

Estimation of severe drug-drug interaction warnings by medical specialist groups for Austrian nationwide eMedication

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Keywords

Drug interactions, medical informatics, public health informatics

Summary

Objective: The objective of this study is to estimate the amount of severe drug-drug interaction warnings per medical specialist group triggered by prescribed drugs of a patient before and after the introduction of a nationwide eMedication system in Austria planned for 2015.

Methods: The estimations of interaction warnings are based on patients' prescriptions of a single health care professional per patient, as well as all patients' prescriptions from all visited health care professionals. We used a research database of the Main Association of Austrian Social Security Organizations that contains health claims data of the years 2006 and 2007.

Results: The study cohort consists of about 1 million patients, with 26.4 million prescribed drugs from about 3,400 different health care professionals. The estimation of interaction warnings show a heterogeneous pattern of severe drug-drug-interaction warnings across medical specialist groups.

Conclusion: During an eMedication implementation it must be taken into consideration that different medical specialist groups require customized support.

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Introduction

Electronic health records (EHRs) and digitally available medical documentation are used by an increasing number of health care professionals (HCPs) to offer patient-specific decision support. Especially drug safety alerts that avoid adverse drug events (ADEs) are seen as crucial in patient safety [1] and help to reduce medication errors [2]. To analyze inadequacies in prescribing, a systematic review of the efficacy of computerized drug alerts was conducted in [3].

Austria is introducing the nationwide shared EHR system “Elektronische Gesundheitsakte” (ELGA) [4] that will start in 2015. Beside laboratory reports, radiology reports and hospital discharge letters, a patient medication history is electronically available. The patient medication list is called “eMedication” in Austria and includes all the prescriptions dispensed to a patient (including prescriber and the dispenser). This enables HCPs to see the prescriptions from their colleagues, which as a consequence should prevent drug-drug interactions (DDIs) and reduce ADEs.

Offering eMedication on a nationwide scale follows a European trend. For example in Denmark and Sweden nationwide eMedication systems have been in use since 2002 [5] and studies show a decrease of unintentional medication discrepancies with potential for patient harm [6]. Furthermore, eMedication can enhance the workload and disrupt the workflow of HCPs due to inflation of interaction warnings [7].

The aim of this study is to estimate the number of severe DDI warnings triggered by the prescriptions from a single HCP in comparison to the number of interaction warnings when prescriptions are available in a shared EHR System from other HCPs. The data source for the estimate was a research database maintained by the Main Association of Austrian Social Security Organizations, which includes anonymized prescription claims data from all Austrian social insurance carriers in 2006 and 2007, and covers about 7.9 million Austrians, 1.7 million of whom are in our study cohort. Besides data of outpatient and inpatient care, data about medication (information about billed prescriptions including the prescriber and dispenser of the drug) are stored.

Methods

In order to estimate the number of DDI warnings for the different HCP groups, the research database of the Main Association of Austrian Social Security Organizations was used as the starting point for analysis. ► Fig. 1 shows how the study cohort was extracted from the research database. The initial study cohort in the database contained 7.9 million patients and was reduced to 1.7 million patients because only three health insurance companies documented the exact date of the drug dispensing, which was necessary to calculate DDIs. The study cohort was further restricted to patients having at least one prescription between July 1, 2006 and June 30, 2007, the one-year time period we focused on, and who were between 20 and 99 years of age. Only HCPs that treated more than 30 cohort patients were used to reduce the effect of mismatching of HCPs in the creation of the research database.

A prescription in the context of this paper refers to the number of packages of a single drug prescribed to a specific patient, at a specific time, from a specific HCP. In order for two prescriptions to result in an interaction warning, one prescription had to have a dispensing date in the time period between July 1, 2006 and June 30, 2007. The second prescription also had to have a date including the lead time of 1.5 quarters. For each prescription, the theoretical duration of intake was calculated using the ATC-DDD classification [8] taking into consideration the prescribed packages. This specific period of time needed to overlap with the prescription of the second drug. Where no theoretical duration of intake was documented (i.e. no defined daily dose was assigned to the ATC-Code), a period of 30 days was assumed. If the time periods of two prescriptions overlapped, the Austria Codex [9] was used to calculate interaction warnings. The Austria Codex categorizes the DDI warnings into minor, moderate, and severe interactions. In this analysis, only severe DDIs, which may cause permanent damage or may be life-threatening were considered. Depending on the prescribed drug in the prescription, one ATC-Code is assigned. This code is allocated to a substance group of the Austria Codex that is used to calculate a DDI warning.

