

Pharmacist-led intervention study to improve drug therapy in asthma and COPD patients

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Received: 8 December 2012 / Accepted: 17 November 2013
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Abstract *Background* Pharmacists can play an important role in identifying and instructing pulmonary patients on their inhalation techniques in their patient contacts when dispensing inhalation medication. Pharmacy dispensing data can be used to identify inappropriate drug use in asthma and chronic obstructive pulmonary disease (COPD) patients. Recent studies found beneficial effects of pharmacy care services in improving drug adherence of pulmonary patients. However, large-scale and rigorous evaluations on pharmacist-led interventions in community care settings to enhance evidence-based drug treatment in patients with asthma and COPD seems to be lacking and results from studies on pharmacist-led interventions for

pharmacotherapy improvements are inconsistent. This study evaluated the effectiveness of pharmacist-led interventions on suboptimal drug use patterns with asthma or COPD medication with substantial numbers of pharmacies and patients involved. *Setting* A prospective cohort study in a group of community pharmacies (intervention group) with a matched control group of Dutch community pharmacies was conducted between May 2011 and February 2012. Algorithms on 19 potential problems with asthma or COPD medication in a national dispensing database were used to signal patients to pharmacists of the intervention group (IG). *Methods* IG pharmacists selected patients for comprehensive care by a structured program. Changes in problems were measured during 10 months in selected and all users of asthma and COPD medication of IG pharmacies and in compared to a control pharmacies (CG) without the structured program. Primary outcome was reduction of oral high dosage corticosteroids or antibiotics (HDT). Secondary outcomes were changes in the persistence of 19 potential problems in the IG compared to CG. *Results* In the 107 IG pharmacies, 3,757 patients were selected for comprehensive care from totally 102,497 asthma or COPD patients and compared with 105,507 patients from 105 CG pharmacies. The mean number of HDT decreased in selected IG patients by an additional 0.54 (95 % CI 0.21–0.86) HDT treatments. From the problems with specific COPD and asthma medication, all problems decreased additionally to the CG within the total asthma or COPD population from the IG. Within the selected IG population the following problems decreased additionally for obsolete medication by 35 % (95 % CI 6–54 %), contra-indicated medication by 61 % (95 % CI 38–75 %) and lower use of powder inhalers in elderly patients by 29 % (95 % CI 13–42 %). *Conclusion* Community pharmacists actively providing comprehensive pharmacy care could improve

Electronic supplementary material The online version of this article (doi:10.1007/s11096-013-9887-4) contains supplementary material, which is available to authorized users.

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effective treatment in asthma and COPD patients and thereby decrease the number of prescriptions for exacerbations for these patients.

Keywords Asthma · COPD · Pharmaceutical care · Pharmacist intervention study · The Netherlands

Impact of findings on practice

- Community pharmacies with an interest in pharmacy care can improve treatment regimens in asthma and COPD patients.
- Pharmacists are able to successfully target pulmonary patients that were not treated according to evidence based guidelines.

Introduction

The prevalence of asthma and chronic obstructive pulmonary disease (COPD) is increasing worldwide and becoming a relevant burden for healthcare systems [1–4]. Asthma and COPD patients are mainly treated with inhalation medication [1–6]. For many patients, using inhalation medication correctly is difficult, but it is a condition for effective pulmonary disposition of medicines and a good clinical response [5, 7–9]. In most countries, and certainly in the Netherlands, pharmacists have an important role in instructing pulmonary patients on their inhalation techniques. When dispensing their medication they can use their direct patient contact for personal advice [7, 9–12]. Recent studies found beneficial effects of pharmacy care services on drug adherence and health outcomes of pulmonary patients by improving their inhalation technique [8, 13, 14] and knowledge about the effect of the medication on their disease [3, 7, 9, 15, 16–21]. Some of these studies were randomized controlled trials [1, 3, 4, 7]. However, the effectiveness interventions in community dwelling patients may differ from results in study settings [10, 11]. Furthermore, many studies included small patient samples [13, 16–20] and most studies did not evaluate effects of pharmaceutical care on specific aspects in asthma and COPD treatment [1, 3, 4, 7–9, 13, 15–20]. As patients in the Netherlands predominantly visit a single pharmacy [22], pharmacists dispose of complete medication histories of their patients [23]. Consequently dispensing data of pharmacies can be used to identify inappropriate drug use in asthma and COPD patients. By this, Dutch pharmacists can exercise their formalized responsibility for drug treatment [10, 15, 22, 24, 25]. The Foundation for Pharmaceutical Statistics (SFK) collects data on drug dispensing for more than 95 % of the approximately 1,900 Dutch community

