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Enhancing healthcare interoperability in Central Europe: implementing IHE profiles in University Hospital Trenčín, University Hospital Olomouc, and CKTCH Brno

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***Abstract*—Background:**

Healthcare interoperability remains a major challenge in Central Europe, where fragmented information systems and legacy data formats hinder efficient clinical data exchange. Despite advances in electronic health records (EHRs) and ePrescription systems, interoperability between institutions in Slovakia and the Czech Republic remains limited.

Objectives:

This study aims to demonstrate how international interoperability frameworks—specifically Integrating the Healthcare Enterprise (IHE) profiles and HL7 Fast Healthcare Interoperability Resources (FHIR)—can enhance secure data sharing, patient identification, and clinical collaboration in Central European hospitals.

Methods:

A qualitative, multi-case analysis was performed across three hospitals: University Hospital Trenčín (Slovakia), University Hospital Olomouc, and the Centre for Cardiovascular and Transplant Surgery (CKTCH) Brno (Czech Republic). Each site implemented selected IHE profiles (XDS.b, PIX, ATNA, XCA, XCPD, XUA) and FHIR APIs to support document sharing and patient identity reconciliation. System architectures, project documentation, and stakeholder feedback were evaluated to assess performance and scalability.

Results:

The Proof-of-Concept in Trenčín achieved a 45% reduction in document retrieval time and improved patient identification accuracy. The Czech deployments in Olomouc and Brno demonstrated successful cross-institutional access to patient records and reduced diagnostic duplication. All implementations were built using standards-compliant commercial solutions, demonstrating scalability, vendor neutrality, and alignment with the European Health Data Space (EHDS) framework.

Conclusions:

The study provides empirical evidence that IHE and FHIR integration substantially improves interoperability and clinical efficiency in multi-institutional healthcare networks. The presented architecture serves as a reusable blueprint for national-level digital health infrastructures, supporting future EHDS implementation and secondary data use across Central Europe.

***Keywords*—Interoperability; Health Information Exchange; FHIR (Fast Healthcare Interoperability Resources; Integrating Healthcare Enterprise (IHE); Electronic Health Records**

I. Introduction

INTEROPERABILITY in healthcare is essential for ensuring seamless communication between institutions, improving clinical outcomes, and optimizing healthcare workflows. In Central Europe, the Slovak and Czech health systems have struggled with fragmented IT infrastructures and legacy data formats, such as the Czech DASTA, which limits integration with international standards like HL7 FHIR. Despite significant advances in electronic health records (EHRs) and ePrescription systems, both countries face considerable barriers to interoperability at the regional and national levels.

The emergence of the European Health Data Space (EHDS) and the increasing adoption of global standards offer a transformative opportunity to modernize these systems. This paper examines two coordinated implementation projects in Trenčín and Olomouc, and their extension to CKTCH Brno, showcasing the application of IHE profiles and FHIR to overcome these limitations and foster regional cooperation.

II. Background and Related Work

IHE is a widely adopted framework that promotes interoperability through standardized integration profiles, such as XDS (Cross-Enterprise Document Sharing), PIX (Patient Identifier Cross-Referencing), and ATNA (Audit Trail and Node Authentication). These profiles define roles and workflows for the exchange of clinical documents, identity reconciliation, and secure data sharing.

IHE's impact is demonstrated across various clinical domains, including radiology and teleophthalmology, where interoperability has facilitated multi-vendor environments and AI-driven workflows. In the US, initiatives like Carequality and the Sequoia Project rely on IHE and FHIR to ensure trust-based, network-to-network data exchange.

FHIR, developed by HL7, complements IHE by enabling fine-grained, real-time data exchange through RESTful APIs. This flexibility supports mobile applications and facilitates integration with national health information infrastructures. Projects like ONCO-FAIR and EU-wide hackathons have proven the relevance of IHE-FHIR combinations in oncology and chronic disease management.

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III. METHODS

A qualitative case study approach was used to assess the implementation of interoperability standards in four hospitals in Slovakia and two in the Czech republic. Project documentation, technical designs, and outcomes were reviewed alongside stakeholder interviews.

