Design and Feasibility Evaluation of a Prototype Automated Kiosk for Hospital Pre-Check-In and Preliminary Vital Sign Capture

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Abstract *— This article presents the design and feasibility evaluation of a prototype hospital pre-check-in kiosk that combines NFC-based patient identification, questionnaire intake, staged vital-sign capture, workflow handling, and vendor-neutral export. Evidence was drawn from the implemented system rather than from a clinical deployment. By May 4, 2026, the prototype had generated 25 intake records, 21 workflow records, 59 audit log entries, and 16 normalized records for descriptive analysis. Within that analyzed set, 6 cases required manual fallback, 5 reflected sensor failure or missing measurements, and 8 remained incomplete but were still preserved through the workflow. These results show that the platform can continue generating structured records even when device capture is incomplete. The prototype, therefore, supports technical and workflow feasibility in a controlled environment while also showing that hardware reliability, complete timing coverage, and real user validation remain future requirements.*

Keywords *— Feasibility Study, Hospital Pre-Check-In, Self-Service Kiosk, Vital Sign Capture.*

INTRODUCTION

Hospital intake is a crucial operational point in the patient's journey, involving identification, registration, symptom reporting, and measurements that occur before clinician review. When these steps are manual, queues grow, clerical work piles up, and staff repeatedly transfer information between patients, paper notes, monitors, and software. This is especially problematic in emergency and urgent care settings, where administrative delays can quickly affect overall service efficiency.

Self-service kiosks aim to streamline early intake by reducing wait times, standardizing initial questions, and capturing structured pre-review information. However, their practical value depends on managing hardware issues, preserving incomplete records without hiding gaps, and ensuring future systems can interpret data consistently.

This work tackles a specific engineering problem. Instead of promising a deployment-ready triage machine or portable medical record, it assesses whether a prototype can integrate secure token identification, structured questionnaires, staged vital-sign capture, workflow management, and exportable data into a single platform. Demonstrating system feasibility is crucial before claiming higher throughput, clinical value, or adoption.

This work offers four elements: a prototype architecture for hospital pre-check-in, an evaluation model based on system evidence, a workflow that maintains continuity with manual fallback and handles missing data, and a structured export layer for future interoperability [1], [2]. These are bound, so the article argues, based on what the prototype shows.

BACKGROUND AND LITERATURE REVIEW

Existing healthcare kiosk literature falls into four areas: self-check-in, digital triage, vital signs, and secure patient ID. Each supports this project, but none fully defines the prototype evaluated.

Administrative self-check-in kiosks are the most mature. Mahmood et al. [3] linked them to shorter emergency wait times, suggesting that registration tasks can be redistributed if the interface is simple and workflow-compatible. However, these

systems typically focus on identity and arrival organization, not vital-sign capture, handling incomplete sensors, or downstream record interpretation.

A second category concerns digital triage or structured symptom intake. Joseph et al. [4] described the efficiency of kiosk-supported triage in the emergency department. Broader reviews note patients are willing to use guided digital intake if questions are understandable, and the kiosk is not technically demanding [1], [5]. However, literature often discusses symptom capture separately from device and workflow constraints present in real intake environments.

A third category covers vital-sign kiosks and health stations. Letafat-Nejad et al. [5] and Bhutani et al. [1] show they collect clinically relevant data and can support screening under controlled conditions. However, reviews highlight issues such as hardware variability, incomplete usability reports, and the gap between prototype feasibility and validated decision support, all of which are relevant to this project.

The literature on identification and interoperability recommends a cautious design. Neame [6] argued that smart cards enhance authentication, while Pharow and Blobel [7] noted that cards work best within broader health systems. Bender and Sartipi [2] described HL7 FHIR as a flexible framework for data exchange. These sources justify treating the NFC component as a secure token and maintaining interoperability via structured export rather than an all-in-one patient record.

The literature gap becomes clearer. While previous work examined check-in kiosks, digital triage, vital-sign kiosks, smart-card concepts, and data models, few reports integrate secure ID, structured symptom intake, staged measurement, fallback logic, patient flow, auditability, and vendor-neutral export within a single platform. This study addresses that integration gap, not clinical replacement.

