Electronic prescription anomalies - A study of frequencies, clarification and effects in Finnish community pharmacies

Johanna Timonen[a] *, Saana Kangas[a], Hanna Kauppinen[a], Riitta Ahonen[a]

[a]School of Pharmacy/ Social Pharmacy, Faculty of Health Sciences, Kuopio Campus, University of Eastern Finland, P.O.B 1627, FI-70211 Kuopio, Finland

Email: Johanna Timonen – johanna.timonen@uef.fi; Saana Kangas – kangas.saana@gmail.com - Hanna Kauppinen – hanna.kauppinen@uef.fi; Riitta Ahonen – riitta.ahonen@uef.fi

Phone: +358 40 355 3881/Johanna Timonen, +358 44 342 8504/Saana Kangas, +358 40 355 3669/Hanna Kauppinen, +358 50 363 7902/Riitta Ahonen

*Corresponding author:

Johanna Timonen

School of Pharmacy / Social Pharmacy, Faculty of Health Sciences

Kuopio Campus, University of Eastern Finland

P.O.Box 1627, FI-70211 Kuopio, Finland

Phone: +358 40 355 3881

Email: johanna.timonen@uef.fi

Abstract

Objectives: To investigate the frequency of e-prescriptions containing prescription anomalies (=errors, ambiguities, and other shortcomings), and the types of e-prescription anomalies occurring in Finnish community pharmacies. Further objectives were to investigate how these anomalies were clarified, together with the time required, as well as the effects such anomalies had in the pharmacies concerned.

Methods: During the three-day study period in 2017, 54 community pharmacies reported all e-prescription anomalies found by pharmacists during medicine dispensing.

Key findings: Of the 41,170 e-prescriptions dispensed during the study period, 2,978 (7.2%) contained anomalies. The most common anomalies were the fact that the dosage instructions were written using abbreviations (63.7%) and that the purpose of the medicine was missing altogether (28.4%). In most cases where the e-prescription contained anomalies (85.9%) the anomalies were clarified. Most anomalies were clarified at the pharmacy by writing out the abbreviations in the dosage instructions (69.6%) or with the customer (23.4%). The average time taken by pharmacists to clarify the anomalies was 1.8 minutes per e-prescription. Anomalies caused problems in 39.6% of the cases. Most often, the anomalies increased the pharmacy's workload (55.9%) and it took longer to serve the customer (51.4%).

Conclusions: E-prescription anomalies are quite common in Finland, indicating that there is a need to improve the quality of e-prescribing. The e-prescribing system should be further developed to encourage prescribers to issue more complete e-prescriptions and in this way improve medication safety and make medicine dispensing easier and more efficient.

Keywords: electronic prescription, prescription anomaly, medication safety, dispensing, community pharmacy

Introduction

A medicine prescription is an important means of communication between physicians, pharmacists and patients. Prescriptions should therefore be correct, complete, clear, and unambiguous. A prescription that contains errors that make it incomplete or unclear may jeopardize medication safety or cause harm to the patient and additional work for healthcare personnel. [1-7] According to previous studies, prescribing is a common source of medication errors in outpatient care.[2,3,8]

Prescribing has been undergoing changes during the past few decades.[9-11] Traditional handwritten prescriptions were superseded by computer-based paper prescriptions at the beginning of the 21st century. Today, the most novel technology allows a paperless procedure in which prescriptions are not merely issued by computer, but also transmitted electronically from the physician to the community pharmacy for dispensing (e-prescriptions).[12] In addition, dispensing information is recorded electronically. Conventional paper prescriptions have several well-known problems that could be a risk to medication safety.[13] For example, illegible physician handwriting, errors in prescription details (e.g. medicine name, strength), and use of unclear abbreviations, while re-entering manually all the prescription details into the pharmacy data system could lead to misinterpretations, human errors in data transcription, and dispensing errors. These problems are expected to be eliminated or minimized by e-prescriptions.[8,13-15]

In recent years, the implementation of e-prescriptions has been assessed as a pharmaceutical policy reform in many countries. [10,11] A full e-prescription process in which every step from issuing the prescription to its dispensing is conducted electronically and is currently in nationwide use in a few European countries, among them being Sweden, Denmark, the Netherlands, Estonia, Iceland, Norway and Finland.[11] In addition, pilot projects are underway or under consideration in most other European countries. E-prescriptions are also widely used in the United States, Canada and Australia[16-18].

