# E-Prescription Systems A Comparative Survey

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Abstract—Medication errors related to prescriptions are among the most significant risks facing the health care sector. Many countries worldwide have implemented ePrescription systems to reduce medication errors. Further, more research is needed to evaluate these systems and their effect on patients' care services. Thus, we conducted a survey study involving eight countries implementing ePrescription systems. We found several challenges and limitations of the surveyed systems, such as information availability, information privacy and security, and new technologies adaptability. Therefore, these challenges need to be addressed to provide quality service, improve patients' medication safety.

## I. Introduction

Patients' safety and information privacy and security are the focus of most healthcare services. A number of services and applications deveoped to manage patients' information and enhance the patients' care services for example Electronic Health Record (EHR) and ePrescription systems [1]–[5]. Those applications and services help to reduce concerns regarding medicaiton errors which can be cuased for sevreal reasons and occur at different stages of the medication prescribing and despising process. For example, drug-drug interactions, misinterpretation prescriber handwriting, and overwhelming the staff workload [6]–[9]. The ePrescription is broadly defined as using an electronic device to submit and exchange the information of a prescription between the involved parties [8], [10]–[14]. However, ePrescription system have the potential to improve the patients' medication safety, enhance service quality, and save cost and time [7], [13]–[21]. However, not all medication errors are entirely preventable by ePrescription systems, such as adaptation of the system by the prescriber and information entry [13], [21]–[25]. These risks could be avoided by including more features in the system and using new technologies [22]–[25]. In this extended abstract, we present our comparative survey on ePrescription systems in eight countries worldwide. We will discuss their potentials and how they compare to each other. Further, we look into the ability of these systems to adopt new technologies such as blockchain and Machine Learning (ML).

## II. Materials and Method

The selection process of countries' ePrescription system was as follows:

1 We choose the leading countries that have deployed e-Prescription systems from each continent.
2 In the second stage, we considered the availability of the ePrescription system to community pharmacies. We excluded countries that implemented the ePrescription system only within hospitals.
3 At this stage, the security and privacy protocols used to compare assess the e-Prescription systems from a technical and security aspect.
4 Finally, we selected these countries to survey: four EU countries (UK, Spain, Sweden, and Denmark), two North American countries (the US and Canada), Australia, and Japan.

We compared the ePrescription systems based on the explained ePrescription system model [8], [26], [27]. The collected data from the countries included:

- The ePrescription system architecture components such as centralized or decentralized system.
- The system identifiers (Pharmacy ID, Prescriber ID, Medication ID, Prescription ID, and Patient ID).
- The process of ePrescription system.

The data for this survey was retrieved by searching for keywords or/and a combination of keywords from the search engines Google, Google Scholar, PubMed, IEEE, ACM, Dalhousie University Libraries, and official digital health websites of the selected countries. The keywords used for the search are "Eprescription", "e-prescription", "electronic prescription", "e-Rx", "eDispensing", or "electronic dispensing" with the name of each of the selected countries. We examined and compared the retrieved papers and related documents with the official website of the systems to remove any outdated or false information.

## III. Discussion

After exploring the current e-Prescription systems, it is clear that they are different in terms of how they implement this service. The difference is due to several reasons; some are related to the countries' regulations, and rules or the existing infrastructure [8]. However, several limitations might hinder the progress of improving the quality of the service provided to the patient.