IHE and FHIR Deployment

In Trenčín, a Proof-of-Concept (PoC) was established to demonstrate laboratory report exchange using XDS.b, supplemented by PIX for patient identity management. The reports remained in the legacy DASTA format but were processed through a gateway that registered and exposed them via the IHE infrastructure.

In Olomouc and Brno, broader sets of IHE profiles were adopted, including XCA, XCPD, and XUA. FHIR APIs enabled mobile access and integration with internal hospital systems. A shared clinical viewer facilitated secure, role-based access to patient records across institutions.

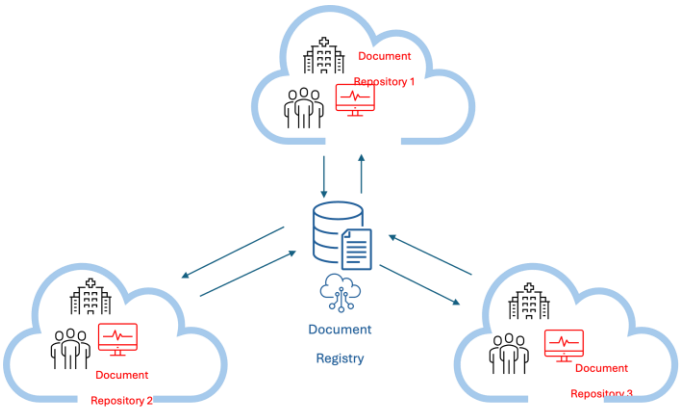

Fig. 1: Architecture overview for IHE affinity domain based on XDS.b profile

IV. RESULTS

A. *University Hospital Trenčín (Slovakia)*

The Slovak proof-of-concept (PoC) was designed to demonstrate the practical feasibility of sharing laboratory reports between a hospital laboratory and clinical care providers that need access to patient information to continue care. The aim was not merely to build a technical prototype, but to verify whether a standards-based interoperability architecture could offer a realistic pathway away from fragmented, point-to-point exchange mechanisms and toward a modern model of health information exchange.

This PoC was conceived as a pragmatic response to a well-known problem in Slovak healthcare: laboratory data are often exchanged in isolated, bilateral, peer-to-peer arrangements that do not scale well, are difficult to govern, and provide only limited interoperability. In many cases, data sharing depends on direct file exchange or custom interfaces between individual providers. Such an approach may function in small, local settings, but it does not establish the institutional or technical foundation required for broader regional or national interoperability.

To address this gap, the PoC adopted an architecture based on the international IHE XDS standard for cross-enterprise document sharing. This choice was important for two reasons. First, IHE XDS is a mature and internationally recognized framework for exchanging healthcare documents between institutions. Second, XDS is content-neutral. This means that the same infrastructure can support different document types and different content standards without redesigning the communication model. In the context of the present project, this allowed the research team to preserve the currently used laboratory content format, DASTA, while embedding it into a much more modern exchange architecture.

The practical use case centred on the hospital laboratory in University Hospital Trenčín as the originating source of content. Laboratory reports created there were made available to clinicians not only within the same hospital but also to selected external healthcare organizations, specifically University Hospital Trnava, the National Oncology Institute in Bratislava, and the East Slovak Institute of Cardiovascular Diseases in Košice. This network of participants was deliberately chosen to represent different forms of clinical continuity of care, including oncology, cardiovascular medicine, and multi-site hospital cooperation.

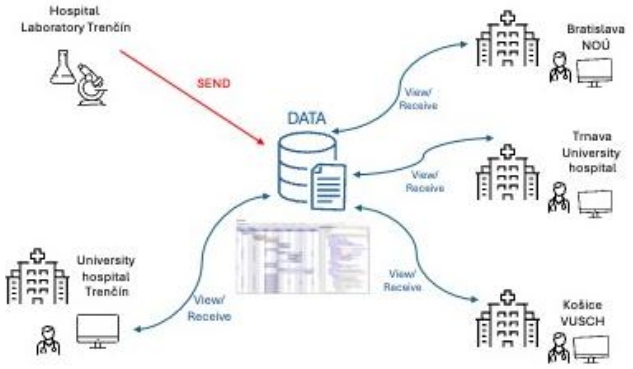

Fig. 2: Architecture for Slovakian Health Information Exchange between 4 healthcare providers where UH Trenčín is the leading one.