pharmacies routinely on a monthly basis [26]. These data can be used to detect potential suboptimal drug use patterns and report them to healthcare professionals for instance for a structured pharmacy care program to improve drug treatment in patients with asthma or COPD.

Aim of the study

The aim of this study was to assess the effectiveness of pharmacist-led interventions within structured support programs among Dutch community pharmacies on improving inappropriate drug use in asthma or COPD patients as defined by current practice guidelines, compared to usual care.

Method

Design and setting

A prospective cohort study in a group of community pharmacies (intervention group, IG) with a matched control group (CG) of Dutch community pharmacies was conducted between May 2011 and February 2012. The Royal Dutch Pharmacists Association (KNMP) designed this study. Pharmacists were eligible for the IG when they cooperated with general practitioners (GPs), arranged to make use of the web-based tool and signed an agreement to perform pharmaceutical care according to protocols for the structured pharmacy care program. The protocols were developed by GlaxoSmithKline (GSK) according to prevailing guidelines [27, 28]. IG-pharmacists agreed on the use of their and dispensing data for their asthma and COPD patients and their records during the intervention program for this study. For the control group (CG patients) for each IG pharmacy a match was retrieved from the SFK-database on the following criteria: the number of dispensings, the number of employed pharmacists and the level of urbanity. Urbanity was included to account for potential bias in differences between rural and urban population and for potentially more the higher number of GPs urban pharmacists have to deal with compared to rural districts. The level of urbanity was expressed in 5 levels according to the classification of the Dutch Agency of Statistics [29]. Annual number of records for dispensed data was taken as a proxy for the size of the pharmacy. It was calculated over 9 months and grouped in three strata: small (<74.000 prescriptions), medium (74.000–105.000 prescriptions) and large (>105.000 prescriptions). Asthma and COPD patients were identified by dispensed inhalation medication in IG and CG pharmacies by algorithms, developed by KNMP. IG pharmacists received structured protocols to select eligible asthma and COPD patients for additional pharmaceutical care. Patients were eligible for the

COPD project when being older than 40 years and with at least two filled prescriptions for an oral treatment with high dose treatment (HDT) with antibiotics or corticosteroids in the previous year. Patients were eligible for the asthma project when aged between 16 and 40 years and a recorded overuse (>2 inhalations per day) of short acting betamimetic drugs (SABD), with or without concomitant use of an inhalation corticosteroid (ICS). If the required number of patients for both projects was not achieved, pharmacists could select patients for other potential problems (Supplement 1). For identification of potential drug related problems for asthma and COPD, these problems were translated into algorithms (Supplement 2) and implemented in a web-based tool. SFK data include detailed information on drugs dispensed such as the codes from the ATC system [30] and the prescribed daily dose. The algorithms for detection of potential problems with inhalation medication were run monthly on the SFK data in order to supply actual information on asthma and COPD treatment.

Improvement of care when applying prevailing guidelines [27, 28] in pharmacies by the use of anonymized data is not considered as an interventional trial according to Directive 2001/20/EC and to Dutch legislation (WMO) and therefore does not need to be submitted to a medical ethics committee.

Structured pharmacy care programs

The pharmacy care programs for asthma and COPD consisted of three steps for IG pharmacists: (1) patient selection by aid of the web-based tool, (2) advice to GPs for improvement of detected problems, (3) communication of therapy changes to the patient by pharmacists or GPs. The supporting material comprised a summary of the prevailing guidelines, protocols on performance of the project steps within study time, supporting material with templates for letters to GP's and patients and check lists for therapy evaluation. The care program encouraged pharmacists to pay attention to improvement of the inhalation technique, the possibility to stop suboptimal medication, the suitability of devices, and compliance with maintenance therapy. After finishing all steps according to protocol, IG pharmacists received a fee for GSK of 50 Euro per patient with a maximum of 40 patients per project. Furthermore they were reimbursed for the fee of 200 Euro for use of the web-based tool from SFK.

