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Smart Prescription Manager: A Comprehensive Review of Electronic Prescribing, Authentication and Verification, Interoperability, and Emerging Technologies

Abuj Prem Balasaheb, Prof. Bangar Abhishek Popat, Prof. S. B. Bhosale, Prof. Karad V. A.
Dept. of Computer Engineering
Jaihind College of Engineering, Kuran, Pune, India

Abstract — A prescription is the link that carries a doctor's decision to the patient and the pharmacy. On paper, however, prescriptions are easily lost or damaged, can be misread when the handwriting is poor, and are difficult to authenticate. Electronic prescribing, in which a prescription is created, stored, shared and verified in digital form, is widely proposed as a remedy. This paper offers a focused narrative review of sixteen verified sources: one foundational consensus report [1], eight review or perspective articles, and seven primary studies covering systems, standards and case studies. Three connected themes are examined: the technologies and design elements behind a Smart Prescription Manager, which is a single secure platform joining doctors, patients and pharmacies; how strong the evidence is on medication errors and computerised prescribing; and the conditions that shape real-world deployment. The sources indicate that computerised prescribing with decision support can lower prescribing errors, and that standards such as HL7 FHIR and blockchain-based access control can be assembled into working prototypes. Yet most of the strong evidence comes from hospitals, most blockchain work remains at prototype level, and little is known about small clinics, pharmacies, telemedicine, staff training, dependence on the internet, or the new errors that software itself may introduce. The review contributes a comparative table, a conceptual architecture linking prescription creation, patient access and pharmacy verification, and a prioritised list of research gaps. The architecture is only a proposal; it has been neither built nor tested.

Keywords— Electronic Prescribing, Smart Prescription Manager, Medication Errors, Computerized Physician Order Entry, Interoperability, HL7 FHIR, Blockchain, Healthcare Security.

I. INTRODUCTION

A prescription reaches treatment through three hands. The doctor writes it, the patient carries it, and the pharmacy dispenses it. On paper, each hand-off carries a risk: the slip may be lost or damaged, the handwriting may be misread, manual record keeping is slow and prone to mistakes, and neither the patient nor the pharmacist can easily confirm that the prescription is genuine.

The problem is a serious one for patient safety. The Institute of Medicine report To Err Is Human estimated that roughly 7,000 deaths each year in the United States were associated with medication errors [1]. This figure refers to medication errors as a whole, and illegible handwriting is only one contributor. A systematic review likewise found that prescribing errors occur frequently among hospital inpatients [2], and an analysis of electronic prescriptions showed that free-text notes can still cause confusion where structured fields are not used [3].

Electronic prescribing (eRx) swaps the paper form for a structured digital record: the doctor creates it, it is stored securely, the patient can view it, and the pharmacy checks it. An early study of computerised physician order entry (CPOE) with decision support reported a large fall in serious medication errors [4], and later reviews and a meta-analysis point in the same direction [5], [6]. A Smart Prescription Manager goes a step further by placing hospitals, clinics, pharmacies and telemedicine services on one secure platform. It pursues three objectives: accuracy, by removing handwriting errors through structured prescriptions; security, by protecting records through authentication and encryption; and accessibility, so that doctors and patients can reach records at any time and from any place.
Three developments make the idea timely. Standards such as HL7 FHIR allow different systems to exchange clinical data [7], [8]. Blockchain has been explored for access control and tamper-evident healthcare records [9], [10]. AI-based decision support, such as checking drug interactions, is also under discussion [11]. This paper reviews sixteen sources that together include a foundational report [1], review articles [2],

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[5], [6], [9], [11], [14]–[16] and primary studies [3], [4], [7], [8], [10], [12], [13]. Three questions guide the review. RQ1: Which technologies and design elements underpin electronic prescribing and a Smart Prescription Manager? RQ2: How strong is the evidence that computerised prescribing reduces errors, and what new risks does it create? RQ3: What does the evidence mean for a platform that connects doctors, patients and pharmacies? The paper closes with a comparative table, a conceptual architecture and a list of research gaps.

II. REVIEW METHODOLOGY

This is a narrative review of a purposively selected set of verified sources, not a systematic review. Searches combined terms such as electronic prescribing, e-prescription, computerized physician order entry, medication error, clinical decision support, HL7 FHIR, interoperability, blockchain healthcare, drug interaction, wearable and telemedicine. Widely cited peer-reviewed journal papers, conference papers and review articles were preferred, and each candidate was checked against its publisher or DOI record. A source was kept if it was peer reviewed; addressed electronic prescribing or medication safety, or an enabling technology such as decision support, interoperability standards, secure access control, blockchain, AI or wearables; described a method, system or review; and carried a DOI that could be verified. Marketing material, blog posts, vendor white papers, news items and anything unverifiable were excluded.