A major functional element of the PoC was the Clinical Viewer application, which enabled laboratory reports to be visualized in a unified manner regardless of the source institution. This user-facing layer was essential because true interoperability in healthcare is not achieved solely by moving data between systems; it also requires that clinicians can meaningfully access, interpret, and use those data in practice. The Clinical Viewer therefore served as the practical bridge between technical exchange and clinical usability.

Although the architecture also allowed edge gateways to download documents and potentially import them into local hospital systems, that import functionality had not yet been implemented in the client systems during the PoC phase. Even so, the project succeeded in proving that a standards-based infrastructure could support shared access to laboratory results across institutional boundaries in Slovakia. We are aware that there is eZdravie, national eHealth in Slovakia – but there are many obstacles in using the available data especially because of the K+D security concept, but the laboratory exchange concept wasn't delivered yet.

1. Technical Architecture of the Proof-of-Concept

The PoC used the IHE XDS.b profile as the core exchange mechanism. In this arrangement, the hospital laboratory information system (LIS) generated laboratory reports and exported them as XML files in the DASTA format. These files were then made available through conventional file-sharing mechanisms, such as a shared disk or FTP. This detail is important because it reflects the operational reality of Slovak healthcare environments, where file-based exchange remains common. Rather than forcing an immediate replacement of existing local workflows, the PoC deliberately built an interoperability layer on top of current practice.

Once exported, the laboratory results were processed by a dedicated component called the PoC Gateway. This gateway performed the crucial role of converting a simple file-based output into a structured interoperability transaction. The processed document was then registered and submitted using the XDS.b Provide and Register Document Set-b transaction to an XDS repository implemented within the broader PoC Platform.

After storage in the XDS.b repository, data from the DASTA document and the accompanying XDS metadata were transformed into a unified structured representation. This internal normalization process made it possible to present the content to clinicians in a more transparent and clinically useful way through the Clinical Viewer. In other words, the architecture did not merely store documents as passive files; it actively extracted and organized relevant information so that laboratory results could be explored in a coherent format.

This architecture demonstrated an important interoperability principle. Legacy content can remain in use temporarily, provided that it is embedded in a modern infrastructure capable of indexing, retrieving, securing, and later transforming that content into more advanced or standardized representations. In the Slovak context, this was a realistic and strategically valuable approach because it avoided the need for immediate full migration away from DASTA, while still creating a future-compatible interoperability foundation.

2. Main Components of the PoC Environment

The proof-of-concept consisted of several key components, each with a clearly defined role in the interoperability workflow.

- *PoC Gateway*

The PoC Gateway acted as the integration bridge between the local laboratory environment and the central interoperability platform. It read DASTA files from the shared file system and executed several sequential operations. First, it extracted patient information from the laboratory document. Second, it sent this patient data to the PoC Platform using the IHE HL7v3 Patient Identity Feed transaction. Third, it queried the platform for the patient identifier assigned within the XDS registry using PIXv3 Query. Fourth, it created the metadata needed to package the DASTA file as an XDS document. Finally, it ensured the registration and storage of the document and its metadata using the XDS.b Provide and Register Document Set-b transaction.

Within the PoC, the Gateway was deployed as a central service in the environment of University Hospital Trenčín. However, from an architectural perspective, it could also be implemented as a separate component directly within a laboratory environment. This flexibility is significant because it means the model can adapt to different organizational arrangements.

- *PoC Platform*

The PoC Platform provided the central services for document storage, metadata management, document retrieval, querying, and presentation of health data. It was composed of three principal components: the Repository, the Registry, and the Clinical Viewer Backend.

- *Repository*

The Repository operated as an independent XDS.b Repository. It accepted documents via the Provide and Register Document Set-b transaction and registered their metadata into the Registry using the Register Document Set-b transaction. Although the Repository was technically capable of serving documents through Retrieve Document Set-b, this function was not used during the PoC. A particularly important feature of the Repository was its transformation engine. This engine converted laboratory results from DASTA into the platform's internal representation, thereby creating a unified data layer that could support downstream visualization and analysis. In practical terms, this means that the PoC did not simply archive laboratory reports but also transformed them into a more usable and semantically coherent form.

