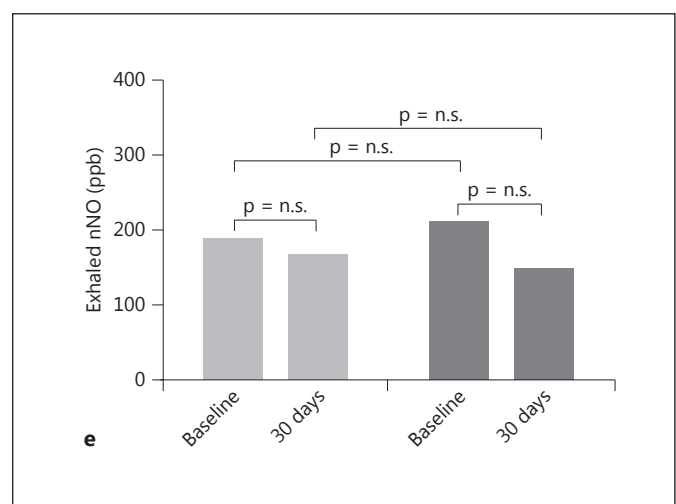
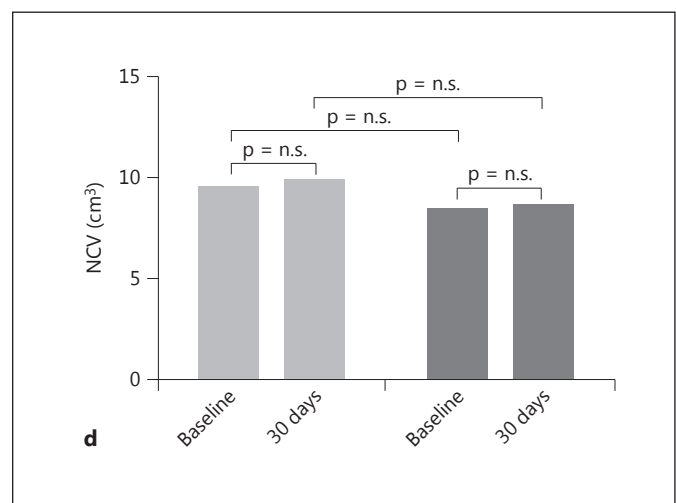
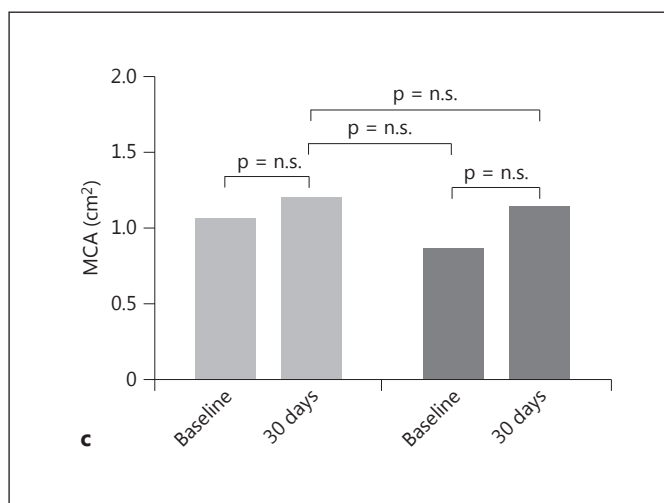
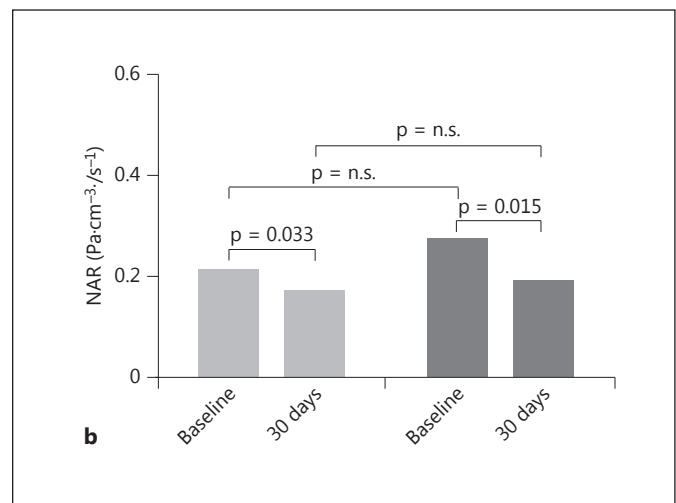
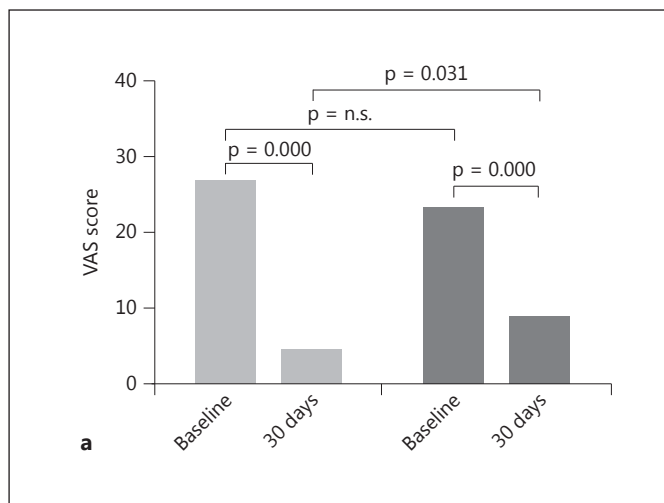