Several studies conducted in outpatient care settings have shown that e-prescriptions improve the quality and safety of prescribing, particularly by improving the legibility and clarity of prescriptions.[8,19-21] E-prescriptions have also reduced prescribing errors.[8,22,23] However, many studies report that e-prescriptions have not succeeded in eliminating or minimizing all types of errors and ambiguities in prescriptions, while at the same time creating new ones.[4,6,7,19,21,24-29] In the light of previous studies, the most common problems associated with

e-prescriptions have been incorrect or unclear dosage instructions and instructions for use,[6-9,19,25] missing prescription information,[7,8,24] incorrect medicinal product (e.g. medicine, strength, pharmaceutical form)[4,6,19], and the quantity or duration of therapy.[6,7,27]

In Finland (excluding the Åland Islands, which constitute an autonomous and monolingual Swedish region of Finland), a fully operational and nationwide e-prescription system has been introduced stepwise by law since 2012, and from the beginning of 2017, conventional prescriptions (paper, telephone) have been allowed only in special cases such as technical system failures.[30] In 2016, pharmacies (there are some 613 pharmacies and 200 subsidiary pharmacies in Finland) dispensed about 55 million e-prescriptions, which is 98% of all prescriptions dispensed in Finland.[31,32] E-prescriptions were implemented with the aim of making the prescribing and dispensing of medicines easier and more efficient and improving medication safety.[30,33] These aims were expected to be achieved for example by improving the quality and safety of prescriptions, and reducing the need to re-enter prescription details at pharmacies.[33] However, Finnish pharmacists have found ambiguities and errors in e-prescriptions or otherwise imperfectly compiled e-prescriptions that require clarification during the dispensing process to be common and among the most common problems and areas needing development in the e-prescription system.[7,34] Accordingly, there is a need for a study that quantifies and identifies in greater detail errors and ambiguities in e-prescriptions and their possible effects on medicine dispensing in pharmacies in order to identify problems in e-prescribing and further develop the system. This need for a study is also recognized at multinational level in a recently published review of the benefits, concerns and risks of e-prescribing[29].

The aim of this study was to investigate the quality of e-prescriptions, as indicated by prescription anomalies detected by pharmacists in Finnish community pharmacies. The term *prescription anomaly* refers here to errors, ambiguities, and other shortcomings in the prescriptions. The specific aims of this study were to investigate (1) the frequency of e-prescriptions containing prescription anomalies, (2) the types of e-prescription anomalies, (3) how the anomalies found were clarified and the time required to do this, and (4) the effects of e-prescription anomalies in Finnish community pharmacies.

Methods

Study context

In Finland, e-prescriptions are issued and signed electronically and entered into a centralized nationwide database called the Prescription Centre.[30] Electronically stored prescriptions can be dispensed from any community pharmacy.[35] At the pharmacy, e-prescriptions are processed in the pharmacy data system, which searches for e-prescriptions in the Prescription Centre. Only staff members with a pharmaceutical education (i.e. B.Sc. in Pharmacy or M.Sc. in Pharmacy, later we use the term *pharmacists* for both) have access to the Prescription Centre.[36] In the pharmacy data system, pharmacists check the information on the dispensing event that has been recompleted based on the e-prescription data and complete the information by filling in dispensing entries and signing the prescription electronically.

Data collection

The study was conducted in February 2017. A random sample of 58 (one-tenth) privately owned community pharmacies was taken from a total of 579 pharmacies listed in the register of the Association of Finnish Pharmacies. However, two of the pharmacies selected were located in a Swedish-speaking region of Finland and were excluded because research material was not available in Swedish. Thus, 56 community pharmacies were invited to participate in the study by e-mail. Of these pharmacies, seven declined to participate. These were replaced by inviting another pharmacy from the same region and with a similar number of prescriptions dispensed per year. In total, 55 pharmacies consented to take part in the study.

During the three-day study period (February 14 to 16, 2017), the pharmacies reported all e-prescription anomalies that pharmacists detected during medicine dispensing. E-prescription anomalies were reported on paper forms. A separate form was filled in for each e-prescription containing an anomaly. If one e-prescription contained several anomalies, all were reported on the same form. The number of report forms for e-prescription anomalies delivered to each pharmacy was adjusted according to the number of prescriptions dispensed daily at the pharmacy. Each pharmacy also received one background form and instructions for filling in the forms. Pharmacists were instructed to fill in the report form for e-prescription anomalies right after the medicine dispensing situation in which they detected the anomalies.

