available at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/rmed

respiratory MEDICINE

Asthma patients' self-reported behaviours toward inhaled corticosteroids

Laurent Laforest [a], Abdelkader El Hasnaoui [b], Céline Pribil [b],
Cécile Ritleng [a], Liesl M. Osman [c], Marie-Sophie Schwalm [d],
Philippe Le Jeunne [d], Eric Van Ganse [a],*

[a] CHU Lyon, Unité de Pharmacoépidémiologie, Service de Neurologie, Hôpital Pierre Wertheimer, 59 Boulevard Pinel, 69677 Bron, France
[b] Epidemiology Department, GSK Laboratory, 100 Route de Versailles, 78163 Marly-le-Roi, France
[c] University of Oxford, NDM Strategic, Nuffield Department of Medicine, Richard Doll Building, Old Road Campus, Roosevelt Drive, Oxford OX3 7LF, UK
[d] Cegedim, 90—92 Route de la Reine, 92100 Boulogne-Billancourt, France

Summary

Background: Patient adherence to recommended use of ICS is questionable in asthma, with irregular use or interruptions occurring frequently. Factors explaining discontinuation of controller therapy could orientate interventions. The characteristics of patients with interruptions of inhaled corticosteroids (ICSs), intentional or accidental, were investigated.

Methods: Asthma patients regularly prescribed ICS by GPs (Cegedim network) were included. Patients' characteristics and behaviours toward ICS (accidental/intentional interruptions, less frequent use of ICS and change in dosing) were identified from self-report questionnaires, and linked to data prescription database. Interrelations between declared behaviours toward ICS were studied with a Multiple Component Analysis (MCA) and the correlates of ICS interruptions were identified.

Results: During the past 3 months, 31.6% of 204 patients (mean age: 53.8 years, females: 59.3%) intentionally interrupted ICS when feeling better, 25.4% forgot ICS and 18.3% deliberately changed the doses. A quarter of patients considered constant use of respiratory medicines as unhealthy. MCA revealed that intentional, accidental interruptions and less frequent use of ICS were closely correlated. Risk of intentional interruption was increased when patients considered constant use of respiratory therapy to be unhealthy (OR = 3.36, 95%CI = [1.47—7.66]). Conversely, risk was significantly lower when ICS was associated or combined with another controller (OR = 0.24, 95%CI = [0.08—0.73]), compared to ICS in

* Corresponding author. Unité de Neuro-épidémiologie et de Pharmaco-épidémiologie, Hôpital Neurologique Pierre Wertheimer, 59 Boulevard Pinel, 69677 BRON Cedex, France. Tel.: +33 (0) 472 129 709; fax: +33 (0) 472 129 714.
   E-mail address: eric.van-ganse@chu-lyon.fr (E. Van Ganse).

monotherapy. Less frequent interruptions were observed in patients older than 65 (OR = 0.35, 95%CI = [0.13−0.89]).

Conclusions: Our study suggests that discontinuation of use of controllers is associated with other inadequate behaviours or beliefs about inhaled controllers. Efforts should be targeted at patients' perceptions and behaviours toward controller therapy.

Introduction

The detrimental effects of asthma on patients' quality of life[1] and medical resource utilization[2] have been highlighted. The quality of asthma management remains an essential issue.[3] Adherence to inhaled corticosteroids therapy (ICS) is a major objective in asthma care. A critical step to improve adherence is to understand patients' beliefs and behaviours toward their inhaled anti-inflammatory therapy.

Guidelines recommend daily and regular use of inhaled anti-inflammatory therapy for patients with persistent asthma.[4] Nonetheless, in real medical practice, many studies have highlighted patients' inadequate adherence to inhaled corticosteroids.[5,6]

Adherence covers successive levels from drug prescription and dispensing up to the actual use by the patients.[7] As a consequence, being prescribed ICS on a regular basis is not a sufficient evidence of satisfactory quality of asthma care, and a more comprehensive understanding of patients' behaviours toward controllers in actual condition of use, which includes intentional or accidental interruptions and changing of doses, is needed. Also, the characteristics of non-adherent patients have been inadequately explored in patients regularly followed and treated for asthma. Besides, it would be of interest to verify to which extent the different behaviours reflecting inadequate adherence are correlated.

In a population of asthma patients receiving ICS, alone or together with other controllers, we examined declared behaviours toward ICS therapy, as approached by different behaviours toward ICS therapy.