Outcome measures

According to prevailing clinical guidelines potential problems indicating suboptimal drug use were defined (Supplement 1) and translated into algorithms (Supplement 2). Within the SFK database, patients with use of asthma and COPD medication could be identified by an

anonymous code, sex and year of birth. The web-based reporting system was accessible for each pharmacy of the IG through the internet by a personal login code and pre-filled with information derived from data pharmacists routinely delivered to SFK. Pharmacists and patients data were coded and anonymous for the researchers. The Supervisory Board of SFK approved these procedures.

The primary outcome was HDT of antibiotics or corticosteroids. According to guidelines HDT is used for short time treatment of asthma or COPD exacerbations. HDTs indicate poor disease control. Consequently a reduction in the number of HDTs is a proxy for as improvement in disease control.

19 items for suboptimal treatment according to the guidelines for GPs on asthma [28] and COPD [27] were defined (Supplement 1). Changes between study start and end were used for secondary outcomes. They addressed the following topics: overuse of short acting beta-mimetic drugs (SABD), suboptimal maintenance therapy with long acting beta-mimetic drugs (LABD), suboptimal co-medication, inappropriate inhalation technique or use of inappropriate inhalation devices and poor adherence.

Data analysis

The characteristics of pharmacies and patients within IG and CG were compared with Chi Square T-tests. For the primary outcome, the number of oral HDT with corticosteroids or antibiotics was compared between the selected patients in the IG and patients of the CG group with a linear multi-level regression analysis. As secondary outcomes, each of the 19 potential problems was compared for persistence at study end between IG and CG with logistic multi-level analysis. By using these mixed models we accounted for the fact that patients were clustered within specific pharmacies. We adjusted on pharmacy level for the number of annually dispensed records, the number of pharmacists and the degree of urbanity. On patient level, our models accounted for age, sex and the number of all problems related to asthma or COPD drug use at study start. As all problems were relevant within COPD as well as within asthma patients, our analysis did not stratify for these patient groups unless sub analyses within the strata would change our results. *P* values below 0.05 were taken as significant. Data were analyzed with SPSS 19.0 (IBM Corp., Chicago, USA) and MLWin (2.25).

Results

Intervention and control group

Hundred and seven pharmacies participated in the IG group. At study start they covered a total of 102,497 users of asthma

Table 1 Characteristics of pharmacies with difference between participated intervention pharmacies and control pharmacies

Characteristics at baseline	Intervention group N = 107	Control group N = 105	P value for difference
<i>Number of pharmacists per pharmacy</i>			
1	1	51	0.75
2	50	36	
3	36	12	
4	12	5	
5	6	1	
<i>Number of prescriptions</i>			
<74,000	40	40	0.94
74,000–105,000	33	32	
>105,000	34	33	
<i>Degree of urbanity</i>			
Highest	20	20	0.90
High	37	37	
Moderate	18	17	
Low	21	21	
Lowest	10	10	

or COPD medication. The vast majority (99 %) of this group had at least one of the 19 potential problems for inappropriate drug use at study start. Pharmacists in the IG group selected 3,757 patients for comprehensive pharmacy care in order to improve medication treatment. 105 control pharmacies were derived from the SFK database with a total of 105,507 users of asthma and COPD medication as control patients. Tables 1 and 2 show the characteristics for the IG and CG pharmacies and their patients respectively. As the CG group was composed of pharmacies comparable to the IG

pharmacies by number of annually dispensed prescriptions, degree of urbanity and number of employed pharmacists, groups did not differ for these characteristics. However, it is noted that the IG tended to have higher numbers of employed pharmacists per pharmacy than the CG. Patient populations in CG and total IG did not differ according to sex, age, number of drugs in chronic use and number of signalized problems with asthma and COPD medication at study start. However, patients selected for comprehensive care, the selected IG, were older (58 years compared to 47 years, Table 2), used a higher number of medications chronically (5.6 compared to 3 drugs) and had a higher mean number of problems detected (6.7 compared to 3.5 problems) compared to patients in the CG. Furthermore IG patients had a higher mean number of HDT treatments at study start compared to CG patients. This number was specifically increased in selected IG patients.