This distinction is important both academically and technically. A kiosk showing only one successful measurement provides little insight into the actual continuity of intake. Conversely, a prototype that preserves incomplete cases, flags uncertainties, moves cases into review, and exports data illustrates a broader systems contribution. The article evaluates measurement capture and the coherence of the record-handling workflow that gives measurements practical meaning.

Problem Statement and Research Question

Hospital intake relies on fragmented manual steps for identification, symptom capture, and early measurement, leading to repetition, omissions, and delays in the handoff to staff for review (see Table 1). The research question is: Can a prototype hospital pre-check-in kiosk support secure ID verification, intake, vital signs, and record creation in a simulated setting? Objectives include integrating hardware and software, evaluating workflow, analyzing fallback effects, and identifying limitations before wider testing.

Table 1
Project Scope and Delimitations

Aspect	Definition in This Study
Setting	Simulated pre-check-in workflow; not a live clinical deployment or full emergency triage service.
Identification	Secure NFC token or identifier; not a complete patient-held medical record.
Measurements	Weight, temperature, blood pressure, heart rate, and oxygen saturation, with manual fallback allowed.
Workflow	Record creation, review states, patient-flow handling, auditing, export, and archive support.
Out of scope	Automated diagnosis, blood collection, direct EHR deployment, and validated clinical-grade use.

System Design and Prototype Architecture

At the implementation level, the prototype was organized as an integrated platform that combines patient-facing hardware, local processing, secure identification, and structured data handling within a single pre-check-in workflow. That integration

begins with the physical and interaction components that define how the system operates at the kiosk level.

Hardware and Interaction Structure

The prototype features a Raspberry Pi host, a sensor-supported microcontroller layer, a USB NFC reader, and a touchscreen. The Pi runs the kiosk, database, record views, and export functions. An Arduino gathers sensor data. The NFC layer provides secure tokens linked to patient records, not storing full clinical data. This modular setup simplifies replacing sensors or adapters.

Since the device is touch-operated, the kiosk flow tolerates manual interaction and hardware issues. The patient path guides identification, questionnaires, and staged measurements, allowing the device to capture or manual entry at each step. This design ensures a traceable record even if sensors are unavailable.

Software and Workflow Structure

The software environment extends beyond a kiosk screen, including a Clinical Operations Console, Patient Flow Workspace, feedback, audit logs, record management, archiving, summary export, and a vendor-neutral layer for future interoperability. It functions as a small operational intake platform, enabling records to be created, reviewed, transitioned, and exported.

The broader environment improved the project's technical coherence by consolidating the kiosk, manager, archive, and export components into a shared record model, reducing engineering friction for future updates. Changes to schemas or models can now propagate seamlessly without redesigning each layer.

This architecture matters for feasibility because a pre-check-in system is only useful if the data remains operationally usable. A record that exists as a loose JSON file but cannot be reviewed, sorted, audited, or translated into downstream formats offers limited value. The prototype includes a raw record layer and a management layer that supports traceability and future integration.

Failure Handling and Export Readiness

A key feature is that missing information does not stop intake. The system marks missing fields, keeps warnings, and continues via manual fallback. This supports the feasibility argument by treating failure handling as normal rather than an exception. Meanwhile, record and FHIR-like exports keep the internal data model separate from hospital adapters, maintaining vendor neutrality.

Figure 1 outlines the pathway from patient interaction to export preparation, showing how the prototype organizes existing components. It does not imply live hospital integration.

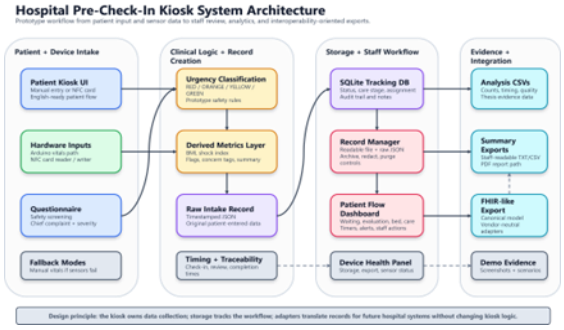

Figure 1
Implemented Architecture from Kiosk Intake to Local Storage and Export Preparation.

This architecture supports practicality by using one local storage and standard records for the patient's kiosk, staff console, card utility, and export tools. This reuse reduces engineering effort because there is no need for separate models for intake, review, and export. Instead, it creates one record path with operational views layered on top.

