Using Data from Ambient Assisted Living and Smart Homes in Electronic Health Records

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Keywords
Assistive technology, ambient assisted living, health information systems, electronic health records, electronic patient records, system integration, medical informatics

Summary
Introduction: This editorial is part of the Focus Theme of Methods of Information in Medicine on “Using Data from Ambient Assisted Living and Smart Homes in Electronic Health Records”.

Background: To increase efficiency in the health care of the future, data from innovative technology like it is used for ambient assisted living (AAL) or smart homes should be available for individual health decisions. Integrating and aggregating data from different medical devices and health records enables a comprehensive view on health data.

Objectives: The objective of this paper is to present examples of the state of the art in research on information management that leads to a sustainable use and long-term storage of health data provided by innovative assistive technologies in daily living.

Results: Current research deals with the perceived usefulness of sensor data, the participatory design of visual displays for presenting monitoring data, and communication architectures for integrating sensor data from home health care environments with health care providers either via a regional health record bank or via a telemedical center.

Conclusions: Integrating data from AAL systems and smart homes with data from electronic patient or health records is still in an early stage. Several projects are in an advanced conceptual phase, some of them exploring feasibility with the help of prototypes. General comprehensive solutions are hardly available and should become a major issue of medical informatics research in the near future.

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1. Motivation of the Focus Theme
Ambient assisted living and smart home are important interdisciplinary fields of research in the past years. The motivation had been to cope with the demographic change in developed countries and to enable citizens to live independently at home as long as possible [1, 2]. The demographic change will also have severe consequences for the health care systems. Health care is regarded as an application area for AAL solutions with great potential [3]. Typical applications of assistive technology for health care purposes are telemonitoring of vital parameters, e.g. for patients with chronic obstructive pulmonary disease (COPD, e.g. [4, 5]) or congestive heart failure (CHF, e.g. [6, 7]) as well as prevention
and detection of falls (e.g. [1, 8, 9]). To increase efficiency in the health care of the future, data from assistive technology should be available for individual health decisions [10]. Aggregating data from different medical devices and integrating them with data in health records enables a comprehensive view on health data. Presenting these data context sensibly and tailored to information needs can lead to more efficient and competent decisions of physicians, nurses, patients, and informal caregivers.

The objective of this focus theme in Methods of Information in Medicine is to present the state of the art in medical informatics research that leads to a sustainable and long-term storage of data from innovative technologies in daily living in electronic patient or health records.

2. Selected Papers

Three papers have been selected in a peer review process for publication in the focus theme 'Using Data from Ambient Assisted Living and Smart Homes in Electronic Health Records' [11–13]. In the following the papers are briefly introduced.

2.1 Perceived Usefulness of Sensor Data and Visual Displays

The paper by Reeder et al. [11] describes a study to characterize if senior citizens perceive the usefulness of in-home sensor data. Adults older than 65 years living in an independent retirement community in Seattle were equipped with in-home sensor technology (motion sensors, gateway, web-based application for administration and data access). After three and after six months semi-structured interviews were transcribed and analyzed with respect to perceived usefulness. The participants developed ideas for which purposes monitoring activity data of senior citizens might be used. As an example, changes in activity patterns in the bathroom might indicate the beginning of diabetes or the efficacy of the administration of diuretics. Several factors that influence the perceived usefulness of sensor data were identified, among others changes in health status and the living situation. Visual displays were regarded especially helpful for relatives and caregivers.

On the basis of these results the authors developed visual displays that present activity data provided by sensors and that could become part of electronic health records. Potential users gave feedback (participatory design) on prototype displays with simulated data to a fall scenario. The feedback was used to improve the design of the visual displays which are presented in detail in [11].

2.2 Integrating Sensor Data into a Regional Health Information System

The paper by Gietzelt et al. [12] describes an architecture that integrates a sensor-based network for home care with a regional health information system. They especially refer to the problem that health information systems are often document-based, but sensor-networks provide continuous data streams. This is solved by implementing placeholder documents which are filled with the monitoring data upon request by a so-called Personal Intelligent Care System (PICS). The PICS is implemented at the home site and collects and stores data from various sensors and executes MLMs according to HL7 Arden Syntax [14, 15] to process the data. Furthermore, it provides communication interfaces for exchanging HL7 CDA-documents. For coding sensor data in a CDA document a Systematic Nomenclature for Contexts, Analysis methods and Problems in Health-Enabling Technology (SNOCAP-HET) was developed and introduced in another paper [16].

As participating health information system the Lower Saxony Bank of Health (LSBH) is introduced in the paper [12]. It enables decentralized document storage based on IHE profiles and a centralized storage of document metadata, document reference and patient identification data. Therefore, special care has been taken to fulfill requirements of data protection, especially by informed consent. A health care professional can access the patient’s home monitoring data via LSBH if authorized by the patient.

The project is in a prototype state. The major components have been developed and implemented. The next step is the integration of PICS and LSBH, followed by an evaluation.

2.3 Communication Architecture for Integrating Sensor Data

The paper by Nitzsche et al. [13] proposes a communication architecture in the context of AAL and health enabling technologies on a more abstract level. They started with an analysis of German AAL and telemedicine projects and identified the necessary application components and communication links. The results were generalized and modeled with the Three-Layer-Graph-based Model (3LGM2) [17] approach. The logical tool layer of this model is presented in the paper [13]. Appropriate standards to support communication and services have to be identified. Finally, integration profiles basing on these standards have to be created as a reference concept for the communication architecture.

The global aim of the standard-based communication architecture is to introduce a reference model for the provision of monitoring data from the home site to a health care provider via a telemedical center.

3. Conclusion

Integrating data from AAL systems and smart homes with data from electronic health or patient records is still in an early stage. The selected articles provide concepts and important prerequisites to establish the use of sensor data for medical decisions. The paper by Reeder et al. [11] has analyzed for which medical decisions older citizen perceive a benefit in monitoring activity patterns and their visualization. The paper by Nitzsche et al. [13] provides a reference architecture for communicating AAL data to a telemedical center, mainly on the logical tool layer and the paper of Gietzelt et al. [12] describes a prototype application of an architecture which bases on a personal intelligent care system at the home site and a regional health record bank with authorized access for health care providers.
providers. All projects are in an advanced conceptual phase, only one of them has already experienced feasibility of the major components.

Semantic integration with data already available in health care institutions has not been addressed by any of the selected papers and will become a topic of future research as well as evaluation studies on benefits and outcome.

Considering the high number of available technical solutions in the area of ambient assisted living and health enabling technologies (e.g. [18–20]) their integration with health information systems and electronic patient records systems is still premature. Existing approaches that prepare sensor data for integration into patient records are often dedicated solutions for particular applications. General comprehensive solutions are hardly available. Future research is necessary to pick up the promising approaches introduced in this focus theme.

Acknowledgment

We want to thank the editors of Methods of Information in Medicine for giving us the opportunity to publish a focus theme on this exciting topic at an early stage.

References