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Bilastine safety in drivers who need antihistamines: new evidence from high-speed simulator driving test on allergic patients

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Abstract. – OBJECTIVE: Bilastine is a highly selective, non-sedating antihistamine, indicated for the symptomatic treatment of allergic rhinoconjunctivitis and urticaria. Available data suggest that bilastine interferes neither with driving ability nor with flying-related performance. However, no data are available on the effect of bilastine on the driving ability in extreme conditions. Here we analyzed the effect of 7 days treatment with 20 mg bilastine in patients with allergic rhinitis and/or chronic urticaria, on psychophysical performance assessed by the Formula One (F1) high-speed simulator-driving test.

PATIENTS AND METHODS: This study is a phase IV, interventional, prospective, mono-centric, single arm, open-label trial. Eighteen outpatients affected by allergic rhinitis and/or chronic urticaria, able to perform a preliminary driving test on F1 simulator were considered (V-1). First, the patients had a screening visit to assess their eligibility (V0). Visit 1 (V1), at the end of placebo before bilastine treatment and Visit 2 (V2), at the end of bilastine treatment. The primary variable parameter was the ability to maintain the vehicle in a central position at different speeds (50, 150, and 250 km/h).

RESULTS: Bilastine had a good safety profile and was well tolerated in terms of adverse events, laboratory parameters and vital signs. Bilastine did not have any negative effect on the ability to maintain the requested path, a constant speed as well as on attention and reactivity levels, even in extreme driving conditions.

CONCLUSIONS: This study is the first done in patients with allergic rhinitis and/or chronic urticaria using a F1-high speed simulator-driving test evaluating subjects' performance under bilastine treatment.

Key Words
Bilastine, Antihistamine, Driving, Allergic rhinitis, Urticaria, High speed, F1 simulator.

Abbreviations
F1 = Formula One; AR = allergic rhinitis; CU = chronic urticaria; CNS = central nervous system; BBB = blood-brain barrier; SDLP = Standard Deviation of Lateral Position; CIs = confidence intervals; TEAE = treatment-emergent adverse event.

Introduction

Antihistamines are widely used for the treatment of allergic rhinitis (AR) and/or urticaria[1-4]. AR is a heterogeneous disorder characterized by one or more symptoms including sneezing, itching, nasal congestion and rhinorrhea as well as non-nasal symptoms such as tearing which can affect driving performance. Epidemiological studies have indicated that the prevalence of AR has increased progressively over the last three decades[5] and presently affects 23-30% of the population in Europe[6]. It is currently estimated that AR has a worldwide prevalence up to 40%, with significant differences in urban and rural environments[7]. Chronic urticaria (CU), defined by the presence of urticaria (hives with or without angioedema) on most days of the week, for a period ≥ of six weeks, affects up to 1 percent of the general adult population in the United States, with similar prevalence in other countries[8-10]. The clinical admissions for urticaria have increased by 100% since 1990[11]. The disease is potentially very disabling for the patients; it is estimated a yearly loss of 5,000 € related to working and scholastic performance[12]. Despite the effectiveness of antihistamines in the treatment of AR and CU, the systemic blocking of H1-receptors, including the central nervous system (CNS) ones, is associated with important side effects.

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H1-antihistamines are functionally classified into two groups. The sedating ones readily cross the blood-brain barrier (BBB) and occupy H1-receptors located on postsynaptic membranes of histaminergic neurons throughout the CNS[13]. For this reason, sedating antihistamine have a potentially undesired impact on psychophysical performance. Although this effect *per se* does not represent a serious health concern, it can lead to diminished concentration, for example, while driving a car or operating machinery and interfere with activities highly depending on effective psychophysical functions with an increased risk of occupational injuries. Also, patients taking sedating antihistamines are likely to have reduced treatment compliance because of excessive fatigue and malaise[14].

These potential negative effects have been mainly overcome by non-sedating antihistamines which basically do not cross the BBB[13]. Their use has reduced the sedative side effects, due to very limited diffusion through the BBB[13] and as a result of the P-glycoprotein-mediated efflux of the drugs from the CNS[15]. Moreover, non-sedating antihistamines have less lipid solubility than sedating agents, preventing cellular membranes diffusion[16].

Bilastine is a highly selective, non-sedating second-generation antihistamine, indicated for the symptomatic treatment of allergic rhinoconjunctivitis (seasonal and perennial) and urticaria and generally well-tolerated[17-19].