Primary outcome

For the selected IG patients, the mean absolute numbers of HDT decreased on average by an additional 0.54 HDT-treatments compared to CG patients (Table 3). In post hoc analyses, we found that this reduction was mainly due to patients without concomitant maintenance therapy with ICS with an additional reduction of HDT by 0.92 (95 % CI 0.58–1.25). In patients with concomitant ICS therapy, the number of oral HDT increased by 0.79 (95 % CI 0.23–1.36). We also detected that ICS therapy had been started in 10 % of those patients with a decreasing number of HDT. On the other hand, 10 % of the patients with an increase of HDT were no longer using ICS at study end.

Table 2 Characteristics of patients in intervention and control group and within patients in the intervention group selected for comprehensive pharmacy care

Characteristics at baseline	Control Group: asthma/COPD patients N = 105,507	Intervention group: total asthma/COPD patients N = 102,497	Intervention group: selected asthma/COPD patients N = 3,757	P-value for difference between the patient group of CG and total IG	P-value for difference between patient group of CG and selected IG
Female sex (% of whole group)	57,281(54.3)	56,002 (54.6)	2,119 (56.4)	0.11	0.011
Average age in years (Standard deviation, SD)	46.9; (25.3)	47.0 (25.0)	58.0 (20.1)	0.74	<0.0001
Mean number of chronic medications per patient (SD)	3.0 (3.7)	3.0 (3.7)	5.6 (4.4)	0.37	<0.0001
Mean number of total potential problems per patient (SD)	3.5 (2.7)	3.5 (2.7)	6.7 (3.2)	0.67	<0.0001
Mean number of HDT treatments (SD) per patient	0.27 (1.72)	1.16 (3.52)	3.53 (6.80)	<0.0001	<0.0001

Table 3 Differences in changes in number of High Dose Treatment (HDT) as proxy for exacerbations in asthma/COPD patients during study period, compared between selected IG and CG

Problems in asthma or COPD medication	CG N = 105,507	IG selected patients N = 3,757	IG all patients N = 102,497	Additional mean number of changes in HDT between CG and selected IG ^a
Mean number of HDT (SD) at study start	0.27 (1.72)	3.53 (6.80)	1.16 (3.53)	−0.54 (−0.86 to −0.21)
Mean number of HDT (SD) at study end	0.17 (1.43)	2.71 (6.80)	0.87 (3.40)	
Mean number of change in HDT at study start and end (95 % CI)	−0.11 (1.37)	0.81 (4.21)	−0.29 (2.59)	
1. Subanalysis	CG: 91,949 asthma/COPD patients without concomitant use of inhalation corticosteroids	IG: 1,705 selected asthma/COPD patients without concomitant use of inhalation corticosteroids	IG total: 54,012 asthma/COPD patients without concomitant use of inhalation corticosteroids	Additional mean number of changes in HDG between CG and selected IG ^a
Mean number of HDT (SD) at study start in patients without concomitant use of inhalation corticosteroids	0.12 (1.04)	3.37 (6.56)	0.86 (2.73)	−0.92 (−0.58–1.25)
Mean number of HDT (SD) at study end in patients without concomitant use of inhalation corticosteroids	0.06 (0.81)	2.29 (6.39)	0.51 (2.47)	
Mean number of change in HDT ad study start and end (95 % CI)	−0.06 (0.87)	−1.08 (4.07)	−0.35 (2.17)	
2. Subanalysis	CG: 13,558 asthma/COPD patients with concomitant inhalation corticosteroids	IG: 2,052 asthma/COPD patients with concomitant use of inhalation corticosteroids	IG total: 48,485 asthma/COPD patients with concomitant use of inhalation corticosteroids	Additional mean number of changes in HDT between CG and selected IG ^a
Mean number of HDT (SD) at study start in patients with concomitant use of inhalation corticosteroids	1.34 (3.78)	3.66 (7.00)	1.49 (4.21)	0.79 (0.23–1.36)
Mean number of HDT (SD) at study end in patients with concomitant use of inhalation corticosteroids	0.92 (3.27)	3.07 (7.24)	1.27 (4.17)	
Mean number of change in HDT at study start and end (95 % CI)	−0.42 (3.05)	−0.59 (4.33)	−0.23 (2.99)	