Fig. 3. Effect of treatment with (light gray bars) or without SMS reminders (dark gray bars) on changes in VAS score (a), NAR (b), MCA (c), total NCV (d), and nNO (e).

Discussion

The findings of this study demonstrated that a daily reminder by SMS significantly improved the self-reported adherence to medication in patients with AR and additionally improved the clinic attendance rate at the end of the treatment period compared to control patients who did not receive such reminders by SMS. Furthermore, patients receiving the SMS reminder reported significantly lower severity of their symptoms by the end of the treatment period compared to control patients, with the vast majority expressing high levels of satisfaction and wanting to continue receiving reminders even after the study completed.

In general, AR is a chronic inflammatory disease and accumulating evidence has revealed that a minimal level of persistent inflammation may persist in the nasal mucosa, even when symptoms are absent in AR patients [23]. This suggests that therapeutic strategies for AR should be revised and aimed at reducing not only the symptoms, but also the underlying persistent airway inflammation. Thus, it is likely that continuous treatment throughout the entire period of allergen exposure, rather than just on symptomatic days, is critical for adequate clinical control of AR [24]. Furthermore, improvement of the adherence to treatment in AR is essential to achieve better disease control [7]. This is particularly important in AR patients, whose perception of 'normal' disease control is not always the same as therapeutically defined disease control, which contributes to poor adherence to treatment [6].

Nonintentional and intentional nonadherence often coexist in the same individual, and guidelines advise a combination of various interventions to achieve and sustain sufficient adherence [7, 8]. In our study, all patients received a thorough briefing and education on the disease, including knowledge of the mechanisms underlying disease, information on the necessity of intranasal corticosteroid treatment, the side effects of intranasal corticosteroids, and correct inhaler technique. Despite this thorough briefing, we found that this initial intervention did not appear to be sufficient in the control group, suggesting a need for a broader approach in improving adherence to treatment. Indeed, our finding of significantly greater rates for both adherence to medication and attendance in the SMS group compared to the control group suggests that additional intervention in the form of daily SMS reminders result in a pronounced improvement in adherence to treatment. Our findings are consistent with those studies evaluating SMS reminders for clinic visits and adherence to

treatment for patients with other medical conditions [18, 25–27]. Based on these findings, it is clear that a daily SMS reminder for at least a month is an appropriate strategy to enhance adherence to therapy for patients with a chronic disease because it is likely to create a higher awareness of disease control and treatment in a patient's daily routine, leading to improved patient behavior and attitude towards adherence and compliance with therapy [27].

Our findings for the main reasons of nonadherence to medication in the present study, which included 'forgot to take the medication', 'fear of side effects', and 'belief that the medication was no longer needed', were in accordance with the findings of Wagner et al. [10]. These authors demonstrated that of 5,284 patients with nasal allergy treated with a prescription drug, about 38% indicated they stopped taking their medications when they felt better, and 39% indicated they forgot to take their medication. We found that more than 60% patients in the control group reported 'forgot to take the medication' as the main reason for nonadherence to medication, which was significantly higher than the 20% of patients in the SMS group reporting this as the main reason for nonadherence to medication. Therefore, it is tempting to speculate that the improvement of adherence to medication in the SMS group was mainly related to a decrease in forgetfulness to take the medication as required.

