

BMJ Open Evaluation of electronic prescription implementation in polymedicated users of Catalonia, Spain: a population-based longitudinal study

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ABSTRACT

Objectives: To assess whether electronic prescribing is a comprehensive health management tool that may contribute to rational drug use, particularly in polymedicated patients receiving 16 or more medications in the public healthcare system in the Barcelona Health Region (BHR).

Design: 16 months of retrospective study followed by 12 months of prospective monitoring.

Setting: Primary healthcare in BHR, Catalonia, Spain.

Participants: All insured patients, especially those who are polymedicated in six basic health areas (BHA). Polymedicated patients were those with a consumption of ≥ 16 drugs/month.

Interventions: Monitoring demographic and consumption variables obtained from the records of prescriptions dispensed in pharmacies and charged to the public health system, as well as the resulting drug use indicators. Territorial variables related to implementation of electronic prescribing were also described and were obtained from the institutional data related to the deployment of the project.

Main outcome measures: Trend in drug use indicators (number of prescriptions per polymedicated user, total cost per polymedicated user and total cost per prescription) according to e-prescription implementation.

Results: There was a significant upward trend in the number of polymedicated users, number of prescriptions and total cost ($p < 0.05$), which seemed independent from the implementation of electronic prescribing when comparing the preimplementation and postimplementation period. Prescriptions per user and cost per user showed a decrease between the preimplementation and postimplementation period, being significant in two BHAs ($p < 0.05$).

Conclusions: Results suggest that after the implementation of electronic prescribing, the rationality of prescribing in polymedicated patients improved. In addition, this study provides a very valuable approach for future impact assessment.

Strengths and limitations of this study

- This is a novel study that describes the implementation of an e-prescribing system in polymedicated users. It establishes many drug use indicators (demographic and consumption variables) and represents a very important step towards integral and integrated pharmaceutical management in health services.
- An economic impact study could not be carried out because it was still too early to attribute all observed changes to electronic prescriptions because their integration into all elements of the health system was not fully completed at the time of study.
- This is the first report showing results of drug use indicators in polymedicated patients with e-prescriptions. It provides a very valuable approach for future impact assessment.

INTRODUCTION

Rec@t is the electronic prescription system in the autonomous region of Catalonia (north-eastern Spain).¹ The Catalan Health Service has played an active part leading the development of the project, as guarantor of public health services that purchases and evaluates healthcare depending on the needs of the population.

Rec@t is a strategic healthcare project that aims to provide advantages concerning quality, accessibility, safety, efficiency, continuity of care and rational drug use.² The implementation of this system is a comprehensive health management tool that addresses the entire process involved in pharmaceutical services. This includes all aspects, from prescribing and dispensing in community pharmacies to the assessment and payment of benefits.³

It entails a different healthcare model than it had thus far, highlighting in particular the

elimination of paper-based prescribing. The key element that helps serve this task is the medication plan,¹ which is the printed sheet given to patients that contains all the information necessary to be able to follow the treatment correctly (ie, dose and frequency of administration). It facilitates the feedback between prescribers and dispensers, forming a new communication channel between them and helping to prevent medication errors and duplicities of treatment.^{2–4,6} Therefore, electronic prescribing is an important tool to control chronic patients, the elderly and polymedicated users, who generate the greatest interest because of their therapeutic complexity, high drug consumption and total cost for the healthcare system.^{7,8}

Rec@t implementation began in 2007 after an initial pilot experience in 2006, which proved the feasibility of the designed system. The progressive extension of electronic prescriptions started and reached 100% of the equipment target in late 2010.² Currently, it is considered fully complete in primary care, and in specialty care it has reached significant levels on the extent and volume of prescriptions issued and dispensed (98.33% of prescriptions were electronic in May 2014), so it is expected to be completed this year.⁹ Community pharmacies work entirely with electronic prescribing, given that more than 90% of prescriptions dispensed are already in electronic format. More than 12 500 physicians who have joined the system so far have made prescriptions to more than 5 million patients, reaching more than 275 million medications dispensed.^{1,9}

Regarding other Spanish autonomous regions, similar projects in electronic prescribing were already underway in primary care at the same time as in Catalonia, the most advanced of which were in Andalusia (southern Spain)¹⁰ and in the Balearic Islands (eastern Spain).¹¹ At an international level, it is noteworthy to mention experiences in Denmark,¹² Sweden¹⁰ and England,^{10,13} where healthcare organisations are involved in improving quality of prescriptions through e-prescribing systems along with Spain.⁹ The ultimate goal of these experiences is to be brought into a single overall system allowing interoperability in the near future, both nationally and throughout Europe.^{9,14,15}

From an international point of view, even though the electronic prescribing system involves a change of paradigm that will enable a better assessment of drug use, there is a lack of evidence reported in the literature in terms of health outcomes evaluation.