The final set holds sixteen sources: one foundational report [1], eight review or perspective articles [2], [5], [6], [9], [11], [14]–[16], and seven primary studies on systems, standards or case studies [3], [4], [7], [8], [10], [12], [13]. The Institute of Medicine report [1] is a consensus report rather than a journal article, but it serves as the basic reference for how large medication errors are. Three limitations should be stated openly. No logged Scopus or Web of Science queries were run, so coverage is not exhaustive and no study counts are reported. Most of the verified papers date from 1998 to 2020, which leaves newer work, and especially studies from the Indian healthcare setting, uncovered. Since the studies differ in scope, setting and evaluation, they are compared in words and their numbers are not pooled.

III. TECHNICAL FOUNDATIONS

1. Electronic Prescribing and Workflow

An electronic prescription is a structured record in which the drug, dose, route, frequency, duration and patient identity go into defined fields instead of being handwritten. In the Smart Prescription Manager concept, a prescription passes through three steps: the doctor creates the eRx, the patient opens it on a device, and the pharmacy verifies it before dispensing. Structured entry is what removes the handwriting problem, and it is also the point at which checks such as allergy alerts and dose limits can run before the prescription leaves the doctor's screen [4].

2. Medication Errors and the Limits of Paper

The scale of the problem has been documented at national level [1], and a systematic review of hospital inpatients found prescribing errors to be a common and repeated finding [2]. Paper adds weaknesses of its own: it can be lost, damaged or unreadable, and it is hard to verify. Even so, handwriting should not take all the blame. Errors also arise from choosing the wrong drug or dose, from missing patient information and from poor communication. Electronic systems are not immune either: an analysis of prescribers' notes in e-prescriptions found free text often used for details that belonged in structured fields, which can introduce ambiguity [3]. Good form design therefore matters as much as going digital.

3. Interoperability and Data Standards

A platform that connects hospitals, clinics, pharmacies and telemedicine services must exchange data between systems built by different vendors. HL7 FHIR represents clinical data as web-friendly resources exchanged through a RESTful interface [7]. SMART on FHIR builds on it by offering a standards-based way to run apps on top of electronic records [8]. Adopting a common data model for medication requests, patient identity and dispensing events is a practical way to avoid a closed, single-vendor system.

4. Security, Authentication and Blockchain

Prescription records are sensitive personal data, so authentication and encryption are essential. Blockchain has been proposed as an additional layer. Mettler [9] gave an early overview of its potential in healthcare, and Azaria et al. [10] built MedRec, a prototype that uses smart contracts to control who may access medical records. Reviews of blockchain in biomedicine and healthcare describe promising uses but also open issues in scalability, privacy and standards [14], and a scoping review found that the literature consists mostly of proposals and early prototypes, with few mature deployments [15]. One more limit applies, as with any ledger: a blockchain can keep a prescription unchanged once written, but it cannot show that the entry was correct or that its author was really a registered doctor. This point follows from the design itself and is this review's own reasoning, not a finding of the cited studies.

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Verifying the identity of prescribers therefore remains necessary.

5. AI Decision Support and Wearables

AI-based support, such as checking a new prescription against the medicines a patient already takes, is a frequent suggestion for future versions. Rajkomar et al. [11] review the promise of machine learning in medicine and stress that it needs careful validation before clinical use. Wearable devices could feed continuous measurements into the record for follow-up care, but a review of consumer wearables lists barriers such as data accuracy, user engagement and privacy [16]. Both are best treated as future work that still needs evaluation, not as proven features.

IV. FEATURES AND DESIGN ELEMENTS

1. Common Building Blocks

Across the reviewed work, six functional building blocks of a Smart Prescription Manager appear repeatedly. (i) Structured entry of drug, dose, route, frequency, duration and patient identity [3], [4]. (ii) Allergy and interaction checks before a prescription is saved [4]. (iii) Authentication, encryption and a digital signature from the prescriber [9]. (iv) A secure record store with a standard FHIR-based interface [7], [8]. (v) Patient access to the prescription on a device. (vi) Pharmacy verification of the signature and record before dispensing, with the dispensing event logged. Two further elements are optional or lie in the future: a blockchain audit trail [10], [14], and AI-based interaction checking together with wearable integration [11], [16].