Despite the VAS score improving significantly from baseline in both study groups, the improvement in the SMS group was more pronounced than in the control group. This suggested that improved adherence to treatment was associated with the improvement of the VAS score in the SMS group. Interestingly, although we observed overall improvements in the secondary outcomes compared with baseline in both groups, only NAR showed statistically significant improvement. Moreover, there was no significant difference between the SMS group and control group for any of the secondary outcomes, suggesting that the effects of a daily SMS reminder on subjective symptoms appear to be somewhat larger than the effects on objective clinical outcomes. To some extent, this was to be expected, as modest amounts of nonadherence may still leave patients within a 'well-treated' therapeutic window [27]. Additionally, some studies have suggested there may be no correlation between the VAS estimates and objective parameters such as NAR, MCA, NCV, and nNO [28–30]. Nevertheless, about 95.0% of the patients in the SMS group indicated that they would like the SMS program to continue at the end of study, suggesting that a daily SMS reminder was related with the patients' perception of positive therapeutic effects.

Despite the positive findings, the present study is limited in some aspects. Firstly, some patients indicated that the timing for receiving the SMS at 7 a.m. was unsuitable as it disrupted daily routines. This suggested that for similar studies in the future, the SMS reminders should be sent out according to the needs of individual patients. Secondly, SMS reminders in the present study were sent daily to patients by one-way communication. However, two-way interactive communication may be more helpful to improve the patients' adherence and interest, as has been suggested by others [31, 32]. Thirdly, the study had a limited sample size and a short follow-up period. Future studies with a much larger study cohort and longer follow-up are required to obtain unequivocal conclusions and assessment of cost-benefit profiles of such SMS reminders for individual patients and society alike, particularly as AR is not only detrimental to health, but also has societal costs [1].

In conclusion, the short-term results of our study suggest that a daily SMS reminder may be an effective intervention to improve adherence to medication and treatment outcomes in AR patients.

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Disclosure Statement

All authors have no competing financial interest in relation to this work.

References

- Greiner AN, Hellings PW, Rotiroti G, Scadding GK: Allergic rhinitis. *Lancet* 2011;378: 2112–2122.
- Bousquet PJ, Demoly P, Devillier P, Mesbah K, Bousquet J: Impact of allergic rhinitis symptoms on quality of life in primary care. *Int Arch Allergy Immunol* 2013;160:393–400.
- Valovirta E, Myrseth SE, Palkonen S: The voice of the patients: allergic rhinitis is not a trivial disease. *Curr Opin Allergy Clin Immunol* 2008;8:1–9.
- Hellings PW, Fokkens WJ, Akdis C, Bachert C, Cingi C, Dietz de Loos D, Gevaert P, Hox V, Kalogjera L, Lund V, Mullol J, Papadopoulos NG, Passalacqua G, Rondon C, Scadding G, Timmermans M, Toskala E, Zhang N, Bousquet J: Uncontrolled allergic rhinitis and chronic rhinosinusitis: where do we stand today? *Allergy* 2013;68:1–7.
- Bousquet PJ, Bachert C, Canonica GW, Casale TB, Mullol J, Klossek JM, Zuberbier T, Bousquet J: Uncontrolled allergic rhinitis during treatment and its impact on quality of life: a cluster randomized trial. *J Allergy Clin Immunol* 2010;126:666–668.e1–5.
- WHO Collaborating Center for Asthma and Rhinitis, Bousquet J, Anto JM, Demoly P, Schunemann HJ, Togias A, Akdis M, et al: Severe chronic allergic (and related) diseases: a uniform approach – a MeDALL-GA2LEN-ARIA position paper. *Int Arch Allergy Immunol* 2012;158:216–231.
- Bukstein D, Luskin AT, Farrar JR: The reality of adherence to rhinitis treatment: identifying and overcoming the barriers. *Allergy Asthma Proc* 2011;32:265–271.
- Osterberg L, Blaschke T: Adherence to medication. *N Engl J Med* 2005;353:487–497.
- Cutler DM, Everett W: Thinking outside the pillbox – medication adherence as a priority for health care reform. *N Engl J Med* 2010; 362:1553–1555.
- Wagner S, Luskin A, Bukstein D, Kaliner M, et al: Self-reported medication adherence in patients with nasal allergies: the disconnect between clinical practice and patient behaviors. *J Allergy Clin Immunol* 2009;123 (suppl):s46.
- Ciprandi G: Clinical utility and patient adherence with ebastine for allergic rhinitis. *Patient Prefer Adherence* 2010;4:389–395.
- Szilagyi PG, Adams WG: Text messaging: a new tool for improving preventive services. *JAMA* 2012;307:1748–1749.
- Petrie KJ, Perry K, Broadbent E, Weinman J: A text message programme designed to modify patients' illness and treatment beliefs improves self-reported adherence to asthma preventer medication. *Br J Health Psychol* 2012;17:74–84.
- Lv Y, Zhao H, Liang Z, Dong H, Liu L, Zhang D, Cai S: A mobile phone short message service improves perceived control of asthma: a randomized controlled trial. *Telemed J E Health* 2012;18:420–426.
- Hussein WI, Hasan K, Jaradat AA: Effectiveness of mobile phone short message service on diabetes mellitus management; the SMS-DM study. *Diabetes Res Clin Pract* 2011; 94:e24–e26.
- Seto E, Leonard KJ, Cafazzo JA, Barnsley J, Masino C, Ross HJ: Mobile phone-based telemonitoring for heart failure management: a randomized controlled trial. *J Med Internet Res* 2012;14:e31.
- Lester RT, Ritvo P, Mills EJ, Kariri A, Karanja S, Chung MH, Jack W, Habyarimana J, Sadatsafavi M, Najafzadeh M, Marra CA, Estambale B, Ngugi E, Ball TB, Thabane L, Gelmon LJ, Kimani J, Ackers M, Plummer FA: Effects of a mobile phone short message service on antiretroviral treatment adherence in Kenya (WelTel Kenya1): a randomised trial. *Lancet* 2010;376:1838–1845.
- Dowshen N, Kuhns LM, Johnson A, Holoyda BJ, Garofalo R: Improving adherence to antiretroviral therapy for youth living with HIV/AIDS: a pilot study using personalized, interactive, daily text message reminders. *J Med Internet Res* 2012;14:e51.
- Chib A, Wilkin H, Ling LX, Hoefman B, Van Biejma H: You have an important message! Evaluating the effectiveness of a text message HIV/AIDS campaign in northwest Uganda. *J Health Commun* 2012;17(suppl 1):146–157.
- Hasvold PE, Wootton R: Use of telephone and SMS reminders to improve attendance at hospital appointments: a systematic review. *J Telemed Telecare* 2011;17:358–364.
- Bousquet PJ, Combescure C, Klossek JM, Daures JP, Bousquet J: Change in visual analog scale score in a pragmatic randomized cluster trial of allergic rhinitis. *J Allergy Clin Immunol* 2009;123:1349–1354.

