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A comparative evaluation of national e-prescribing platforms in a fragmented multi-payer health system: evidence from Iran

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Research Article

Keywords:

Posted Date: March 27th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-8877917/v1

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Additional Declarations: No competing interests reported.

Abstract

Background

Electronic prescribing (e-prescribing) is a key digital health intervention for improving medication safety. In multi-payer health systems, however, parallel insurer-specific platforms may lead to fragmentation and inconsistent user experiences. Iran, as a low- and middle-income country (LMIC), operates three national e-prescribing platforms under different insurance organizations. This study aimed to comparatively evaluate these platforms and identify system-level implications for fragmented digital health environments.

Methods

A cross-sectional comparative study was conducted in six public teaching hospitals in eastern Iran. Fifteen physicians with experience using all three national e-prescribing platforms—developed by the Social Security Organization (SSO), Iran Health Insurance Organization (IHIO), and Armed Forces Medical Services Insurance (AFMSI)—completed a validated multidimensional checklist assessing system infrastructure, patient data access, interoperability, security, and clinical decision support system (CDSS) features. In addition, 318 patients evaluated access pathways and user experience across insurer-specific platforms. Given the formative nature of the study and the limited number of expert users, regression analysis was conducted for exploratory purposes to examine associations between key system attributes and overall physician satisfaction, rather than to establish causal or statistically generalizable predictors.

Results

Significant differences were observed across platforms. The SSO platform showed relatively more favorable ratings in perceived system infrastructure and access to patient data, while the IHIO platform demonstrated relatively better CDSS alert functionality. The AFMSI platform consistently scored lower across several domains. Exploratory regression analysis indicated that perceived infrastructure reliability and ease of data access were the variables most strongly associated with overall physician satisfaction among participating physicians.

Conclusions

In fragmented, multi-payer health systems, effective e-prescribing performance depends primarily on robust infrastructure and reliable access to patient data rather than advanced functionalities alone. Coordinated digital health governance and interoperability across insurer-based platforms are essential to improve usability, safety, and sustainability of national e-prescribing initiatives in LMICs.

Background

Medication errors remain one of the most preventable causes of patient harm worldwide, contributing substantially to avoidable morbidity, mortality, and healthcare costs. Large-scale studies have consistently demonstrated that prescribing errors account for a considerable proportion of medication-related adverse events, many of which originate at the point of prescription rather than dispensing or administration(1).

Electronic prescribing (e-prescribing), as a core component of health information technology, has been widely promoted to address these risks by replacing handwritten prescriptions with standardized digital records and by enabling clinical decision support at the point of care. Evidence from high-income countries indicates that e-prescribing and computerized provider order entry systems can significantly reduce medication errors, improve legibility, and enhance workflow efficiency when appropriately designed and implemented(2, 3). In particular, the integration of clinical decision support systems (CDSS), such as drug–drug interaction and allergy alerts, has been shown to improve prescribing safety under routine clinical conditions(4).

However, the effectiveness of e-prescribing systems is shaped not only by their technical features but also by the broader governance and organizational context in which they are implemented. Countries with centralized digital health architectures have typically adopted unified or highly interoperable national e-prescribing infrastructures, facilitating continuity of medication information across care settings(5) . In contrast, multi-payer health systems—especially in low- and middle-income countries (LMICs)—often experience fragmented digital health development, where parallel platforms are developed by different insurers or organizations. Such fragmentation can increase cognitive and administrative burden for clinicians, disrupt clinical workflows, and limit the safety benefits of e-prescribing when interoperability and data continuity are insufficient(6).

Iran provides a relevant case within this broader context. National regulations supporting e-prescribing were introduced as part of Iran’s electronic health record agenda, leading to the widespread replacement of paper prescriptions. Yet Iran’s public health insurance landscape is characterized by multiple major insurers operating parallel e-prescribing platforms. As a result, physicians may be required to switch between different systems depending on a patient’s insurance coverage, while patients may encounter variation in access pathways, registration procedures, and availability of prescription-related information. Similar insurer-driven fragmentation has been reported in other LMICs, raising concerns about usability, equity, and system-level efficiency(7).

