

A Portable Patient Health Record System for Ghana

Addressing Facility-Siloed Data Through Patient-Centered Interoperability

A Research and Product Methodology Paper

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Abstract

Ghana operates two non-interoperable national digital health systems (DHIMS and LHIMS), creating a structural gap in patient-level data continuity across facilities. This paper presents the problem analysis, system design rationale, and product requirements for a Portable Patient Health Record (PPHR) platform that decouples clinical data from facility-specific silos using a patient-controlled identity layer linked to the Ghana Card. The proposed MVP architecture addresses care fragmentation without requiring hospital-to-hospital integration agreements. Findings from the literature on personal health records, health information exchange in low- and middle-income countries, patient safety risks from incomplete medication history, and unique patient identifier systems are synthesized to validate each design decision.

Keywords: portable health records, health information exchange, interoperability, Ghana, patient-controlled health records, unique patient identifiers, digital health, low- and middle-income countries

1. Introduction

Patient safety in multi-provider care environments depends critically on information continuity. When a patient receives care at a facility that has no access to their prior diagnoses, current medications, or documented allergies, clinicians are forced to operate on incomplete data — a condition that materially increases the risk of adverse drug events and redundant investigation.

Ghana has made substantial investments in digital health infrastructure. By 2017, the country had deployed two national systems: the District Health Information Management System (DHIMS), a public-health-level aggregate repository administered by the Ghana Health Service; and the Lightwave Health Information Management System (LHIMS), a patient-level electronic medical record deployed across district, regional, and teaching hospitals [1]. Critically, these two systems are currently not interoperable. The dual deployment without integration has resulted in data duplication and inaccuracies, fragmenting information across service points and preventing a consolidated view of any individual patient's clinical history [2].

This fragmentation is not merely an administrative inconvenience. Care fragmentation has been linked to significantly higher rates of potentially inappropriate medication use and elevated all-cause mortality, even after adjusting for comorbidity and socioeconomic factors [3]. A systematic review of 22 cohort studies across nine countries found that increased continuity of care with doctors is associated with lower mortality rates, with 18 of 22 high-quality studies reporting statistically significant protective effects [4]. The absence of accessible, portable patient records in Ghana operationalises exactly the care-fragmentation risk these studies describe.

Beyond mortality, incomplete allergy and medication documentation is a documented patient safety hazard. Studies have found that a meaningful

share of potentially harmful medication errors arise from incomplete or incorrect allergy documentation [5], and the failure to access a patient's summary care record has been ruled a direct contributing factor to fatal anaphylactic reactions in inquest findings [6].

The proposed Portable Patient Health Record (PPHR) system addresses this gap by decoupling clinical records from the facility that created them and placing data access control in the hands of the patient, using a unique identifier that simulates the existing Ghana Card-NHIS linkage infrastructure.

2. Related Work

2.1. Personal Health Records and Patient-Controlled Systems

The concept of patient-controlled health records has a well-established body of literature. Detmer et al. identified the “integrated PHR” — in which records are automatically populated from multiple providers and made accessible across institutions — as the only model with genuine transformative potential, while cataloguing barriers including lack of technical interoperability standards, uncertain market demand, and digital-divide concerns [7]. Archer et al. conducted a scoping review of the PHR field and found that PHR adoption depends substantially on primary care physician linkage and on providing patient-oriented self-management functionalities rather than merely replicating provider-oriented records [8].

The Indivo system (Children’s Hospital Boston) demonstrated that a personally controlled health record using open standards and APIs could assemble records from diverse institutional sources under the patient’s control [9]. Early deployment experiences confirmed that patients value the ability to co-locate, view, update, and share health information with providers, and that early adopters consistently perceive benefits as outweighing privacy risks [10].

Mobile personal health records have been proposed as particularly useful in emergency and multi-provider scenarios — precisely the cross-facility care context Ghana exhibits — with patient-accessible portable records shown to minimise medical errors when patients present to unfamiliar providers [11].