- *Registry*

The Registry functioned both as the XDS.b Registry and as a PIXv3 Manager. It stored patient record metadata and document metadata and supported the Register Document Set-b and Registry Stored Query services. As a PIXv3 Manager, it also maintained mappings between source patient identifiers used by healthcare providers and the patient identifier assigned in the XDS Registry. This dual role was central to the ability of the PoC to reconcile identities across institutional systems.

- *Clinical Viewer Backend*

The Clinical Viewer Backend processed requests originating from the Clinical Viewer user interface. Its main tasks included searching for patients through Registry services, collecting unified data from the Repository, and assembling a clear display of clinical data elements for users. Within the PoC, the displayed elements consisted primarily of laboratory results and notes.

- *Clinical Viewer*

The Clinical Viewer itself was implemented as a single-page web application displayed in an internet browser. It enabled users to search for specific patients and to view comprehensive health records derived from the Repository data. Clinicians from participating hospitals could also access patient records directly through URL parameters containing patient identifiers, which allowed fast navigation to laboratory data without manual searching. This direct-access model simplified real-world clinical use and demonstrated a low-friction access path for external providers.

- *Operational Monitoring and Transaction Processing*

The PoC Gateway and PoC Platform could be administered and monitored through a web-based administrative interface. This interface supported configuration display, monitoring of service operations, analysis of transaction logs, and management of user permissions and access rights. Such operational visibility is highly relevant in any real interoperability deployment, because health information exchange must be auditable and governable, not only functional. From the transaction perspective, the full flow began with DASTA processing in the PoC Gateway. This included patient record creation or update via PIXv3 Patient Identity Feed, patient identifier query via PIXv3 Query, optional query for a previous version of the document via Registry Stored Query, and final document submission via Provide and Register Document Set-b. On the Registry side, the system processed identity feed transactions, PIX queries, and registry queries. On the Repository side, the system handled the Provide and Register workflow, metadata registration, and asynchronous extraction of granular data into the unified repository.

This sequence is important because it demonstrates that the PoC did not rely on ad hoc integration. Instead, it implemented a transaction chain fully aligned with internationally recognized IHE mechanisms.

3. Demonstration Data and Clinical Usage Scenario

To validate the system, artificial laboratory data were created for two fictional patients: Maximilián Hanzal and René Hanzel. For both patients, a series of repeated measurements were entered into the laboratory information system of University Hospital Trenčín, including glucose, urea, creatinine, sodium, leukocytes, erythrocytes, hemoglobin, and erythrocyte mean corpuscular hemoglobin concentration.

The values were intentionally structured to resemble realistic clinical monitoring over time. This enabled the project not only to demonstrate document exchange but also to show how trends in laboratory data could be visualized and clinically interpreted. The same fictional patients were also created in the hospital information system of University Hospital Trnava.

Clinicians in Trnava were then able to launch a direct link, based on the patient identifier, into the PoC Clinical Viewer and access a unified display of the patient's laboratory data. The same method was used in Bratislava, where clinicians could open a patient record from their hospital information system and use the Clinical Viewer to inspect available laboratory results. This demonstrated a highly practical use case: local systems retained their own records and identifiers, while the shared interoperability platform enabled cross-institutional visibility of clinically relevant data.

Within the Clinical Viewer, users could search for patients, view unified laboratory data, and display trends for measurements both in tables and in graphical form. This feature is especially important in laboratory medicine, where single values are often less informative than longitudinal patterns.

4. SWOT Analysis and Strategic Interpretation

The SWOT analysis of the Slovak PoC revealed a highly promising but still transitional solution.

Its strongest advantage was extensibility. Although the project currently focused on laboratory reports, the underlying architecture could serve as a general eHealth infrastructure for sharing virtually any type of clinical document. This includes document types required by EEHRxF and EHDS, such as discharge summaries, radiology reports, and patient summaries, as well as documents from primary care and nursing.

A second major strength was the readiness for multi-domain deployment. The architecture was designed in such a way that it could scale beyond a single centralized implementation. If all data cannot or should not be held in one central repository, the architecture can be expanded into multiple federated domains. This is critical for future geographic expansion.

