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Review Article

Innovation of New Medical Devices and Promotion of Digital Pharmacy Using Artificial Intelligence

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ABSTRACT

Healthcare is moving toward connected devices, data-driven decision support, remote monitoring, and digitally enabled pharmacy services. Artificial intelligence (AI) can contribute to this transition by helping medical devices interpret signals, identify patterns, support early warnings, and personalize monitoring. In digital pharmacy, AI can assist with medicine information, prescription workflow, inventory forecasting, adherence reminders, interaction screening, and patient communication when these functions are designed with appropriate human oversight. This project proposes an integrated concept called AI-Enabled SmartCare Pharmacy. The concept combines a connected medication dispenser, a multi-parameter home monitoring kit, an AI-assisted medication review platform, and a digital pharmacy service. The proposed system is designed around patient safety, pharmacist supervision, data minimization, cybersecurity, accessibility, and regulatory awareness. The central principle is that AI should support healthcare professionals rather than replace them. The strongest value comes from combining reliable sensing, clear clinical workflows, pharmacist review, explainable alerts, and continuous evaluation.

INTRODUCTION

Healthcare delivery increasingly involves information generated outside hospitals: home blood-pressure readings, glucose measurements, medication schedules, prescription records, refill histories, and patient-reported symptoms. The growth of smartphones, connected sensors, cloud platforms, and machine-learning methods creates an opportunity to connect these data sources with pharmacy services.

A digital pharmacy is more than an online medicine-ordering website. In a patient-centred model, it can provide electronic prescription handling, medication information, refill support, adherence services, pharmacist counselling, stock visibility, and

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communication through secure digital channels. AI can add another layer by identifying routine patterns and directing attention toward cases that may need a pharmacist's review.

Medical-device innovation complements this model. Devices that are easier to use, connected to a secure application, and designed around real-world patient needs can extend monitoring beyond the clinic. A device needs a defined purpose, reliable measurements, usability testing, risk controls, and an appropriate regulatory pathway.

2.BACKGROUND AND NEED

Patients may forget doses, misunderstand instructions, have difficulty recording home measurements, or delay contacting a healthcare professional when a condition changes. Pharmacists may also spend substantial time on repetitive administrative work, while clinically important information can be distributed across different systems.

AI can help organize information, but automated systems can also introduce false alerts, biased outputs, privacy risks, and unsafe recommendations. Therefore, this project uses a human-in-the-loop model: AI generates structured insights or alerts, while a qualified pharmacist or clinician remains responsible for professional decisions.

3.AIM AND OBJECTIVES

The aim is to design a conceptual, patient-centred model that combines innovative connected medical devices with AI-supported digital pharmacy services while maintaining safety, privacy, usability, and professional oversight.

Objectives

•Design a connected medication dispenser that records dose events and provides reminders without independently changing prescribed therapy.

•Develop a home-monitoring kit concept that can capture selected physiological measurements and transfer them securely to an application.

•Create an AI layer that summarizes trends and prioritizes alerts for pharmacist review.

•Design digital-pharmacy functions for prescription management, refill reminders, medication education, and pharmacist communication.

•Define safeguards for privacy, cybersecurity, bias, explainability, and human oversight.

•Propose measurable indicators for technical performance, patient experience, pharmacyworkflow, and safety.

4.PROPOSED INNOVATION

The proposed solution is called AI-Enabled SmartCare Pharmacy. It is a conceptual ecosystem rather than a finished medical product. It contains four connected components.

4.1Smart Medication Dispenser

The dispenser supports adherence through audible or visual reminders and records whether a scheduled compartment was opened. It can notify the pharmacy team when a repeated missed-dose pattern appears. The design deliberately avoids automatically altering the prescribed dose.

4.2Home Health Monitoring Kit

The kit can accept approved peripheral devices such as a blood-pressure monitor, pulse oximeter, thermometer, or glucose meter, depending on the clinical use case. Data are time-stamped and linked to the appropriate patient account. Quality checks can identify missing readings, implausible values, or device errors before an alert is generated.

4.3AI Health Insight Engine

The AI layer summarizes trends instead of presenting a large volume of raw measurements. It can flag repeated missed-dose events, sustained changes in a monitored parameter, or unusual refill patterns. The output should include the reason for the alert, relevant data window, and uncertainty information where appropriate. A professional reviews the information before clinical action.

4.4Digital Pharmacy Portal

The portal provides electronic prescription workflow, medication information, refill requests, reminders, secure messaging, delivery or collection status, and pharmacist-led counselling. AI may help classify

routine queries or prepare a draft summary, but patient-specific therapeutic decisions remain under professional control.

5.AI IN DIGITAL PHARMACY

AI can be used at several points in a pharmacy workflow. The following applications are proposed as assistive functions rather than autonomous prescribing.

Application	Possible AI role	Human control
Medication adheren c | ceDetect repeated missed-dose patterns and | riPoritize follow-up.		harmacist reviews
Refill forecasting | Estimate when a routine refill may be neede | d Pfrom authorized dispens ng history.		the pattern and
Medication informat i | ioOnrganize approved information into plain-la | gPuage summaries. Interaction screenin | p gFlag possible interactions or duplicate thera | pyQ for review.ualified professional verifies clinical elevance. Inventory managem | enFtorecast demand and identify unusual stock | mPovement.harmacy manager makes purchasing de Application | Possible AI role | Human control Patient communicat i | ioCnlassify routine messages and suggest draft | rHesponses.		contacts the patient w harmacy cverifies prescription validity and actual

patient n harmacist checks high-risk or patient-specific questions. uman review for clinical, sensitive, or ambiguous messag

A key design principle is that an AI output should be traceable. The interface should show what information contributed to an alert, when it was generated, and what action is expected. This reduces the risk that a probability score is mistaken for a diagnosis.