The number of DDI warnings a HCP receives is calculated either by comparing the current prescription to the previous prescriptions of the same HCP (i.e. without eMedication) or by comparing it with all previous prescriptions of all HCPs (i.e. with eMedication).

Results

The 26.4 million prescriptions prescribed in Austria resulted in 11.7 million DDI warnings; of those, 66,788 were severe DDI warnings. For our further analysis, we focused on the median number of severe DDI warnings depending on the medical specialists group. Thus, we chose 12 groups of medical specialists with the most HCPs assigned. The 3,365 Austrian healthcare providers had more than 30 patients: 1,572 (46.8%) from Lower Austria, 944 (28.1%) from Carinthia, 762 (22.7%) from Salzburg and the remaining 77 (2.4%) were split between the other 6 Austrian provinces. Out of 3,365 HCPs, 2,620 were assigned to these 12 groups, with 1,412 (53%) general practitioners. In ► Table 1, for each medical specialist group the median number of patients and the median number of prescription are listed.

In ► Table 2, the estimates for severe DDI warnings depending on the visited medical specialists group before the introduction of the eMedication system are shown. Of all HCPs, only some HCPs actually triggered severe DDI warnings and only those were included in ► Table 2. In ► Table 3 estimates of severe DDI warnings per medical specialist groups are shown if the prescriptions from other HCPs are considered (with eMedication) additionally. Depending on the medical specialists group, the median number of severe DDI warnings varies considerably. Pharmacies are confronted with the highest number of warnings. Among the primary care physicians and specialists, general practitioners yield the most warnings. A total of 1,260 out of 1,412 general practitioners had patients with severe DDI warnings without eMedication; with eMedication, 1,280 general practitioners were affected. The median number of severe DDI warnings for general practitioners is 7 without eMedication and 9 with eMedication. In the medical specialist group internal medicine, 96 HCPs (77%) received severe DDI warnings before eMedication and 114 (91%) with eMedication. The median number of DDI warnings increased from 2 to 4. In the Group Ophthalmology and Orthopedics, only 1 (1%) and 2 (3%) of the HCPs received severe DDI warnings before eMedication, whereas 53 (47%) and 36 (53%) received one with eMedication. Pulmonologists face the highest increase of DDI warnings with eMedication (without eMedication 0 warnings, with eMedication 4).

Discussion

The data presented indicate a heterogeneous pattern of severe DDI warnings across medical specialist groups in Austria following the introduction of eMedication. As expected, pharmacies were confronted with the highest amount of DDI warnings. This is due to the fact that independent of the health care provider visited by the patient, the prescriptions were dispensed by the pharmacy. The pharmacies could be seen as the second line of defense for patient safety. General practitioners were already confronted with more DDI warnings than the other medical specialist groups and will face an increase of 2 DDI warnings per year after the introduction of eMedication. The biggest change for patient safety is expected with medical specialist groups that are not frequently visited by patients. These medical specialist groups only have a very limited view on concomitant prescriptions.

A centralized interaction check is not planned in the forthcoming ELGA (see §16 in [10]) and the responses of HCP to warnings will not be documented. As a result if a warning is classified as irrelevant by a HCP, this information is not passed to the other HCP of the patient. A centralized interaction check would result in more consistency.

The described estimate is based on anonymized health claims data of the years 2006 and 2007 hence the estimates reflect the number of severe DDI warnings of these years and not of the year 2015 when the eMedication system will be available in Austria. Using routine data could help to complement results from other studies [11]. The advantage of covering a whole population, or in our case, a significant part, stands in opposition to the fact that other important information was not documented in the health claims data. For example, no dosage or duration of intake, or the number

of over-the-counter drugs (OTCs) sold directly to a consumer without prescription, are documented in the research database. Only the relevant information for accounting and billing purposes is available. Since only prescriptions with the exact date of dispensing could be used, only patients from three out of the nine Austrian provinces are represented in our study cohort, hence a generalization of the results to the behavior of Austrians as a whole cannot be made directly.

This work is a follow-up to a preliminary study [12], where we analyzed ADEs based on the diagnoses of hospitalizations and which combination of prescriptions frequently lead to DDI warnings. Again, this estimate is limited by potential overestimation and underestimation. The underestimation may result from the fact that no prescriptions from hospitals are documented and no OTC drugs are considered. Moreover, we have an overestimation because many prescriptions were never actually dispensed or taken by patients [13]. The theoretical duration of intake was not available in many cases, in 50% of the triggered DDI warnings the default value of 30 days was used. The average theoretical duration of intake, where no default value was available, was only 20 days. Our default value of 30 days could lead to an overestimation, which should be considered in future estimates. Additionally, an overestimation might occur if prescriptions are from the same day since no order of prescription can be deduced and both combinations are checked. This mainly applies to prescriptions from the same HCP. Further, the median numbers of DDI per HCP have to be interpreted with care. For example, for ointments or other external applied drugs information about the defined daily dosage is not meaningful and the theoretical duration of intake cannot be calculated.