Additional strengths included a unified access model across information systems, the possibility of scaling central components into a national eHealth service, the availability of ready-made standards-based products on the market, and the fact that the solution was not monolithic. Because XDS divides the infrastructure into components, different vendors can supply different parts of the system. This reduces vendor lock-in and encourages competition. The Gateway also allows easy connection of new data sources, while the Clinical Viewer supports rapid client integration and RESTful API access for mobile use.

The weaknesses, however, were also important. The PoC did not use a European content standard such as EEHRxF for laboratory reports, relying instead on DASTA. This limits the ability to use certain metadata features available in the XDS architecture and may constrain cross-border compatibility. The PoC also did not integrate central patient identification services, such as national electronic identity mechanisms, and it lacked comprehensive access control and consent management.

The opportunities are substantial. The architecture could become the basis for future EHDS compatibility in Slovakia. Because it is reusable across multiple use cases, it could also reduce future costs of national eHealth infrastructure development. If laboratory content were migrated to a European format, the system could support secondary use of data for research and analytics. Its standards-based design also preserves freedom from dependence on a single vendor.

The main identified threat was incompatibility with the K+D concept currently used in Slovak national eHealth services. This points to an important strategic issue: technically sound local innovation does not automatically align with existing national infrastructures. A future pathway would therefore require either adaptation of the PoC architecture or harmonization at the policy level.

5. Extensibility Across Use Cases and Geographic Scope

One of the most important findings of the Slovak PoC is that its value extends far beyond the immediate laboratory-report use case. Because IHE XDS is content-neutral, the same infrastructure can be used to share any type of clinical document in virtually any format, including PDF, XML, CDA, proprietary formats, and even binary objects such as images or audio.

This means the platform could support a unified model for exchanging laboratory reports, discharge summaries, radiology reports, patient summaries, ambulatory summaries, and nursing summaries. It could also become the basis for migrating existing Slovak services, such as eLab and eExamination, toward more modern and European-compatible standards.

From the geographic perspective, the PoC also has strong scalability potential. IHE XDS, especially when combined with IHE XCA, provides the basis for a federated environment that

can span multiple domains, regions, or even countries. If expanded to the national level, it may become necessary to distribute data repositories across Slovakia, in a way similar to architectures used in countries such as Austria.

6. Conclusion

The Slovak proof-of-concept centered on University Hospital Trenčín represents the main architectural and experimental contribution of this work. It demonstrates that even in an environment still shaped by legacy data formats and point-to-point exchange practices, it is possible to build a robust interoperability layer using international standards.

The project successfully showed how laboratory reports from one hospital laboratory can be shared with multiple clinical institutions through a modern IHE XDS.b-based infrastructure. It validated the technical feasibility of standards-based document sharing, patient identity reconciliation, metadata registration, unified clinical visualization, and cross-institutional access to laboratory results.

At the same time, the PoC highlighted important limitations and strategic questions, especially regarding content standardization, identity integration, access control, and national compatibility. These limitations do not reduce the importance of the results; rather, they clarify the next steps needed for transition from proof-of-concept to production-scale interoperability.

Most importantly, the project demonstrated that the architecture is flexible, reusable, and scalable. It can serve not only as a solution for laboratory data exchange but also as a foundation for wider eHealth interoperability in Slovakia and, potentially, for alignment with the future requirements of EHDS. As such, it represents both a practical pilot and a strategic model for further development of healthcare interoperability in Central Europe. Until now, Slovakia doesn't have functioning strategy for delivering infrastructure for National Contact Point (NCP) serving as the main hud for interstate HER exchange amongst EU member states, in fact this NCP wasn't defined at all still at the beginning of 2025. This project and POC could serve as a role model for such international exchange.