The report form for e-prescription anomalies covered two pages and consisted of five questions. The form was piloted in two local pharmacies in December 2016, and minor modifications were made to the form based on the pilot. Details of the medicines dispensed (brand name, strength and pharmaceutical form) were reported in response to an open-ended question. The research group afterwards classified the medicines according to the 5th level of

the Anatomic Therapeutic Chemical (ATC) classification.[37] E-prescription anomaly details were investigated with the structured question, "What kind of anomaly did the e-prescription contain?", with a list of several fixed responses to choose from and also space for an open answer. On the list of fixed responses, the anomaly types were categorized in relation to the patient (e.g. wrong patient, incorrect weight of a child), the medicine prescribed and its quantity (e.g. wrong medicine, incorrect medicine strength, incorrect medicine quantity), dosage instructions and instructions for use (e.g. dosage instructions written using abbreviations, unclear dosage instructions), the patient's other medication (e.g. class D interaction observed with the customer's current medication) and other. The list of anomaly types was designed on the basis of the requirements for e-prescribing set by law and guidelines in Finland,[38,39] and the definition of prescribing error.[40,41]

E-prescription anomaly clarification and its effect in the pharmacies were elicited with the structured questions: "Were the prescription anomalies clarified?" and "Did the e-prescription anomaly cause problems at the pharmacy?" Both questions had two response options: 1. No, 2. Yes. If the pharmacists answered "Yes", they were asked to specify the clarification action or the problems caused using a list of several fixed answers, and there was also space for an open answer. These two questions were designed on the basis of the researchers' own experiences and some previous studies.[6,42] The total duration of the e-prescription anomaly clarification at the pharmacy was investigated with an open-ended question.

On the background form, structured questions yielded information on the location of the pharmacy and the number of prescriptions dispensed per year at the pharmacy. The number of prescriptions dispensed during the three-day study period at the pharmacy was obtained through an open-ended question.

Data analysis

The data were analyzed using SPSS for Windows, version 23.0 (SPSS Inc. Chicago, IL, USA). A descriptive approach was used in the analysis, using frequencies, percentages, and cross-tabulations. In the background characteristics, differences between groups were tested using the $\chi 2$ test and Fisher's exact test. The level of statistical significance was defined as p-values < 0.05.

Ethical statement

The study setting and research process were in accordance with the local and national ethical instructions for research (Finnish Advisory Board on Research Integrity: http://www.tenk.fi/en/ethical-review-in-human-sciences). This study required no ethical approval, because an ethical review is not required for this type of human sciences research in Finland (Finnish Advisory Board on Research Integrity: http://www.tenk.fi/en/ethical-review-in-finland).

Results

Of the 55 study pharmacies, 54 (98%) responded to the study and a total of 3,000 report forms for e-prescription anomalies were returned. However, 22 forms were removed from the final study material because the e-prescription anomalies reported on the forms were not in line with the definition of prescription anomalies in this study (n = 15), the forms were filled in with information about conventional prescriptions (paper, telephone) (n = 5) or automated unit-dose dispensing prescription (n = 1), or the form lacked information about what kind of anomaly the e-prescription contained (n = 1). Consequently, the final study material consisted of 2,978 forms.

The representativeness of the study pharmacies compared with all pharmacies in Finland was analyzed with respect to pharmacy location and number of prescriptions dispensed per year at the pharmacy (Table 1). This showed the study pharmacies to be representative of the pharmacies in Finland in terms of location and number of prescriptions dispensed per year.

(Table 1)

E-prescription anomalies detected

During the three-day study period the pharmacies dispensed a total of 41,170 e-prescriptions, of which 2,978 (7.2%) contained anomalies. In total, 3,622 anomalies were recorded. The average number of anomalies per e-prescription was 1.2 (range 1−4). The most common classes of medicines in which anomalies were found related to the nervous system (22.9%) and cardiovascular system (18.1%) (Table 2).

(Table 2)

Of all recorded e-prescription anomalies (n = 3,622), 87.5% related to dosage instructions and instructions for use, 9.4% to the prescribed medicine and medicine quantity, 0.6% to the patient's other medication, 0.3% to the patient, and 2.1% related to some other anomaly. The

most common anomaly reported by the pharmacists in the e-prescriptions (n = 2,978) was that the dosage instructions were written using abbreviations (63.7%) (Table 3). Another common e-prescription anomaly was that the purpose of the medicine was missing altogether (28.4%).

(Table 3)

Clarification of the e-prescription anomalies detected

Pharmacists clarified anomalies in most (85.9%) of the cases where an anomaly was detected. Most often anomalies were clarified at the pharmacy by writing out the abbreviations in the dosage instructions (69.6%), or at the pharmacy by discussing them with the customer (23.4%) (Table 4). The physician was contacted for clarification in 4.1% of e-prescriptions with anomalies. Of the e-prescriptions in which pharmacists did not clarify anomalies (n = 394), most lacked information regarding the purpose of the medicine (72.3%), and the fact that the dosage instructions contained abbreviations (18.3%).

(Table 4)

The time required to clarify perceived anomalies was reported for 1,764 of the 2,978 e-prescriptions with anomalies. In total, pharmacists required 55 hours and 30 minutes to clarify these e-prescriptions. The average time taken per e-prescription was 1.8 minutes (range 3 seconds to 120 minutes). Anomalies most commonly took 1−5 minutes to clarify (58.9%), followed by under one minute (36.3%) and 6−15 minutes (3.9%). In three of the e-prescriptions with anomalies, the time required for clarification was over 60 minutes.