Our study showed that the secondary use of routine data can complement previous studies, and the results can help to raise awareness of patient safety. As seen in [14], the number of ADEs is coupled with the size of the study cohort. Since our cohort size was quite large, the rate of increase is meaningful.

A nationwide eMedication system may help prevent severe DDI and improve patient safety. During an eMedication implementation, it must be considered that the number of DDI warnings depends on the medical specialist group. Medical specialist groups with a high number of warnings have to be counseled regarding the importance of drug prescription safety.

Since only a small number of specific DDIs are responsible for the majority of warnings [15], we plan to further analyze which specific groups of DDIs were mainly responsible for the detected DDI warnings and if certain DDI groups can be prioritized.

Clinical Relevance

The presented data helps to estimate the effect of nationwide eMedication systems on the number of severe DDIs. The number of severe DDIs varies between medical specialist groups, and this must be considered when implementing drug safety alert systems.

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Conflict of Interest

G. Endel is an employee of the Main Association of Austrian Social Security Organisations. There is no other declarable conflict of interest.

Human-Subject Protections

The procedures used have been reviewed in compliance with the ethical standards of the responsible committee on human experimentation

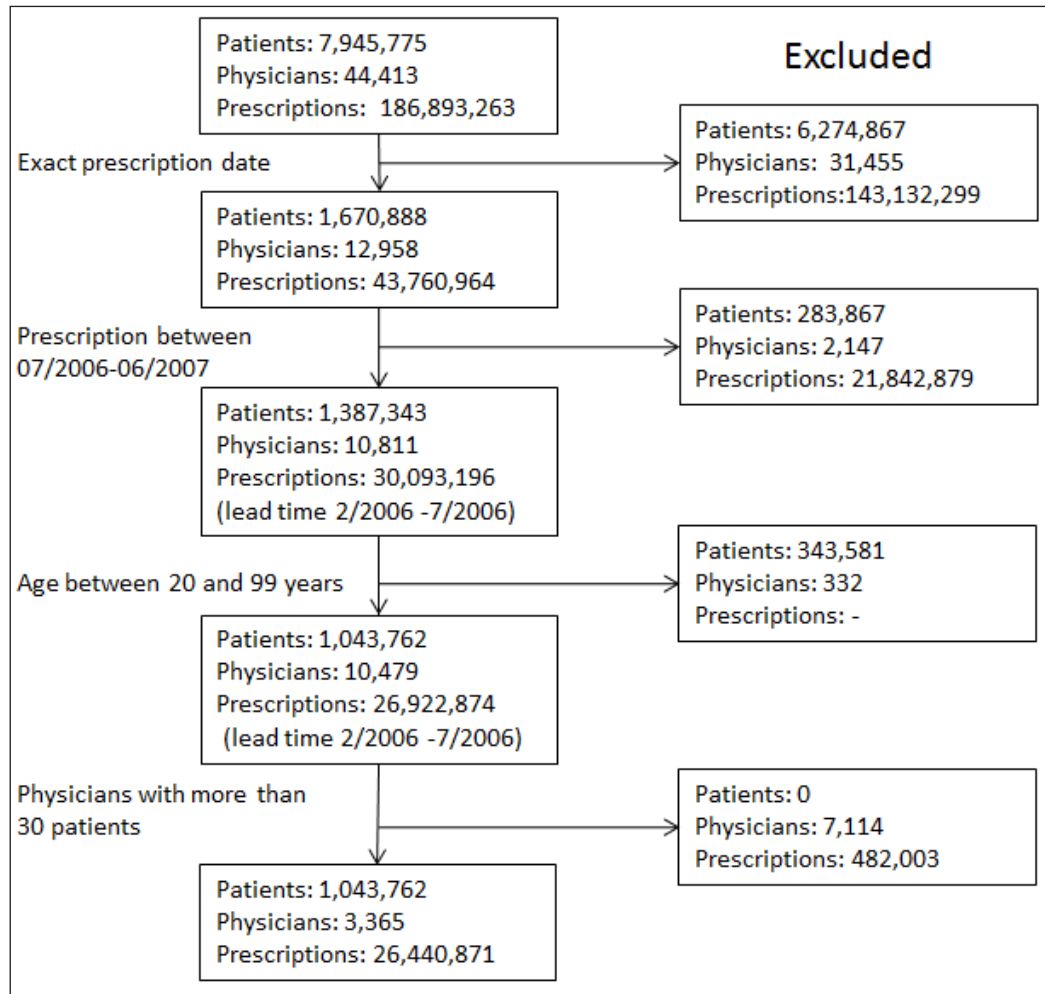


Fig. 1 Inclusion and exclusion criteria and the effects on the study cohort

Table 1 Number of HCP in the study cohort, including the number of patients and number of prescriptions