More recently, blockchain-based frameworks for patient-centered records (e.g., HealthChain) have demonstrated that immutable, patient-controlled, HL7 FHIR-compliant data sharing is technically feasible [12]. An interoperable blockchain-based EHR framework survey confirms that HL7 FHIR, HIPAA compliance,

and semantic interoperability standards represent the current best practice for cross-institutional health record portability [13].

2.2. Health Information Exchange in Low- and Middle-Income Countries

A systematic review of barriers and facilitators to health information exchange (HIE) in LMICs identified inadequate technical infrastructure, weak governance, lack of training, and insufficient importance given to data in decision-making as the primary challenges [14]. The review also found that leapfrog technologies — mHealth, mobile-first architectures, and lightweight web applications — represent successful models of HIE delivery in resource-constrained environments, offering a justification for the lightweight web-app approach proposed here.

A systematic review of HIE policy and standards across Africa found that African countries have adopted varying syntactic and semantic interoperability standards, but that comprehensive interoperable technical standards are not yet uniformly implemented at the national level [15]. Tanzania's national HIE implementation provides a relevant precedent: using a "Mind the GAPS" governance framework and a middleware interoperability layer, Tanzania connected 15 separate health information systems and achieved measurable data-availability improvements [16]. Ghana's own broader digital health governance landscape is characterised by strategic objectives for interoperability that are not yet backed by enforceable technical requirements or deployment sanctions [17].

Labrique et al.'s review of best practices for scaling digital health in LMICs identifies five critical success factors: tangible benefit addressing an unmet need (with end-user input), stakeholder engagement, technical simplicity and interoperability, alignment with national health policy, and sustainable fund-

ing [18]. The PPHR design is aligned with each of these factors.

Olu et al. proposed a conceptual framework for deploying digital health at scale for universal health coverage in Africa, underscoring that lack of interoperability among numerous digital health systems is one of the continent's primary obstacles to realising digital health benefits [19].

2.3. EHR Adoption Readiness in Ghana

A cross-sectional study across two hospitals in northern Ghana found that overall provider readiness for electronic health records was 54.9%, with engagement readiness notably lower at 43.1%. Age, computer literacy, and prior knowledge of EHR systems were significant determinants of readiness [20]. This readiness gap underscores the importance of a clinician-facing interface that is minimal and intuitive — a core non-functional requirement of the PPHR's MoSCoW specification.

2.4. Unique Patient Identifiers

Accurate patient identification across facilities is a prerequisite for any portable record architecture. Riplinger et al. reviewed six common patient identification techniques used globally and found that no single technique achieves a 100% match rate, and that unresolved patient identification directly produces treatment errors, care delivery failures, and data-sharing barriers [21].

Mills et al. examined how national civil registration and unique identification number systems can anchor unique health identifiers and found that countries linking health identifiers to civil registration (as Ghana is doing with the Ghana Card) achieve more efficient universal health coverage programmes [22]. Chukwu et al.'s analysis of patient ID systems in Nigeria found that no existing patient ID strategy simultaneously satisfies the six desirable attributes

of uniqueness, unchanging nature, low cost, ubiquity, and simplicity required for reliable health management information systems – and proposed a decentralised offline model closely analogous to the PPHR’s approach of simulating the Ghana Card number for demo-context identification [23]. A landscape analysis across Southern African Development Community countries found that, without a functional and reliable unique patient identifier, tracking patients across care cascades remains chronically difficult [24].

2.5. Medication Reconciliation and Care Transitions

A Cochrane review of 25 randomised trials of medication reconciliation at care transitions found that reconciliation interventions reduced the risk of patients having at least one medication discrepancy by 47% (risk ratio 0.53, 95% CI 0.42–0.67) [25]. A systematic review of medication errors and medication-related harm following hospital discharge found median medication error rates of 53% and adverse drug event rates of 19% in the post-discharge window [26]. Both findings provide quantitative justification for the PPHR’s “Must Have” requirement of displaying allergies, current medications, and chronic conditions at point-of-care entry to a new facility.