Methods

Study design and study population

A cross-sectional observational study was conducted in primary care (2004−2005) among asthma patients, aged 15 or more, supervised by GPs members of CEGEDIM network. This network includes a nationwide representative sample of French GPs who participate to a computerized prescription database. Only patients regularly followed (two or more visits during the past 12 months) and with at least one prescription of ICS (alone or combined with acting beta agonist) during the past 6 months before the study were eligible. Additionally, when this ICS prescription was recent (at inclusion or within the 3 preceding months), the presence of a former one in the database was requested in order to avoid newly treated patients. Patients were excluded in case of associated COPD diagnosis or language/understanding problems. Patients who met inclusion criteria were recruited when they visited their GP. After explanation of the study, patients who agreed to participate were included. The protocol of the study was approved by the French Data Protection Authority.

Data collected

Data were obtained from self-reported questionnaires completed at inclusion visit and a computerized prescription database.

Patients' characteristics and factors related to asthma

Patient questionnaires reported sociodemographic data and quality of life (QVSA).[8] QVSA score ranged from 0% to 100% (optimal quality of life). The Asthma Control Test was used to assess the level of asthma control. It was coded as correct vs. inadequate control with the Sum score method.[9]

Patients' behaviours toward asthma controller therapy

Patients reported in questionnaires how they behaved toward their inhaled controller therapy during the 3 months before inclusion. Six non-exclusive declared behaviours toward ICS were investigated: (1) accidental interruption, (2) intentional interruption when feeling better, (3) intentional interruption when feeling worse, (4) reduced use when feeling better, (5) more frequent use of ICS in case of preliminary signs of asthma attack and (6) intentional changes of doses, independently of physician. The reference for reduced use and more frequent use was the frequency prescribed by the physician. Patients also mentioned whether they considered constant use of respiratory drugs as unhealthy. The corresponding variables (except intentional changes of doses) were coded with a Likert-scale (never/scarcely/sometimes/often/very often).

Prescribed asthma therapy

Asthma therapy was obtained from the prescription computerized database. It consisted of controllers and rescue medications (short-acting beta agonists and anticholinergic drugs). Controller medication classes included inhaled corticosteroids (ICS), long-acting beta agonists (LABA), LABA−ICS fixed combinations, oral beta agonists, oral xanthine, leukotriene receptor antagonists (LTRA). Controller regimens were classified as follows: ICS only, ICS and LABA (as separate medications), combined LABA−ICS alone, combined LABA−ICS with other controllers and other associations of controllers. The average daily dose of prescribed ICS (Beclomethasone

dipropionate equivalent) was computed during the 6 months before index date. Based on GINA criteria, these doses were considered as high, medium or high ($\leq$500, >500–1000, >1000 μg/d, Beclomethasone equipotent respectively).[4]

Analyses

Patients' characteristics and self-reported behaviours toward ICS

Overall 204 patients were eligible and no newly treated patient was identified among them.

First, patients disease characteristics and prescribed therapy were studied. Then, patients' reported behaviours toward ICS and belief about regular use of ICS were described.

A multiple component analysis (MCA) was performed with these variables to ascertain to which extent they were altogether associated. Given the limited counts, available items 'never' and 'scarcely' on one hand, and 'sometimes', 'often' and 'very often' on the other hand, were pooled together as in prior analyses.

Correlates of accidental and intentional interruption of ICS

Inferential analyses focused specifically on accidental and intentional (when feeling better) interruptions of ICS ('sometimes or more' vs. 'never/scarcely'). Both variables were studied according to patients' characteristics, asthma control and asthma therapy. Chi-Square test and Wilcoxon ranked test were used for univariate analyses.

Multivariate logistic regression models were computed. The risks of accidental and intentional interruption of ICS therapy (sometimes or more) were studied, respectively. Both models systematically included age, gender, asthma control, use of oral corticosteroid burst and asthma controller regimens (with ICS monotherapy as reference). Other factors were included in the model when they showed a significant univariate association with the studied variable ($p < 0.10$). The variables referring to declared behaviours to ICS were not entered into models as they were not considered as explanatory factors.

Results

Patients' characteristics (Table 1)

Patients were included from May 2004 until July 2005. Mean age of the 204 patients who completed questionnaires was 53.8 years (SD = 19.6), with 59.3% females, 13.7% were smokers. During the 6 months before the survey, most patients received combined LABA–ICS alone (39.2%) or with another controller (24.5%). Other categories were ICS monotherapy (12.3%), ICS and LABA in two separate drugs (14.2%), and other regimens (9.8%). The 'Other regimens' category consisted of ICS + LABA + LTRA ($n = 8$), ICS + oral beta agonist ($n = 3$), ICS + oral xanthine ($n = 3$), ICS + LTRA ($n = 2$), ICS + LABA + oral xanthine ($n = 2$), ICS + oral xanthine + oral beta agonist ($n = 1$) and ICS + LTRA + LABA + oral beta agonist ($n = 1$).

