A Regional Health Care Network: eHealth.Braunschweig
Domain Fields and Architectural Challenges

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Keywords
Regional health care networks, patient-centered care, integrated health care systems, intersectoral communication.

Summary
Background: Health care network eHealth.Braunschweig has been started in the South-East region of Lower Saxony in Germany in 2009. It composes major health care players, participants from research institutions and important local industry partners.

Objectives: The objective of this paper is firstly to describe the relevant regional characteristics and distinctions of the eHealth.Braunschweig health care network and to inform about the goals and structure of eHealth.Braunschweig; secondly to picture and discuss the main concepts and domain fields which are addressed in the health care network; and finally to discuss the architectural challenges of eHealth.Braunschweig regarding the addressed domain fields and defined requirements.

Methods: Based on respective literature and former conducted projects we discuss the project structure and goals of eHealth.Braunschweig, depict major domain fields and requirements gained in workshops with participants and discuss the architectural challenges as well as the architectural approach of eHealth.Braunschweig network.

Results: The regional healthcare network eHealth.Braunschweig has been established in April 2009. Since then the network has grown constantly and a sufficient progress in network activities has been achieved. The main domain fields have been specified in different workshops with network participants and an architectural realization approach for the transinstitutional information system architecture in the healthcare network has been developed. However, the effects on quality of information processing and quality of patient care have not been proved yet. Systematic evaluation studies have to be done in future in order to investigate the impact of information and communication technology on the quality of information processing and the quality of patient care.

Conclusions: In general, the aspects described in this paper are expected to contribute to a systematic approach for the establishment of regional health care networks with lasting and sustainable effects on patient-centered health care in a regional context.

1. Introduction
Collaboration and cooperation in health care is considered as an essential need to achieve high-quality and patient-oriented care beyond sectoral boundaries of primary care, secondary care, outpatient care, rehabilitation or home care. Also the application of information and communication technologies in health care systems and the establishment of regional health care networks are expected to have positive effects on the availability of data, enabling data exchange and accessing relevant data, effectiveness of patient care and quality of communication and coordination within a region [1–4]. Although computer based information and communication technologies have been used in health care institutions for several years and electronic medical records within health care institutions are already common and well appreciated, the communication of medical documents between different institutions such as discharge letters, images, findings or nursing summaries is still mainly paper based. Despite general consensus on the importance of coordinated cross-sectoral cooperation in health care networks the required cross-institutional services are not yet implemented, while cost pressure increases and quality expectations rise constantly [5]. Due to the demographic change there are growing numbers of older citizens entailing a growing number of chronic diseases and multi-morbidity. To afford suitable treatment for these complex diseases a lot of health care providers need to adjust with each other over a long period of time.

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some extent the present situation in the German health care does not reflect the need of patient-centered care and appropriate supply of the required health care services beyond the borders of health care institutions [6–8].

The German eHealth policy has started in 2003 and intended the introduction of an electronic health card and electronic health record on national level. Since then a national competence center for health telematics has been responsible for planning, implementing and introducing the national eHealth infrastructure. Due to various reasons, including organizational and technical difficulties, the national eHealth project has been delayed by several years and has been now resumed in the year 2010 with a restructured organization and a new streamlined project management. National eHealth activities have been pushed forward since then and the actual nationwide introduction of the electronic health card is expected at the earliest by the end of the year 2012.

At the same time, without waiting for the final implementation of the national eHealth project, many eHealth projects started over the past years with the main objective to establish communication between health care providers via information and communication technology (ICT). Admittedly the success and achieved results of many undertaken eHealth projects vary on a wide range in quality and sustainability. Reasons could be the heterogeneity of the ICT landscape in the German health care system, missing business models to continue operating the established networks as well as slow rethinking among the health care providers and last but not least the delayed and biased implementation of the national eHealth project.

The regional network initiative eHealth.Braunschweig has been started in April 2009. The main goal of all members – health care providers and representatives from science and economy – is to establish a cross-sectoral ICT supported health care network spanning all health care sectors including home care in the region of Braunschweig. The main idea of the project is: move the information not the patient; or even more applicable: move the information together with the patient.