The aim of our study was to assess whether electronic prescribing may contribute to rational drug use, particularly in polymedicated patients receiving 16 or more medications in the public healthcare system in the Barcelona Health Region (BHR). These results will be useful to obtain prior information for future impact assessments of this technology on risk population.

METHOD

Design and setting of the study

This is a longitudinal study in a primary care setting, conducted on the general population and polymedicated patients in those basic health areas (BHAs) in BHR with the greatest cumulative grade of implementation in e-prescription between May and December of 2009. Monitoring included 16 months of retrospective study (January 2008–April 2009) and 12 months of prospective follow-up from the beginning of the implementation of Rec@t in BHR (May 2009) to April 2010. This was considered a sufficiently large analysis for the objectives to be achieved (28 months).

The Catalan healthcare model is decentralised to better know the health needs of the population and to develop a better relationship with providers in each health region and their respective BHAs. BHAs are the basic territorial units around which primary healthcare services are organised (areas or municipalities), according to the population's access to the services and the efficiency in organising health resources.^{1,16} In terms of prescriptions billing, during the period 2008–2010, the average of total prescriptions per year in Catalonia was 143 753 915±4 500 218 (99 786 576±1 251 654 in BHR). According to the average yearly number of prescriptions per capita and cost per prescription, both indicators were similar in Catalonia and BHR: 18.98±0.50 vs 18.94±0.78 and 13.24±0.18 vs 13.25±0.19, respectively.¹⁷

A polymedicated user in the present study was defined as someone receiving 16 or more drugs in a month, according to the Efficiency Indicators in Primary Care, which are periodically evaluated by an internal Management Committee in the Catalan Health Service (macromanagement level).¹⁸

Data source

The study used population data from 2008, 2009 and 2010 Catalonia censuses.¹⁷ Records of billed prescriptions were also utilised, based on paper as well as electronic prescriptions that were dispensed in community pharmacies and charged to the Catalan Health Service. This information was obtained by means of the personal healthcare card, the document that provides citizens with access to the centres, services and benefits of the public health system (these services include drugs subsidised by the Catalan Health Service).¹ This information is stored monthly in a computer system, which allows the design and gathering of information required for the management and monitoring of pharmaceutical services.

Prescriptions in paper format are usually issued for 3 months ('chronic patients programme' in primary care setting) and electronic prescriptions are usually issued for 12 months (maximum); at least once a year patients visit their doctor to renew them.

Polymedicated users were selected monthly, so polymedicated population varied throughout the whole study (28 months, which involved 28 data analysis). Owing to

the fact that each user had her/his own identification code, given by the personal healthcare card, subsequent analyses could be carried out so as to determine monthly duplicities of users.

Ethical statement

Ethics approval was not required since this was a secondary analysis of suitably anonymised data sets. It was not an experimental treatment, patients were not recruited. The study was unfunded.

Variables of the study

The variables used to analyse the implementation of e-prescription were as follows.

Territorial: number and percentage of BHAs implemented, percentage of primary care centres implemented, grade of implementation, number of general practitioners (e-prescription prescribers), percentage of general practitioners implemented, number of community pharmacies that dispensed electronic prescriptions and percentage of community pharmacies implemented. Grade of implementation is the percentage of electronic prescribing on the total number of prescriptions billed (sum of prescriptions on paper and electronic format) for a given month or a specific time period (cumulative implementation grade). Depending on the variable described, the grade of implementation is indicative of the deployment of electronic prescription in the territory (ie, in a given BHA) or the percentage of electronic prescriptions prescribed to an individual in a given period.

Demographic: number and percentage of users implemented, percentage of users with more than 50% of electronic prescriptions and percentage of users with more than 90% of electronic prescriptions, and number of polymedicated users implemented. By definition it is assumed that total percentage of users with electronic prescription includes those users with more than 50% and 90% implementation of electronic records, and that those users with more than 90% implementation rates are consequently also included in the user group with implementation greater than 50%.

