

A FHIR-Enabled Living Lab-ready Platform for Integrating Smart Home, Ambient Assisted Living, and Medical Device Data in Health Services Research

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Hintergrund/Background

Smart-home, Ambient Assisted Living (AAL), and outpatient medical-device ecosystems remain fragmented across heterogeneous device interfaces, incompatible data models, and poorly aligned research workflows. At the same time, health services research increasingly depends on multimodal, real-world, and privacy-sensitive data collected in domestic and ambulatory settings.

Zielsetzung/Objectives

This contribution presents the concept of a modular, FHIR-enabled platform that integrates smart-home orchestration, AAL sensing, and outpatient medical-device interoperability within a governed living-lab environment for timing-sensitive, participatory health services research.

Methode/Method

The platform is designed as a layered socio-technical infrastructure. Home Assistant is used as the local interaction layer for smart-home and AAL functions, while a dedicated interoperability and governance layer transforms device and context data into HL7 FHIR resources and separates operational automation from the processing of sensitive health data. A research layer adds session management, metadata capture, consent-aware workflows, and pseudonymized export for secondary use in observational, implementation, and intervention studies. This architecture is intended to support configurable real-world studies without treating home-automation software itself as the primary repository for sensitive medical data.

Ergebnisse/Results

The platform addresses a central implementation gap in digital health: many promising systems fail not because sensing technology is unavailable, but because interoperability, privacy, usability, and long-term adoption are handled in isolation. The design therefore combines standards-based interoperability with living-lab principles such as co-design, transparent documentation, scalable infrastructure, and iterative evaluation. This framing is supported by current literature: FHIR-based open-source work demonstrates the feasibility of real-time biomedical acquisition and interoperable monitoring; LISA shows that research-grade multimodal living labs require a modular architecture with coordinated acquisition and privacy-aware data management beyond standard smart-home platforms; living-lab research highlights the importance of user involvement, regulatory compliance, sustainability, and scalability; and the NASSS framework emphasizes that successful adoption depends on reducing and managing socio-technical complexity across technologies, organizations, users, and wider systems.

Implikation für Forschung und/oder (Versorgungs-)Praxis/Implications for Research and/or (Healthcare) Practice

The result is a transferable platform concept for patient-centred, cross-sector, and data-intensive health services research at the intersection of smart living, assisted care, outpatient monitoring, and interoperable research data management. It is particularly relevant for home-based and outpatient settings in which local technical configurations vary, but core functions for safe data handling, interoperability, and participatory evaluation must remain stable.