The systems are divided into two types, namely, centralized and distributed. Countries like UK [28], Spain [29], [30], Sweden [31]–[35], Denmark [8], [29], [36], and

Canada [37] used the centralized architecture approach. Those countries chose this approach for various reasons, mainly because of the in-place infrastructure that helped with system integration. Additionally, the centralized approach provides more information availability and better accessibility for all the involved parties (i.e. prescribers, pharmacists, and patients). We noticed the system with a centralized approach collects and links all the information using identifiers such as prescriber Id, pharmacists Id, and patient Id. The systems with a centralized approach are more likely to adopt the new technologies (e.g. ML) due to a large amount of collected data on patients. However, the decentralized system is more robust against security threats and provides a better level of information privacy for the patients [38]–[42]. Countries like US [43], Australia [44]–[46], and Japan [47] chose the decentralized approach for several reasons: a high cost or no digital health infrastructure available across the country. There are disadvantages associated with decentralized approaches, such as patients' information available only by request, the service available only to subscribers, and no patient identity verification. These disadvantages might hold back the ability to adapt ML. However, the decentralized infrastructure might help to advance to using blockchain.

From our survey, we see a clear difference in terms of information collection and availability. These two aspects are essential for advancing the new era of information technologies to provide a quality care service and improve patient medication safety. Improving on the data collection infrastructure will speed the ML technology which can be used to detect and predect the errors in advance. Thus helping improving the healthcare service regarding the patients medication prescribing and dispensing [48]. Also, making the information available to all parties while mentaning the patients' information security and privacy is a big challenge for most of the system. Therefore, we believe using blockchain to manage patients' information will help to address the mentioned challenges. Finally, making the paetins information available to all parties will help saving time and cost due to the reduced workload spent to clearfy and correct patients' prescription information between the prescribers and pharmacists [49], [50].

## IV. Conclusion

In conclusion, as a result of the survey, we suggest considering an alternative ePrescription model to address the discussed challenges in current systems. The approach should include the advantages of centralized and decentralized systems. Such advantages are information available to all parties, improving patients' information security and privacy while keeping digital records, and enhancing patients' medication prescribing and dispensing safety. The new approach should incorporate these advantages by adopting new technologies such as blockchain and ML. Finally, we believe this survey will provide a broader perspective to improve and enhance the ePrescription systems worldwide.

## References


[1] B. Shickel, P. J. Tighe, A. Bihorac, and P. Rashidi, "Deep ehr: A survey of recent advances in deep learning techniques for electronic health record (ehr) analysis," IEEE Journal of Biomedical and Health Informatics, vol. 22, no. 5, pp. 1589–1604, Sep. 2018.

[2] G. S. Birkhead, M. Klompas, and N. R. Shah, "Uses of electronic health records for public health surveillance to advance public health," Annual Review of Public Health, vol. 36, no. 1, pp. 345–359, 2015, pMID: 25581157. [Online]. Available: https://doi.org/10.1146/annurev-publhealth-031914-122747

[3] A. Motulsky, C. Sicotte, M.-P. Gagnon, J. Payne-Gagnon, J.-A. Langué-Dubé, C. M. Rochefort, and R. Tamblyn, "Challenges to the implementation of a nationwide electronic prescribing network in primary care: a qualitative study of users' perceptions," Journal of the American Medical Informatics Association, vol. 22, no. 4, pp. 838–848, 04 2015. [Online]. Available: https://doi.org/10.1093/jamia/ocv026

[4] A. Agrawal, "Medication errors: prevention using information technology systems," British Journal of Clinical Pharmacology, vol. 67, no. 6, pp. 681–686, 2009. [Online]. Available: https://bpspubs.onlinelibrary.wiley.com/doi/abs/10.1111/j.1365-2125.2009.03427.x

[5] T. Porteous, C. Bond, R. Robertson, P. Hannaford, and E. Reiter, "Electronic transfer of prescription-related information: comparing views of patients, general practitioners, and pharmacists." British Journal of General Practice, vol. 53, no. 488, pp. 204–209, 2003. [Online]. Available: https://bjgp.org/content/53/488/204

[6] R. P. Nair, D. Kappil, and T. M. Woods, "Pharmacist to pharmacist-10 strategies for minimizing dispensing errors-dispensing errors can be costly for the pharmacist as well as potentially dangerous for the patient. pharmacists can take simple steps to help eliminate this problem." Pharmacy Times, vol. 76, no. 1, p. 92, 2010.