During the 6 months, 21.1%, 44.6% and 34.3% of patients received low, medium, and high daily equipotent doses of ICS, respectively.

Nearly half the patients were prescribed short-acting beta agonists (SABA, 51.5%). Few received SABA with anticholinergic drugs combined or not with SABA (6.9%). A minority of patients (12.4%) reported the use of oral or injected corticosteroids during the past 3 months. Based on the Asthma Control Test score, about 40% of patients were inadequately controlled. QVSA score ranged from 8.3 to 98.3%, with a mean value at 58.4% (SD = 17.8%).

Patients' reported behaviours toward ICS therapy (past 3 months)

Descriptive analyses

Interruptions of ICS were commonly reported. Nearly one-third of patients reported intentional interruptions while a quarter of them omitted ICS therapy (Table 1). So was patients' less frequent use or intentional interruption of ICS when feeling better. About, 5% interrupted ICS when feeling worse. Nearly one patient in four believed that constant use of respiratory drug was unhealthy (Table 1), and about one patient in five spontaneously changed dosing during the past 3 months. These changes mainly consisted of reducing ICS doses. A more frequent use of ICS in the case of preliminary signs of asthma attacks was only reported by about 20% of patients.

Associations between behaviours toward ICS

Multiple component analyses conducted on the 204 patients suggested that the three behaviours resulting in a lower use of ICS (accidental interruption, intentional interruption, less frequent use when feeling better) were all closely associated (Fig. 1). These three behaviours appeared correlated with the belief that constant use of respiratory drugs was unhealthy. Conversely, changing of doses and increasing doses in case of signs of asthma attacks seemed more independent from the latter variables (Fig. 1). Most of these findings were confirmed in univariate analyses (Table 2). Interruption of ICS when feeling worse was not included in the multiple component analysis given its low frequency.

Correlates of intentional and accidental interruptions of ICS therapy (past 3 months before inclusion)

Univariate analyses

More than twofold higher rates of interruptions (intentional or accidental) were observed among patients aged 45 or less compared to their counterparts older than 65 (Table 2). Despite the absence of global significant difference in ICS interruption between the different types of controller regimens, higher rates of interruptions (intentional or accidental) were observed in the ICS monotherapy category. Patients who considered constant use of respiratory drugs as unhealthy were more likely to interrupt intentionally or accidentally their ICS therapy (Table 2). Conversely, no effect of the daily dose of ICS was observed.

No significant association was observed between ICS interruption and gender, use of oral or injected corticosteroid course, intensity of ICS therapy, smoking status, asthma control or quality of life (Table 2).

Table 1 Characteristics of the study population.

Overall	n, %	
	204	100
Female gender	121	59.3
Age (years)		
15—45	68	33.3
46—65	65	31.9
>65	71	34.8
Current smoking	28	13.7
Asthma severity (n = 193)		
No oral or injected corticosteroid course (past 3 months)	169	87.6
At least one oral or injected corticosteroid course (past 3 months)	24	12.4
Average daily doses of prescribed ICS[a] (past 6 months)		
≤500 μg/d	43	21.1
>500—1000 μg/d	91	44.6
>1000 μg/d	70	34.3
Inadequate asthma control (Asthma Control Test)	76	39.8
Correct asthma control	115	60.2
Quality of life (QVSA score)[b]		
<52%	56	33.3
53—66%	57	33.9
>66%	55	32.7
Controller regimens (past 6 months)		
Inhaled corticosteroids (ICS) alone	25	12.3
ICS + long-acting beta agonist (two separate drugs)	29	14.2
Combined ICS − long-acting beta agonist alone	80	39.2
Combined ICS − long-acting beta agonist with other controllers	50	24.5
Other regimens	20	9.8
Short-acting beta agonists (SABA)	99	48.5
Anticholinergic or SABA-anticholinergic	14	6.9
Patients' behaviours and beliefs toward controller therapy		
Believing that continuous use of respiratory drugs is unhealthy[c]	44	23.7
Self-reported behaviours during the past 3 months		
Accidental interruption of ICS		
Never/scarcely	138	74.6
Sometimes/often/very often	47	25.4
Intentional interruption of ICS when feeling better		
Never/scarcely	128	68.4
Sometimes/often/very often	59	31.6
Intentional interruption of ICS when feeling worse		
Never/scarcely	176	94.6
Sometimes/often/very often	10	5.4
Less frequent use of ICS when feeling better		
Never/scarcely	136	68.7
Sometimes/often/very often	62	31.3
More frequent use of ICS in case of premonitory signs of asthma attack		
Never/scarcely	156	78.8
Sometimes/often/very often	42	21.2