Consumption: number of total prescriptions (sum of prescriptions on paper and electronic format), number and percentage of electronic prescriptions, and total cost of medications dispensed. Total cost refers to the total cost of medications dispensed (the amount of reimbursement by the Catalan Health Service plus the out-of-pocket amount paid by patients). Drug use indicators were calculated from the following variables: number of prescriptions per polymedicated user (total and electronic format), total cost per polymedicated user and total cost per prescription.

Literature review

A systematic search was conducted (April 2014) through the PubMed database to identify the available evidence on electronic prescribing related to polypharmacy and

health expenditure or cost analysis. The terms to run the search were located by the vocabulary Medical Subject Headings, with which the articles are indexed in the MEDLINE database. In order to complete this search and extend the results, additional searches combining free terms were also conducted. All search strategies (12) resulted in only 78 references. The studies identified through this search were evaluated by two independent reviewers to assess their inclusion in this document.

Data processing and statistical analysis

A database was designed. Analysis of variance and Student's t tests were used to determine the statistical significance ($p < 0.05$) of the differences using the SPSS V.20.0 statistics program. Regression testing was also performed in order to describe the tendency of the indicators relating to pharmaceutical services.

RESULTS

General population

According to internal data in the Catalan Health Service and coinciding with published information,¹⁹ the project achieved the implementation in 273 BHAs, representing 75% of the total territory in 2009. In December 2009, a cumulative total of 16 million electronic prescriptions dispensed was reached, adding more than 800 000 of the insured population and more than 5000 health professionals (3289 general practitioners and 2497 pharmacists). Taking into account the progressive inclusion of primary care teams of BHR in the project during December 2009, the deployment of e-prescribing in primary care settings was considered complete (13% of patients who needed a prescription received an electronic one, 67.4% of whom had more than 90% of their dispensed medications through e-prescribing). Therefore, electronic prescriptions could be dispensed throughout Catalonia.

In late 2009, 91% of primary care centres were prescribing electronically and the remaining 9% were under implementation of the tasks prior to incorporation, that is, adaptation of computer applications or training professionals.

During 2009, electronic prescription systems were implemented in 174 BHAs of BHR (82.1% of total BHAs in BHR). In total, 2 255 724 electronic prescriptions were billed, which accounted for 3% of total prescriptions billed. A total of 494 628 users were included (3% of total users with prescriptions in BHR). In the included BHAs, 1810 general practitioners (47% of total in BHR) prescribed in electronic format and 95.5% of community pharmacies in the territory dispensed prescriptions of this type.

Out of the 28 BHAs in BHR that implemented electronic prescribing in May 2009, only six reached the highest cumulative implementation grade (>25%) during the period May–December 2009.

General details on the number of total insured users assigned to each of the six BHAs and the percentage of total electronic prescriptions during the period May–December 2009 are shown in [table 1](#).

Polymedicated users

Data concerning e-prescription in polymedicated users in these BHAs are disclosed in [table 2](#). In the 28 months study period, the six BHAs met a monthly average of 169 ± 31 (min 89; max 238) polymedicated users. 1575 polymedicated users were analysed: 54.4% of them were polymedicated for only 1 month of the study; 4% of them were polymedicated for >10 months; there were no users being polymedicated for >20 months.

There was a significant upward trend in the number of polymedicated users, number of prescriptions and total cost ($p<0.05$), comparing the period January 2008–April 2009 with May 2009–April 2010. As depicted in online supplementary appendixes 1–3, the increase in those indicators seems independent from the implementation of electronic prescribing. Individually, five of the six BHAs showed this increase in those indicators, with the increase being significant in four of them ($p<0.05$). On the other hand, prescriptions per user and cost per user showed a decrease between the preimplementation and postimplementation period, whereas cost per prescription showed no variation. The decrease in prescription per user and cost per user was evident for overall as well as three of the six BHAs individually, with results being significant in two of them ($p<0.05$). A slight upward trend is observed graphically in those two indicators prior to the implementation of electronic prescription; after this point the overall trend was decreasing ([figures 1–3](#)).

DISCUSSION

In order to explain the results from the study conducted, it should be noted that this is an exploratory and longitudinal study about the implementation and deployment of electronic prescription in polymedicated users belonging to particular BHAs. Studying pharmaceutical services in polymedicated users using new technologies such as e-prescription may be important for health authorities; it could be a step forward in the monitoring of the high costs entailed and thereby help to manage chronic care patients more efficiently.^{18 20} Hence, this study was designed to describe the tendency of some drug use indicators in the studied population.