2. Elements Used in the Reviewed Studies

Bates et al. [4] studied CPOE paired with a team intervention in a hospital. Kaushal et al. [5] and Radley et al. [6] reviewed CPOE and clinical decision support across many studies, while Bender and Sartipi [7] and Mandel et al. [8] describe the data-exchange standard and the apps platform built on it. Azaria et al. [10] built a blockchain prototype for managing record permissions, and Dhavle et al. [3] examined the notes field of electronic prescriptions. Each study addresses one layer of the problem; combining creation, access and verification is discussed only in concept.

3. Cautions

Several cautions recur. Free-text fields can bring ambiguity back into electronic systems [3]. A CPOE system can itself make medication errors more likely through confusing screens and workflows that do not match the work [12], and clinical information technology can introduce new kinds of error [13]. A tamper-evident record does not prove that the prescriber is registered or that the entry is clinically right. AI support needs careful validation before clinical use [11], and wearable data face barriers of accuracy and privacy [16]. A Smart Prescription Manager must therefore be designed and tested together with its users, not simply rolled out.

V. EVIDENCE OF EFFECTIVENESS

1. Evidence for Computerised Prescribing

Bates et al. [4] reported a clear drop in serious medication errors after CPOE with a team intervention in a hospital. A systematic review of CPOE and clinical decision support found evidence of better medication safety, while noting that much of it came from a few leading institutions [5]. A later meta-analysis associated CPOE adoption with fewer medication errors in hospitals [6].

2. Unintended Consequences

The picture is not wholly positive. Koppel et al. [12] described many ways in which a CPOE system can make medication errors more likely, and Ash et al. [13] documented unintended consequences of health information technology, including new kinds of error. Dhavle et al. [3] found that free text in e-prescriptions can create ambiguity even where structured fields exist.

3. Quality and Coverage

The strongest outcome evidence comes from hospitals [4]–[6]. The verified set says little about community pharmacies, small clinics and telemedicine. Most blockchain and interoperability work consists of prototypes, specifications and reviews rather than clinical evaluations [7], [8], [10], [14], [15]. Most papers date from 1998 to 2020, and none of the reviewed work comes from the Indian healthcare setting.

VI. REPRESENTATIVE SYSTEMS IN PRACTICE

Three works illustrate what has actually been built or tested. Bates et al. [4] ran a hospital CPOE study at a single institution, pairing the software with a team intervention, and reported fewer serious medication errors. MedRec [10] is a prototype that uses smart contracts to manage permissions to medical records; it demonstrates that blockchain access control can work as a prototype but is not a field deployment. SMART on FHIR [8] is a platform that lets apps run on top of electronic health records through a standards-based interface; its design is described, yet its adoption was not measured.

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Taken together, these examples show that the building blocks exist: structured ordering with checks, standard data exchange and permission control. What they do not show is how the blocks behave once combined in a single platform used by small clinics, community pharmacies and telemedicine services. Whether hospital CPOE results would carry over to those settings is untested in the sources reviewed.

VII. COMPARATIVE ANALYSIS

Table I summarises representative primary studies and review articles. Because they differ in scope, setting and evaluation, they are compared in words rather than numbers.

Table 1: Comparison of Representative Studies on Electronic Prescribing and its Enabling Technologies

Author, year	Type / objective	Technologies	Main contribution	Scope limitation
Bates et al., 1998 [4]	Intervention study; hospital medication safety	CPOE, team intervention	Reported a substantial reduction in serious medication errors	Hospital setting; one institution
Koppel et al., 2005 [12]	Observational study; CPOE risks	CPOE	Identified ways CPOE can facilitate medication errors	Single-site study
Ash et al., 2004 [13]	Qualitative study; unintended consequences	Health information systems	Described new kinds of error caused by clinical IT	Not prescribing-specific
Bender and Sartipi, 2013 [7]	Standard overview; data exchange	HL7 FHIR	Describes resource-based, RESTful clinical data exchange	Specification overview; no clinical outcome data
Mandel et al., 2016 [8]	Platform description; app interoperability	SMART on FHIR	Standards-based apps platform for electronic health records	Platform design; adoption not measured
Azaria et al., 2016 [10]	Prototype; record access control	Blockchain, smart contracts	MedRec manages permissions to medical records	Prototype; not a field deployment
Dhavle et al., 2016 [3]	Retrospective analysis; e-prescriptions	Electronic prescribing	Analysed free-text notes in e-prescriptions and the risk they pose	Ambulatory US data; covers notes only
Kaushal et al., 2003 [5]	Systematic review; medication safety	CPOE, decision support	Found evidence of safety benefit from CPOE and decision support	Evidence from few institutions
Radley et al., 2013 [6]	Meta-analysis; hospital medication errors	CPOE	Associated CPOE adoption with fewer medication errors	Hospital studies only
Kuo et al., 2017 [14]	Review; biomedical blockchain	Blockchain	Describes uses and open issues of blockchain in health care	Review; no new system
Hasselgren et al., 2020 [15]	Scoping review; healthcare blockchain	Blockchain	Maps the literature on blockchain in healthcare	Review; literature mostly proposals and prototypes