Effects of the e-prescription anomalies detected

The anomalies detected caused problems in 39.6% of the cases where the e-prescription contained anomalies. In most cases they increased the pharmacy's workload (55.9%) and it took longer to serve the customer (51.4%) (Table 5).

(Table 5)

Discussion

The main finding of this study was that e-prescriptions containing anomalies were quite common in Finland. The most common anomaly was that the dosage instructions and instructions for use were written using abbreviations. In general, the anomalies were clarified at the pharmacies without the need to contact the prescribing physician. However, the anomalies often increased workloads and extended customer service times at pharmacies.

The findings of this study were based on a fully operational e-prescription system that is in nationwide use with a very high utilization rate of e-prescriptions, and this is one strength of this study. The study pharmacies were randomly selected from the affiliate register that covers almost all Finnish pharmacies, and the pharmacy participation rate was high and higher than in some earlier similar studies.[19,42] The study pharmacies also represented Finnish pharmacies well in terms of location and the number of prescriptions dispensed per year. In addition, this study adds some new information to previous studies in this field.[4,6-8,19,24,25] First, the study gives a wider description of e-prescription anomalies than some of the earlier studies because it included not only cases that necessitate contact with the prescriber for clarification, but also cases that could be clarified at pharmacies without contacting the prescriber, as well as cases where the pharmacist did not find it necessary to clarify the anomalies at all. Second, to the best of our knowledge, the present study is the first in which the use of abbreviations has been reported as a separate type of e-prescription anomaly related to dosage instructions and instructions for use.

According to this study, prescription anomalies occurred in 7.2% of the e-prescriptions issued in Finland. This is rather high in comparison to previous studies, in which the figure ranged between 1% and 11.7%.[4,5,24,25,27] In addition, our finding suggests that in Finland the anomaly rate in e-prescriptions is higher than in conventional prescriptions, in which the rate has been reported to be 1.3%.[43] However, there is much variation in design between studies, and thus the results are not directly comparable. For example, the rate of errors, ambiguities and other problems in e-prescriptions has been lower in studies that focused only on cases where pharmacists had to contact the prescriber for clarification.[4,24,25]

In this study, a large majority of the e-prescription anomalies detected related to dosage instructions and instructions for use, which is consistent with many previous studies.[4,6-8,19,24,25] Our results indicate that in Finnish e-prescriptions the main problem in the dosage instructions and instructions for use is the use of abbreviations. This is against the operations model of e-prescribing, which requires the dosage instructions and instructions for use in e-prescriptions to be written in full by the prescriber.[39] At the pharmacies, abbreviations require pharmacists' manual intervention and they have to be written out so that the dosage instructions and instructions for use are clear and comprehensible to the patient. This causes much additional work for pharmacists and may hinder easy and efficient dispensing.[6,34,44,45] At worst, the use of abbreviations could lead to misinterpretations and human errors in editing, which in turn could endanger medication safety.[13,46] On the other hand, anomalies in dosage instructions

that are most likely to endanger medication safety usually relate to missing, unclear or conflicting information and not directly to the use of abbreviations[5,46]. However, this study did not provide detailed information about what kind of abbreviations e-prescriptions contained and thus what is their real significance for medication safety. This needs more research in the future.

Missing information about the purpose of the medicine was identified as another frequent problem in the e-prescriptions in this study. This finding is in line with some previous studies. [8,24] According to the Decree on the Prescription of Medicines in Finland, a prescription should state the purpose of the medicine unless there is some reasonable reason to omit it.[38] In e-prescriptions, the prescriber enters this information in a separate data field,[39] from which it is printed onto the instruction label to be attached to the medicine package given to the patient. Omitting information about the purpose of the medicine is not necessarily confusing to pharmacists, but it could be detrimental to the patient. The patient should always know for what purpose they are using the medicine. However, medicines can have many uses. Also, the names and packages of medicinal products could change, for example due to generic substitution policies,[47] and this could confuse patients.

In previous studies, selecting an incorrect medicinal product (e.g. medicine, strength, pharmaceutical form) has also been a common type of error and ambiguity in e-prescriptions. [4,6,19] In this respect, our findings differ from other studies. This may result from the fact that there are differences in the design, software and thus usability of e-prescribing systems. For example, poorly designed drop-down menus or data fields have been suggested to be one factor posing the risk of selecting incorrect prescription information.[6,48,49] Our results suggest that the Finnish e-prescribing system has succeeded in minimizing this kind of error quite well.