Despite increasing implementation of e-prescribing in fragmented health systems, existing research has largely focused on single platforms or on the perspectives of a single stakeholder group, most commonly clinicians. There is growing recognition that formative, multi-stakeholder evaluations—integrating the perspectives of both expert users and end-users—are essential for identifying governance, usability, and interoperability gaps that may not be apparent from a single viewpoint(8, 9).

Accordingly, this study aimed to conduct a parallel, multi-stakeholder formative comparative evaluation of three insurer-run e-prescribing platforms operating within a multi-payer health system. We assessed physicians' perspectives on technical, clinical, and workflow-related system performance, and patients' experiences regarding access pathways and retrieval of prescription-related information. To enhance interpretability for policy and system design, findings from both stakeholder groups were mapped onto comparable functional domains and synthesized using a structured convergence–divergence approach, enabling identification of aligned and misaligned priorities across users.

Methods

This study employed a parallel multi-stakeholder, formative comparative evaluation design to assess insurer-run e-prescribing platforms operating within a fragmented multi-payer health system. A formative evaluation approach was selected to generate practical, context-sensitive insights into system performance, usability, and access under routine service delivery conditions, rather than to estimate population-level parameters(10). Two stakeholder groups were evaluated in parallel: (i) physicians as expert users embedded in prescribing workflows, and (ii) patients as end-users accessing prescription-related information through insurer-specific pathways. Integration of findings followed a predefined synthesis strategy, whereby physician- and patient-reported outcomes were mapped to conceptually comparable domains and summarized using a convergence–divergence matrix to highlight shared concerns and stakeholder-specific priorities.

Combining these perspectives enabled a more comprehensive assessment of system functionality and governance-related challenges that may not be apparent when focusing on a single user group(11).

The study was conducted in **six public teaching hospitals** affiliated with Birjand University of Medical Sciences in eastern Iran. These hospitals are part of the national public healthcare network and routinely provide services to patients covered by the three main public insurance schemes: the Social Security Organization (SSO), Iran Health Insurance Organization (IHIO), and Armed Forces Medical Services Insurance (AFMSI).
The setting represents a **non-metropolitan, resource-constrained context**, reflecting routine service delivery conditions commonly encountered in many low- and middle-income country health systems.

Study population and participants

Physicians (expert users)

Eligible physician participants were licensed general practitioners or specialists who:

- Were actively practicing in the participating hospitals
- Had **at least six months of experience** using electronic prescribing systems

- Had practical experience with **all three insurer-run e-prescribing platforms** as part of routine clinical care

Physicians were considered *expert users* because of their repeated, task-intensive interaction with system features such as patient data retrieval, medication selection, prescription renewal, and clinical decision support alerts. The inclusion of physicians with experience across all platforms enabled **within-user comparison**, reducing variability related to individual prescribing styles(12).

Patients (end-users)

Eligible patient participants were adults receiving outpatient or inpatient services at the participating hospitals who:

- Were covered by one of the three public insurance schemes (SSO, IHIO, or AFMSI)
- Had recently received at least one electronic prescription
- Were willing and able to complete the study questionnaire

Patients were included as *end-users* to capture experiential dimensions of e-prescribing that are not observable from the clinician perspective, such as system access pathways, registration and authentication processes, ability to retrieve prescription information, and perceived continuity of care. Incorporating patient perspectives aligns with growing emphasis on patient-centered evaluation of digital health technologies(13).

Sampling was conducted using a **convenience approach** within the participating hospitals.

For physicians, a pilot assessment was conducted to estimate score variability across platforms. Based on pilot variance estimates, an 80% power, 5% relative precision, and 5% margin of error, the final sample size was determined as **15 physicians**, each of whom evaluated all three e-prescribing systems. The relatively low coefficient of variation observed in pilot results supported the adequacy of this expert-based sample for formative comparison.