- 22 Clement PA, Gordts F, Standardisation Committee on Objective Assessment of the Nasal Airway, IRS, and ERS: Consensus report on acoustic rhinometry and rhinomanometry. *Rhinology* 2005;43:169–179.
- 23 Storms WW: Minimal persistent inflammation, an emerging concept in the nature and treatment of allergic rhinitis: the possible role of leukotrienes. *Ann Allergy Asthma Immunol* 2003;91:131–140.
- 24 Canonica GW, Compalati E: Minimal persistent inflammation in allergic rhinitis: Implications for current treatment strategies. *Clin Exp Immunol* 2009;158:260–271.
- 25 Prasad S, Anand R: Use of mobile telephone short message service as a reminder: the effect on patient attendance. *Int Dent J* 2012;62:21–26.
- 26 Foreman KF, Stockl KM, Le LB, Fisk E, Shah SM, Lew HC, Solow BK, Curtis BS: Impact of a text messaging pilot program on patient medication adherence. *Clin Ther* 2012;34:1084–1091.
- 27 Strandbygaard U, Thomsen SF, Backer V: A daily SMS reminder increases adherence to asthma treatment: a three-month follow-up study. *Respir Med* 2010;104:166–171.
- 28 Haavisto LE, Vahlberg TJ, Sipilä JI: Correlation between acoustic rhinometry and visual analogue scale in children with no nasal symptoms: a prospective cohort study. *Clin Otolaryngol* 2011;36:129–133.
- 29 Thulesius HL, Cervin A, Jessen M: Can we always trust rhinomanometry? *Rhinology* 2011;49:46–52.
- 30 Phillips PS, Sacks R, Marcellis GN, Cohen NA, Harvey RJ: Nasal nitric oxide and sinonasal disease: a systematic review of published evidence. *Otolaryngol Head Neck Surg* 2011;144:159–169.
- 31 Odeny TA, Bailey RC, Bukusi EA, Simoni JM, Tapia KA, Yuhás K, Holmes KK, McClelland RS: Text messaging to improve attendance at post-operative clinic visits after adult male circumcision for HIV prevention: a randomized controlled trial. *PloS One* 2012;7:e43832.
- 32 Mbuagbaw L, Thabane L, Ongolo-Zogo P, Lester RT, Mills EJ, Smieja M, Dolovich L, Kouanfack C: The Cameroon Mobile Phone SMS (CAMPS) trial: a randomized trial of text messaging versus usual care for adherence to antiretroviral therapy. *PloS One* 2012;7:e46909.