In clinical studies, bilastine has shown to be non-sedating at therapeutic doses; furthermore, bilastine does not potentiate the performance impairment associated with alcohol consumption[20] or with treatment with the benzodiazepine lorazepam[21]. Available data suggest that bilastine at the doses of 20 and 40 mg does not impair driving ability[22,23] nor psychomotor performance[24]. The flying-related performance, assessed in hypobaric conditions simulating an altitude of roughly 8000 feet in healthy volunteers gave similar results[25]. On the other hand, no data are available on the effects on driving performance in extreme conditions in patients treated with bilastine.

The present study was designed to determine the effects on patients' attention and reactivity levels of seven consecutive day treatment with bilastine 20 mg in subjects with allergic rhinitis and/or urticaria, both tested with the Formula One (F1) high- speed simulator-driving test.

Patients and Methods

Study Design

This was a phase IV, interventional, prospective, mono-centric, single arm, open-label trial. Eligible patients underwent 3 ambulatory visits at the hospital site and 3 driving tests at the simulator center (Figure 1).

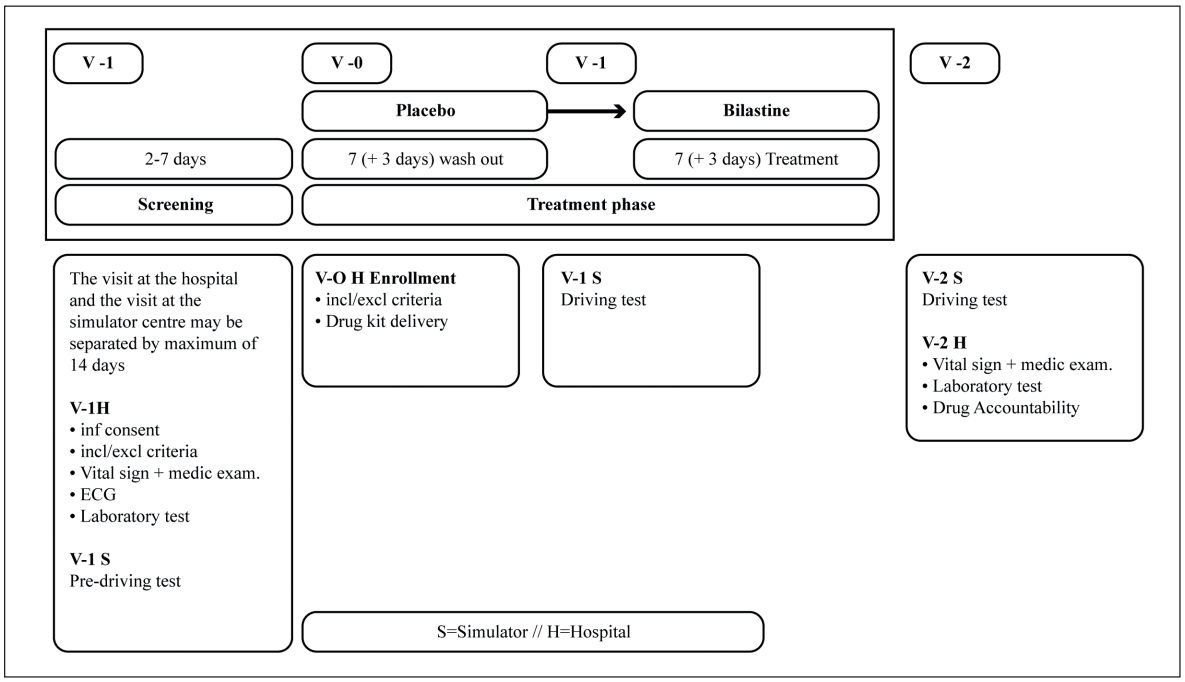

Figure 1. Study design diagram.

A screening visit (Visit 1) was performed at both the hospital and the simulator center, during which patients were evaluated to assess their eligibility in taking part in the study. The screening visit driving test was intended not only to assess the ability of the patients to drive without experiencing signs or symptoms of intolerance (e.g., nausea, vomiting or dizziness, etc.), but also to let them familiarize with the driving simulator. Patients satisfying all inclusion and exclusion criteria attended an enrolling visit (Visit 0) at the hospital within 2-7 days and started a 7 (+3)-day washout period with placebo. Then patients repeated the F1-high speed simulator test at Visit 1, and afterwards initiated the 7 (+3)-day treatment period with bilastine 20 mg. At the end of the bilastine-treatment period patients performed the final visit (Visit 2) at the simulator center first, where they performed the final F1-high speed simulator test, and then at the hospital to assess clinical and laboratory examination and drug accountability. The overall study duration for each patient lasted approximately 6 weeks. The study was conducted in compliance with the Declaration of Helsinki, current Good Clinical Practices and applicable European and local regulatory requirements.