3. Methodology

3.1. Problem Formulation

The problem was scoped using an altitude check to avoid both over-broad framing (all of Ghana's healthcare data) and over-narrow framing (a single anecdote). The helicopter-level formulation is: when a patient in Ghana is treated at a hospital other than the one that last treated them, the new clinician has no access to that patient's prior diagnoses, allergies, or medications — because each facility's records exist only within its own system.

This framing was validated against a wicked-problem checklist. Three of eight wicked-problem criteria apply (no single correct formulation; symptom of a deeper problem; multiple valid explanations). The problem is thus structurally complex but tractable within a product scope, consistent with the hackathon usage guidance.

The root cause is documented: DHIMS operates at the aggregate public health level while LHIMS operates at the patient care level, and the two systems are not interoperable [1]. This is corroborated by Ghana's own governance review, which identifies that facility-level transactional systems and electronic medical records frequently operate independently, with linkage limited to aggregate reporting [17].

A PESTLE analysis confirmed that political conditions are permissive: the Ghana Card-NHIS linkage is a live government initiative providing an existing identity layer onto which a clinical data layer can be anchored. The economic case is supported by the well-established finding that duplicate testing and re-investigation due to missing records represent avoidable system costs. The technological constraint — DHIMS/LHIMS non-interoperability — is documented and unresolved, but the PPHR's design deliberately does not depend

on resolving it.

3.2. Stakeholder Analysis

The primary stakeholder is the Ghanaian patient transitioning between facilities (e.g., Korle Bu Teaching Hospital to Ridge Hospital to UGMC). The direct operational stakeholder is the attending clinician at the receiving facility who must currently treat without full information. Secondary stakeholders include pharmacists, who dispense without complete drug-interaction and allergy data; the Ghana Health Service and Africa CDC, which require longitudinal outbreak surveillance data; and the National Health Insurance Authority (NHIA), whose identity infrastructure provides the patient identifier foundation.

3.3. Design Principles

Four principles govern the PPHR architecture.

Patient-centricity. The record is owned by the patient, not by any facility. The patient grants access rather than the hospital, sidestepping the institutional trust and data-sovereignty barriers that have historically prevented facility-to-facility interoperability. This approach is consistent with the personally controlled health record (PCHR) model, in which patients assemble, maintain, and grant access to a secure copy of their medical data [9]. It also addresses the riskiest institutional assumption identified in the product requirements document: hospitals historically protect their own data rather than sharing it.

Minimal viable scope. The MVP targets patient-carried record retrieval only — not a full hospital EMR replacement, not real-time DHIMS/LHIMS integration, and not AI-based diagnostic support. This is consistent with Labrique

et al.'s recommendation that digital health tools in LMICs be driven by simplicity and adaptability rather than feature richness, which has consistently correlated with higher adoption and sustainability [18].

Offline-first architecture. Ghana's regional connectivity challenges are well-documented: intermittent internet connectivity is cited as a major implementation barrier across digital health deployments in the country [27]. The PPHR's non-functional requirements specify that the system must function under intermittent connectivity, following the offline-first design pattern that has proven effective in similar LMIC deployments.

Standards-compatible identity layer. The simulated Ghana Card number used in the MVP demo is designed as a proxy for the Ghana Card-NHIS linkage, consistent with literature recommendations that health identifiers be anchored to national civil registration systems to achieve uniqueness and sustainability [22].

3.4. Requirements Specification (MoSCoW)

Must Have. A patient profile containing allergies, current medications, chronic conditions, and blood type, addressable by patient identifier with a QR code lookup; an add-a-visit workflow enabling record updates across facility logins; and a demo-ready data set covering three mock facilities (Korle Bu, Ridge, UGMC).

Should Have. A lightweight consent flow enabling patient-authorised record access; multi-facility demo data; and clinician-facing record displays optimised for triage-speed retrieval.

