Chapter 3

Computer-assisted medication review for asthmatic patients in community pharmacies as a basis for an intervention

Constructing and validating an algorithmic computer instrument in pharmacy practice

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Introduction

Patients suffering from tightness of the chest, as is the case in asthma, can be well treated with different types of drugs. In The Netherlands there are evidence-based guidelines for this treatment, established by the Dutch College of General Practitioners (Nederlands Huisartsen Genootschap 1997, revised in 2001), in which the use of drugs is shown to be progressively dependent on the severity of the illness (1,2). The pulmonologists have similar guidelines (3). The Dutch guidelines are developed for persons older than 13 years of age; there are special guidelines for children.

A brief survey of the different levels of asthma treatment in adults is shown in Figure 1. The first step is the inhalation of short-acting beta-2 agonists. In the second step a combination of short-acting beta-2 agonists and inhalation corticosteroids is introduced to reduce inflammation. Step three offers a choice between a combination of daily long-acting beta-2 agonists and a larger quantity of corticosteroids. Step four combines both drugs and ipratropium or the systemic use of drugs such as corticosteroids or theophylline. Revision of the Dutch guidelines in 2001 did not influence this stepwise approach. These guidelines are familiar to most Dutch general practitioners (GPs), pulmonologists and pharmacists.

Although asthma treatment will initially be prescribed according to the guidelines, patient compliance is often a problem. Therefore these patients use their medicines suboptimally and are not treated according to the guidelines. In this study the principle is endorsed that the recommended treatment will lead to better clinical outcomes and that the suboptimal use of asthma treatment by patients can result in the worsening of symptoms and in a poor long-term prognosis (4 – 6).

In The Netherlands, patients often consult several physicians, but usually have their prescriptions filled at the same community pharmacy. All Dutch pharmacies use a computer system to register all prescriptions dispensed to an individual patient; this system provides an almost complete overview of a patient’s medication (7).

The responsibilities of a Dutch pharmacist include dispensing the correct medicine, the evaluation of a new medication in relation to the patient’s current medication, medication surveillance and the instruction of the patient in the use of a new medication or special device (8).
Figure 1 The long-term management of asthma among adults: Treatment using the stepwise approach (25)

Step 1: Intermittent
- Inhalation of short-acting beta2-agonists as needed but less than once a week

Step 2: Mild persistent
- Daily medication of inhaled corticosteroids (low dose) or cromones
- Inhalation of short-acting beta2-agonists as needed, not to exceed 3-4 times in one day

Step 3: Moderate persistent
- Daily medication of either increased dose of inhaled corticosteroids or combination with inhaled long-acting beta2-agonists
- Inhalation of short-acting beta2-agonists as needed, not to exceed 3-4 times in one day

Step 4: Severe persistent
- Daily medications of inhaled corticosteroids (high dose) and inhaled long-acting beta2-agonists or ipratropium or sustained-release theophylline (oral corticosteroid long term)
- Inhalation of short-acting beta2-agonists as needed

Continuous symptoms, frequent exacerbations, frequent nighttime asthma symptoms >3-4 inhalations of short-acting beta2-agonists in one day

Symptoms daily; nighttime asthma > 1 time a week
>3-4 inhalations of short-acting beta2-agonists in one day

CNA = if control is not achieved
If control is not achieved, consider step up

When control has been sustained for at least 3 months, a gradual stepwise reduction in treatment may be possible
Normally, when a problem of any kind occurs with a prescription, the pharmacist will contact the prescribing physician, seeking authority to solve the problem (9). The patient will therefore start the use of a new medication correctly.

Nevertheless, there can be a gap between the long-term goals of asthma management and the result of the treatment (10). Especially when drug therapy does not produce the intended therapeutic outcome, it can result in drug-related morbidity (11).

By reviewing the complete medication record of a patient the pharmacist can assess whether the drugs are prescribed according to the guidelines and to the registered doses.

Using pharmaceutical care protocols, the pharmacist can support his patients during long-term drug use (12-14) and improve patient compliance, thus achieving the optimum efficacy with as few as possible or no adverse effects: optimum pharmacotherapy. Our aim was to identify patients receiving asthma treatment who may especially benefit from a medication review.