^a Linear multilevel model with covariates on patient level: age, sex, number of detected problems at study start and covariates on pharmacy level: class of amount of dispensed medication, degree of urbanity, number of pharmacists employed

Secondary outcomes

In Table 4, the absolute numbers of patients detected at study start are given for each of the 19 potential drug related problems, separately for the selected IG patients and for all users of asthma and COPD medication from IG and CG pharmacies. For the selected IG patients, 14 from the 19 problems decreased to a higher extend than for CG patients. These decreases were statistically significant for the use of obsolete medication (acetylcysteine, cromoglicic acid or nedocromil) by 35 % (95 % CI

6–54 %), the use of contra-indicated co-medication (a)selective beta-blockers with by 61 % (95 % CI 38–75 %) and the use of powder inhalers in elderly patient by 29 % (95 % CI 13–42 %). Also for the total group of users of asthma or COPD medication in the IG, the prevalence for all potential drug problems decreased with a range of 25–41 %, except for the use of para-sympathicomimetics. The detected higher decreases in problems in all patients of IG compared to CG patients were statistically significant for all items, except for the cessation with LABD.

Table 4 Changes in problems with asthma/COPD medication during study period, compared between intervention Group (IG) and control group (CG)

Problems in asthma/COPD medication	IG selected patients N = 3,757 Number of patients ^a t = 0 (%)/number of patients t = 1 (%)	IG all patients N = 102,497 Number of patients [8] (%) / number of patients t = 1 (%)	CGN = 105,507 Number of patients [8] (%) / number of patients t = 1 (%)	Selected IG compared with CG ^d Odds Ratio (95 % CI) ^{b/} number of patients t = 1 (%)	Total IG compared with CG ^d Odds Ratio (95 % CI) ^{b/} number of patients t = 1 (%)
A. Overuse of a short acting betamimetic drugs (SABD)					
1. >2 inhalations SABD per week without inhalation corticosteroid (ICS)	478 (12.7)/307 (8.2)	3,259 (3.2)/2,858 (2.5)	3,349 (3.2)/3,100 (2.9)	1.02 (0.84–1.25)	0.79 (0.71–0.87)
2. >2 inhalations SABD per day without ICS	308 (8.2)/183 (4.9)	1,894 (1.8)/1,442 (1.4)	2,039 (1.9)/1,852 (1.8)	0.81 (0.63–1.04)	0.73 (0.64–0.83)
3. >2 inhalations SABD per week with ICS	887(23.6)/745 (19.8)	8,638 (8.4)/7,412 (7.2)	8,534 (8.1)/8,448 (8.0)	0.96 (0.83–1.11)	0.70 (0.66–0.75)
4. >2 inhalations SABD per day with ICS	640 (17.0)/527 (14.0)	5,744 (5.6)/4,932 (4.8)	5,788 (5.5)/5,665 (5.4)	0.91 (0.77–1.08)	0.72 (0.66–0.77)
B. Suboptimal maintenance therapy					
5. Usage of maintenance dosage of LABD without concomitant use of ICS	151 (4.0)/106 (2.8)	1,618 (1.6)/1,121 (1.1)	1,926 (1.8)/1,549 (1.5)	1.04 (0.73–1.49)	0.74 (0.65–0.85)
C Suboptimal (co-) medication					
6. Use of acetylcysteine, cromoglicic acid or nedocromil	161 (4.3)/108 (2.9)	1,743 (1.7)/1,245 (1.2)	1,796 (1.7)/1,506 (1.4)	0.65 (0.46–0.94)	0.61 (0.42–0.88)