Patients

Nineteen outpatients affected by AR and/or CU, who needed antihistamine therapy entered the study. Main inclusion criteria were: age between 21 and 55 years; a body mass index (BMI) between 19 and 30 kg/m^2; ability to give an informed consent; a negative pregnancy test and contraception from at least 30 days before the study and up to the end of the study; a valid driving license from more than 3 years; a driving experience of at least 5000 km per year. Exclusion criteria were the presence of autoimmune urticaria, known allergic reactions to antihistamines, patients in treatment with diuretics, corticosteroids (other than medication applied topically), central nervous system drugs, or medication with sedative effects (sleep-inducing or antidepressant, sedative medications), other drugs that could interact with bilastine. The study was approved by the Ethical Local Committee and was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments. All the patients provided written informed consent.

F1-Simulator Driving Test

The F1-simulator driving test lasted approximately 30 minutes; the maximum speed reached was 250 km/h. The test was made up of 3 loops: the first one was used for the familiarization of the patient with the test procedures, the second one was a linear track with no perturbations, and the third one assessed the patient's reaction to pre-defined stimulation and obstacles. Different speeds were used, to provide different response parameters of the vehicle thus providing conditions of different difficulties in maintaining the constant speed and path. There were no changes in direction; the entire test had to be done while keeping the car in a straight line or an extremely wide curvature.

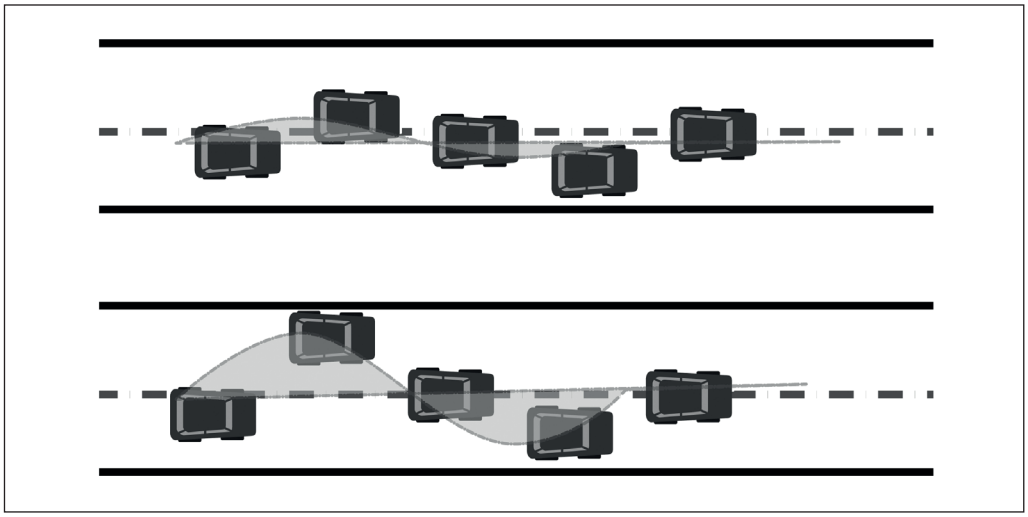

Figure 2. SDLP scheme. In the driving test, the principal parameter measured is the ability to drive with a steady lane position, or the standard deviation from the lateral position.

The following parameters were assessed: 1) Standard Deviation of Lateral Position – SDLP (mainly assessing attention capacities). This was a measure of weaving and quality in keeping the requested path (Figure 2); 2) Maintaining Constant Speed (mainly assessing attention capacities). Different speeds were maintained as requested by the simulator. Patients were asked to drive for 30 seconds each at 50 km/h, 150 tkm/h, and 250 km/h, for a covered distance of 400 m, 1250 m, and 2000 m, respectively; 3) Time to reaction (assessing the alert grade-attention level and reactivity capacities). During the test, at different times, the patient was requested (by led enlighten on the dashboard) to execute actions on the steering wheel. At the appearance of the signal, patients had to press a button. Two buttons were used, one on the left and one on the right (button A and button B), and patients were requested to press the right button while maintaining the correct vehicle position and the constant speed. The delay between the appearance of the signal and the time of button pressing was registered.