The research presented here is part of the IPMP study (Interventions on the principle of Pulmonary Medication Profiles), which investigates the role of Dutch community pharmacists in counselling individual patients concerning the treatment of their asthma or the use of their pulmonary drugs. The IPMP study will also demonstrate how pharmacists working as health care professionals collaborate with GPs and specialists.

The purpose of the present research is to construct an instrument that will detect patients who exhibit non-adherent behaviour when judged against the asthma guidelines or the registered dose by the use of patients’ medication records (15,16), and to validate the selection profiles composed by the computer instrument as indicators for theoretically suboptimal pulmonary drug use by patients.

Materials and Methods

Outline
The medication records of pulmonary patients in one Dutch community pharmacy were reviewed in order to determine deviant drug use compared with asthma guidelines and the registered doses. Different selection profiles as indicators for deviant pulmonary drug use were composed and
transformed into an algorithmic computer instrument. This selection method was tested in four community pharmacies and confirmed in a consensus meeting.

**Study population.**
Patients older than 13 years of age using four or more prescriptions of any of the drugs recommended for the treatment of asthma (anatomical therapeutic chemical (ATC) classification index code R03 [17]) during a period of one year and registered in the pharmacy computer were included in this study.

A maximum age of 40 years was maintained because of the fact that chronic obstructive pulmonary disease (COPD) is an indication for the use of these drugs by older people. By selecting those patients with four or more prescriptions only those receiving long-term therapy were taken into account rather than those with incidental respiratory infections.

**Levels in asthma treatment according to the Dutch guidelines.**
The treatment guidelines for asthma patients follow four progressive levels (Figure 1).

The use of pulmonary drugs in any level can be expressed per pharmacological drug-group (listed in Table 1) in DDDs (defined daily doses [17]) over a fixed period, indicating the numerical differences in doses of various drugs to be used in the four levels.

**Table 1**  *Drugs used in the treatment of asthma in the Netherlands in 1998*

<table>
<thead>
<tr>
<th>Pharmacological drug group</th>
<th>ATC codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short-acting beta-2 agonists</td>
<td>R03 AC 02/03/04</td>
</tr>
<tr>
<td>Long-acting beta-2 agonists</td>
<td>R03 AC 12/13</td>
</tr>
<tr>
<td>Combination: Fenoterol + Ipratropiumbromide</td>
<td>R03 AK 03</td>
</tr>
<tr>
<td>Combination: Salmeterol + Fluticasone</td>
<td>R03 AK 06</td>
</tr>
<tr>
<td>Corticosteroids by inhalation</td>
<td>R03 BA 01/02/05</td>
</tr>
<tr>
<td>Anticholinergics by inhalation</td>
<td>R03 BB 01</td>
</tr>
<tr>
<td>Cromones</td>
<td>R03 BC 01/03</td>
</tr>
<tr>
<td>Oral adrenergics</td>
<td>R03 CC 02/03/04</td>
</tr>
<tr>
<td>Theophylline</td>
<td>R03 DA</td>
</tr>
</tbody>
</table>
As summarized in Figure 1, the use of short-acting beta-2 agonists is limited. When a patient requires more than the recommended dose of medication within a level, he must be advised on and assisted in the use of drugs in the next level. Correct profiles of drug use in one year can be defined for each level. Patients deviating from the recommended profiles can be identified as being “at risk” of suboptimal drug use. The deviant profiles are listed in Table 2.

**Table 2**  
*Deviant profiles according to the step by step treatment of asthma as shown in Figure 1*

<table>
<thead>
<tr>
<th>Deviant profile</th>
<th>Description of use</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>To step 1</strong></td>
<td>The use of &gt; 2 inhalations of short-acting beta-2 agonists a day during more than 4 weeks without anti-inflammatory drugs (corticosteroids or cromones by inhalation)</td>
</tr>
<tr>
<td></td>
<td>The use of oral adrenergic drugs longer than 6 weeks</td>
</tr>
<tr>
<td><strong>To step 2</strong></td>
<td>The use of &gt; 3 to 4 inhalations of short-acting beta-2 agonists a day with too low, or non-daily use of anti-inflammatory drugs or with moderate use (= 1DDD) of anti-inflammatory drugs</td>
</tr>
<tr>
<td><strong>To step 3</strong></td>
<td>The use of &gt; 3 to 4 inhalations of short-acting beta-2 agonists a day with daily and regular use of anti-inflammatory drugs, but without long-acting beta-2 agonists by inhalation</td>
</tr>
<tr>
<td></td>
<td>The use of long-acting beta-2 agonists without the corresponding use of corticosteroids by inhalation</td>
</tr>
</tbody>
</table>

An algorithmic computer instrument was developed to identify these patients automatically, based on deviant profiles, expressed in DDDs, concerning the pharmacological subgroups of the different steps.