2. Objectives

The main objective of this paper is to provide a contribution to the research field of transinstitutional health information systems, intersectoral health information management and the management of regional health care networks by answering the following questions in the context of eHealth.Braunschweig:

- Q1: What regional characteristics and distinctions are crucial to the establishment of regional health care networks?
- Q2: What are the main domain fields and requirements to be addressed in a regional health care network and how can these domain fields be supported by modern information and communication technology?
- Q3: What architectural challenges do regional health care networks face, regarding defined requirements and what architectural approach can be suitable to meet these challenges?

3. Methods

Our methodology is based on our previous work and experiences in the field of transinstitutional sensor-enhanced health information systems [4, 9–11] and integrated health care networks [12–17]. In order to answer questions Q1 and Q2 we established an organizational structure and specified requirements for the relevant network domain fields addressed in the eHealth.Braunschweig initiative. The specification was based on expert interviews and requirement analysis workshops with health care providers, participants from medical informatics research institutions as well as patients, respectively elderly citizens. Expert interviews with health care network members were conducted in an earlier project called IT based management of integrated health care networks [16]. Health care providers and network managers from seven integrated health care networks where interviewed in order to determine the actual barriers and chances of inter-organizational cooperation and communication in health care networks [17]. Considering the outcome of this earlier project the requirements analysis could be done based on previously gathered knowledge about the actual needs of the health care actors. Working groups related to every network domain field have been established comprising participants of different cooperating organizations. Every working group conducted a series of workshops directed at analyzing the present communication processes between institutions within particular use cases and deriving requirements to future inter-organizational communication. These workshop series resulted in functional requirements specification within each domain field.

In order to attend question Q3 we identified and analyzed existing architectural approaches for development of inter-organizational health care information infrastructure. In order to systematize the knowledge about transinstitutional information system architectures in cooperative health care environments it is desirable to rely on a consistent taxonomy for systematic description, when analysis, assessment or comparison of architectures is in the scope of examination. Before the analysis of existing architectures such a taxonomy describing transinstitutional information system architectures in health care had been developed [18]. In order to identify the relevant content of the taxonomy different classification and description frameworks of information system architectures in general and in health care in particular have been analyzed. The architecture layers and characteristics related to cross-institutional facets have been derived and clustered. After undertaken examination the derived taxonomy finally consists of five axes: strategy, organization, application system, integration and infrastructure. Each axis describes different architectural aspects stating a bunch of categories for each axis. The organization axis for example consists of the following categories: type of health system, participating actors, supported inter-organizational tasks and functions, governing body and ownership, responsibility for data storage and maintenance, centralization of architecture responsibilities and geographical reach. For each category a number of characteristic values have been specified. Equipped with the developed taxonomy a
literature search was conducted on the databases Pubmed, IEEE Xplore and Web of Knowledge. Resulting publications which contained a description of implemented inter-organizational health information system architectures were included in further architecture analysis. Out of over 100 selected publications a small sample consists of the following publications: [4, 10, 11] and [19–25]. Detailed study design and results of the literature study will be published separately. Based on this analysis and the functional requirements specified during the workshops we derived architectural requirements for our regional eHealth infrastructure and developed an implementation concept for the regional eHealth infrastructure. Taking into account the literature search results presenting related projects with similar objectives the ideas and approaches of eHealth.Braunschweig are compared with related research.

4. Results

4.1 Regional Characteristics and Structure of eHealth.Braunschweig

Developing a regional IT-infrastructure for health care networks a wide variety of quickly changing economic, political and technical conditions have to be considered. Basic foundation of a well operating and accepted health care network arises from integrating all relevant stakeholders and their particular goals into the network from the beginning. Thus, as a first step, we invited the most important care providers and other stakeholders to collaborate within eHealth.Braunschweig initiative. Amongst the participants is e.g. the Medical Center Braunschweig, a tertiary academic teaching hospital and the largest health care provider in the region, the German Red Cross (DRK) with representatives of nursing homes and mobile nursing services and the Association of Statutory Health Insurance Physicians of Lower Saxony with all licensed general practitioners and medical specialists in Lower Saxony as members of this association. Further cooperation partners are the City Council and the Public Health Department of the City of Braunschweig, the Council of Elderly People, a local house-building company, several business companies and two research institutions.