Could Have. Antibiotic and drug-tracking with basic antimicrobial resistance (AMR)-relevant aggregation. The global AMR burden — estimated at 1.27 million deaths attributable directly to antimicrobial resistance in 2019, with

western sub-Saharan Africa carrying the highest all-age death rate — provides substantive public health motivation for this optional tier [28].

Won't Have (This Round). Real DHIMS/LHIMS integration; real Ghana Card/NHIS API integration; AI-based differential diagnosis.

3.5. Technical Approach

The PPHR is implemented as a lightweight web application with a centralised patient profile store keyed by a unique patient identifier. Facility “views” are distinct authenticated login contexts that query the same backend record, avoiding any need for a facility-to-facility data exchange protocol in the MVP. This centralised, patient-keyed architecture is consistent with the data-portability framing used by MyPHRMachines, in which health data and the software to view it are stored independently of any specific institution [29].

No AI component is included in the MVP, consistent with the diagnosis that the problem is one of data portability, not of reasoning. If time allows, an anonymised, aggregate-only symptom-clustering layer is added to enable facility-level outbreak detection while preserving individual patient privacy.

4. Discussion

4.1. The Institutional Adoption Problem

The literature consistently identifies institutional inertia and data-sovereignty concerns as the primary barriers to interoperability — not technical incapacity. A systematic review of barriers to cross-institutional HIE lists economic loss to competitors, security concerns, and federated data-ownership as dominant obstacles [30]. The PPHR’s patient-controlled architecture is designed explicitly to route around this barrier: because access is granted by the patient and the record is not housed within any single facility’s system, no facility is required to relinquish control of its own data. This “thin critical-facts layer” wedge strategy is consistent with the design recommendation from Weitzman et al. that PCHRs should be designed to encourage widespread participation by patients, providers, and institutions by making personal control both transparent and unambiguous [10].

4.2. Legal and Regulatory Considerations

Ghana’s Data Protection Act 2012 (Act 843) governs the collection, processing, and storage of personal data including health data. Any deployment beyond a hackathon demo requires a documented data-processing agreement, patient consent architecture, and cross-facility data-sharing framework compliant with the Act. This is analogous to challenges documented in comparable African EHR deployments, where data protection legislation compliance is identified as a critical prerequisite for national deployment but is often under-addressed at the design phase [31].

4.3. Scalability and Alignment with National Strategy

Ghana's Ministry of Health has a stated priority for developing a national digital health interoperability framework aligned with WHO guidelines and architectures such as OpenHIE [32]. The PPHR's HL7 FHIR-compatible design aspiration (for future iterations) positions it as a layer that can be absorbed into that national framework rather than becoming yet another siloed system. Torab-Miandoab et al.'s systematic review of interoperability requirements confirms that HL7 FHIR and semantic interaction represent the most robust path to cross-system health data exchange [33].

5. Conclusion

Ghana's DHIMS-LHIMS interoperability gap is a documented, persistent constraint on patient-level data continuity [1]. The care fragmentation it produces is not merely operational friction: the clinical literature links fragmented care to higher inappropriate medication rates and elevated mortality [3, 4]. The Portable Patient Health Record system proposed here addresses this gap through a patient-controlled, facility-agnostic architecture that decouples clinical records from facility silos, anchors patient identity to the Ghana Card-NHIS linkage infrastructure, and operates under intermittent-connectivity constraints.

The design deliberately avoids the institutional negotiation that has historically blocked facility-to-facility data sharing, instead placing data access rights with the patient. This approach is validated by a substantial international literature on personally controlled health records [9, 7], best practices for digital health scaling in LMICs [18], and patient identifier frameworks for universal health coverage [22].

Immediate next steps include legal review under the Data Protection Act 2012, stakeholder engagement with NHIA and the Ghana Health Service, and alignment with Ghana's emerging national digital health interoperability framework to ensure the PPHR can mature into a standards-compliant component of the national health information architecture rather than an isolated point solution.

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