METHODOLOGY

Because the project was framed as a feasibility study rather than a clinical deployment study, the evaluation was centered on controlled prototype operation and evidence generated directly by the implemented system. This methodological approach guided the selection of the study design, data sources, metrics, and descriptive analysis used in the article.

Study Design

This article uses a design-and-feasibility framework. The study was not a formal clinical trial and lacked a large participant sample for statistical analysis. Instead, the evaluation assessed if the prototype could generate and maintain structured records, move records through workflow stages, manage missing hardware inputs, and prepare outputs for future integration. The goal is system-level verification of architecture, workflow, and failure tolerance, not statistical validation.

Data Sources

The evidence came from the prototype: intake JSON files, SQLite tables, workflow records, audit logs, archive entries, analysis and feedback exports, and screenshot evidence. The goal was not to prove patient-outcome improvement, but to evaluate if the architecture behaved consistently enough for future validation.

The software now captures patient comments, staff observations, and system events separately, beyond basic logs. Though still early, this feature prepares the platform for future usability and acceptance studies without impacting this article.

Dataset

At analysis time, the environment included 25 intake records, 21 managed workflow records, 59 audit logs, 18 raw JSON files, 30 interoperability files, 5 summary files, 3 feedback files, and 2 archived records. The main dataset comprised 16 normalized records from the analysis export layer, used for comparing urgency labels, fallback use, missing data, and advisory flags.

Metrics

The evaluation examined feasibility metrics: record creation, workflow, fallback frequency, missing data, export, and timing or audit evidence. These align with the prototype's engineering goals and can be extracted without overstating hardware quality.

Analysis Method and Boundary Conditions

The analysis was descriptive, using counts, proportions, and comparisons of system conditions to interpret behavior. Inferential methods such as t-tests, ANOVA, p-values, or correlation were avoided because the data did not come from a controlled trial. The report focuses on what the prototype demonstrated in a controlled setting and avoids stronger claims that require a different study design (see Table 2).

Table 2
Evaluation Metrics Used in the Feasibility Study

Type	Metric	What It Measures
Functional	Record creation	Whether intake sessions become structured JSON and SQLite records.
Workflow	Stage handling	Whether cases continue into review and patient-flow states.
Reliability	Manual fallback	Whether the intake remains usable when devices are unavailable.
Quality	Completeness	Whether missing values are preserved and explicitly flagged.
Interoperability	Export generation	Whether the record can be translated into structured future-use outputs.

A final methodological boundary is that several outputs intentionally mix evidence types. Some values describe direct record counts; others summarize normalized analytical rows, and others reflect the existence of operational artifacts such as audit logs, summary exports, and archive files. Rather than treating these as interchangeable statistics, the article uses them as complementary indicators of feasibility. Together, they address whether the platform can sustain a functioning intake ecosystem, even though they do not yet address clinical performance questions.

Results and Discussion

The resulting evidence allows the prototype to be assessed not only in terms of whether it functioned, but also in terms of how consistently it supported the intended intake and management workflow under controlled conditions. The discussion therefore begins with record generation

and workflow continuity, since these outputs provide the clearest indication of end-to-end system behavior.

Record Generation and Workflow Continuity

The prototype showed evidence across multiple layers, not just at a single intake point. It contained 25 intake records, 21 workflow records, and 59 audit-log entries, with 16 records normalized in the descriptive analysis layer for comparison. This demonstrates that the system was not only collecting data but also storing, managing, and tracking it. In essence, the prototype exhibited functional continuity beyond a basic data-entry mock-up.

The ratio of intake to workflow records indicates that most sessions had downstream data at the snapshot. The 59 audit logs across 21 workflow records show the system recorded transitions or actions, not just stored files. This supports the idea that the project evolved into a workflow-focused platform rather than just a kiosk screen.

The output folders contained raw JSON exports, interoperability files, summaries, feedback files, archived records, and database records. This indicates the platform managed data at multiple levels: raw intake, human-readable summaries, interoperability preparation, and record retention. These layers show that the system was not just collecting data but also managing it for various purposes.

Fallback, Sensor Failure, and Incomplete Records

The most informative result concerns system resilience. Of the 16 analyzed records, 6 required manual fallback and 5 reflected sensor failure or missing measurements, corresponding to 37.5% fallback usage and 31.25% sensor-failure or missing-data incidence within the normalized dataset (see Table 3). These values are too high to interpret the sensing layer as mature or clinically dependable. However, the same counts also show that the intake flow continued rather than collapsing when hardware capture was incomplete.