*Constructing the instrument*  
To conceptualize the instrument one community pharmacist compared his personal view concerning the drug use of asthma patients with the above defined profiles for the duration of one year, taking into account the amount and the combinations of drugs having ATC code R03.
This resulted in a list of patients who had had deviant drug use in that year according to the professional experience of the community pharmacist.

The data of this pharmacy were also transferred to the InterAction database of the Department of Social Pharmacy and Pharmacoepidemiology of the University of Groningen (18). This database contains the data of all patients and their dispensed drugs since 1994, as registered in twelve community pharmacies (N= 152000) for pharmacoepidemiological research.

Asthma medication prescribed to patients during a period of one year (in this study 1998) can be assigned the appropriate DDD value concerning all pharmacological subgroups.

In addition to the total amount of DDDs of drugs used, the number of inhalations of short-acting beta-2 agonists by one patient during that year was of interest. This was calculated as follows: two inhalations using some device and in an adult dosage (powder capsules, Rotadisks ®, metered dose inhalers and multi dose powder inhalers such as Turbuhaler ® or Diskus ®) were counted as one “device DDD” (dDDD), independent of the amount of drug in one dose.

We also counted two inhalations of the dosage strengths used by children as one dDDD for persons of 13 to 20 years old.

<table>
<thead>
<tr>
<th>Device: Salbutamol mcg</th>
<th>DDD</th>
<th>Equivalent of 2 inhalations</th>
<th>Calculation factor</th>
<th>dDDD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyclocaps 400</td>
<td>800 mcg</td>
<td>800 mcg</td>
<td>1</td>
<td>800 mcg</td>
</tr>
<tr>
<td>Rotacaps ® 400 *</td>
<td>800 mcg</td>
<td>800 mcg</td>
<td>1</td>
<td>800 mcg</td>
</tr>
<tr>
<td>Rotadisk ®400</td>
<td>800 mcg</td>
<td>800 mcg</td>
<td>1</td>
<td>800 mcg</td>
</tr>
<tr>
<td>Diskus ®200</td>
<td>800 mcg</td>
<td>400 mcg</td>
<td>2</td>
<td>400 mcg</td>
</tr>
<tr>
<td>MDI 200</td>
<td>800 mcg</td>
<td>400 mcg</td>
<td>2</td>
<td>400 mcg</td>
</tr>
<tr>
<td>Turbuhaler® 100 *</td>
<td>800 mcg</td>
<td>200 mcg</td>
<td>4</td>
<td>200 mcg</td>
</tr>
</tbody>
</table>
In addition for young people 13-20 years

<table>
<thead>
<tr>
<th>Device: Salbutamol mcg</th>
<th>DDD</th>
<th>Equivalent of 2 inhalations</th>
<th>Calculation factor</th>
<th>dDDD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyclocaps 200</td>
<td>800 mcg</td>
<td>400 mcg</td>
<td>2</td>
<td>400 mcg</td>
</tr>
<tr>
<td>Rotacaps ® 200 *</td>
<td>800 mcg</td>
<td>400 mcg</td>
<td>2</td>
<td>400 mcg</td>
</tr>
<tr>
<td>Rotadisk ® 200</td>
<td>800 mcg</td>
<td>400 mcg</td>
<td>2</td>
<td>400 mcg</td>
</tr>
<tr>
<td>MDI 100</td>
<td>800 mcg</td>
<td>200 mcg</td>
<td>4</td>
<td>200 mcg</td>
</tr>
<tr>
<td>Turbuhaler ® 50 *</td>
<td>800 mcg</td>
<td>100 mcg</td>
<td>8</td>
<td>100 mcg</td>
</tr>
</tbody>
</table>

*Available in the Netherlands till May 2001

The calculations of the dDDDs are summarized in Table 3. The prescriptions for salbutamol exceed the other two short-acting beta-2 agonists, terbutaline and fenoterol (90.3 % versus 8.5 % or 1.2 % in 1998); therefore only salbutamol is used in this calculation.