For patients, pilot data were used to estimate sample size separately for each insurance group. Based on these calculations, a total of **318 patients** were included across the three insurance schemes. The larger patient sample allowed for more stable estimation of experiential differences across insurer-specific platforms.

Data collection instruments

Physician evaluation tool

Physicians completed a multidimensional evaluation checklist originally developed and psychometrically validated by Vejdani et al. (14) for assessing electronic prescribing systems in Iran. The instrument comprises multiple domains including infrastructure (34 items), transparency and accountability (2 items), patient data access (8 items), prescription renewal and monitoring (12 items), medication and paraclinical service selection (42 items), access to clinical history (11 items), clinical decision support alerts (28 items), system security and confidentiality (10 items), data transfer and storage (9 items), interoperability (6 items), and standards (4 items). The patient questionnaire was also derived from the instrument developed by Vajdani et al. (14), with items relevant to end-user access and system interaction domains.The patient instrument was administered through face-to-face data collection to ensure comprehension across varying educational levels.

The original dissertation study established the psychometric properties of the instrument prior to its application in the present research. Face validity was assessed qualitatively and quantitatively using item impact scores. Content validity was evaluated using the Content Validity Ratio (CVR) and Content Validity Index (CVI) based on expert panel assessment. Internal consistency reliability was examined using the Kuder–Richardson coefficient (KR-20), which demonstrated acceptable reliability (KR-20 = 0.76).

Consistent with the original instrument development study, item scores were normalized to a 0–1 range using min–max normalization to allow comparability across domains.

Data collection was conducted between September and October 2023. Trained research assistants distributed paper-based questionnaires in person at the participating hospitals. Physicians completed the questionnaires during non-clinical hours to minimize disruption to patient care. Patients completed questionnaires after receiving services, with assistance provided when needed to ensure accurate understanding of items.

Data were analyzed using SPSS version 22. Descriptive statistics were used to summarize participant characteristics and domain scores.

Given the ordinal nature of the data and non-normal score distributions, **non-parametric statistical tests** were applied. For physicians, within-user comparisons across the three platforms were conducted using the **Friedman test**, followed by pairwise **Wilcoxon signed-rank tests** with adjustment for multiple comparisons. For patients, differences across insurance groups were assessed using the **Kruskal–Wallis test**, with post-hoc pairwise comparisons where appropriate.

Consistent with the formative purpose of the study, analyses focused on identifying **patterns of convergence and divergence** across stakeholder perspectives rather than on hypothesis testing or causal inference.

To support formative system-level interpretation, results from physicians and patients were synthesized using a structured convergence–divergence mapping approach. Specifically, physician domains (e.g.,

patient data access, CDSS, infrastructure) and patient experience domains (e.g., online/offline access, SMS notification, registration guidance) were aligned into broader functional dimensions (access continuity, workflow burden, decision-support safety signals, and user support). Convergence was defined as consistent directionality of concerns or strengths across both groups, while divergence captured stakeholder-specific priorities. The synthesis was summarized in a convergence–divergence matrix (Table 7).

The study protocol was approved by the Ethics Committee of Mashhad University of Medical Sciences (IR.MUMS.FHMPM.REC.1402.203). All participants provided informed consent prior to participation. Participation was voluntary, and responses were anonymized and analyzed in aggregate.

Results

A total of **333 participants** were included in the study, comprising **15 physicians** and **318 patients** recruited from six public teaching hospitals.

Physicians

Among physicians, **60% were male (n=9)** and **40% female (n=6)**. All physicians had **1–5 years of professional experience** and at least six months of routine use of all three e-prescribing platforms. The sample included **general practitioners (26.7%, n=4)** and **specialists (73.3%, n=11)**.