This is where fallback design is crucial. A less resilient version would cause abandoned sessions, lost data, or untraceable retribution. The prototype saved each case as a structured record, even when fields were missing. Thus, fallback was not just a backup but a key part of maintaining workflow amid hardware issues.

The complete-versus-incomplete comparison shows 8 complete and 8 incomplete cases, revealing that the measurement stack needs reliability improvements. Constructively, it demonstrates that the software layer can preserve half-complete sessions without masking uncertainty, which is more defensible than presenting incomplete inputs as complete measurements.

This split between complete and incomplete records clarifies what is meant by feasibility in this study. The prototype is feasible not because all readings succeeded, but because record-handling and patient-flow logic continued to function across both complete and partial data scenarios. Many prototypes seem successful only by excluding failure cases, but here, failure cases support the continuity of claim.

Table 3
Prototype Evidence Summary Used for Interpretation

Metric	Value	Interpretation
Intake records	25	Shows repeated use of the intake layer beyond a single demonstration case.
Managed workflow records	21	It indicates that most stored sessions also entered the management layer.
Audit-log entries	59	Demonstrates traceability across record handling actions and state changes.
Analyzed records	16	Defines the normalized subset used for descriptive comparison.
Manual fallback cases	6	Shows that alternative entry paths were actively needed and used.
Sensor failure or missing cases	5	Identifies the largest remaining hardware reliability gap.
Complete records	8	Represents cases with fuller data capture across the analytical subset.
Incomplete records	8	Confirms that missing-data preservation is a real, not hypothetical, requirement.

Urgency, Derived Flags, and Information Usefulness

The urgency distribution shows that the prototype can convert intake data into a structured operational context. Of 16 normalized records, 2 are RED, 7 are ORANGE, 1 is YELLOW, and 6 are GREEN. This spread is useful for feasibility evaluation as it tests multiple urgency paths rather than trivial low-priority cases, supporting the existing queue and patient-flow logic.

The complaint profile varied: chest pain in 6, other complaints in 6, trouble breathing in 3, and fever or infection in 1. The advisory layer identified tachycardia in 4, hypoxia in 3, severe hypoxia in 2, fever in 2, and a chest-pain-plus-tachycardia concern in 1. These counts do not validate diagnosis but show the system can turn raw data into structured cues that may improve with hardware validation and staff review.

Timing, Operational Meaning, and Limits of Interpretation

The system averaged 2.67 seconds between workflow events, reflecting partial internal timestamps like record creation and updates, not total check-in time. User-dependent steps like identification, questionnaire, sensor use, and manual data entry are excluded, so this result only shows system-level processing behavior.

The platform can timestamp and track workflow transitions, laying groundwork for future timing analysis. But a full assessment of intake duration requires end-to-end measurement with real users, which is outside this study's scope.

Operational and Economic Significance

The findings support future development, highlighting operational value. Structured intake reduces duplicate data entry. Incomplete records are preferable to abandoned sessions, as they offer reviewable patient reports. JSON, SQLite, and interoperability exports facilitate future integration without reworking intake logic. Though not yet quantified, these reasons demonstrate the platform's practical value.

The patient-flow layer also has an operational-readiness aspect. At the snapshot, the environment had 17 records waiting for review, 2 assigned to beds, 1 under evaluation, and 1 in the treatment area. These numbers do not show hospital throughput gains but illustrate that the platform can differentiate care stages from record status. This is useful because staff think operationally: not just if a file exists, but where a patient is in the process.

The software now supports census-style awareness with intake capture. Patients can check in, review, stage, archive, export, and trace via audit entries without leaving the system. This behavior justifies further development, suggesting the project could evolve from a kiosk to a full intake-support platform.

Implementation and Economic Relevance

A feasibility study is stronger if it explains why further development is economically rational. The prototype does not yet show cost reduction in a hospital but demonstrates engineering features supporting future ROI. It centralizes intake, workflow review, exports, and archives on a low-cost Raspberry Pi. Its local JSON and SQLite enable operation without a full hospital backend during early deployment. Its fallback-first logic reduces the risk of a single device failure disrupting the process.