To develop the computer instrument the expertise of the staff of the InterAction database was used: different searches of the pharmacy data have been made utilizing changing combinations and amounts of the drugs used in order to select the same patients as the consulting pharmacist had chosen. This information was then used to develop selection profiles as an instrument for detecting patients with, in theory, suboptimal pulmonary drug use based on the experience of the consulting pharmacist. These selection profiles are listed in Table 4 with the corresponding drug doses expressed in DDDs or dDDDs.

Selection profile X represents the disproportionately high use of any drug by inhalation, namely three or more times the average dose.

In selection profile A patients can be found with a certain number of inhalations of short-acting beta-2 agonists without anti-inflammatory drugs such as inhalation corticosteroids, as recommended in level 2 of Figure 1.
It is very important to stratify these patients as soon as possible. In this case, profile A, the number of dDDD’s was reduced to 250 so that those just beginning therapy would be included in the selection.

Table 4  The computer instrument: selection profiles as indicators for theoretically suboptimal pulmonary drug use

<table>
<thead>
<tr>
<th>Annual profile</th>
<th>Description</th>
<th>Validated</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Any drug by inhalation</td>
<td>≥ 950 dDDDs or DDDs</td>
</tr>
<tr>
<td>A</td>
<td>Short-acting beta-2 agonists without Corticosteroids by inhalation</td>
<td>&gt; 250 dDDDs or DDDs</td>
</tr>
<tr>
<td>B</td>
<td>Short-acting beta-2 agonists + Corticosteroids by inhalation</td>
<td>≥ 350 dDDDs or DDDs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤ 300 DDDs</td>
</tr>
<tr>
<td>C</td>
<td>Short-acting beta-2 agonists + Long-acting beta-2 agonists + Corticosteroids by inhalation</td>
<td>≥ 350 dDDDs or DDDs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤ 300 DDDs</td>
</tr>
<tr>
<td>D1</td>
<td>Short-acting beta-2 agonists without long-acting beta-2 agonists + Corticosteroids by inhalation</td>
<td>≥ 350 dDDDs or DDDs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; 300 DDDs</td>
</tr>
<tr>
<td>D2</td>
<td>Short-acting beta-2 agonists + Long-acting beta-2 agonists + Corticosteroids by inhalation</td>
<td>≥ 350 dDDDs or DDDs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; 300 DDDs</td>
</tr>
<tr>
<td>E</td>
<td>Long-acting beta-2 agonists without corticosteroids by inhalation</td>
<td>&gt; 100 DDDs</td>
</tr>
<tr>
<td>F</td>
<td>Long-acting beta-2 agonists (lab) + Corticosteroids (cort) by inhalation</td>
<td>&gt; 250 DDDs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; Ratio 6 lab/5 cort</td>
</tr>
<tr>
<td>G</td>
<td>Oral adrenergics</td>
<td>&gt; 50 DDDs</td>
</tr>
</tbody>
</table>

Patients in selection profiles B and C use fewer inhalation corticosteroids than is recommended in level 2 of Figure 1. They have an average use of short-acting beta-2 agonists of more than two daily inhalations over the whole year (≥ 350 dDDDs). Selection profile C patients are also treated with long-acting inhalation beta-2 agonists.
Patients in selection profiles D1 and D2 use more than two daily inhalations of short-acting beta-2 agonists although they have a daily intake of higher doses of corticosteroids (> 300 DDDs). Patients in profile D1 are not treated with long-acting beta-2 agonists whereas those in profile D2 are.

In the case of the other two short-acting beta-2 agonists (terbutaline and fenoterol), patients using > 250 DDDs were placed in selection profile A and those using > 350 DDDs were placed in the other profiles.

Patients using long-acting beta-2 agonists but having no concomitant use of anti-inflammatory drugs as is recommended (1-3) in the treatment of asthma are placed in selection profile E.