[7] B. Aldughayfiq and S. Sampalli, "A system to lower the risk of dispensing medication errors at pharmacies using nfc," in 2018 IEEE International Conference on Internet of Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (SmartData), July 2018, pp. 196–202.

[8] M. Samadbeik, M. Ahmadi, F. Sadoughi, and A. Garavand, "A copmarative review of electronic prescription systems: Lessons learned from developed countries," Journal of research in pharmacy practice, vol. 6, no. 1, p. 3, 2017. [Online]. Available: http://www.jrpp.net/text.asp?2017/6/1/3/200993

[9] G. P. Velo and P. Minuz, "Medication errors: prescribing faults and prescription errors," British Journal of Clinical Pharmacology, vol. 67, no. 6, pp. 624–628, 2009. [Online]. Available: https://bpspubs.onlinelibrary.wiley.com/doi/abs/10.1111/j.1365-2125.2009.03425.x

[10] D. S. Bell, S. Cretin, R. S. Marken, and A. B. Landman, "A conceptual framework for evaluating outpatient electronic prescribing systems based on their functional capabilities," Journal of the American Medical Informatics Association, vol. 11, no. 1, pp. 60–70, 2004.

[11] A. M. A. (AMA), A. A. of Family Physicians (AAFP), A. C. of Physicians (ACP), M. G. M. A. (MGMA), eHealth Initiative, the Center for Improving Medication Management, the Surescripts, AAFP, MGMA, B. B. Association, Humana, and Intel, Clinician's Guide to e -Prescribing, 2011. [Online]. Available: http://www.americanehr.com/Upload/Clinicians-Guide-to-E-Prescribing.pdf

[12] D. T. Mon, "American health information management association (ahima) written and oral testimony at the ncvhs privacy, confidentiality and security subcommittee hearing on personal health records may 20, 2009," AHIM AtestimonyonPHRprivacy-final052009. pdf (http://www. ahima. org/downloads/pdfs/advocacy/AHIM AtestimonyonPHRprivacy-final052009. pdf)(Accessed: 1 December 2010), 2009.

[13] O. K. Odukoya and M. A. Chui, "E-prescribing: a focused review and new approach to addressing safety in pharmacies and primary care," Research in Social and Administrative Pharmacy, vol. 9, no. 6, pp. 996–1003, 2013.

[14] L. Van Dijk, H. De Vries, and D. Bell, "Electronic prescribing in the united kingdom and in the netherlands," Prepared for: Agency for Healthcare Research and Quality US Department of Health and Human Services, vol. 540, 2011.

[15] C. M. Byrne, L. M. Mercincavage, E. C. Pan, A. G. Vincent, D. S. Johnston, and B. Middleton, "The value from investments in health information technology at the us department of veterans affairs," Health Affairs, vol. 29, no. 4, pp. 629–638, 2010.

[16] E. B. Devine, R. N. Hansen, J. L. Wilson-Norton, N. M. Lawless, A. W. Fisk, D. K. Blough, D. P. Martin, and S. D. Sullivan, "The impact of computerized provider order entry on medication errors in a multispecialty group practice," Journal of the American Medical Informatics Association, vol. 17, no. 1, pp. 78–84, 2010.

[17] L. T. Kohn, Electronic Prescribing: CMS Should Address Inconsistencies in Its Two Incentive Programs That Encourage the Use of Healthy Information Technology. DIANE Publishing, 2011.

[18] M. Samadbeik, M. Ahmadi, and S. M. H. Asanjan, "A theoretical approach to electronic prescription system: Lesson learned from literature review," Iranian Red Crescent Medical Journal, vol. 15, no. 10, 2013.

[19] J. A. Taylor, L. A. Loan, J. Kamara, S. Blackburn, and D. Whitney, "Medication administration variances before and after implementation of computerized physician order entry in a neonatal intensive care unit," Pediatrics, vol. 121, no. 1, pp. 123–128, 2008.