Table 1 (*continued*)

Overall	n, %	
	204	100
Intentional change in the dosing of ICS[d]	35	18.3
Increase	5	
Decrease	23	
Both	7	

[a] Beclomethasone equivalent doses.
[b] Dichotomised according to tertile values.
[c] Out of 186 patients.
[d] Out of 191 patients.

Multivariate models

Multivariate models confirmed most univariate findings. Significantly decreased risks of intentional and accidental interruptions were observed for older patients. Patients' belief that continuous use of asthma therapy was unhealthy which was a prominent predictor of both outcomes (Table 3).

Compared to patients under ICS monotherapy, those who received additional controller(s), or combined LABA—ICS therapy exhibited lower risk of intentional interruption (Table 3). When all the categories of patients who received ICS and another controller (combined or concurrent drugs) were merged, a significantly decreased risk was observed compared to ICS monotherapy (OR = 0.24, 95%CI = [0.08—0.73]). In contrast, the corresponding risk was not significant for accidental ICS interruption: OR = 0.38, 95%CI = [0.13—1.17].

Discussion

In this population of asthma patients treated with inhaled corticosteroids (ICS) in primary care, self-reported adherence to controllers was far from optimal. Interruptions and changes of doses were common. Most misbehaviours toward ICS were closely correlated and ICS interruptions were also associated with patients' belief that continuous use of respiratory drug is harmful. Accidental and intentional interruptions of ICS treatment also decreased with age and when another controller was associated with ICS (Table 2).

Patients' behaviours toward ICS therapy

During the past 3 months, interruptions of ICS were common in this population of regularly followed asthma
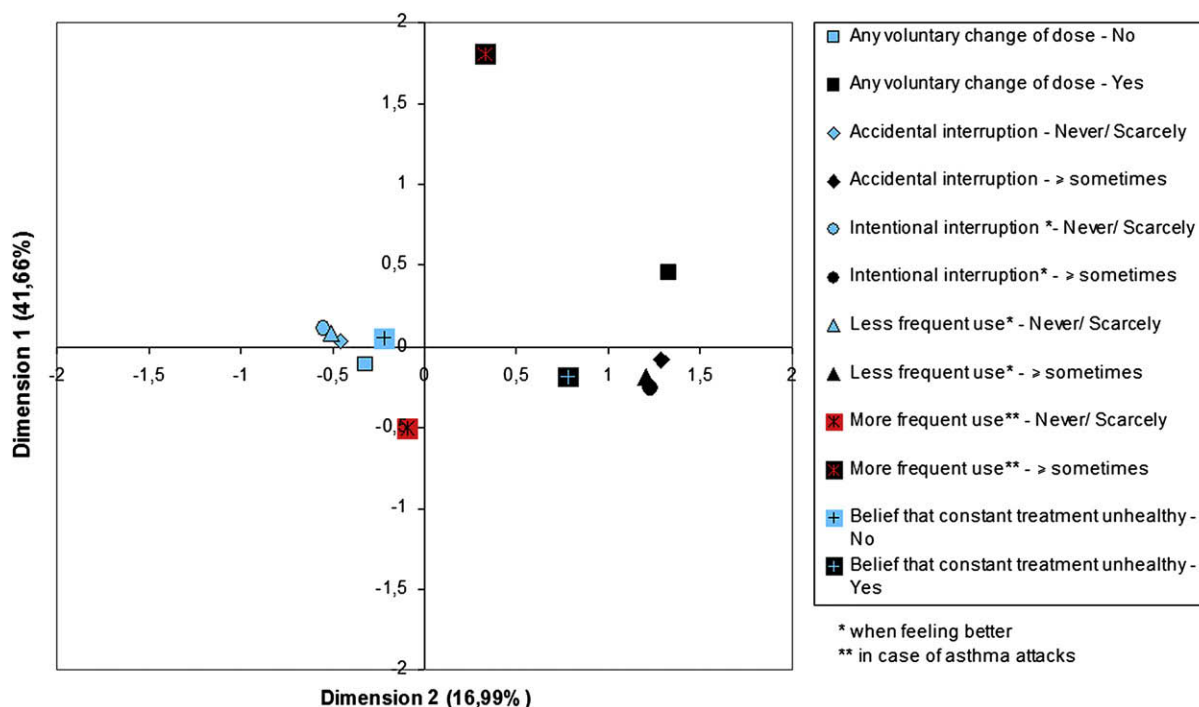
Figure 1 Patients' self-reported behaviours and beliefs toward ICS therapy during the 3 months preceding inclusion (Multiple component analysis).