Evaluation of Efficacy

The primary endpoint of the study was the SDLP. The vehicle position was analyzed, and a synthesis value, representing the mean deviation value from a central position was obtained. The F1-simulator recorded the vehicle position at pre-specified time intervals during the performance (sample recording every 0.1 seconds). Data were automatically analyzed, and the mean square deviation from central position summarized the stable parameter of quality in keeping the requested path.

The secondary endpoints of the study were: 1) maintenance of constant speed. Changes from requested speed were recorded and reported. A summary value was provided to resume the mean deviation from the requested speed; 2) time to react. Delay in handling on the steering wheel at request (when led enlighten on the dashboard) gives information on the reactivity level during the test. The mean delay value summarizes the subjects' alert grade during the test.

All the tests were performed at different speeds (50, 150, and 250 km/h) and all the obtained data were used to evaluate the differences of performance pre- (V1) and post- (V2) continuous treatment of 7 (+3) days with bilastine 20 mg for every efficacy endpoints.

Safety Evaluation

The safety endpoints of the study were adverse events, safety laboratory parameters (routine hematology, blood chemistry screen, and urinalysis), vital signs (weight, blood pressure, heart rate, and respiratory rate) and physical examination.

Statistical Analysis

Data were analyzed using the SAS System version 9.4. Statistical analysis was performed by SPARC Consulting, Milan, Italy on behalf of LB Research, Cantù, Italy. Continuous variables were summarized by descriptive statistics (number of cases, mean, standard deviation, and median, minimum, maximum, first and third quartile). Categorical variables were summarized using counts of patients and percentages. All statistical tests were conducted at the α level of 0.05, and confidence intervals (CIs) were calculated at the confidence level of 95%.

Results

Study Population

Nineteen (19) patients were enrolled. One patient was excluded after the screening visit to evaluate the ability to complete the test without discomfort (V-1), as this patient did not tolerate to use the simulator. Eighteen patients started the treatment period and regularly completed the study. Characteristics of the 18 patients enrolled are reported in Table I. Of them, 12 (66.7%) had allergic rhinitis and 6 (33.3%) had urticaria. Among patients with allergic rhinitis, 10 (83.3%) had perennial rhinitis, and 2 (16.7%) had seasonal rhinitis.

Efficacy Results

Primary Endpoint

Standard deviation of lateral position. SDLP results are reported in Table II. The mean square deviation of the movement away from central position significantly decreased from day 8 to day 15. The mean (± SD) change from day 8 to day 15 was -0.041 ± 0.047 m (95% CI: -0.064

Table I. Demographic characteristics of patients.

Gender	Male No. (%)	10 (55.6%)
	Female No. (%)	8 (44.4%)
Age, years; mean ± SD (range)		38.4 ± 7.3 (25-49)
Weight, kg; mean ± SD (range)		69.1 ± 12.9 (49-95)
Height, cm; mean ± SD (range)		169.1 ± 9.6 (156-185)
BMI, kg/m^2; mean ± SD (range)		24.0 ± 2.7 (19.4-30.0)

No. = number of patients

Table II. Results of SDLP (ITT/PP population).

	Overall	50 km/h	150 km/h	250 km/h
Day 8, m (mean ± SD)	0.15 ± 0.07	0.07 ± 0.03	0.10 ± 0.05	0.14 ± 0.08
Day 15, m (mean ± SD)	0.11 ± 0.04	0.06 ± 0.03	0.07 ± 0.03	0.11 ± 0.04
Change day 15-day 8, m (mean ± SD)	-0.041 ± 0.047	-0.014 ± 0.028	-0.028 ± 0.055	-0.031 ± 0.058
95% CI of mean change, m[1]	-0.064 to -0.017	-0.027 to 0.000	-0.056 to -0.001	-0.060 to -0.002
p-value t-test	0.0020	0.0550	0.0424	0.0388
p-value Wilcoxon Signed Rank test	0.001	0.048	0.048	0.043

Values are the mean square deviation of the deviations from central position. [1] = *t*-test

to -0.017; $p = 0.0020$ in the paired *t*-test and $p = 0.001$ in the Wilcoxon Signed Rank test), thus indicating no negative effect of bilastine on this parameter.