[20] C. J. Wang, M. H. Patel, A. J. Schueth, M. Bradley, S. Wu, J. C. Crosson, P. A. Glassman, and D. S. Bell, "Perceptions of standards-based electronic prescribing systems as implemented in outpatient primary care: a physician survey," Journal of the American Medical Informatics Association, vol. 16, no. 4, pp. 493–502, 2009.

[21] J. Timonen, S. Kangas, H. Kauppinen, and R. Ahonen, "Electronic prescription anomalies: a study of frequencies, clarification and effects in finnish community pharmacies," Journal of Pharmaceutical Health Services Research, vol. 9, no. 3, pp. 183–189, 2018.

[22] D. Reed-Kane, K. Kittell, J. Adkins, S. Flocks, and T. Nguyen, "E-prescribing errors identified in a compounding pharmacy: a quality-improvement project." International journal of pharmaceutical compounding, vol. 18, no. 1, pp. 83–86, 2014.

[23] J. W. Salmon and R. Jiang, "E-prescribing: history, issues, and potentials," Online Journal of Public Health Informatics, vol. 4, no. 3, 2012.

[24] O. K. Odukoya, J. A. Stone, and M. A. Chui, "E-prescribing errors in community pharmacies: Exploring consequences and contributing factors," International journal of medical informatics, vol. 83, no. 6, pp. 427–437, Jun. 2014. [Online]. Available: https://linkinghub.elsevier.com/retrieve/pii/S1386505614000434

[25] Y. Yang, S. Ward-Charlerie, N. Kashyap, R. DeMayo, T. Agresta, and J. Green, "Analysis of medication therapy discontinuation orders in new electronic prescriptions and opportunities for implementing CancelRx," Journal of the American Medical Informatics Association, vol. 25, no. 11, pp. 1516–1523, Nov. 2018. [Online]. Available: https://academic.oup.com/jamia/article/25/11/1516/5067936

[26] eHealth Initiative et al., "A clinician's guide to electronic prescribing," Washington DC: serial online, 2008.

[27] T. C. for Improving Medication Management, A Cinician'sGuide to Electronic Prescribing, 2011.

[28] N. H. S. NHS, "Start using electronic prescriptions," Apr. 2019. [Online]. Available: https://www.nhs.uk/using-the-nhs/nhs-services/pharmacies/electronic-prescription-service/

[29] P. Kierkegaard, "E-prescription across europe," Health and Technology, vol. 3, no. 3, pp. 205–219, Sep 2013. [Online]. Available: https://doi.org/10.1007/s12553-012-0037-0

[30] S. S. Ministry of Health and Equality, ePrescription in Spain Patient safety. Ministry of Health, Social Services and Equality, 2014. [Online]. Available: http://www.ehealth2014.org/wp-content/uploads/2014/05/ePrescription-in-Spain.pdf

[31] S.-E. Öhlund, B. Åstrand, and G. Petersson, "Improving interoperability in eprescribing," Interact J Med Res, vol. 1, no. 2, p. e17, Nov 2012. [Online]. Available: http://www.i-jmr.org/2012/2/e17/

[32] M. Grepstad and P. Kanavos, "A comparative analysis of coverage decisions for outpatient pharmaceuticals: Evidence from denmark, norway and sweden," Health Policy, vol. 119, no. 2, pp. 203–211, 2015.

[33] G. O. Klein, "History of electronic prescriptions in sweden: From time-sharing systems via smartcards to edi," in IFIP Conference on History of Nordic Computing. Springer, 2010, pp. 65–73.

[34] T. Hammar, S. Nyström, G. Petersson, B. Astrand, and T. Rydberg, "Patients satisfied with e-prescribing in sweden: A survey of a nationwide implementation," Journal of Pharmaceutical Health Services Research, vol. 2, pp. 97–105, 06 2011.