According to this study, e-prescription anomalies often have negative consequences for pharmacies, particularly by increasing workloads and extending customer service times. This has also been found in a previous study.[6] Anomalies in e-prescriptions were generally clarified by pharmacists unaided or with the customer alongside during medicine dispensing. This took on average 1.8 minutes, which is less than in studies where most of the errors and ambiguities in e-prescriptions were solved together with prescriber.[4,24,27] However, calculated annually, the time that Finnish pharmacists use to clarify e-prescription anomalies is equal to the working hours of approximately 56 pharmacists, which is a significant amount of time. This means that pharmacists make a considerable contribution to detecting and clarifying e-prescribing

anomalies. On the other hand, the pharmacists could use this time, for example for medicine counseling and communication with patients about their medication, if the e-prescriptions issued were more complete. Nevertheless, another important finding was that anomalies in e-prescriptions rarely delay the dispensing of medicines significantly and customers generally receive their medicine immediately or during the same day.

Based on the results of this study, some recommendations can be made to improve the quality of e-prescriptions. First, e-prescription anomalies are not necessarily the result of poorly designed e-prescribing software, but can also relate to old prescribing habits such as the use of abbreviations in dosage instructions and instructions for use. However, e-prescribing systems should be developed so that prescribers are prompted to enter dosage instructions and instructions for use entirely without abbreviations. One way to achieve this might be to introduce structured instruction data fields[46]. Second, e-prescribing systems should be developed in such a way that they direct prescribers to make all required entries – such as the purpose of the medicine – in the correct data fields. This could be achieved by introducing forcing functions, [5] which ensure that the prescriber cannot transmit an e-prescription unless all required data fields are completed or reasons have been given for omitting any information.

Limitations

It should be noted that the results of this study are based on e-prescription anomaly detection by, and self-reports from, community pharmacists. The pharmacists were required to take time to fill in report forms for e-prescription anomalies right after medicine dispensing during the three-day study period. Consequently, it is possible that not all cases in which e-prescriptions contained anomalies were reported in this study. The report forms may have not been filled in for several reasons, such as time pressures and heavy workload during medicine dispensing, forgetting, and poor adherence to the study instructions. This means that e-prescription anomalies may occur even more frequently than suggested in this study. In addition, the time required to clarify the e-prescription anomalies reported in this study is based on pharmacists' own estimates and is thus not the actual time.

Conclusions

e-prescriptions containing anomalies are quite common in Finland, indicating there is a need to improve the quality of e-prescribing. In particular, more attention should be given to the use of abbreviations in the dosage instructions and instructions for use and to changes in prescribing practices. In addition, information on the purpose of the medicine has often been

omitted from e-prescriptions. In general, e-prescription anomalies can be clarified at the pharmacy without the need to contact the prescriber. However, the anomalies often have negative consequences for pharmacies, particularly by increasing workloads and extending customer service times. The e-prescribing system should be further developed to encourage prescribers to issue more complete e-prescriptions and in this way improve medication safety and make medicine dispensing easier and more efficient.

Conflict of interest

The Authors declare that they have no conflicts of interest to disclose.

Funding

This work was supported by The Social Insurance Institution of Finland (Kela) (grant number 6/26/2016). The opinions expressed in this document are those of the authors and do not reflect the official position of Kela.

Acknowledgements

The authors would like to thank the Association of Finnish Pharmacies for their help with the study sample. The authors also wish to thank the study pharmacies for their help in data collection.

Authors' contributions

All authors participated in designing the study and collecting the data. JT and SK conducted the data analysis. All authors participated in discussing the findings. JT drafted the first version of the manuscript. All authors contributed to the critical revision of the manuscript, and read and approved the final manuscript.

References

1. Buurma H et al. Nature, frequency and determinants of prescription modification in Dutch community pharmacies. *Br J Clin Pharmacol* 2000; 52: 52-91.

2. Gandhi TK et al. Outpatient prescribing errors and the impact of computerized prescribing. *J Gen Intern Med* 2005; 20: 837-841.

3. Kuo GM et al. Medication errors reported by US family physicians and their office staff. *Qual Saf Health Care* 2008; 17: 286-290.

4. Ekedahl A. Problem prescriptions in Sweden necessitating contact with the prescriber before dispensing. *Res Social Adm Pharm* 2010; 6: 174-184.

5. Nanji KC et al. Errors associated with outpatient computerized prescribing systems. *J Am Med Inform Assoc* 2011; 18: 767–773.

6. Odukoya OK et al. E-prescribing errors in community pharmacies: Exploring consequences and contributing factors. *Int J Med Inform* 2014; 83: 427-437.

7. Kauppinen H et al. The impact of electronic prescriptions on medication safety in Finnish community pharmacies: A survey of pharmacists. *Int J Med Inform* 2017; 100: 56-62.

8. Kaushal R et al. Electronic prescribing improves medication safety in community-based office practices. *J Gen Intern Med* 2010; 25: 560-536.

9. Bell DS et al. A conceptual framework for evaluating outpatient electronic prescribing systems based on their functional capabilities. *J Am Med Assoc* 2004; 11: 60−70.