Patients using long-acting beta-2 agonists on a long-term basis without a corresponding amount of corticosteroids are placed in selection profile F. Fixed amounts of DDDs are not used in this profile; a ratio of 6 to 5 between DDDs of long-acting beta-2 agonists and corticosteroids is utilized to express concomitant drug use.

Patients using oral adrenergics are placed in selection profile G.

Validation
These selection profiles as indicators for theoretically suboptimal drug use by patients were validated in four different community pharmacies participating in the InterAction database. In these pharmacies with an estimated total population of 60390 there were 3962 users of pulmonary drugs in 1998. These pharmacies were selected because their pharmacists were experienced in the evaluation of drug data, were knowledgeable about the drug use of their patients and had experience in consulting the prescribing physician, if necessary, as well as in informing the patient about the use of the medication.

In each pharmacy all patients between 13-40 years of age, having four or more prescriptions for pulmonary drugs in one year, were selected (in total N= 332) and listed, showing the different pharmacological subgroups used and the corresponding number of DDDs or dDDDs. Simultaneously, the four pharmacists were asked to make a list of possible asthma patients who had suboptimal drug use according to their professional experience, and whose drug files were located in their own pharmacy computer.
To validate these indicators the individual lists of the four pharmacists were compared with the selection of the instrument, as shown in Table 4, using the InterAction database. This stratification is shown in Figure 2.

Figure 2  Stratification of patients in profiles made by the computer instrument

Patients in the 4 pharmacies in 1998

Patients with asthma medication

Study population aged 13-40 years

With 4 prescriptions or more

Selected by the computer instrument

N = 60390

N = 3962

N = 1107

N = 332

First division): 102

Second division): 20

Profile X = 19
Profile A = 28
Profile B = 36
Profile C = 7
Profile E = 5
Profile F = 7
Profile D1 = 16
Profile D2 = 4
Profile G = 0

*) Terms ‘first and second division’ are explained under ‘results’.

During a consensus meeting with the four participating community pharmacists all variations concerning agreement on further details of the
selection profiles were discussed. The selection profiles were grouped in two divisions to indicate different levels in suboptimal treatment.

Data analysis
In all 332 cases the results of the computer instrument were compared with those of the pharmacist to see whether a patient had suboptimal drug use. The results of the four pharmacies were summed up and then classified according to the different profiles.

As in a diagnostic test the positive and negative predictive value of the instrument profiles can be calculated, using the pharmacist’s own judgement as “gold standard” (26).

A positive predictive value indicates the probability that all patients who are at risk of suboptimal drug use according to the judgement of the pharmacist are actually selected by the computer instrument. In the same way, a negative predictive value indicates the probability that those patients who are not at risk are not selected.

The calculation formulas are shown in Box 1.

Box 1  Formulas of positive predictive value and negative predictive value

\[
\text{Positive predictive value} = \frac{a}{a + b} \times 100\%
\]

\(a = \) ‘selection made by the computer instrument and agreed on by pharmacists’

\(b = \) ‘selection made by pharmacists but not selected by the computer instrument’

\[
\text{Negative predictive value} = \frac{d}{c + d} \times 100\%
\]

\(d = \) ‘not selected by both computer instrument and pharmacists’

\(c = \) ‘selection made by the computer instrument but not agreed on by pharmacists’
Results

The goal of the validation was to determine the predictive value of the selection profiles as indicators for theoretically suboptimal drug use by asthma patients. The results are shown in Table 5.

**Improved Instrument**

Selection profile X, representing a disproportionately high use (1000 DDD = about three times the usual amount) of any drug by inhalation, occurred in all four pharmacies. The four pharmacists selected all patients selected by the instrument, resulting in 100% negative predictive value. However, they also selected two more patients, resulting in 89% positive predictive value. The reduction of the amount of DDDs to 950, thus improving the positive predictive value to 100%, was agreed upon in the consensus meeting.

In regard to selection profile A, representing more than 2 daily inhalations of short-acting beta-2 agonists without concurrent inhalation of corticosteroids, the positive predictive value was 81% and the negative predictive value was 98%. All pharmacists agreed on a reduced level of 250 (d)DDD versus 350 (d)DDD in the other profiles; therefore this (d)DDD level was not altered in the consensus meeting.