These features lower development risk and operational hurdles. Hospitals or research teams can test the platform without full commitments to enterprise integration, sensor replacement, or large servers. The prototype functions as a local edge system, storing records and transmitting them outward as infrastructure develops.

The project demonstrates how automation enables intake data to transition from raw JSON to staff views, archives, and exports, minimizing manual reformatting (see Table 4 and Table 5). This helps save costs by preventing duplicate data processing and making it easier to generate reports, summaries, or payloads from a single record.

Table 4
Additional Operational Artifacts Generated by the Prototype

Artifact or Flow Layer	Observed Count	Why It Matters
Raw JSON exports	18	Shows that original intake events are being preserved outside the database.
Interoperability exports	30	Indicates repeated transformation into structured future-facing exchange outputs.
Readable summaries	5	It shows that staff-facing handoff artifacts can already be produced from stored records.
Feedback exports	3	Demonstrates that user and staff evaluation data can be retained separately from intake data.
Archived records	2	Confirms that the system already distinguishes active workflow from inactive retention states.

Table 5
Prototype Design Choices With Practical and Economic Relevance

Prototype Design Choice	Near-Term Benefit	Longer-Term Relevance
Raspberry Pi and commodity peripherals	Keeps initial build cost low	Supports affordable replication and pilot-scale testing.
Local JSON + SQLite persistence	Allows offline-first record retention	Reduces dependence on immediate backend integration.
Manual fallback on every measurement path	Prevents sensor failure from stopping intake	Protects workflow continuity while hardware improves.
Canonical and FHIR-like export layers	Separates the collection from external translation	Reduces redesign effort for future hospital adapters.
Shared record model across the kiosk and the manager	Avoids duplicated data-handling logic	It improves maintainability and lowers future development costs.

Limits of What the Current Evidence Demonstrates

Current evidence shows engineering feasibility, traceability, and resilient record handling, but lacks data on user satisfaction, clinical accuracy, regulatory approval, or cost savings. The sensing layer is at prototype stage; datasets are small, and timing only covers some internal events. These limits are boundary conditions, not weaknesses, supporting the article's argument. By maintaining feasible claims, the study aligns with current software and evidence, which is stronger than claiming validated clinical deployment.

Deployment Readiness in a Bounded Field Context

Another interpretation concerns field readiness at a prototype level. The platform is reorganized around a Raspberry Pi field bundle, touch layouts, on-screen keyboard support, staged measurement screens, and low-memory deployment for a 1 GB Raspberry Pi. This indicates that the software has moved beyond a desktop prototype and is beginning to address practical constraints of kiosk hardware.

That bounded readiness boosts the feasibility argument by connecting software behavior to a real host platform. A system only functional in development offers weaker evidence than one designed for field devices, touch navigation, local installation, and hardware-optional measurements. These deployment improvements do not replace validation but make the engineering process more credible.

Figure 2 shows the current touch kiosk interface, and Figure 3 displays a staff monitoring view. They demonstrate the project's scope, including patient input and operational review, making the results more meaningful than a single-screen demo. Figure 4 adds the patient-flow workspace for inspecting active records and staging movement, highlighting the management layer and showing the system now supports both patient-facing and staff-facing functions.

Figure 2
Current Touch-Oriented Patient Kiosk Interface

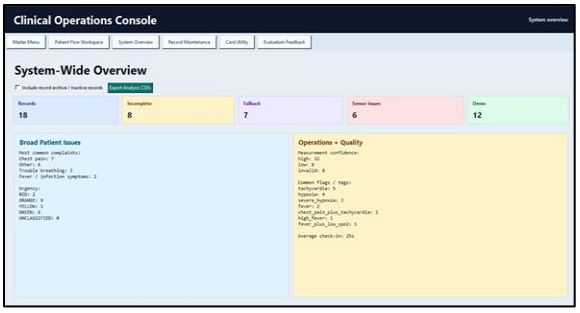

Figure 3

Staff-Facing System Overview for Patient Flow Monitoring

Figure 4

Patient-Flow Workspace Used for Active Case Review and Stage Management

Figure 5 shows a readable record-management view demonstrating how structured intake data can be reviewed in a clinician-friendly format instead of raw JSON. This is relevant to feasibility because a hospital's usefulness depends on collecting and presenting information in an easily interpretable way.