[35] M. Hassel, "E-prescriptions in sweden," Swedish eHealth Agency, Tech. Rep., 2019. [Online]. Available: https://ehealthresearch.no/files/documents/Undersider/WHO-Symposium-2019/3-1-Hassel-ENG.pdf

[36] A. Krag, B. Hansen, and E. Nielsen, "ehealth in denmark. ehealth as a part of a coherent danish health care system," technical report, Danish Ministry of Health, Copenhagen, Tech. Rep., 2012. [Online]. Available: https://www.medcom.dk/media/1211/ehealth-in-denmark-ehealth-as-a-part-of-a-coherent-danish-health-care-system.pdf

[37] C. H. Infoway, "Our approach to privacy," Website, 2019. [Online]. Available: https://www.prescribeit.ca/about-us/privacy

[38] E. Zaghloul, T. Li, and J. Ren, "Security and privacy of electronic health records: Decentralized and hierarchical data sharing using smart contracts," in 2019 International Conference on Computing, Networking and Communications (ICNC), Feb 2019, pp. 375–379.

[39] F. Lau, S. H. Rubin, M. H. Smith, and L. Trajkovic, "Distributed denial of service attacks," in Smc 2000 conference proceedings. 2000 ieee international conference on systems, man and cybernetics. 'cybernetics evolving to systems, humans, organizations, and their complex interactions' (cat. no.0, vol. 3, Oct 2000, pp. 2275–2280 vol.3.

[40] R. Anderson, Security engineering: a guide to building dependable distributed systems. John Wiley & Sons, 2020.

[41] H. K. Patil and R. Seshadri, "Big data security and privacy issues in healthcare," in 2014 IEEE international congress on big data. IEEE, 2014, pp. 762–765.

[42] L. PONEMON, "Cost of a data breach study: Global overview," Benchmark research sponsored by IBM Security Independently conducted by Ponemon Institute LLC, 2018.

[43] Surescripts, Demystifying Electronic Prior Authorization (ePA). Surescripts, 2015. [Online]. Available: https://surescripts.com/docs/default-source/products-and-services/surescripts-white-paper—demystifying-electronic-prior-authorization_final.pdf

[44] MediSecure, "Medisecure how it works," 2019. [Online]. Available: http://www.medisecure.com.au/products-and-platforms/#etp

[45] eRx, "https://www.erx.com.au/for-pharmacists/how-erx-works/," website, 2018. [Online]. Available: https://www.erx.com.au/for-pharmacists/how-erx-works/

[46] AustralianGovernment, National e-Authentication Framework. Australian Government, 2009. [Online]. Available: https://www.finance.gov.au/sites/default/files/NeAF-Framework.pdf

[47] L. Ministry of Health and Welfare, "Complete demonstration project for full-scale operation of electronic prescriptions [translated from japanese]," Ministry of Health, Labor and Welfare, Tech. Rep., 2019. [Online]. Available: https://www.mhlw.go.jp/content/11120000/000496837.pdf

[48] A. Flynn, "Using artificial intelligence in health-system pharmacy practice: Finding new patterns that matter," American Journal of Health-System Pharmacy, vol. 76,

no. 9, pp. 622–627, 04 2019. [Online]. Available: https://doi.org/10.1093/ajhp/zxz018

[49] S. Schmiedl, M. Rottenkolber, J. Hasford, D. Rottenkolber, K. Farker, B. Drewelow, M. Hippius, K. Saljé, and P. Thürmann, "Self-medication with over-the-counter and prescribed drugs causing adverse-drug-reaction-related hospital admissions: results of a prospective, long-term multi-centre study," Drug safety, vol. 37, no. 4, pp. 225–235, 2014.

[50] G. N. Norén, R. Sundberg, A. Bate, and I. R. Edwards, "A statistical methodology for drug–drug interaction surveillance," Statistics in medicine, vol. 27, no. 16, pp. 3057–3070, 2008.