Table 2 Intentional and accidental ICS interruptions (sometimes or more) according to patients' characteristics and asthma therapy (during the past 3 months before inclusion).

	Intentional interruption of ICS treatment			Accidental interruption of ICS treatment		
	Total count	% 'Sometimes or more'	P[a]	Total count	% 'Sometimes or more'	P[a]
Overall	187	31.5	—	185	25.4	—
Gender						
Female	106	32.1	0.86	105	26.7	0.65
Male	81	30.9		80	23.7	
Age (years)						
15—45	66	43.9	0.007	65	40.0	0.0035
46—65	60	31.7		60	18.3	
>65	61	18.0		60	16.7	
Smoking status						
Current smoking	28	39.3	0.34	28	25.0	0.96
No smokers	159	30.2		157	25.5	
Asthma severity (past 3 months)						
No oral or injected corticosteroid course	159	33.3	0.57	157	25.5	0.86
At least one oral or injected corticosteroid course	22	27.3		22	27.3	
Average daily doses of prescribed ICS[b] (past 6 months)						
≤500 μg/d	43	41.9	0.15	42	33.3	0.28
>500—1000 μg/d	80	25.0		79	20.2	
>1000 μg/d	64	32.8		64	26.6	
Asthma control level (Asthma Control Test)						
Inadequate	71	32.4	0.83	70	30.0	0.21
Correct	107	30.8		106	21.7	
Controller regimens (past 6 months)			0.13			0.57
Inhaled corticosteroids alone	22	45.4		22	31.8	
CI + long-acting Beta Agonist (two separate drugs)	28	28.6		28	21.4	
Combined CI − long-acting beta agonist alone	76	28.9		75	25.3	
Combined CI − long-acting beta agonist with other controllers	43	39.5		43	30.2	
Other regimens	18	11.1		17	11.8	
Short-acting beta agonists	93	28.0	0.29	93	22.6	0.37
Anticholinergic or SABA-anticholinergic	13	30.8	1.00	12	16.7	0.37
Declared behaviours toward ICS						
Intentional interruption of ICS when feeling better						<0.0001
Never/scarcely		—		128	7.8	
Sometimes/often/very often		—		57	64.9	
Intentional interruption of ICS when feeling worse			0.0007			0.0002
Never/scarcely	176	29.0		175	22.9	
Sometimes/often/very often	10	80.0		9	77.8	
Less frequent use of ICS when feeling better			<0.0001			<0.0001
Never/scarcely	130	14.6		129	12.4	
Sometimes/often/very often	56	71.4		55	56.4	

Table 2 (*continued*)

	Intentional interruption of ICS treatment			Accidental interruption of ICS treatment		
	Total count	% 'Sometimes or more'	P^a	Total count	% 'Sometimes or more'	P^a
More frequent use of ICS in case of premonitory signs of asthma attack			0.67			0.06
Never/scarcely	147	30.6		145	22.1	
Sometimes/often/very often	38	34.2		38	36.8	
Intentional change in the dosing of ICS			<0.0001			0.0001
Yes	35	65.7		35	51.4	
No	150	24.0		148	19.6	
Belief that continuous use of respiratory drugs is unhealthy						
Yes	41	51.2	0.002	40	42.5	0.008
No	140	25.7		139	21.6	
Global QVSA score			0.80			0.92
<52	53	32.1		51	25.5	
53—66	52	32.7		52	28.8	
>66	53	37.7		53	26.4	

[a] Difference between patients who interrupted therapy sometimes or more often and the other patients.
[b] Beclomethasone equivalent dose.

patients. So was the belief that there was a risk for health through continuous use of respiratory drugs (Table 1). Intentional and accidental non-adherence with ICS have been commonly described in asthma by previous studies.[10] More specifically, lack of perceived symptoms by patients ('no symptom no asthma') has been found as a major cause of patients' intentional interruption of ICS.[11,12] The absence of immediate perceived relief with ICS (except for combined LABA—ICS therapy) may contribute to this inadequate use.