The mean (± SD) change of SDLP at the speed of 50 km/h from day 8 to day 15 calculated by *t*-test was -0.014 ± 0.028 m (95% CI: -0.027 to 0.000). The change was not statistically significant in the paired t-test ($p = 0.0550$) and was statistically significant in the Wilcoxon Signed Rank test ($p = 0.048$). The mean (± SD) change of SDLP at the speed of 150 km/h from day 8 to day 15 was -0.028 ± 0.055 m (95% CI: -0.056 to -0.001; $p = 0.0424$ in the paired *t*-test and $p = 0.048$ in the Wilcoxon Signed Rank test), while the mean (± SD) change of SDLP at the speed of 250 km/h was -0.031 ± 0.058 m (95% CI: -0.060 to -0.002; $p = 0.0388$ in the paired *t*-test and $p = 0.043$ in the Wilcoxon Signed Rank test). The results of the ANOVA model did not show statistically significant effects over time at any speed. Altogether, the results indicate no negative effects of bilastine on driving performance even at high speed.

Secondary endpoint

Maintenance of constant speed. The mean square deviation of the speed deviations from the requested speed slightly decreased from day 8 to day 15 (Table III). The mean (± SD) change from day 8 to day 15 was -1.397 ± 2.991 km/h (95% CI: -2.884 to -0.090) and was not statistically significant ($p = 0.0639$ in the paired *t*-test and $p = 0.090$ in the Wilcoxon Signed Rank test).

At the speed of 50 km/h, the mean (± SD) change from day 8 to day 15 was 0.036 ± 1.784 km/h (95% CI: -0.851 to 0.923) and was not statistically significant ($p = 0.9326$ in the paired *t*-test and $p = 0.865$ in the Wilcoxon Signed Rank

Table III. Results of Maintenance of Constant Speed (ITT/PP population).

	Overall	50 km/h	150 km/h	250 km/h
Day 8, km/h (mean ± SD)	5.26 ± 3.38	2.46 ± 1.26	4.09 ± 4.12	6.26 ± 4.31
Day 15, km/h (mean ± SD)	3.87 ± 2.03	2.50 ± 1.74	2.05 ± 1.42	4.75 ± 2.79
Change day 15-day 8, km/h (mean ± SD)[1]	-1.397 ± 2.991	0.036 ± 1.784	-2.039 ± 3.701	-1.515 ± 4.578
95% CI of mean change, km/h[1]	-2.884 to 0.090	-0.851 to 0.923	-3.879 to -0.198	-3.792 to 0.761
p-value t-test	0.0639	0.9326	0.0319	0.1782
p-value Wilcoxon Signed Rank test	0.090	0.865	0.010	0.393

Values are the mean square deviation of the speed deviations from the requested speed in all the 18 patients. [1] = t-test

Table IV. Results of Time to Reaction (ITT/PP population).

Parameter	Button A	Button B
Parameter	Button A	Button B
Day 8, m/sec	695 ± 120	662 ± 144
Day 15, m/sec	660 ± 167	644 ± 105
Change day 15-day 8, m/sec[1]	-34.50 ± 95.71	-18.25 ± 66.28
95% CI of mean change, m/sec[1]	-82.10 to 13.10	-51.21 to 14.72
p-value t-test	0.1446	0.2590
p-value Wilcoxon Signed Rank test	0.048	0.468

Values are the mean ± SD of the times to reaction in all the 18 patients. [1] = t-test

Table V. Results of Time to Reaction at 250 km/h speed.

Parameter	Button A	Button B
Change day 15-day 8, m/sec (mean ± SD)[1]	-36.46 ± 98.10	-47.42 ± 112.88
95% CI of mean change, m/sec[1]	-85.24 to 12.33	-103.55 to 8.72
p-value *t*-test	0.1333	0.0926
p-value Wilcoxon Signed Rank test	0.074	0.212

Values are the mean ± SD of the times to reaction in all the 18 patients. [1] = *t*-test

test). At the speed of 150 km/h the mean (± SD) change from was -2.039 ± 3.701 km/h (95% CI: -3.879 to -0.198) and was statistically significant (p = 0.0319 in the paired *t*-test and p = 0.010 in the Wilcoxon Signed Rank test), i.e., the mean change was indicative of an improvement. At the speed of 250 km/h was -1.515 ± 4.578 km/h (95% CI: -3.792 to 0.761) and was not statistically significant (p = 0.1782 in the paired *t*-test and p = 0.393 in the Wilcoxon Signed Rank test). The results of the ANOVA model did not show statistically significant effects over time at any speed.