Three patterns emerge. The most solid outcome evidence relates to CPOE and decision support in hospitals [4]–[6], while community pharmacies, small clinics and telemedicine receive little attention in the verified set. Studies of the software itself also show that digitisation can generate fresh errors unless design and workflow are tested [3], [12], [13]. Finally, the work on blockchain and interoperability is made up largely of prototypes, specifications and reviews rather than clinical evaluations [7], [8], [10], [14], [15]. Given how much the settings, platforms and evaluation methods vary, this evidence does not support naming any one technology stack as the best.

VIII. PROPOSED CONCEPTUAL ARCHITECTURE

Figure 1 turns the design lessons of the reviewed work, together with the three aims of the Smart Prescription Manager (accuracy, security and accessibility), into a layered

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architecture. It is a conceptual proposal drawn from the literature, and it has not been tested experimentally.

The first layer represents the actors, namely doctors, patients and pharmacists working in hospitals, clinics, pharmacies and telemedicine services. In the second layer, each user signs in, the prescriber's identity is verified, and the prescriber digitally signs every prescription [9]. In the third layer, the doctor builds a structured eRx; before saving, the system runs allergy and interaction checks and attaches a unique identifier [4]. The fourth layer is a secure record store exposed through a standard FHIR-based interface [7], [8].

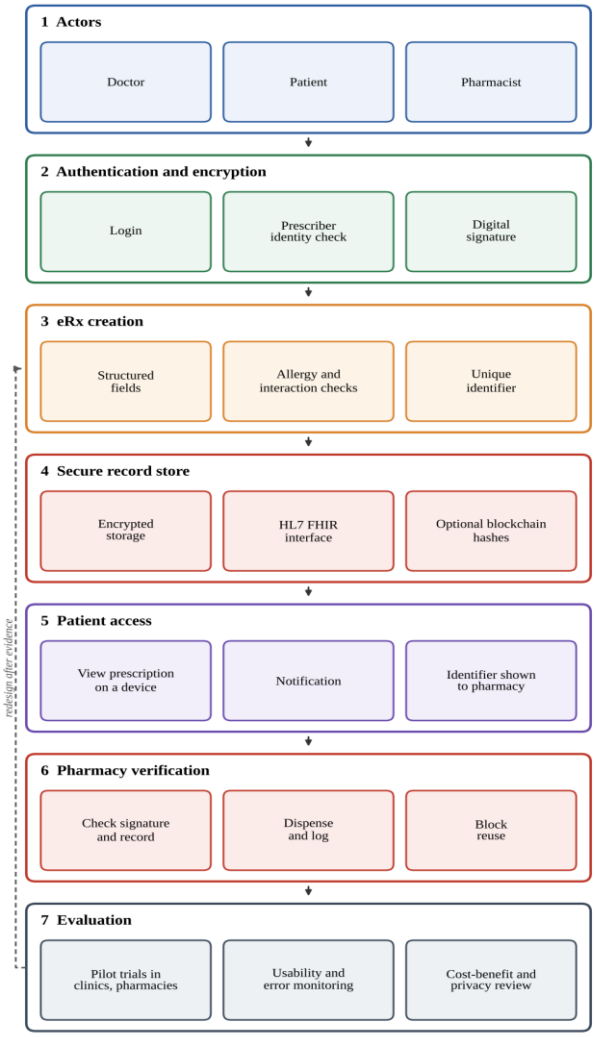

Fig. 1. Proposed conceptual architecture for a Smart Prescription Manager (conceptual, not experimentally validated)

Where a tamper-evident audit trail is desired, a permissioned blockchain can hold just the hashes of the records, not the clinical content, which keeps personal data off-chain [10], [14]. In the fifth layer, the patient views the prescription in an app. In the sixth, the pharmacist verifies the signature and record before dispensing, then logs the event. The seventh layer closes the loop with evaluation, through pilot trials, usability and error monitoring, and cost-benefit and privacy review [12]–[15], and its findings flow back into the earlier layers. The authors added this evaluation layer themselves; none of the reviewed studies tested it.