It was still early to conduct a proper impact analysis of electronic prescription on all implemented users and population subgroups (by age, gender, pathology, polymedicated users), because it would be essential that total deployment of electronic prescription and subsequent penetration into the population were fulfilled.^{10 21} The Catalan Health Service considered the deployment of electronic prescription in the territory finished in the primary care setting at the time of

Table 1 Detail on the number of total users, prescriptions and percentages in the six BHAs of study during the period May–December 2009

BHAs of prescription	Total users	Total prescriptions	Average number of prescriptions per user	Electronic prescriptions* (%)	Users with electronic prescriptions† (%)			Users >90% of electronic prescriptions‡ (%)
					Users with electronic prescriptions†	Users with >50% of electronic prescriptions‡ (%)	Users >90% of electronic prescriptions‡ (%)	
BHA 1	107 306	438 228	4.08	42.03	35 000	32.62	28.55	21.03
BHA 2	55 776	293 860	5.27	37.69	20 593	36.92	32.75	24.74
BHA 3	72 484	329 073	4.54	33.81	24 100	33.25	29.55	23.41
BHA 4	43 731	191 705	4.38	32.96	14 346	32.81	28.32	21.97
BHA 5	72 585	351 972	4.85	29.57	23 274	32.06	28.18	22.10
BHA 6	53 511	264 308	4.94	25.06	13 142	24.56	21.08	15.14
Total	405 393	1 869 146	4.61	34.20	130 455	32.20	28.20	21.50

*Percentage of electronic prescriptions=(total electronic prescriptions/total prescriptions) $\times 100$ =% cumulative implementation grade (>25%).

†Users with electronic prescriptions: users with at least one electronic prescription.

‡Percentage of users with electronic prescriptions=(users with electronic prescriptions/total users) $\times 100$.

Results were calculated from global cumulative data in each BHA.

BHA, basic health areas.

Table 2 Detail on the number of polymedicated users, prescriptions and related drug use indicators in the six BHAs during the postimplementation period May 2009–April 2010

BHAs of prescription	Polymedicated users	Electronic prescriptions	Total prescriptions	Electronic prescription (%)*	Average number of prescriptions per polymedicated user	Average cost per polymedicated user	Average cost per prescription
BHA 1	241	11 708	18 243	64.18	30.71±3.01	€ 404.02±48.25	€ 13.28±1.89
BHA 2	112	7497	12 149	61.71	31.44±1.97	€ 455.69±48.80	€ 14.52±1.53
BHA 3	297	6099	11 976	50.93	29.65±2.82	€ 467.32±70.36	€ 15.73±1.38
BHA 4	275	1995	4,026	49.55	30.57±3.83	€ 500.14±88.99	€ 16.41±2.34
BHA 5	284	3796	10 133	37.46	30.70±1.56	€ 503.95±70.23	€ 16.41±2.02
BHA 6	366	1322	5,554	23.80	32±3.36	€ 450.74±50.30	€ 14.10±0.79
Total	1575	32 417	62 081	52.22	30.73±1.96	€ 454.03±35.22	€ 14.79±0.98

Averages of monthly global data in the six BHAs were calculated for prescriptions/user, cost/user and cost/prescription.

All data included made reference to the whole prospective follow-up period (average data resulting from 12 months, postimplementation period).

*Percentage of electronic prescriptions=(total electronic prescriptions/total prescriptions)×100.

BHA, basic health areas.

study, but the truth is that all BHAs in Catalonia were not implemented. Impact studies could not be carried out until all BHAs were at least 80% implemented and had between 6 months and 1 year of experience with electronic prescription. In case of insured users, the implementation criterion could be considered as more than 90% of electronic prescriptions prescribed. In this sense, results derived from the measurement of indicators suggest previous approaches in our setting, and are essential to strengthen and guide any future evaluation of impact in primary care and in those areas where implementation is developing (specialty care, emergency departments, mental health centres and nursing homes).