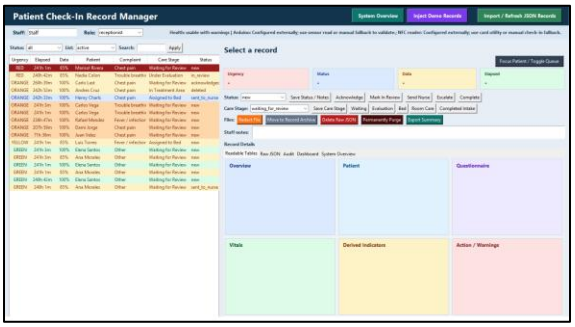

Figure 5

Readable Record-Management Interface for Detailed Intake Review

CONCLUSIONS

This work achieved its main technical goal: the prototype integrates secure token-based ID, structured questionnaires, staged vital-sign handling, local storage, workflow tracking, audit logs, and export prep in one platform. Evidence shows system feasibility. Record counts, workflow data, audit logs, fallback cases, and export artifacts demonstrate the platform's ability to produce structured outputs despite hardware issues. This continuity is the study's strongest result.

The evidence lacks clinical validity, throughput gains, or patient acceptance. Record distribution, fallback cases, sensor failures, and partial timing data suggest the prototype is still an engineering platform, not a validated hospital product.

The project shows that a vendor-neutral, workflow-aware pre-check-in architecture can be responsibly implemented, providing a solid foundation for future validation, device testing, and usability or operational studies.

The article highlights that the project’s value goes beyond measurement capture, covering record governance, auditability, export readiness, and operational review. These features support a comprehensive intake-support ecosystem, not just prototypes. It also shows hospital intake systems rely less on perfect measurement and more on workflow continuity and structured data preservation.

FUTURE WORK

Future work should enhance the sensor layer, increase controlled tests, improve timing instrumentation, validate fallback frequency under realistic conditions, and assess user and staff experience during studies. The export layer can extend to live adapters once hardware reliability and governance are addressed. These steps will help the prototype move from feasibility proof to a more complete demonstration of practical utility.

REFERENCES

[1] S. Bhutani, A. Alian, R. R. Fletcher, H. Bomberg, U. Eichenberger, C. Menon, and M. Elgendi, "Vital Signs-Based Healthcare Kiosks for Screening Chronic and Infectious Diseases: A Systematic Review," Communications Medicine (Lond), vol. 5, art. no. 28, Jan. 2025, doi: 10.1038/s43856-025-00738-5.

[2] D. Bender and K. Sartipi, "HL7 FHIR: An Agile and RESTful Approach to Healthcare Information Exchange," Proceedings of the IEEE Symposium on Computer-Based Medical Systems, Jun. 2013, pp. 326-331. Doi: 10.1109/CBMS.2013.6627810.

[3] A. Mahmood, D. K. Wyant, S. Kedia, S. Ahn, M. P. Powell, Y. Jiang, and S. S. Bhuyan, "Self-Check-In Kiosks Utilization and Their Association With Wait Times in Emergency Departments in the United States," The Journal of Emergency Medicine, vol. 58, no. 5, pp. 829-840, May 2020. Doi: 10.1016/j.jemermed.2019.11.019.

[4] M. J. Joseph, M. Summerscales, S. Yogesan, A. Bell, M. Genevieve, and Y. Kanagasingam, "The Use of Kiosks to Improve Triage Efficiency in the Emergency Department," npj Digital Medicine, vol. 6, art. no. 19, Feb. 2023. Doi: 10.1038/s41746-023-00758-2.

[5] M. Letafat-Nejad, P. Ebrahimi, M. Maleki, and A. Aryankhesal, "Utilization of Integrated Health Kiosks: A Systematic Review," Medical Journal of the Islamic Republic of Iran, vol. 34, no. 114, Sept. 2020. Doi: 10.34171/mjiri.34.114.

[6] R. Neame, "Smart Cards—The Key to Trustworthy Health Information Systems." BMJ, vol. 314, no. 7080, p. 573, Feb. 1997. Doi: 10.1136/bmj.314.7080.573.

[7] P. Pharow and B. Blobel, "Benefits and Weaknesses of Health Cards Used in Health Information Systems," Studies in Health Technology and Informatics, vol. 124, pp. 320-325, Feb. 2006. Doi: 10.3233/978-1-58603-647-8-320.