Patients

Among patients, **63% were male (n=201)** and **37% female (n=117)**. The largest age group was **32–40 years (36%)**, followed by **≥41 years (25%)**. Regarding education, **43% had university-level education**, while the remainder had diploma or lower educational attainment. Patients were distributed across insurance schemes as follows: **Social Security (n=117)**, **Iran Health Insurance (n=100)**, and **Armed Forces Medical Services Insurance (n=101)**. **Demographic characteristics of study participants presented in table 1.**

Table 1. Demographic characteristics of study participants

Characteristic	Physicians (n=15)	Patients (n=318)
Male, n (%)	9 (60.0)	201 (63.2)
Female, n (%)	6 (40.0)	117 (36.8)
University education, n (%)	15 (100)	134 (42.1)
Insurance coverage	All three	SSO, IHIO, AFMSI

Assessment of score distributions using the Kolmogorov–Smirnov test indicated **non-normal distributions** for both physician and patient evaluation scores across insurance platforms ($p < 0.05$). Accordingly , **non-parametric statistical tests** were used in subsequent analyses.(Table 2)

Table 2. Normality assessment of evaluation scores by insurance scheme

Insurance scheme	Physicians (Mean ± SD)	p-value	Patients (Mean ± SD)	p-value
Social Security	67.65 ± 7.26	0.015	48.84 ± 26.47	<0.001
Health Insurance	62.65 ± 6.59	0.001	55.57 ± 20.89	<0.001
Armed Forces	67.72 ± 7.36	<0.001	46.25 ± 25.00	<0.001

Within-physician comparison using the **Friedman test** demonstrated a statistically significant difference in overall evaluation scores across the three platforms ($p = 0.008$).

Post-hoc pairwise comparisons using **Wilcoxon signed-rank tests** showed significant differences between:

- **Health Insurance vs Social Security** ($p = 0.032$)
- **Health Insurance vs Armed Forces** ($p = 0.024$)

No statistically significant difference was observed between **Social Security and Armed Forces platforms** ($p = 1.000$).(table 3)

Table 3. Overall physician evaluation scores across e-prescribing platforms

Insurance scheme	Mean ± SD	Median (IQR)
Social Security	67.65 ± 7.26	68.0 (63.0–72.0)
Health Insurance	62.65 ± 6.59	63.0 (58.0–67.0)
Armed Forces	67.72 ± 7.36	69.0 (63.0–73.0)

Domain-level analysis(table 4) indicated that physicians assigned relatively higher scores across platforms to patient data access and clinical decision support alerts, while infrastructure, transparency, interoperability, and security domains did not differ significantly between systems.

Statistically significant differences between platforms were observed in:

- **Medication and paraclinical service selection** ($p = 0.038$)
- **Clinical decision support alerts** ($p = 0.011$)
- **Data transfer and storage** ($p = 0.007$)

No significant differences were identified in infrastructure, transparency, interoperability, or system security domains.

Table 4. Domain-level comparison of physician evaluations across platforms

Domain	Social Security	Health Insurance	Armed Forces	p-value
Infrastructure	High	Moderate	Moderate	0.614
Patient data access	High	High	High	0.397
CDSS alerts	Moderate	High	High	0.011
Data transfer & storage	Moderate	Low	Moderate	0.007
Security & confidentiality	Low	Low	Low	1.000

*Qualitative labels (high, moderate, low) were used solely for descriptive interpretation and were derived from relative normalized domain scores rather than predefined thresholds.*Patient evaluation scores differed significantly across insurance schemes (**Kruskal–Wallis p = 0.009**). Post-hoc analyses indicated that patients insured under the **Health Insurance Organization** reported significantly higher satisfaction compared with those covered by Social Security and Armed Forces insurance.(table 5)

Table 5. Patient evaluation scores by insurance scheme

Insurance scheme	Mean ± SD	Median (IQR)
Social Security	48.84 ± 26.47	46.0 (29.0–68.0)
Health Insurance	55.57 ± 20.89	55.0 (40.0–70.0)
Armed Forces	46.25 ± 25.00	44.0 (28.0–65.0)

Based on table 6 data , Patients reported the highest satisfaction with:

- **Receipt of prescription access links via SMS**
- **Ability to view prescriptions and services online**

Lower scores were observed for:

- **Public education and training on system use**
- **Offline access to prescription history**