In addition, patients' misuse of ICS may also result from a misunderstanding about their exact role in asthma therapy,[13] fear of addiction[14] and of potential side effects.[13,14] As well, the necessity of daily use of ICS may not always be understood by patients.[12] Our data illustrated the common occurrence of prejudices about respiratory therapy (Table 1). Moreover, the relationship between such misperception of respiratory therapy and ICS misuse was clearly illustrated (Table 3).

Changes of ICS doses were also common (Table 1) and mostly consisted of reducing doses. However, interpreting these results may be difficult. First, patients' spontaneous increase and decrease of dose may correspond to distinct therapy behaviour patterns. Unfortunately, counts of patients who only increased ICS doses were too limited for meaningful analyses. Moreover, patients' spontaneous change in ICS dose may be considered as positive, provided that it is in accordance with care-giver directions and/or asthma plans.

Only 20% of patients used ICS therapy more frequently in the case of preliminary signs of asthma attacks. This inadequate proportion could be explained by a higher use of rescue medication for asthma attack, at the expense of increasing inhaled anti-inflammatory therapy.[10,15]

Associations of the different behaviours toward ICS therapy

The strong correlations observed between ICS intentional interruption, less frequent use when feeling better and accidental interruption suggest that under-users of ICS may correspond to a unique profile of patients. Conversely, changes of doses and, more specifically, more frequent use of ICS therapy in case of attacks appeared less correlated with under-use of ICS (Table 2). These findings were illustrated by the multiple component analysis (Fig. 1).

Patients' perception of constant use of respiratory drugs as unhealthy was a major predictor of ICS interruption. Horne et al. found a stronger influence of medications' beliefs about adherence, compared to personal or clinical factors.[16] This association may reflect fear of adverse events or overdosing and would deserve further investigation.

This finding is of concern as it strongly suggests that an erroneous perception of asthma therapy may lead to an under-use of controllers, whether intentional or not. Indeed, higher adherence to asthma therapy has been shown to be associated with patients' stronger beliefs in the benefits of the treatments.[10,17]

Other correlates of ICS interruption (intentional and accidental)

Significantly fewer ICS interruptions were observed in older asthma patients (Tables 2, 3). A better adherence to ICS in older asthma patients has been reported,[16,18] although other studies did not confirm this result.[19,20]

Table 3 Logistic models, risks of intentional (Model 1) and accidental interruption of ICS (Model 2).

	OR	95%CI
MODEL 1: risk of intentional interruption of ICS during the past three months (sometimes or more), when feeling better ($n = 170$)		
Age (years)		
15—45	Ref	—
46—65	0.56	0.25—1.27
>65	0.35	0.13—0.89
Male gender	1.00	0.48—2.01
At least one oral or injected corticosteroid course (past 3 months)	0.75	0.22—2.58
Inadequate asthma control	0.93	0.41—2.09
Controller regimens (past 6 months)		
ICS alone	Ref	—
ICS + Long-acting beta agonist (two separate drugs)	0.21	0.05—0.85
Combined ICS − Long-acting beta agonist alone	0.27	0.09—0.85
Combined ICS − Long-acting beta agonist with other controllers	0.36	0.10—1.23
Other regimens	0.08	0.01—0.50
Belief that continuous use of respiratory drugs is unhealthy	3.36	1.47—7.66
MODEL 2: risk of accidental interruption of ICS during the past three months (sometimes or more) ($n = 168$)		
Age (years)		
15—45	Ref.	—
46—65	0.34	0.14—0.84
>65	0.37	0.14—0.97
Male gender	0.79	0.36—1.73
At least one oral or injected corticosteroid course (past 3 months)	0.88	0.26—3.06
Inadequate asthma control	1.36	0.59—3.12
Controller regimens (past 6 months)		
ICS alone	Ref.	—
ICS + long-acting beta agonist (two separate drugs)	0.30	0.07—1.29
Combined ICS − long-acting beta agonist alone	0.40	0.12—1.31
Combined ICS − long-acting beta agonist with other controllers	0.52	0.15—1.85
Other regimens	0.15	0.02—0.97
Belief that continuous use of respiratory drugs is unhealthy	2.53	1.08—5.91