Because of the heterogeneity and diversity of eHealth.Braunschweig participants a clear organizational structure is crucial to succeed. Thus, next to the usual project management, an advisory board with members from the top management level of each institution was established. The advisory board is an important instrument of strategic management within the regional health care network and decides on strategic direction of the network partners. Furthermore the advisory board enforces the alignment of the network goals with the individual goals of the participating organizations and their information management goals. Moreover the advisory board keeps contact with activities of the federal eHealth program of Lower Saxony.

Below the project management and advisory board level eHealth.Braunschweig is organized in sub-projects with associated working groups, each one representing relevant domain fields of the network. The main domain fields and their requirements will be described in the next section.

Figure 1 shows an overview of the eHealth.Braunschweig organization.

The major objective of eHealth.Braunschweig is to develop, implement and evaluate new information and communication services for a patient-centered regional health care network. Integrating the institutional information infrastructure of network participants into a transinstitutional regional health information system is the major intention and challenge of the project. Moreover, eHealth.Braunschweig aims at establishing a new regional organization structure for being in charge of the long-time network management, support and maintenance of regional infrastruc-
ture, further network development and long time-evaluation of network impacts. Addressing Q1 the essential regional key characteristics of eHealth.Braunschweig regarding the network establishment are summarized in Table 1. The organization and structure of eHealth.Braunschweig is rather specific and unique at least in Germany.

Involving a broad variety of health care providers and other health related regional actors and bringing them together in order to work on one particular solution for current urgent problems is the main credit of eHealth.Braunschweig. In particular including nursing care services, nursing homes, public health authorities and building companies is a differentiating factor and an incentive to many regional network actors. The effort of creating and establishing a sustainable organization structure distinguishes the eHealth.Braunschweig project from many other research projects. The first step of establishing an independent regional organization has been made by introducing a regional advisory board of eHealth.Braunschweig and could be extended to further organizational forms.

### 4.2 Domain Fields and Requirements of eHealth.Braunschweig

Based on the project objectives and previously described regional characteristics we identified fields of activity addressing the objectives of eHealth.Braunschweig. The main goal is to integrate communication processes in the health care region vertically (across different health care sectors) as well as horizontally (across different specialization fields, indications and diseases). We identified four domain fields depicting the essential parts of inter-organizational communication and collaboration in a regional health care network. These domain fields include 1) health and home care for elderly, 2) regional network for combating multiresistant organisms, 3) regional trauma network and 4) information management and regional communication platform and are described in the following sections.

#### 4.2.1 Health and Home Care for Elderly

The ageing of the population is progressing very fast. Thus, the improvement of the health and home care support for elderly people is an important activity field in regional communities. Development and exploration of intelligent home environments for elderly people and the integration of sensor-enhanced health information systems into regional health care networks might contribute significantly to improving the health and quality of living of elderly people [26].

As one important domain field of the eHealth.Braunschweig initiative we concentrate on establishing ambient assistive technologies into the real home environments of elderly people in Braunschweig. Apartments for elderly people owned by local house-building companies in Braunschweig will be prepared as age appropriate apartments and equipped with sensor-enhanced information technology. The data collected by several sensors can be processed at the seniors’ home and in some cases supplied to care givers in the regional health care network who are involved in the treatment of these people [10, 26]. These integrated technologies can help to provide new health care services for elderly people (e.g. for home monitoring and accessing the state of health, education services, feedback services and others) in order to support a self-sufficient and self-determined life. Unlike most existing works on ambient assistive and health-enabling technologies published in the scientific literature we concentrate on functional and economic aspects rather than technical aspects and explore information management issues of the developed sensor-enhanced transinstitutional architectures.