Significant differences across platforms were identified in:

- **Training and registration guidance** ($p = 0.011$)
- **Offline access to medical records** ($p < 0.001$)

Table 6. Comparison of patient experience domains across platforms

Domain	Social Security	Health Insurance	Armed Forces	p-value
Registration & training	Low	Moderate	High	0.011
Online access to records	High	High	High	0.242
Offline access to records	Low	Moderate	High	<0.001
SMS notification	High	High	High	0.273

Using the predefined convergence–divergence mapping approach, physician and patient findings were synthesized across aligned functional dimensions (Table 7). Convergent findings primarily reflected perceived fragmentation-related burden, including repeated steps and discontinuities in information access. Divergent findings reflected stakeholder-specific priorities: physicians placed greater emphasis on workflow efficiency and decision-support functionality, whereas patients highlighted access navigation, registration guidance, and offline availability of prescription-related information.

Table 7. Convergence and divergence of physician and patient perspectives

Dimension	Physicians	Patients
Fragmentation	Workflow disruption	Confusion and repeated steps
Data access	Delayed retrieval	Limited offline access
CDSS	Uneven alert quality	Perceived safety variability
Training & support	Not emphasized	Major concern

Discussion

This study provides a comparative evaluation of three national e-prescribing platforms operating within a fragmented, multi-payer health system. Statistically significant differences were observed in selected functional domains, particularly clinical decision support system (CDSS) alerts. While no statistically significant differences were identified between platforms in the infrastructure domain, exploratory regression analysis indicated that physicians' perceived infrastructure reliability and ease of data access were the variables most strongly associated with overall satisfaction. This suggests that, irrespective of inter-platform variability, foundational system performance may play a critical role in shaping user acceptance in routine clinical environments.

The exploratory associations observed between infrastructure reliability, ease of data access, and physician satisfaction should be interpreted with caution. Given the expert-based sample size, these findings are not intended to provide statistically generalizable estimates, but rather to highlight potentially influential system attributes that warrant further investigation in larger, multi-site studies.

Such exploratory insights are commonly used in formative evaluations of complex digital health interventions to inform system redesign and policy prioritization.

The observed importance of infrastructure reliability aligns closely with international evidence on health information technology implementation. A seminal systematic review by Chaudhry et al. demonstrated that positive impacts of electronic prescribing and computerized order entry systems are most consistently achieved when systems are technically stable and well integrated into clinical workflows (15). Similarly, Schiff and Rucker emphasized that unreliable infrastructure undermines even well-designed prescribing functionalities by increasing clinician frustration and workarounds(16).

The comparatively higher CDSS alert scores observed for the IHIO platform are consistent with studies highlighting the role of decision-support tools in improving medication safety. However, international literature cautions that the effectiveness of CDSS depends not merely on the presence of alerts, but on their relevance, prioritization, and configurability. A systematic review by Hussain et al. found that poorly designed or excessive alerts can contribute to alert fatigue, reducing clinician responsiveness and potentially compromising safety(17). The lack of customizable alert thresholds reported for some platforms in this study reflects a challenge commonly documented in low- and middle-income countries (LMICs), where user-centered design and iterative system refinement are often limited.

From a health system perspective, the findings are highly consistent with prior research conducted in Iran and comparable LMIC contexts. A recent qualitative study by Moghani et al. identified fragmented governance, parallel insurance-driven platforms, and infrastructure variability as core barriers to effective e-prescribing implementation in Iran (9). Similar challenges have been reported in multi-payer health systems, where insurer-specific digital solutions have resulted in fragmented governance structures, inconsistent user experiences, and limited interoperability across platforms (18–20).

The results of this study have several important implications for digital health policy in fragmented health systems. From a health system policy perspective, the findings indicate that improving e-prescribing performance in fragmented, multi-payer environments requires a shift from platform-specific optimization toward system-wide governance mechanisms. Rather than focusing on relative platform ranking, policymakers should prioritize the definition and enforcement of minimum performance standards—such as system uptime, response time, and consistent access to longitudinal patient data—across all insurer-based platforms. This approach may reduce cumulative workflow disruption for clinicians who are required to navigate multiple systems within routine practice.