All pharmacists were of the same opinion concerning selection profiles B and C, both of which utilize a low dosage of inhalation corticosteroids and concurrent daily use of short-acting beta-2 agonists. The positive predictive value was 100% and the negative predictive value was 99%.

There were only a few patients using long-acting beta-2 agonists as monotherapy, as is shown in profile E. Although the pharmacists had a different opinion in one case, no reason was found to change the low number of DDDs of long-acting beta-2 agonists.

More discussion was necessary concerning the long-acting beta-2 agonists and the low dosage of inhalation corticosteroids. All pharmacists agreed upon the new dosage levels of drugs used: the positive and negative predictive values were 100% after validation.

The profiles X, A, B, C, E and F, all identifying patients at risk of suboptimal use of asthma medication, selected 102 out of 332 patients in four community pharmacies (see Figure 2). This indicates that approximately 30% of the patients evaluated in this study were theoretically at risk of
### Table 5  Validation of the Instrument
*Total number of selected asthma patients (aged 13 – 40 years) in four pharmacies: N = 332*

<table>
<thead>
<tr>
<th>Selection Profile</th>
<th>Population</th>
<th><strong>Cell a</strong> 1) Instrument + Pharmacist +</th>
<th><strong>Cell c</strong> 2) Instrument + Pharmacist –</th>
<th><strong>Cell d</strong> 3) Instrument – Pharmacist –</th>
<th><strong>Cell b</strong> 4) Instrument – Pharmacist +</th>
<th>Positive predictive value 5)</th>
<th>Negative predictive value 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>332</td>
<td>19</td>
<td>0</td>
<td>313</td>
<td>0</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>A</td>
<td>313</td>
<td>22</td>
<td>6</td>
<td>280</td>
<td>5</td>
<td>81</td>
<td>98</td>
</tr>
<tr>
<td>B</td>
<td>313</td>
<td>32</td>
<td>4</td>
<td>270</td>
<td>0</td>
<td>B+C: 100</td>
<td>B+C: 99</td>
</tr>
<tr>
<td>C</td>
<td>313</td>
<td>7</td>
<td>0</td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>313</td>
<td>4</td>
<td>1</td>
<td>308</td>
<td>0</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>F</td>
<td>313</td>
<td>6</td>
<td>1</td>
<td>306</td>
<td>0</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td><strong>First Division</strong></td>
<td><strong>332</strong></td>
<td><strong>90</strong></td>
<td><strong>12</strong></td>
<td><strong>225</strong></td>
<td><strong>5</strong></td>
<td><strong>95</strong></td>
<td><strong>95</strong></td>
</tr>
<tr>
<td>D1</td>
<td>313</td>
<td>12</td>
<td>4</td>
<td>293</td>
<td>0</td>
<td>D1+D2: 100</td>
<td>D1 + D2: 98</td>
</tr>
<tr>
<td>D2</td>
<td>313</td>
<td>2</td>
<td>2</td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>313</td>
<td>0</td>
<td>0</td>
<td>313</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>All Profiles</strong></td>
<td><strong>332</strong></td>
<td><strong>104</strong></td>
<td><strong>18</strong></td>
<td><strong>205</strong></td>
<td><strong>5</strong></td>
<td><strong>1</strong></td>
<td><strong>95</strong></td>
</tr>
</tbody>
</table>
suboptimal drug use. The positive and negative predictive values of all profiles together were 95%.

These profiles have been grouped as the first division: patient drug use in the case of a physician-confirmed asthma probably has to be changed with regard to the dispensed drugs.

In level 3 of the asthma treatment all pharmacists selected patients who may have problems with their disease (profiles D1 and D2). Although the opinions were not always similar to the results of the computer instrument, all pharmacists agreed on the levels of medication used in the defined combinations.

There were no patients using oral adrenergic drugs on a regular basis (profile G). All pharmacists were of the opinion that, in general, oral administration was not preferred.

The profiles D1, D2 and G together were grouped as the second division to indicate that the drug treatment may be optimized after consultation with the physician.