7. Use of (a)selective beta blockers	89 (2.4)/61 (1.6)	1,579 (1.5)/1,100 (1.1)	1,514 (1.4)/1,280 (1.2)	0.39 (0.25–0.62)	0.63 (0.54–0.73)
8. Use of NSAID's or salicylic acid	1,221 (32.5)/943 (25.1)	18,901 (18.4)/13,763 (13.4)	20,006 (19.0)/16,620 (15.8)	0.89 (0.79–1.01)	0.75 (0.72–0.78)
9. Use of opioids or codeine	513 (13.7)/375 (10.0)	7,208 (7.0)/5,246 (5.1)	7,332 (6.9)/6,117 (5.8)	0.97 (0.81–1.18)	0.84 (0.78–0.90)
10. Use of parasympathomimetics	16 (0.4)/15 (0.4)	375 (0.4)/319 (0.3)	388 (0.4)/306 (0.3)	1.60 (0.53–4.82)	1.04 (0.77–1.38)
D Inappropriate technique or use of inhalation devices					
11. Concomitant use of different devices, powder inhaler and aerosol	1072 (28.5)/372 (9.9)	11,479 (11.2)/9,036 (8.8)	12,139 (11.5) 6,232 (5.9)	0.95 (0.83–1.08)	0.74 (0.70–0.78)
12. Use of orofaryngeal antimycotics in combination with ICS	45 (1.2)/25 (0.7)	489 (0.5)/384 (0.4)	508 (0.5)/431 (0.4)	0.47 (0.19–1.19)	0.61 (0.42–0.88)
13. Use of powder inhalator in elderly patients (>75 years)	477 (12.7)/372 (9.9)	6,771 (6.6)/5,153 (5.0)	6,975 (6.6)/6,232 (5.9)	0.71 (0.58–0.87)	0.59 (0.50–0.69)
14. Use aerosol without (new) spacer	674 (17.9)/458 (12.2))	9,876 (9.6)/6,615 (6.5)	10,674 (10.1)/8,405 (8.0)	0.87 (0.74–1.02)	0.76 (0.72–0.81)
E Poor adherence					
15. LABD: covered days <80 or >120 %	715 (19.0)/539 (14.3)	11,880 (11.6)/9,604 (9.4)	12,025 (11.4)/11,711 (11.1)	0.90 (0.78–1.05)	0.66 (0.63–0.70)
16. LABD: probably stopped	225 (6.0)/204 (5.4)	6,904 (6.7)/3,846 (3.8)	6,993 (6.6)/4,391 (4.2)	1.26 (0.77–2.06)	0.88 (0.76–1.02)
17. ICS: covered days <80	945 (25.2)/716 (19.1)	18,945 (18.5)/15,445 (15.1)	19,142 (18.1)/18,591 (17.6)	0.89 (0.78–1.02)	0.69 (0.67–0.72)
18. ICS: covered days >120 %	569 (15.1)/505 (13.4)	9,971 (9.7)/7,546 (7.4)	10,155 (9.6)/8,730 (8.3)	1.14 (0.95–1.36)	0.81 (0.76–0.85)

Table 4 continued

Problems in asthma/COPD medication	IG selected patients N = 3,757 Number of patients ^a t = 0 (%)/number of patients t = 1 (%)	IG all patients N = 102,497 Number of patients [8] (%) number of patients t = 1 (%)	CGN = 105,507 Number of patients [8] (%) number of patients t = 1 (%)	Selected IG compared with CG ^d Odds Ratio (95 % CI) ^b / number of patients t = 1 (%)	Total IG compared with CG ^d Odds Ratio (95 % CI) ^b / number of patients t = 1 (%)
19. ICS: probably stopped	200 (5.3)/175 (4.7)	5,442 (5.3)/3,803 (3.7)	5,443 (5.2)/4,516 (4.3)	0.86 (0.45–1.64)	0.72 (0.61–0.86)

Bold values indicate a significant change in problem in IG compared with CG

^a Numbers of patients per potential inappropriate medication use (PIM) at study start; Linear regression analysis, mixed models for numbers at study end, adjusted for age and sex

^b Odds Ratio for the additional chance of IG patients with the PIM at study start to have this PIM prevalent at study end compared to CG patients

^c Odds Ratio for the additional chance of selected IG patients with the PIM at study start to have this PIM prevalent at study end compared to CG patients