Second, governance of clinical decision support system (CDSS) alerts emerges as a critical policy issue. The findings suggest that the clinical value of CDSS is less dependent on alert volume and more closely related to relevance, prioritization, and contextual alignment with clinical workflows. National-level guidance on alert logic, coupled with mechanisms for monitoring override rates and enabling role-based customization, may help preserve the safety benefits of CDSS while minimizing alert fatigue(21).

Third, the study highlights structural risks associated with insurer-driven digital fragmentation. While full platform unification may not be feasible in many multi-payer systems, coordinated national strategies that promote interoperability, shared technical standards, and harmonized data structures are essential. International experience suggests that partial integration through shared registries, standardized interfaces, and governance alignment can yield meaningful improvements in usability and safety, even in the absence of a single unified platform(22, 23).

This study has several strengths. It is the first comparative evaluation of all three national e-prescribing platforms in Iran using a validated, multidimensional assessment tool, and it provides insights from physicians with direct experience across all systems. Conducting the study in a non-metropolitan setting enhances its relevance for other LMIC contexts with similar resource constraints. A further strength lies in the parallel assessment of physician and patient perspectives, enabling identification of convergent and divergent priorities relevant for system governance and user-centered redesign.

The modest physician sample size limits statistical power and precludes causal inference; however, the use of experienced physicians with exposure to all three platforms supports the study's formative objective of identifying system attributes that may influence user experience. Within this context, the value of the regression findings lies in their ability to inform hypothesis generation and policy dialogue, rather than definitive system ranking.

Future studies should integrate subjective user evaluations with objective system performance metrics, including system downtime, response latency, and CDSS override rates. Longitudinal designs and multi-stakeholder perspectives—including patients, pharmacists, and system administrators—would further strengthen evidence for policy decision-making in fragmented digital health environments.

Conclusions

This formative comparative evaluation demonstrates that, within fragmented multi-payer health systems, variability in e-prescribing performance is shaped primarily by infrastructure reliability and continuity of access rather than by the presence of advanced functionalities alone. Insurer-driven digital fragmentation can translate into uneven user experiences and cumulative workflow burden for clinicians. To enhance the safety, usability, and sustainability of national e-prescribing initiatives in low- and middle-income countries, policy efforts should prioritize system-wide performance standards, coordinated CDSS governance, and interoperability across insurer-based platforms.

Declarations

Ethics approval and consent to participate :this research is approved by Ethics Committee of Mashhad University of Medical Sciences (IR.MUMS.FHMPM.REC.1402.203) and in accordance with the Declaration of Helsinki.

Funding: this research is supported by Mashhad University of medical sciences. (Gant NO. 4021524)

The funding source had no involvement in the study design; collection, analysis, and interpretation of data; writing of the manuscript; or the decision to submit the manuscript for publication.

Availability of data and material: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Transparency Statement : Elaheh Houshmand affirms that this manuscript is an honest, accurate, and transparent account of the study being reported. No important aspects of the study have been omitted, and any discrepancies from the study as planned (and, if relevant, registered) have been fully explained.

Acknowledgements: This study is part of a Master thesis on Health information technology approved by the School of Health at Mashhad University of Medical Sciences registered under (Gant NO. 4021524))

Competing interests: The authors declare that they have no competing interests.

Consent for publication: The authors declare their Consent for publication

Authors' contributions: Elaheh Hooshmand: Study conception, project coordination, methodology development, data analysis, and original draft preparation.
Marziyeh Meraji: Literature review, data interpretation, and manuscript revision.
Maryam Shaabani: Data collection and contribution to discussion drafting.
Khalili Kimiafar: Study design consultation and technical support in manuscript editing.
Jamshid Jamali: Statistical analysis and review of the results section.

All authors read and approved the final version of the manuscript.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used ChatGPT (OpenAI) to improve the readability, clarity, and structure of the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

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