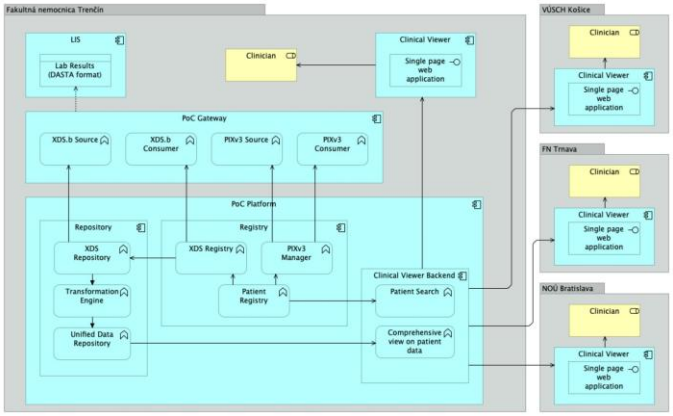

Fig. 3: Diagram represents an **interoperability framework** for **clinical data sharing and viewing** among several Slovak hospitals, with **Fakultná nemocnica Trenčín** (Trenčín Faculty Hospital) at the center, connecting with: VÚSCH Košice, FN Trnava, NOÚ Bratislava.

B. FN Olomouc and CKTCH Brno (Czech Republic)

The interoperability project between University Hospital Olomouc (FNOL) and the Centre for Cardiovascular and Transplant Surgery Brno (CKTCH) represents a significant step toward achieving practical, standards-based health information exchange in the Czech Republic. The initiative demonstrates how international interoperability frameworks, particularly Integrating the Healthcare Enterprise (IHE), can be successfully implemented in real-world clinical environments to enable secure, efficient, and clinically meaningful data exchange.

At its core, the project addresses one of the most persistent challenges in modern healthcare systems: the fragmentation of patient data across institutions. In the Czech healthcare ecosystem, as in many other countries, patients frequently receive care from multiple providers. This is particularly evident in highly specialized domains such as cardiovascular medicine, where diagnostic procedures, surgical interventions, and post-operative care may be distributed across different facilities. Without effective interoperability, clinicians often lack access to complete and up-to-date patient information, leading to inefficiencies, duplicated diagnostics, and increased clinical risk.

The primary objective of the FNOL–CKTCH project was therefore to establish an interoperable infrastructure that enables immediate access to patient data across institutional boundaries. By ensuring that both hospitals have access to consistent and current medical information, the project aims to improve clinical decision-making, enhance collaboration between healthcare providers, and ultimately improve patient outcomes. This objective is closely aligned with broader European eHealth strategies, including the European Health Data Space (EHDS), which emphasizes standardized, cross-border data exchange.

1. Conceptual Framework and Strategic Motivation

The project is grounded in the IHE framework, a globally recognized approach to healthcare interoperability that builds on existing standards such as HL7, DICOM, and various clinical terminologies. Rather than introducing new standards, IHE defines integration profiles that specify how these standards should be used together in concrete clinical scenarios. This approach ensures both technical and process interoperability, which are essential for real-world adoption.

Several key motivations drove the implementation of the project. First, the need to address fragmented healthcare data was critical. Patients treated in both FNOL and CKTCH often had medical records distributed across multiple systems, making it difficult for clinicians to obtain a comprehensive view of patient history. Second, ensuring continuity of care was particularly important in cardiovascular medicine, where treatment pathways are complex and time-sensitive. Third, improving patient safety was a central concern, as delayed or incomplete access to clinical data can lead to medical errors or unnecessary procedures. Finally, compliance with international standards was essential to ensure long-term sustainability and compatibility with European initiatives.

2. Technical Architecture and IHE Profiles

The technical solution is based on a set of complementary IHE profiles that together enable secure, federated data exchange across institutional boundaries. These profiles define both the

structure of communication and the roles of participating systems.

A critical component of the architecture is the ability to accurately identify patients across different systems. This is achieved through the combined use of IHE-XCPD (Cross-Community Patient Discovery), IHE-PIX (Patient Identifier Cross-Referencing), and IHE-PDQ (Patient Demographics Query). These profiles enable the system to locate patient records across institutions, reconcile different patient identifiers, and retrieve demographic data in real time. This functionality is essential in environments where no universal patient identifier exists or where multiple identifiers are used.

Once patient identity is established, clinical documents can be accessed using IHE-XCA (Cross-Community Access) and IHE-XDS (Cross-Enterprise Document Sharing). XDS provides a structured mechanism for storing and indexing clinical documents, while XCA enables their retrieval from remote repositories. Together, these profiles create a federated document-sharing infrastructure in which each institution maintains control over its data while allowing authorized access from external partners.