6.SYSTEM ARCHITECTURE AND WORKFLOW

The proposed architecture consists of five layers: sensing, secure communication, data storage, AI analytics, and professional action.

- Sensing layer: connected devices collect authorized measurements and medication-eventdata.
- Communication layer: encrypted transmission moves data from devices to the applicationplatform.
- Data layer: patient data are stored with access controls, audit records, retention rules, andidentity management.
- AI layer: algorithms perform trend analysis, classification, forecasting, or summarizationwithin their validated scope.
- Care layer: pharmacists or clinicians review relevant alerts and communicate with the patient.

Example workflow: a patient takes or misses a scheduled medicine; the dispenser records the event; the event is securely transmitted; the system compares it with the planned schedule; repeated deviations are summarized; an alert is prioritized; the pharmacist reviews the case; and the patient receives an appropriate reminder, counselling message, or referral.

7.DEVELOPMENT AND IMPLEMENTATION PLAN

Phase 1 — Needs assessment: interview pharmacists, patients, caregivers, and other stakeholders to identify workflow problems, accessibility requirements, and high-risk scenarios.

Phase 2 — Prototype: build a non-clinical prototype of the dispenser interface, monitoring dashboard, pharmacy portal, and alert logic. Use simulated data initially.

Phase 3 — Verification: test sensor communication, data integrity, authentication, cybersecurity, failure modes, alert timing, and usability.

Phase 4 — Controlled pilot: introduce the system to a limited user group under appropriate professional and institutional oversight. Measure usability, false-alert burden, workflow time, and safety events.

Phase 5 — Evaluation and refinement: analyze performance, document problems, update the design, and repeat testing before broader deployment. Suggested project timeline

Month	Major activity
1	Literature review, stakeholder needs, risk identification
2	System requirements and device concept design
3	Prototype interfaces and simulated AI workflow
4	Cybersecurity, usability, and technical verification
5	Small supervised pilot and data collection
6	Evaluation, report writing, and future-development plan

8.SAFETY, ETHICS, PRIVACY AND REGULATION

Healthcare AI requires stronger safeguards than many consumer applications because errors can affect patient care. The proposed project therefore treats safety as a design requirement rather than a final-stage feature.

Patient safety: alerts should be conservative and clinically interpretable. The system must define what happens when a device fails, data are missing, the patient is offline, or an AI model produces an uncertain result. Emergency situations should not depend solely on an automated digital service.

Privacy and security: only necessary information should be collected. Authentication, role-based access, encryption, audit trails, secure software updates, and appropriate retention periods should be implemented. Patients should be told what information is collected and why.

Bias and accessibility: models trained on limited populations may perform differently across populations. Testing should include representative users where possible. Interfaces should support people with limited digital literacy, vision, hearing, or mobility.

Regulatory awareness: whether a particular software feature or device is regulated as a medical device depends on its intended use, claims, risk classification, and jurisdiction.

Development should therefore begin with a regulatory assessment.

Professional accountability: AI should not independently diagnose, prescribe, discontinue medication, or make highrisk treatment decisions in this project. Pharmacists and clinicians remain responsible for professional judgment within their scope of practice.

9.EVALUATION FRAMEWORK

The project should be evaluated using measurable indicators instead of relying only on demonstrations.

Area	Example indicator	Desired direction
Device reliability	Successful transmission / valid readings	Higher reliability
AI alert quality	Sensitivity, specificity, false-alert rate	Appropriate balance
Area	Example indicator	Desired direction
Usability	Task completion and user-reported ease	Improved usability
Pharmacy workflow	Time spent per reviewed alert	Reduce unnecessary workload
Adherence support	Change in documented missed-dose events	Reduction where appropriate
Safety	Unresolved high-risk alerts or system-related inci	deMntsinimize and investigate
Privacy/security	Access violations or security incidents	Zero avoidable incidents

A pilot should compare baseline and post-implementation measures where ethically and methodologically appropriate. Qualitative interviews are also important because a technically accurate system may still fail if patients find it confusing or pharmacists find the alert volume impractical.

10.EXPECTED BENEFITS AND LIMITATIONS

Expected benefits include better organization of medication information, earlier recognition of adherence patterns, improved continuity between home monitoring and pharmacy support, more efficient routine

workflows, and more opportunities for pharmacist-patient communication. For pharmacy operations, forecasting tools may also help reduce avoidable stock-outs and excess inventory.

Important limitations remain. AI predictions are not automatically correct; connected devices can produce inaccurate or missing measurements; internet and electricity may be unavailable; patients may share devices; and digital

services can exclude people with low connectivity or limited digital literacy. There is also a risk of alert fatigue if the

system produces too many notifications.

11.FUTURE SCOPE

•Multilingual voice interfaces for patients who prefer spoken interaction.

•Privacy-preserving learning approaches where appropriate and validated.

•Integration with electronic health records and authorized pharmacy systems using interoperable standards.

•Better calibration of alerts for individual patients while maintaining clinical safeguards.

•Computer-vision assistance for packaging or label verification under professional supervision.

•Predictive stock management for rural and community pharmacies.

•Remote pharmacist counselling and structured follow-up programs for chronic conditions.

CONCLUSION

AI can support a new generation of medical devices and digital pharmacy services when it is applied to clearly defined

problems and embedded in safe workflows. This project proposes an integrated model in which connected devices

collect useful information, AI organizes patterns and prioritizes attention, and pharmacists or clinicians make professional decisions.

The most important innovation is not AI alone. It is the combination of usable devices, secure data handling, explainable decision support, pharmacist involvement, and continuous evaluation. A responsible implementation

should begin with patient needs and safety requirements, followed by technical development and regulatory

assessment.

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