Discussion and conclusion

During this study an algorithmic computer instrument was constructed to identify patients having theoretically deviant drug use when compared with the different prescription levels of the Dutch asthma guidelines. The identification is based on nine different selection profiles, grouped in two divisions.

\[ \text{Positive predictive value} = \frac{a}{a + b} \times 100\% \]

\[ \text{Negative predictive value} = \frac{d}{c + d} \times 100\% \]

1) ‘selection made by the computer instrument and agreed on by pharmacists’
2) ‘selection made by the computer instrument but not agreed on by pharmacists’
3) ‘not selected by both computer instrument and pharmacists’
4) ‘selection made by pharmacists but not selected by the computer instrument’
5) \[ \text{Positive predictive value} = \frac{a}{a + b} \times 100\% \]
6) \[ \text{Negative predictive value} = \frac{d}{c + d} \times 100\% \]
7) one person selected by the pharmacists with a different profile but not deviant from the guidelines
8) seven persons selected by one pharmacist with low use of corticosteroids, but not deviant from the guidelines
7) and 8) are not included in the final analysis
The computer instrument was tested in four community pharmacies, comparing the professional judgement of the pharmacists with the computer results. These comparisons were used as a basis to improve the selection profiles, thereby stratifying all possible asthma patients aged 13-40 years having theoretically suboptimal drug use. The result is a computer-assisted medication review to select patients at risk of suboptimal treatment.

The positive and negative predictive values were both 95% in the first division, indicating that the selection made by the computer was in agreement with the selections made by the pharmacists. In other words, the chance of false-positive results is 5%. The results in the second division were comparable.

These results are much better than the positive predictive value (19%) of the computer-based models described by Lieu in which patients at risk of asthma-related hospitalization and emergency department visits were identified (19).

Using our computer assisted medication review, the pharmacist has an opportunity to provide pharmaceutical care to those patients who need it most. In this way the selection profiles resemble the idea of medication indicators of preventable drug-related morbidity such as those described by Mackinnon and Hepler (20) for older adults in 2002.

The suboptimal use of drugs may occur for different reasons. The patients’ disease may be in recession or perhaps the patients have little knowledge of the drugs they use (21), their disease or the long-term prognosis. The dosage schedule or the use of special devices, such as a respiratory inhaler (22) can also present problems. The pharmacist can counsel these selected patients concerning their problems and either help them himself or, in co-operation with the prescribing physician, change the pharmacotherapy. The goal is that an individual patient will be optimally treated both now and in the future.

In addition, “asthma” may not be the correct diagnosis and this may lead to the deviant use of medication. If a pharmacist were to have access to a patient’s diagnosis and medical data, the instrument could be improved. However, most pharmacists do not have this information. At this moment a record of the physician’s diagnosis, i.e., the reason for treatment, on the prescription is under discussion.
Chapter 3

All profiles encompass patients with a theoretically incorrect use of medication during the year of the investigation, based upon the drugs dispensed to one person by his pharmacy. It is possible that not all drugs were used consistently or concomitantly during this year, which is why in the intended IPMP-study direct intervention following the selection based on computer files (19,23,24) will not take place. Pharmacists will compare the selected patients in their pharmacy using their own files and their professional interpretation prior to an intervention (15,16).

Some interventions can be done by the pharmacist himself. In other cases the pharmacist must first consult the prescribing physician, thereby learning the true diagnosis and receiving his authorization, before changing the prescription. In this way the Dutch pharmacist can work as a health care professional in collaboration with the prescribing physician.

This research is the beginning of the IPMP-study to investigate the role of the Dutch community pharmacist in counselling individual patients concerning the treatment of their asthma. Following the use of this algorithmic computer instrument to review patient medication records, which can be found in the patients' pharmacy, a valid list of patients with medication problems can be made with a predictive value of 95%.

**Next steps of the IPMP study:**

The IPMP study is intended to improve the drug therapy of individual asthma patients thus improving their wellbeing.

Using the pharmaceutical care protocols developed for the IPMP study, pharmacists can provide support to those patients selected by the computer instrument concerning the treatment of their asthma as well as improve the patients’ knowledge of their disease, the medication used or the use of device(s) necessary to administer medication.

Should a change in treatment be necessary, the pharmacist himself or the pharmacist in co-operation with the physician will be able to assist in attaining the optimal use of medication, leading to better treatment of the disease and a favourable long-term prognosis. The investigation is designed as a randomized controlled trial concerning 999 patients in 24 community pharmacies in The Netherlands during a period of one year (2001-2002).
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