There are currently no national published studies showing results in polymedicated populations as presented here. In the general population, some autonomous communities in Spain, which have been operating with e-prescription (ie, Andalusia, the Balearic Islands, the Community of Valencia, Galicia) have found that visits to professionals have been reduced by between 15% and 60% depending on the profile of the population being observed.^{10–22} However, it is difficult to measure in economic terms the savings to the health system generated by a reduction in the number of visits as this cannot yet be quantified precisely. What has been determined, although there is controversy in the published results, is that in many of these communities the switch to electronic prescriptions coincided with an increase in health spending, as well as in number of prescriptions issued and total cost per user,^{23–25} the latter differing from the results presented here (a decrease in cost per user between the preimplementation and postimplementation period was observed). The increase in drug expenditure may not always be significantly related to implementation of e-prescription, and could even be associated with the personal profile of users included in the e-prescription system and their health condition²³ (ie, polymedicated users). Furthermore, specialised reports on public pharmaceutical expenditure issues show that the fluctuation in the number of prescriptions always follows a seasonal pattern in Spain.²⁶ Throughout the year the number of prescriptions increases in January, June and October, mainly due to visits to physicians before (June) and after (January and October) the holiday period; this peak can also be observed for Easter holiday season (ie, March 2008 and 2010; April 2009). In addition, during the study period, the increase in prescriptions every April was due to the annual review of the reference pricing system by the government, which reduces the price of drugs from year to year. The new prices came into effect in May and therefore the market share of these products and the turnover rate in pharmacies increased (and, consequently, the number of patients and billed prescriptions) in the previous month. In either case, it is important to highlight that all these monthly increases are merely transitory and they are irrelevant in the medium–long-term evolution

Figure 1 Evolution of number of prescriptions per polymedicated user in the six basic health areas of study.

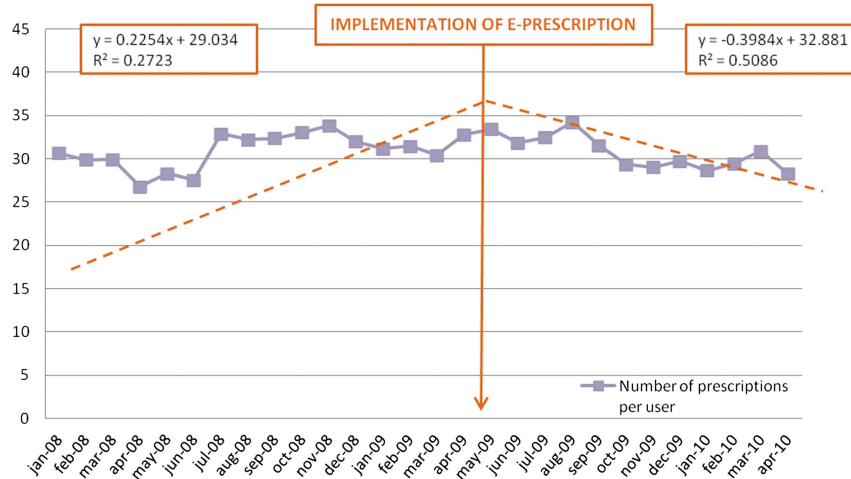


Figure 2 Evolution of total cost per polymedicated user in the six basic health areas of study.

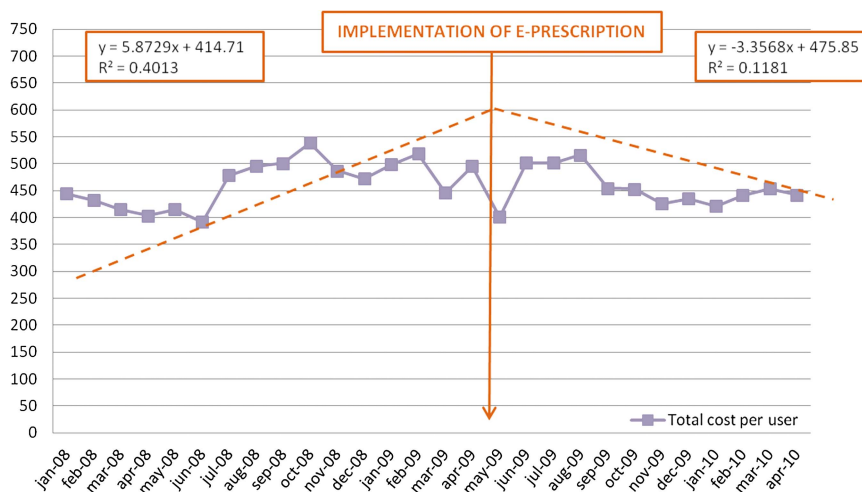
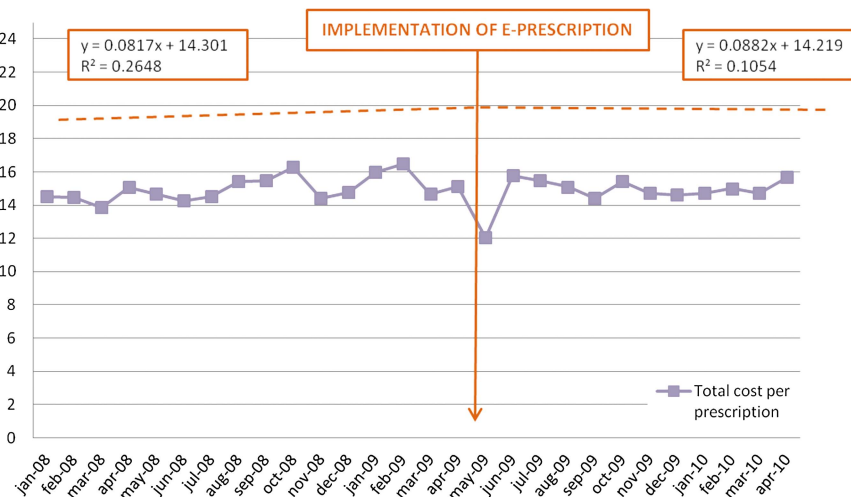