10. Kierkegaard P. E-prescription across Europe. *Health Technol* 2013; 3: 205-219.

11. Brennan J et al. National health models and the adoption of eHealth and ePrescribing in primary care – new evidence from Europe. *J Innov Health Inform* 2015; 22: 399-408.

12. Stroetmann KA et al. European countries on their journey towards national eHealth infrastructure. Final European progress report. eHealth Strategies Report, European Commission, 2011.

13. Samadbeik M et al. A theoretical approach to electronic prescription system: Lesson learned from literature review. *Iran Red Crescent Med J* 2013; 15: e8436.

14. Ammenwerth E et al. The effect of electronic prescribing on medication errors and adverse drug events: a systematic review. *J Am Med Inform Assoc* 2008; 15: 585-600.

15. Doormaal J et al. The influence that electronic prescribing has on medication errors and preventable adverse drug events: an interrupted time-series study. *J Am Med Inform Assoc* 2009; 16: 816-825.

16. SureScripts. National progress report on e-prescribing and safe-Rx rankings, year 2013. http://surescripts.com/docs/default-source/national-progress-reports/surescripts_2013_national_progress_report.pdf (accessed 29 January 2018).

17. eRx Script Exchange. ePrescribing. https://www.erx.com.au/eprescribing/ (accessed 29 January 2018).

18. PrescribeIT. Canada's electronic prescription service. https://www.prescribeit.ca/ (accessed 1 February 2018).

19. Rupp MT, Warholak TL. Evaluation of e-prescribing in chain community pharmacy: best-practice recommendations. *J Am Pharm Assoc* 2008; 48: 364–370.

20. Hammar T et al. Swedish pharmacists value ePrescribing: a survey of a nationwide implementation. *J Pharm Health Serv Res* 2010; 1: 23–32.

21. Odukoya O, Chui MA. Retail pharmacy staff perceptions of design strengths and weaknesses of electronic prescribing. *J Am Med Inform Assoc* 2012; 19: 1059–1065.

22. Rahimi B, Timpka T. Pharmacists' views on integrated electronic prescribing systems: associations between usefulness, pharmacological safety, and barriers to technology use. *Eur J Clin Pharmacol* 2011; 67: 179–184.

23. Albarrak AI et al. Assessment of legibility and completeness of handwritten and electronic prescriptions. *Saudi Pharm J* 2014; 22: 522−527.

24. Warholak TL, Rupp MT. Analysis of community chain pharmacists' interventions on electronic prescriptions. *J Am Pharm Assoc* 2009; 49: 59–64.

25. Åstrand B et al. Assessment of ePrescription quality: an observational study at three mail-order pharmacies. *BMC Med Inform Decis Mak* 2009; 9: 8.

26. Grossman JM et al. Transmitting and processing electronic prescriptions: experiences of physician practices and pharmacies. *J Am Med Inform Assoc* 2012; 19: 353-359.

27. Gilligan AM et al. Analysis of pharmacists' interventions on electronic versus traditional prescriptions in 2 community pharmacies. *Res Social Adm Pharm* 2012; 8: 523-532.

28. Volmer D et al. Use of a generic protocol in documentation of prescription errors in Estonia, Norway and Sweden. *Pharm Prac* 2012; 10: 72-77.

29. Zadeh PE, Tremblay MC. A review of the literature and proposed classification on e-prescribing: Functions, assimilation stages, benefits, concerns, and risks. *Res Social Adm Pharm* 2016; 12: 1–19.

30. The Act on Electronic Prescriptions 61/2007. [in Finnish].

31. National Archive of Health Information Services (Kanta). Statistics. http://www.kanta.fi/fi/web/ammattilaisille/tilastot?inheritRedirect=true (accessed 1 December 2017).

32. Finnish Medicines Agency Fimea and Social Insurance Institution. Finnish Statistics on Medicines 2016. Helsinki: Erweko Oy, 2017.

33. Finnish Government. The Government Bill (250/2006) to the Parliament. Government proposal. 2006. [in Finnish].

34. Timonen J et al. [Problems and areas needing development in electronic prescriptions - A survey of community pharmacy staff] *Suomen Lääkäril* 2015; 3: 51–59 [in Finnish, abstract in English].

35. National Archive of Health Information Service (Kanta). Electronic prescription. http://www.kanta.fi/en/resepti-esittely (accessed 11 December 2017).