Patients who received another controller in addition to ICS − combined or concurrent drug − were less likely to intentionally interrupt ICS. Most of the 179 regimens with at least one controller in addition to ICS included a LABA ($n = 170$). The beneficial impact adjunction of LABA to ICS on asthma control has been demonstrated.[21,22] Patients who perceive the broncho-dilatation physiological effects of the beta agonist may be more prone to regular use of their asthma drugs. Conversely, no difference in interruption rates appeared between patients under combined LABA—ICS therapy and those with two concurrent controllers, which are not in line with the conclusions of previous studies: better adherence rates with combined LABA—ICS therapy compared to concurrent therapy have been reported.[23,24] Interpreting the observed differences in adherence patterns according to the type of controller therapy requires caution. First, our study explored only some dimensions of adherence. As a consequence, no conclusion can be drawn with regard to adherence as an overall outcome. Then, our number of patients under isolated ICS therapy was limited. Hence,

a confirmation on a higher number of patients is desirable. Last, our observational study did not provide a level of evidence similar to those of randomised trials. In contrast, no association emerged between ICS interruptions, the use of oral or injected corticosteroids, the intensity of prescribed therapy, and more surprisingly asthma control. The detrimental impact of inadequate ICS use on asthma control has been established.[6] Our assessment of ICS use without precise dates of interruptions was a limitation to examining in detail the effects on asthma control with a detailed temporality. Nevertheless, this unexpected finding should be interpreted with care and requires confirmation in further studies.

This study had other limitations. Due to the low counts of patients, the different items of the semi quantitative Likert-scale of declared behaviours ('never' to 'very often') were merged into two categories ('never' or 'scarcely' vs. 'sometimes' or 'more often'), which prevented more accurate analyses. Also, behaviours toward ICS therapy were retrospectively self-reported by patients, which could lead to under-assessment of treatment omission due to

memory bias. Nonetheless, these behaviours were estimated only during 3 months in order to limit this risk. Lastly, despite such potential bias, high rates of self-reported misbehaviours were still observed. Our study was conducted in a selected sample of asthma patients receiving ICS, who volunteered to participate. As a consequence, worse results could be expected in a more general population of asthma patients. Lastly, education level,[25] psychological factors[26] or duration of asthma[17] that may potentially influence adherence to controllers were not documented.

Our data are of concern as they underline the inadequate adherence to ICS, even in a selected population of regularly treated asthma patients. In addition to the detrimental consequences on health and quality of life, under-use of ICS, along with an overuse of rescue medication, may result in a higher use of medical care resources.[27]

The precise reasons why patients purposely under-use or forget ICS therapy should be more thoroughly investigated. Our data advocate the need for better education for asthma patients, most particularly on the role of ICS in asthma therapy. Notably, potential prejudices toward controllers should be better addressed to effectively correct them.[13] As underlined by Horne, failure to adhere to chronic therapy is correlated with patients' doubts about personal need for medication and fear of adverse effects.[16] Hence, the rationale of the regular use of ICS requires the understanding by patients of asthma as a chronic disease, even in the absence of overt symptoms.[14]

A better communication between care-givers and patients, and more efficient involvement of patients in the management of their disease are also highly desirable. Patients are more likely to report regular use of ICS if they see themselves as active participants in disease management.[11,28] Specific attention should be directed to patients under 45, whose adherence seems less adequate.

In conclusion, the irregular use of ICS in this population of treated asthma patients is of concern. This underlines the urgent need to better educate patients about inhaled anti-inflammatory therapy in asthma.

Acknowledgments

Conflict of interest statement

Céline Pribil and Abdelkader El Hasnaoui are employed by GlaxoSmithKline. They actively participated in the writing of the protocol. However, GlaxoSmithKline was not involved at any stage of the analyses or of the interpretation of results that were performed independently by the Pharmacoepidemiology Unit (Lyon).

Ethics statement

The protocol of the study was approved by the French Data Protection Authority. This study was purely observational (patients' management was not affected by the study).