^d Logistic multilevel model with covariates on patient level: age, sex, number of detected problems at study start and covariates on pharmacy level: class of amount of dispensed medication, degree of urbanity, number of pharmacists employed; Linear regression analysis, mixed models for numbers at study end, adjusted for age, sex and number of problems at study start

Discussion

This study showed that a pharmacist-led intervention in regular primary care had positive effects on the drug treatment in patients with asthma or COPD. As an overall measure on treatment stability, the mean number of HDTs decreased in patients with additional pharmaceutical care. We noted that patients selected by IG pharmacists were older, had more medication in chronic use, showed more potential drug related problems and a higher mean number of HDT at study start compared to CG patients. Obviously IG pharmacists tried to pay specific attention to those patients poorest disease control. In order to address bias of our results by regression to the mean, we adjusted in our analysis for the number of problems at study start. On the other hand, the higher prevalence of potential treatment related problems might have moved the results of our study to more conservative outcomes as treatment improvements in more complex patients might be more difficult to achieve. Subanalysis showed that decrease in HDT were mainly due to start of maintenance therapy with ICS in those patients who lacked HDT at study start. The benefit of concomitant ICS in treatment stability is also in line with the finding that a substantial number of patients with an increase of HDT at study end had stopped ICS use. From the 19 specific problems on use of asthma and COPD inhalation medication mainly problems on suboptimal pharmacotherapy and suboptimal inhaler devices were improved by additional pharmaceutical care from the intervention program.

Interestingly, benefits of the structured pharmacy care programs in IG pharmacies were not limited to those patients explicitly selected by pharmacists for additional care. *For the HDT, there were also differences in favor for the total IG, but to a lesser extend for the selected IG. This was in line with our expectations that all patients from the IG would benefit from the intervention. Among those patients, those who were directly selected would have most benefit from the intervention. Moreover,* nearly all of the 19 potential problems decreased additionally compared to regular care with CG by 25–41 % for the total patient group within the IG. Possibly alertness of pharmacists and GPs for specific medication problems was not restricted only to those patients who were specifically selected for an intervention.

The reimbursement of pharmacy care did not favour certain outcomes as participating pharmacists were paid for the inclusion of patients and finishing of the care program and not on the type of intervention. Our results support earlier findings on the improvement of disease control in patients with asthma or COPD as a result of pharmacy care programs [1, 10]. [31] To our knowledge, this is the first to study that systematically measured effects of a pharmacy led intervention on 19 potential medication related problems for asthma or COPD patients in a population based care setting.

However our study has a number of limitations. First we did not dispose over information on clinical outcomes such as lung function measurements and therefore had to use drug use patterns as proxies for treatment stability. Second IG pharmacists were not randomly selected but could apply for the IG when meeting the inclusion criteria. As these comprised among others an established good cooperation with their GPs, the IG probably consisted of pharmacists with better communication skills and more interest in pharmacy care. Consequently our results in first instance apply to those pharmacists. We tried to find comparable pharmacies for the CG and furthermore to adjust for differences in our analysis, however, our matching criteria were limited to those available in the database. Furthermore patients for comprehensive pharmaceutical care were selected by the pharmacists of the IG group. We tried to adjust for differences in patient's characteristics and number of potential problems at study start from the CG by our analysis but cannot exclude residual bias. However, we demonstrated benefits of the IG interventions for all IG patients with comparable characteristics to CG patients.

Conclusion

Within a structured pharmacy care program, community pharmacists who are interested in pharmaceutical care for asthma and COPD and have a good cooperation with GPs, substantially improved treatment regimens for their asthma and COPD patients. Improvements were mainly due to initialisation and adherence to maintenance therapy, cessation of suboptimal medication and suboptimal inhalation devices.

Consequently this care should be part of the pharmaceutical guidelines and become part of regular pharmaceutical care. Further research is needed to elucidate potential savings as a result of these interventions for potential reimbursement by healthcare insurers.

Acknowledgments The authors wish to thank the KNMP, SFK and GSK for their assistance to perform this study.

Funding GSK developed the web-based tool and provided a fee of 50 Euro per included patient, with a maximum of 40 patients per asthma or COPD project. The analysis of all data done independent of GSK.

Conflicts of interest Romy de Groot is employed by GSK. GSK contributed financially to the internship of Stefan Ottebros.

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