36. Finnish Medicines Agency. The Administrative regulation of medicine dispensing (5/2011). [in Finnish].

37. WHO. ATC structure and principles. https://www.whocc.no/atc/structure_and_principles/ (accessed 15 August 2017).

38. Ministry of Social Affairs and Health. Decree on the Prescription of Medicines (1088/2010). [in Finnish].

39. National Archive of Health Information Services (Kanta), National Institute for Health and Welfare. The operations model of electronic prescriptions v. 1.61. http://www.kanta.fi/documents/12105/4091841/S%C3%A4hk%C3%B6isen+l%C3%A4%C3

%A4kem%C3%A4%C3%A4r%C3%A4yksen+toimintamallit+v1.6/a39da080-c87c-471f-81cf-bbb9faae8a2d?version=1.3 (accessed 11 December 2017). [in Finnish].

40. National Research and Development Centre for Welfare and Health (Stakes) and Centre for Pharmacotherapy Development (ROHTO). Potilasturvallisuussanasto, lääkehoidon turvallisuussanasto. https://www.thl.fi/documents/10531/102913/potilasturvallisuuden_sanasto_071209.pdf. (accessed 1 December 2017). [in Finnish].

41. WHO. The Conceptual Framework for the International Classification for Patient Safety. World Health Organization, Geneva, 2009. http://www.who.int/patientsafety/taxonomy/icps_full_report.pdf (accessed 1 December 2017).

42. Heiskanen K et al. Medicine shortages – A study of community pharmacies in Finland. *Health Pol* 2015; 119: 232-238.

43. Backas L. Apteekit korjaavat epäselviä ja virheellisiä reseptejä. *Apteekkari* 2008; 97: 18-20. [“Pharmacists correct unclear and erroneous prescriptions.” In Finnish].

44. Odukoya O, Chui MA. Relationship between e-prescriptions and community pharmacy workflow. *J Am Pharm Assoc* 2012; 52: e168-e174.

45. Franklin BD et al. Community pharmacists’ interventions with electronic prescriptions in England: an exploratory study. *Int J Clin Pharm* 2013; 35: 1030-1035.

46. Yang Y et al. Quality and variability of patient directions in electronic prescriptions in the ambulatory care settings. *J Manag Care Spec Pharm* 2018; 8: 1.

47. The Social Insurance Institution of Finland (Kela). Generic substitution and reference price system. http://www.kela.fi/web/en/generic-substitution-and-the-reference-price-system?inheritRedirect=true (accessed 5 August 2017).

48. Lapane KL et al. e-Prescribing and patient safety: results from a mixed method study. *Am J Pharm Benefits* 2011; 3: e24-e34.

49. Khajouei R, Jaspers MWM. CPOE system design aspects and their qualitative effects on usability. *Stud Health Technol Inform* 2008; 136: 309-314.

Table 1. Characteristics and representativeness of the study pharmacies.

	Study pharmacies		Pharmacies in Finland[a]		p-value[b]
	%	(n)	%	(n)	
Pharmacy location	n= 54		n=615		
Southern Finland	31.5	(17)	35.1	(216)	0.590
Western and Central Finland	33.3	(18)	24.4.	(150)	0.059
Southwestern Finland	13.0	(7)	14.1	(87)	0.810
Eastern Finland	9.3	(5)	13.2	(81)	0.410
Northern Finland	7.4	(4)	9.6	(59)	0.598
Lapland	5.6	(3)	3.6	(22)	0.462
Number of prescriptions dispensed per year at the pharmacy	n=54		n=600		
≤30,000	7.4	(4)	8.3	(50)	1.000
30,001–60,000	18.5	(10)	29.3	(176)	0.092
60,001–100,000	33.3	(18)	28.8	(173)	0.486
≥100,000	40.7	(22)	33.5	(201)	0.282

[a] Information based on the affiliate register of the Association of Finnish Pharmacies in 2012 (location of the pharmacy) and in 2017 (number of prescriptions dispensed per year at the pharmacy).
[b] $\chi 2$ test and Fisher's exact test; p-value < 0.05 considered statistically significant.

Table 2. Medicine classes involved in e-prescriptions with anomalies (n=2,976)[a].

Anatomical Therapeutic Chemical (ATC) classification[b]	%	(n)
Nervous system (N)	22.9	(682)
Analgesics (N02)	7.1	(211)
Psycholeptics (N05)	7.0	(208)
Psychoanaleptics (N06)	5.1	(152)
Cardiovascular system (C)	18.1	(538)
Agents acting on the renin-angiotensin system (C09)	5.3	(158)
Beta blocking agents (C07)	4.5	(134)
Lipid modifying agents C10)	2.9	(85)
Alimentary tract and metabolism (A)	9.8	(291)
Medicines for acid related disorders (A02)	3.0	(90)
Medicines used in diabetes (A10)	3.0	(88)
Mineral supplements (A12)	1.2	(36)
Antiinfectives for systemic use (J)	9.1	(270)
Antibacterials for systemic use (J01)	8.1	(242)
Antivirals for systemic use (J05)	0.4	(13)
Antimycotics for systemic use (J02)	0.3	(9)
Respiratory system (R)	8.6	(257)
Musculo-skeletal system (M)	8.3	(248)
Genito-urinary system and sex hormones (G)	5.5	(164)
Sensory organs (S)	4.1	(123)
Systemic hormonal preparations, excluding sex hormones and insulins (H)	3.9	(115)
Blood and blood forming organs (B)	3.5	(103)
Dermatologicals (D)	2.5	(75)
Other	3.7	(110)

[a] Two of the report forms did not include information about medicine class.