Figure 3 Evolution of total cost per prescription in polymedicated users in the six basic health areas of study.



of time series, so they do not set a trend only by themselves.

Internationally, there are studies that describe quantitatively the influence of e-prescribing on implementation of pharmaceutical services and other elements of the health system. These results are mainly related to

potential savings of e-prescribing (total cost of time taken by the practitioners, medical attendance, less equipment and operational costs).^{10-13 27} However, there are none that assess drug use indicators in polymedicated users and therefore comparable to the results obtained in the present study.

Qualitative results were mostly observed in the six BHAs selected. Those results were inherent to the development of electronic prescription over the territories (ie, increase in electronic prescribing and a decrease of the proportion of paper prescriptions). However, it is important to highlight that some quantitatively different aspects have been significant since the introduction of electronic prescribing in the territory in May 2009. This includes the decrease in the number of prescriptions per user, and total cost per user. In contrast, there was an increase in the number of prescriptions and the total cost, which could be attributed to the progressive deterioration of polymedicated users' health and the consequent need for more complex treatments such as the prescribing of therapeutic innovations, which are more expensive. In addition, duplication in the dispensation (due to coexistence of paper and electronic prescriptions in the same user) was also suggested as a cause of that increase.²⁸ It is noteworthy that the results of any health intervention begin to appear at least 1 year after its start, and in this regard it would be necessary to assess the evolution over the years 2010 and 2011 to see whether there are more significant changes on any of the measured indicators. The implementation of electronic prescribing was a dynamic process that followed different patterns depending on the time (different degree of implementation throughout the development, period of adaptation to the new tool), territory, providers (often there was variability between providers and even within the same provider), type of users (polymedicated/non-polymedicated, by age group, etc) and healthcare professionals, among others, which will hinder future development of common profiles and design of a model of this implementation globally.^{28 29} However, there were other specific factors that more directly influenced one of the indicators analysed: the case of the total cost (per user and per prescription), which could be affected by policies of rationalisation of medication (generic prescribing, standardised protocols)^{30 31} and changes in drug pricing (review of medication prices by the government), among others.

Study limitation

This is an exploratory, longitudinal study and may have an inherent bias common to this type of study. Furthermore, the period covered is short to establish causal relationships between e-prescribing and variations in drug use indicators. However, it gives hints of some trends that are essential to conduct future impact assessment studies and it could also provide evidence on this topic. This study was carried out in six BHAs because at the time of study they were those BHAs with the greatest implementation grade.

CONCLUSIONS

Results suggest that after the implementation of electronic prescribing (May 2009), the rationality of

prescribing in polymedicated patients improved. This study provides a very valuable approach for future impact assessment.

The electronic prescribing system allows the closest follow-up of drug use indicators in each stage (ie, number of prescriptions issued vs dispensed), so health professionals can control risk patients in terms of rational drug use, improving quality of services and health promotion.

Contributors IL-D collected the data, conducted the analysis and wrote the first draft of the manuscript. PM advised on design of the study, data analysis and helped revise the draft of the manuscript. PL-C helped in conducting the study and data analysis. CFL was involved in data analysis and helped revise the draft of the manuscript. JLS contributed expertise in interpretation and analysis and helped revise the draft manuscript. AG-P contributed to design the study and provided expertise in interpretation and analysis. ELM contributed to the study design, provided expertise in interpretation and analysis, and assisted in revising the draft manuscript. All authors reviewed and agreed on the submitted version of the manuscript.

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