Security and access control are ensured through IHE-XUA (Cross-Enterprise User Assertion), which provides authentication and authorization mechanisms across institutional boundaries. This is complemented by IHE-SVS (Shared Value Sets), which ensures consistent use of clinical terminologies and coding systems, thereby supporting semantic interoperability.

3. *Implementation Approach*

The implementation followed a structured, multi-phase approach designed to minimize disruption to clinical workflows while ensuring robust integration.

The first phase focused on the integration of hospital information systems. Both FNOL and CKTCH connected their electronic health record (EHR) systems to an interoperability layer based on IHE standards. This integration was facilitated by middleware components that act as intermediaries between internal hospital systems and the external interoperability infrastructure.

The second phase introduced an interoperability bus, which serves as the central integration layer. This component is responsible for data exchange, transformation, and validation. It also enables secure API-based communication between participating systems, allowing for future scalability and integration of additional institutions.

The third phase addressed patient identification and data querying. When a patient interacts with both hospitals, the system automatically performs a sequence of operations: it discovers the patient across domains using XCPD, reconciles identifiers using PIX, and retrieves demographic data via PDQ. This ensures that clinicians always work with accurate and up-to-date patient information.

The fourth phase focused on clinical document exchange. When a clinician requests patient data, the system retrieves relevant documents using XCA and XDS. These documents are then presented through a Clinical Viewer, which provides a unified interface for accessing data from multiple sources.

The fifth phase ensured security and access control. All transactions are secured using XUA, while SVS ensures consistent interpretation of clinical data. This combination supports both data protection and clinical usability.

4. *Clinical Applications and Benefits*

The implementation has already demonstrated significant benefits in several clinical scenarios. One of the most important use cases is shared care for cardiovascular patients. Patients undergoing procedures in one hospital can have their data immediately accessed by clinicians in the other institution, ensuring continuity of care and reducing the risk of information gaps.

In emergency situations, the benefits are even more pronounced. If a patient from FNOL is admitted to CKTCH, clinicians can instantly access the patient's medical history, including previous diagnoses, medications, and laboratory results. This reduces response times and supports more accurate clinical decisions.

The project also enhances diagnostic collaboration. Clinicians can share imaging data, laboratory results, and discharge reports in real time, enabling joint evaluation and reducing the need for repeated examinations. This not only improves diagnostic accuracy but also reduces costs and patient burden.

Another important application is remote consultation and second opinions. Specialists in FNOL and CKTCH can access shared patient data and provide expert input without requiring physical patient transfer. This supports telemedicine and expands access to specialized care.

5. *Challenges and Future Directions*

Despite its success, the project faces several challenges that must be addressed to ensure long-term sustainability and scalability. Data protection remains a critical issue, particularly in ensuring compliance with GDPR and national regulations. Robust governance frameworks and access control mechanisms are essential to maintain trust and legal compliance.

Integration with additional hospitals presents both an opportunity and a challenge. Expanding the network requires further technical integration, as well as alignment of workflows and governance models across institutions. User adoption is another important factor, as clinicians must be trained to effectively use interoperable systems.

Scalability of the infrastructure is also a key concern. As the network expands to include additional institutions such as FNUSA (university Hospiotal of St. Anne in Brno) and other regional hospitals, the underlying architecture must be capable of handling increased data volumes and complexity.

Future development plans include the integration of artificial intelligence for clinical decision support. Machine learning algorithms could analyze shared patient data to provide predictive insights and support personalized treatment. The project also aims to expand interoperability to primary care and regional providers, creating a more comprehensive healthcare network.

6. *Conclusion*

The interoperability project between University Hospital Olomouc and CKTCH Brno represents a practical and scalable model for digital transformation in Czech healthcare. By leveraging IHE profiles and FHIR-based approaches, the project

demonstrates how standardized interoperability can be achieved in a complex, multi-institutional environment.

The results confirm that such implementations can significantly improve clinical efficiency, enhance patient safety, and support better coordination of care. Moreover, the project aligns with European initiatives such as EHDS, positioning the Czech healthcare system for future integration into a broader, interoperable health data ecosystem.

As healthcare systems continue to evolve toward data-driven and patient-centered models, projects like this provide valuable evidence that interoperability is not only technically feasible but also clinically and economically beneficial.