[b] The three most common subgroups are presented from the four most common main groups.

Table 3. E-prescription anomalies detected by pharmacists during medicine dispensing (n=2,978).

e-prescription anomaly	%[a]	(n)[a]
Dosage instructions and instructions for use		
Dosage instructions written using abbreviations	63.7	(1,897)
Purpose of the medicine missing altogether	28.4	(847)
Unclear dosage instructions	6.7	(201)
Incorrect dosage instructions	3.7	(110)
Dosage instructions missing altogether	2.0	(60)
"Sic!" recorded in incorrect field [b]	1.0	(30)
"Sic!" missing altogether (unusual dosage or purpose of use) [b]	0.8	(25)
Prescribed medicine and medicine quantity		
Incorrect medicine quantity	2.9	(86)
Remaining medicine quantity miscalculated during previous dispensing	2.4	(71)
Medicinal product no longer on the market or not yet available	2.0	(59)
Generic substitution prohibition recorded in incorrect field	1.1	(34)
Incorrect pharmaceutical form	0.7	(22)
Unclear medicine quantity	0.6	(19)
Incorrect or unclear iteration details[c]	0.3	(10)
Compound prescription written incorrectly	0.3	(10)
Incorrect medicine strength	0.3	(9)
Medicine quantity recorded in incorrect field	0.2	(8)
Generic substitution prohibition missing altogether	0.2	(7)
Wrong medicine	0.2	(5)
Iteration details recorded in incorrect field [c]	0.1	(2)
Patient's other medication		
Class D interaction observed in customer's current medication [d]	0.6	(18)
Inappropriate overlap in customer's current medication	0.1	(4)
Customer is allergic to the prescribed medicine	0.0	(1)
Patient		
Incorrect weight of a child (< 12 years)	0.3	(8)
Wrong patient	0.1	(3)
Other [e]	2.5	(76)

[a] One e-prescription could contain several anomalies.

[b] In Finland, the marking "Sic!" specifies that the physician is consciously prescribing a medicine with an exceptionally high dose or for off-label use.

[c] The physician can use iteration to allow the supply of the medicine at regular intervals.

[d] Clinically relevant interaction that should be avoided.

[e] For example, separate report for medicine reimbursement was recorded in incorrect field, prescription renewal prohibition was recorded in incorrect field.

Table 4. Actions taken by pharmacists to clarify anomalies detected in e-prescriptions (n=2,376)[a].

Clarification of e-prescription anomalies	%[b]	(n)[b]
At the pharmacy by writing out the abbreviations in the dosage instructions	69.6	(1,654)
At the pharmacy with the customer	23.4	(555)
At the pharmacy by correcting incorrect prescription details	4.9	(117)
With a physician	4.1	(97)
At the pharmacy by recording the prescription details in the correct fields	2.1	(51)
With nursing staff	1.2	(29)
At the pharmacy by changing to a generic substitute product	1.1	(26)
The customer will solve the problem without help from the pharmacy	0.9	(22)
With another pharmacy	0.1	(2)
In some other way. Please specify [c]	2.8	(67)

[a] Only e-prescriptions that contained anomalies for which the pharmacist reported the action taken to clarify anomalies.

[b] Pharmacist could report multiple actions.

[c] For example, at the pharmacy by changing to a correct medicine, at the pharmacy by asking for a renewal for the prescription, at the pharmacy by solving the problem with the help of previous prescriptions.

Table 5. Problems caused by e-prescription anomalies in the pharmacy (n=1,021)[a].

Problems	%[b]	(n)[b]
Increased pharmacy's workload	55.9	(571)
Took longer to serve the customer	51.4	(525)
The pharmacy staff felt frustrated	42.8	(437)
Increased sense of hurry at the pharmacy	5.6	(57)
The customer felt dissatisfied	4.9	(50)
The customer did not receive the medicine immediately	2.9	(30)
The customer did not receive the medicine on the same day	1.7	(17)
The healthcare staff felt frustrated	1.4	(14)
The customer did not receive the medicine at all	1.1	(11)
Other. Please specify [c]	1.1	(11)

[a] Only e-prescriptions that contained anomalies for which the pharmacist reported the problems caused to the pharmacy.

[b] Pharmacist could report multiple problems.

[c] For example, the customer had to pay more for the medicines due to the anomalies.