Time to reaction. For both A and B buttons the times to the reaction slightly decreased from Day 8 to day 15 (Table IV). The mean (± SD) change from day 8 to day 15 for button A was -34.50 ± 95.71 m/sec (95% CI: -82.10 to 13.10). The change from day 8 to day 15 was not statistically significant in the paired *t*-test (p =0.1446) and was statistically significant in the Wilcoxon Signed Rank test (p = 0.048), thus indicating no negative effect of bilastine in this parameter. The mean (± SD) change from day 8 to day 15 for button B was -18.25 ± 66.28 m/sec (95% CI -51.21 to 14.72) and was not statistically significant (p = 0.2590 in the paired *t*-test and p = 0.468 in the Wilcoxon Signed Rank test).

The results clearly show that treatment with bilastine does not affect responsiveness. Interestingly, response times were decrease after bilastine treatment at very high speed of 250 km/h (Table V), similar results were also obtained when the speed of 50 km/h and 150 km/h were considered (data not shown).

Safety Results

No serious adverse events were reported in any patient. Patients experienced at least one treatment-emergent adverse event (TEAE); however, none of the TEAEs was treatment-related, and none of the TEAEs led to dose reduction, discontinuation or early withdrawal. All but one TEAEs consisted in laboratory parameters out of range, which were not clinically significant (data not shown). One patient had bradycardia, which was considered a TEAE. A further verification by the investigator showed that bradycardia was already present at baseline ECG. Since this event was not reported at baseline, it was necessarily stated as TEAE.

Discussion

Bilastine, which has proved to be very efficacious in controlling allergic rhinitis and urticaria[1-3,17,18,26,27], is a non-sedating antihistamine. The drug meets several criteria defined by the international ARIA ("allergic rhinitis and its impact on asthma") guidelines, which include pharmacological properties, efficacy and side effects[1,28]. It has been shown to have a favorable pharmacokinetic profile and a low brain penetrance[13,15,16,29]; these features prevent the sedation that often occurs in patients under treatment with first generation histamine-H1 receptor antagonists[30-32].

The data obtained so far indicate that the drug does not impair the driving ability, and more in general, the psychomotor performance when administered at therapeutic doses[20,22,24]. However, the majority of the studies were performed in healthy volunteers, and limited data are available in patients with allergic rhinitis and urticaria requiring treatment with antihistamine drugs. Moreover, the driving test performed in healthy volunteers was executed at speeds close to the speed limits. It is important to demonstrate that bilastine does not impair the attention and reactivity levels in more stringent conditions, such as those used in the F1 simulator, where speeds from 50 to 250 km/h could be reached. Given this background, the current study was undertaken to evaluate the effect of bilastine treatment on attention and reactivity levels in patients with allergic rhinitis and chronic urticaria, measuring psychomotor performance at the Formula One (F1)-high speed simulator driving test. In this test very high speed (250

km/h) was reached, requiring extreme care and high reactivity levels. The level of attention was evaluated by assessing the capacity of the patient to maintain the central position while driving the F1, a measure of weaving and quality in keeping the requested path. Furthermore, the ability to maintain a constant speed with respect to the requested one was assessed as well. On the other hand, alert grade, attention and reactivity levels were evaluated by measuring the reaction response in performing actions on the steering wheel indicated by lead enlighten on the dashboard.

Our results, obtained in 18 patients with allergic rhinitis and/or chronic urticaria, clearly show that bilastine, 20 mg given for seven consecutive days does not modify the attention and reactivity levels in any condition applied during the simulation, even when very high speed (250 km/h) is utilized. In fact, treatment with bilastine, 20 mg for seven days, did not have any negative effect on ability on keeping the requested path as measured with the SDPL. The slight improvement seen in the capacity to maintaining the car in the central position could be explained with patients' familiarization with the driving simulator. Also, the lack of any bilastine negative effect on the attention levels was shown by the ability of the patients to maintain a constant speed and reactiveness, as shown by means of time to reaction values. The results observed at 250 km/h, i.e., the speed that requires the maximum response levels, were similar to those observed at a regular speed (50 km/h) and the speed of 150 km/h, suggesting that patients were able to reach the maximum speed without any interference of bilastine treatment.

Our results are in line with the recent observation that bilastine 20 mg/single dose did not induce sleepiness and did not alter the performance on tasks related to flying such as those assessed in hypobaric conditions simulating an altitude of 8000 Ft[25].

Conclusions

Our study showed that bilastine at the therapeutic dose of 20 mg during one week does not have any negative effects on attention and reactivity levels in allergic patients performing a Formula 1-high speed simulator driving test. Furthermore, these data corroborate the drug good safety profile.

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Conflict of Interest

The Authors declare that they have no conflict of interests.

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