1. Working Principle

The workflow runs in five steps. (1) A registered doctor signs in and fills in the eRx through structured fields, after which the system performs allergy and interaction checks and issues a unique identifier for the prescription. (2) The doctor applies a digital signature, and the signed record goes into the store. (3) The patient receives a notification and can open the prescription on a device. The patient may pass its identifier to the chosen pharmacy, for instance as a code or a link; this is a design choice that none of the reviewed studies tested. (4) At the pharmacy, the pharmacist signs in, fetches the prescription using that identifier, and confirms that the signature is valid, that the record is unaltered, and that it has not been dispensed before. (5) Once the pharmacy logs the dispensing, the doctor and the patient can both see its status, and the prescription cannot quietly be used a second time.

IX. RESEARCH GAPS AND FUTURE DIRECTIONS

Gaps backed by the reviewed evidence. (i) Privacy and security: because prescription data are sensitive, privacy, cyber threats and compliance with data-protection law are central worries, and blockchain reviews in healthcare name privacy as an unresolved issue [14]. (ii) Dependence on the internet: a platform that functions only online may break down in areas with weak connectivity, so offline access and a safe fallback deserve study. (iii) Barriers to adoption: doctors, pharmacy staff and patients all need training, which costs time and money, and software that sits badly with the workflow can cause errors itself [12], [13]. (iv) Thin evidence beyond hospitals: the best results come from hospital CPOE [4]–[6], whereas small clinics, community pharmacies and telemedicine have little evidence. (v) Unstructured data: free-text fields can reintroduce ambiguity even in electronic systems [3]. (vi) Interoperability and standards: records cannot move smoothly between platforms unless they share a data model [7], [8]. (vii) Trust in identity and entries: a tamper-evident record proves neither that

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the prescriber is registered nor that the entry is clinically correct. (viii) Validation of AI and wearables: both require solid clinical validation before use [11], [16]. (ix) Scalability and cost of blockchain: reviews name scalability as an open issue [14], [15], and nobody has established whether a ledger justifies its cost in a prescription workflow. (x) Regulation and governance: electronic prescribing and telemedicine fall under national rules, and data-protection law, such as India's Digital Personal Data Protection Act, 2023, shapes what may be stored and shared. These rules are not analysed in detail here.

Directions requiring investigation. Priorities include pilot trials in clinics, pharmacies and telemedicine services, not only large hospitals; usability and training studies with doctors and pharmacists that look specifically for new errors caused by the software [12], [13]; reliable prescriber identity checks and digital signatures; a design that still works with poor connectivity; interoperability tests with FHIR-based systems [7], [8]; clinical validation of AI-based drug-interaction checking [11]; wearable and mobile-first integration for continuous care [16]; cost-benefit and privacy evaluation of a blockchain audit trail [14], [15]; and legal and regulatory compliance for data protection and telemedicine prescribing.

X. CONCLUSION

Paper prescriptions can be lost, damaged or misread, and they are hard to verify. Electronic prescribing offers a structured, secure and more accessible alternative. Across the sixteen sources reviewed, computerised prescribing with decision support can reduce medication errors in hospitals [4]–[6], standards such as HL7 FHIR support data exchange between systems [7], [8], and blockchain-based access control can be built as a prototype [10]. At the same time, the evidence comes mostly from hospitals, prototypes and conceptual frameworks, and software can introduce new errors of its own [3], [12], [13]. Privacy and security, staff and patient adoption, internet dependency, clinical validation of AI and the cost of blockchain remain open problems. The architecture proposed here is a starting point, not a validated result.

Future work should extend this review to the most recent studies, including work from the Indian healthcare setting, and test the proposed architecture in a pilot with real clinics and pharmacies. It should also explore AI-based drug-interaction support secured through blockchain immutability, along with wearable and mobile-first integration for continuous care, and judge each addition by cost, usability, safety and the reliability of the data it records.

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