Medical Specialist Group	No. of HCP	No. of Patients per HCP			No. of Prescriptions per HCP		
		1st Qu.	Median	3rd Qu.	1st Qu.	Median	3rd Qu.
General Practitioner	1,412	676	1,020	1,349	10,683	16,352	22,285
Ophthalmology	113	344	460	636	1,341	1,917	2,525
Surgery	58	133	251	534	324	622	946
Dermatology	75	1,256	2,084	2,627	3,553	5,612	8,306
Gynecology and Obstetrics	167	332	660	913	697	1,588	2,407
Internal Medicine	125	372	618	950	2,625	5,311	8,754
Otorhinolaryngology	65	694	988	1,448	1,240	1,967	3,186
Pulmonology	44	694	1,084	1,475	2,487	2,790	4,710
Neurology and Psychiatry	71	299	664	1,028	1,920	4,938	7,644
Orthopedy	68	463	778	1,007	1,312	1,892	2,924
Pharmacy	376	3,414	5,228	7,572	39,663	55,258	78,426
Urology	46	647	857	1,091	2,124	2,819	3,666
Sum	2,620						

Table 2 Number of HCP in the study cohort with severe DDI warnings without eMedication including their number of patients and number of prescriptions

Medical Specialist Group	No. of HCP	No. of Patients per HCP			No. of prescriptions per HCP			Median number of severe DDI warnings per HCP		
		1st Qu.	Median	3rd Qu.	1st Qu.	Median	3rd Qu.	1st Qu.	Median	3rd Qu.
General Practitioner	1,260	788	1,086	1,382	12,566	17,296	23,152	4	7	11
Ophthalmology	1	244	244	244	905	905	905	0	0	0
Surgery	4	234	473	716	842	1,348	2,156	0	0	0
Dermatology	3	3,128	3,441	3,793	10,714	13,046	15,520	0	0	0
Gynecology and Obstetrics	7	700	1,177	1,502	2,088	2,696	3,462	0	0	0
Internal Medicine	96	502	731	997	3,995	6,103	9,386	1	2	4
Otorhinolaryngology	3	873	1,012	1,188	2,086	2,244	2,572	0	0	0
Pulmonology	10	822	1,126	1,440	4,170	4,638	5,541	0	0	1
Neurology and Psychiatry	28	646	952	1,102	5,114	6,966	10,055	0	0	2
Orthopedy	2	652	861	1,069	2,575	2,914	3,252	0	0	0
Pharmacy	370	3,497	5,310	7,602	40,433	55,766	78,637	15	23	36
Urology	4	928	1,098	1,280	3,235	4,011	4,634	0	0	0
Sum	1,788									

Table 3 Number of HCP in the study cohort with severe DDI warnings with eMedication including their number of patients and number of prescriptions

Medical Specialist Group	No. of HCP	No. of Patients per HCP			No. of Prescriptions per HCP			Median Number of Severe DDI Warnings per HCP		
		1st Qu.	Median	3rd Qu.	1st Qu.	Median	3rd Qu.	1st Qu.	Median	3rd Qu.
General Practitioner	1,280	774	1,080	1,376	12,317	17,154	23,105	5	9	13
Ophthalmology	53	385	553	704	1,735	2,283	2,872	1	2	2
Surgery	23	314	552	775	902	1,121	1,750	1	3	4
Dermatology	37	2,066	2,571	3,072	5,404	7,593	9,362	1	2	3
Gynecology and Obstetrics	46	692	849	1,302	1,532	2,185	2,980	1	1	2
Internal Medicine	114	428	677	959	3,264	5,665	9,000	2	4	8
Otorhinolaryngology	39	713	1,012	1,584	1,210	2,169	3,620	1	2	3
Pulmonology	35	797	1,190	1,544	3,205	4,294	5,462	2	4	7
Neurology and Psychiatry	58	402	877	1,098	3,075	5,553	8,568	1	3	5
Orthopedy	36	729	945	1,189	1,819	2,352	3,208	1	1	2
Pharmacy	370	3,497	5,310	7,602	40,433	55,766	78,637	21	30	45
Urology	37	748	909	1,172	2,336	2,933	3,687	1	2	3
Sum	2,128									

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