References

1. Laforest L, Pacheco Y, Bartsch P, et al. Correlates of quality of life in patients with asthma. *Ann Allerg Asthma Immunol* 2005;**94**: 473—9.
2. Van Ganse E, Laforest L, Pietri G, et al. Persistent asthma: disease control, resource utilisation and direct costs. *Eur Respir J* 2002;**20**:260—7.
3. Laforest L, Pacheco Y, Bousquet J, Sazonov Kocevar V, Yin D, Van Ganse E. How appropriate is asthma management in general practice? *Fundam Clin Pharmacol* 2004;**19**:107—15.
4. Global Initiative for Asthma. *Global strategy for asthma management and prevention NHLBI/WHO WORKSHOP report*. Bethesda, USA: National Institute of Health; 2006.
5. Williams LK, Pladevall M, Xi H, et al. Relationship between adherence to inhaled corticosteroids and poor outcomes among adults with asthma. *J Allergy Clin Immunol* 2004;**114**: 1288—93.
6. Krishnan JA, Riekert KA, McCoy JV, et al. Corticosteroid use after hospital discharge among high-risk adults with asthma. *Am J Respir Crit Care Med* 2004;**170**:1281—5. Epub.
7. Storm B. Pharmacoepidemiology. In: Storm B, editor. 3rd ed. Chichester, UK: Wiley; 2000.
8. Lenne X, Dervaux B, Lebrun T, El Hasnaoui A. Comparisons between two statistical treatments of quality of life. Assessment scales. *Health Syst Sci* 1998;**2**:19—32.
9. Nathan RA, Sorkness CA, Kosinski M, et al. Development of the asthma control test: a survey for assessing asthma control. *J Allergy Clin Immunol* 2004;**113**:59—65.
10. Ulrik CS, Backer V, Soes-Petersen U, Lange P, Harving H, Plaschke PP. The patient's perspective: adherence or non-adherence to asthma controller therapy. *J Asthma* 2006;**43**: 701—4.
11. Chambers CV, Markson L, Diamond JJ, Lasch L, Berger M. Health beliefs and compliance with inhaled corticosteroids by asthmatic patients in primary care practices. *Respir Med* 1999; **93**:88—94.
12. Halm EA, Mora P, Leventhal H. No symptoms, no asthma: the acute episodic disease belief is associated with poor self-management among inner-city adults with persistent asthma. *Chest* 2006 Mar;**129**(3):573—80.
13. Boulet LP. Perception of the role and potential side effects of inhaled corticosteroids among asthmatic patients. *Chest* 1998; **113**:587—92.
14. Horne R. Compliance, adherence, and concordance: implications for asthma treatment. *Chest* 2006 Jul;**130**(1 Suppl.): 65S—72S.
15. Partridge MR, van der Molen T, Myrseth SE, Busse WW. Attitudes and actions of asthma patients on regular maintenance therapy: the INSPIRE study. *BMC Pulm Med* 2006;**6**:13.
16. Horne R, Weinman J. Patients' beliefs about prescribed medicines and their role in adherence to treatment in chronic physical illness. *J Psychosom Res* 1999 Dec;**47**(6):555—67.
17. De Smet BD, Erickson SR, Kirking DM. Self-reported adherence in patients with asthma. *Ann Pharmacother* 2006;**40**:414—20.
18. Lacasse Y, Archibald H, Ernst P, Boulet LP. Patterns and determinants of compliance with inhaled steroids in adults with asthma. *Can Respir J* 2005;**12**:211—7.

19. Corsico AG, Cazzoletti L, de Marco R, et al. Factors affecting adherence to asthma treatment in an international cohort of young and middle-aged adults. *Respir Med* 2007;**101**:1363—7.

20. Apter AJ, Reisine ST, Affleck G, Barrows E, ZuWallack RL. Adherence with twice-daily dosing of inhaled steroids. Socio-economic and health-belief differences. *Am J Respir Crit Care Med* 1998;**157**:1810—7.

21. Remington TL, Digiovine B. Long-acting beta-agonists: anti-inflammatory properties and synergy with corticosteroids in asthma. *Curr Opin Pulm Med* 2005;**11**:74—8.

22. Barnes PJ. Scientific rationale for using a single inhaler for asthma control. *Eur Respir J* 2007;**29**:587—95.

23. Stoloff SW, Stempel DA, Meyer J, Stanford RH, Carranza Rosenzweig JR. Improved refill persistence with fluticasone propionate and salmeterol in a single inhaler compared with other controller therapies. *J Allergy Clin Immunol* 2004;**113**:245—51.

24. Marceau C, Lemiere C, Berbiche D, Perreault S, Blais L. Persistence, adherence, and effectiveness of combination therapy among adult patients with asthma. *J Allergy Clin Immunol* 2006;**118**:574—81.

25. Apter AJ, Boston RC, George M, et al. Modifiable barriers to adherence to inhaled steroids among adults with asthma: it's not just black and white. *J Allergy Clin Immunol* 2003;**111**:1219—26.

26. Smith A, Krishnan JA, Bilderback A, Riekert KA, Rand CS, Bartlett SJ. Depressive symptoms and adherence to asthma therapy after hospital discharge. *Chest* 2006;**130**:1034—8.

27. Anis AH, Lynd LD, Wang XH, et al. Double trouble: impact of inappropriate use of asthma medication on the use of health care resources. *CMAJ* 2001;**164**:625—31.

28. Gibson PG, Powell H, Coughlan J, et al. Self-management education and regular practitioner review for adults with asthma. *Cochrane Database Syst Rev* 2003: CD001117.