V. DISCUSSION

These implementations highlight the potential of combining IHE and FHIR to address persistent fragmentation in Central Europe's health systems. The Czech and Slovak projects align with broader EHDS goals by enabling secure, standards-based data sharing that supports both primary care and secondary research.

Emerging profiles, such as IHE's Mobile Access to Health Documents (MHD), offer further avenues to integrate AI and interactive reporting within EHR systems. Lessons from radiology, oncology, and chronic disease management underscore the need for process interoperability and unified terminologies.

Barriers persist, including organizational inertia, lack of technical skills, and legacy infrastructure. However, these can be overcome through phased adoption strategies, stakeholder training, and alignment with national digital health policies.

VI. CONCLUSION

This study examined two proof-of-concept interoperability projects developed in Central Europe and used them to assess the practical applicability of international health information exchange standards in real clinical environments. Although the two pilots were implemented in different national contexts and addressed different clinical scenarios, together they provide a coherent and highly relevant body of evidence for the future development of interoperable digital healthcare in the Czech Republic and Slovakia.

The Slovak pilot, centered on University Hospital Trenčín, demonstrated that even in an environment still shaped by legacy exchange practices and the continued use of the DASTA format, it is possible to build a modern interoperability layer based on IHE XDS.b. By enabling the structured sharing of laboratory reports across multiple healthcare institutions, the project showed that standards-based architecture can overcome the limitations of bilateral, peer-to-peer exchange and create a foundation for wider document sharing. Its importance lies not only in the technical validation of document registration, patient identity handling, repository functions, and unified data visualization, but also in the strategic insight that content-neutral infrastructures such as XDS can serve as transitional bridges from legacy ecosystems toward European-compatible health data exchange. The Slovak PoC therefore confirmed that interoperability does not require immediate full replacement of national legacy standards; rather, it can begin with a carefully designed architectural framework that enables gradual modernization.

The Czech pilot between University Hospital Olomouc and CKTCH Brno complemented this finding by demonstrating interoperability in a more clinically integrated and workflow-oriented scenario. While the Slovak project focused primarily on laboratory data exchange, the Czech project addressed continuity of care for cardiovascular patients treated across multiple institutions. Through the use of IHE profiles such as XCPD, PIX, PDQ, XCA, XDS, and XUA, the project validated secure and timely cross-institutional access to patient records, improved collaboration between specialists, and supported faster clinical decision-making. Its contribution is especially significant because it shows how interoperability can directly affect patient care in situations where rapid access to complete information is essential. The project confirmed that interoperable infrastructures are not merely technical achievements but clinically valuable tools that reduce fragmentation, limit duplication of examinations, and improve safety and coordination.

Taken together, the two proof-of-concept projects demonstrate that IHE-based interoperability is both feasible and beneficial in the healthcare systems of Central Europe. The projects differ in scope, maturity, and clinical orientation, yet precisely this diversity strengthens the conclusions of the study. The Slovak pilot proved the architectural and infrastructural viability of standards-based document exchange in a legacy environment, while the Czech pilot proved the clinical and organizational value of such interoperability in a more advanced shared-care setting. Combined, they show that the path toward national and regional health information exchange can begin with targeted, clinically meaningful implementations that gradually expand in scope.

At the same time, both projects revealed common barriers that must be addressed before these models can be scaled. These include incomplete alignment with European content standards, the need for stronger patient identity management, robust consent and access-control mechanisms, integration with existing national eHealth services, and broader user training. These limitations should not be interpreted as failures of the pilots, but rather as expected findings of translational research in digital health. They identify the precise areas where future policy, governance, and technical investment should be directed.

In a broader perspective, the findings of this article are highly relevant in light of the European Health Data Space. Both PoCs show that the adoption of international interoperability standards is not only a regulatory necessity but also a practical opportunity to modernize healthcare delivery, improve continuity of care, and prepare national health systems for secondary use of data, analytics, and future AI-supported services. The two pilots therefore provide more than local implementation experience: they offer a replicable model for how hospitals and healthcare networks in the region can move from fragmented data silos toward interoperable, scalable, and patient-centered digital ecosystems.

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