#### 4.2.2 Regional Network for Combating Multiresistant Organisms

One of the most important reasons for regional cooperation is the increasing development of antibiotic resistance in many important infectious disease organisms. E.g., Methicillin-resistant Staphylococcus aureus (MRSA), which is multiresistant against a large panel of antibiotics, including most broad-spectrum antibiotics, has become one of the most common causative agents for hospital-acquired infections worldwide. MRSA infections are associated with increased mortality and prolonged hospital stay, requiring large additional efforts from the medical staff and generating high additional costs in hospitals and nursing homes. In Germany the MRSA rate is estimated to be around 25%. Thus, compared to some other countries, such as the Netherlands with less than 3% MRSA rate [27], there is huge room for improvement in Germany.

By following the model of the EU-REGIO MRSA-net project from Muensterland (Germany) and Twente (Netherlands) region [28] the main goal of this domain

| 1. Involving network participants from all health care sectors | – ambulatory care  
| – hospital care  
| – nursing care  
| – rehabilitation  
| – prevention |
| 2. Involving public authorities | – City of Braunschweig  
| – Public Health Department  
| – Council of Elderly People |
| 3. Innovation transfer between health care providers, research and industry | – Participating research institutions  
| – ICT business companies  
| – local house building companies  
| – other health networks |
| 4. Joint advisory board representing network members | – Research representatives  
| – Hospital representatives  
| – Physicians representatives  
| – Public authority representatives  
| – Industry representatives |

Table 1: Key characteristics of eHealth.Braunschweig
field is to set up common standards for detection, treatment and prevention of colonization and infection of patients with multiresistant organisms. Crucial to this approach is a fast and reliable information exchange between all collaborating institutions.

The working group of infectious disease specialists and hygienists from all participating hospitals is currently in the process of specifying a minimal exchange data set on MRSA patients. Based on guidelines from the Robert-Koch Institute, other MRSA networks and the requirements of the federal state public health authority of Lower Saxony the exchange data set should contain at least the following items (see also Table 2): patient name and birthdate, discharging institution, contact information for callbacks, information about the present status (past MRSA colonization/infec-
tion, MRSA colonization incl. localization, MRSA infection incl. localization), MRSA positive test results (swabs, incl. localization), decontamination measures (no attempts, decontamination complete: successful/unsuccessful, decontamination in progress: scheme, current status).

The participating organizations will directly benefit from the network collaboration by receiving relevant information about the MRSA status of their patients fast and reliably together with patient admission, transfer or readmission. The eHealth.Braunschweig efforts finally aim at an electronic MRSA registry in conjunction with a standardized nursing discharge summary for each affected patient in the whole South-East region of Lower Saxony. Additional education programs and training courses for the involved health care institutions will be established. As long-term result, a general standardization of all diagnostic, therapeutic and preventive activities along the treatment pathway of affected patients according to the German Antibiotic Resistance Strategy [29] is intended.

4.2.3 Regional Trauma Network

Another collaboration scenario in regional health networks is the remote consultation of specialists for appraisal of e.g. radiological images. The main goal in the treatment of poly-traumatic patents is providing the best medical care as soon as possible at any time and any place by implementing standardized quality measurements. Clinical studies show that treatment success of polytraumatic patients depends on different criteria such as duration of pre-clinical care or the availability of 24 hours acute diagnostic and therapy [30–32]. The German Society for Trauma Surgery developed guidelines for implementation of trauma surgery hospital networks (trauma networks), which are intended to be applied to local and regional conditions. Participating hospitals in a trauma network fulfill different roles according to their resources as local, regional or inter-regional trauma center. Immediate appraisal of the injury e.g. by a neurosurgeon based on radiological images and findings and a fast decision about potentially necessary transfer to a regional or inter-regional trauma center is crucial and often life-saving.

The fast and efficient communication of images and findings in trauma networks supported by the use of information and communication technologies is an inevitable requirement. In eHealth.Braunschweig the Regional Trauma Network domain field was introduced as a domain field in order to develop a homogenous regional infrastructure for radiologic image communication within the trauma network. The trauma network use case of image communication is one of the first use cases that will be implemented in eHealth.Braunschweig communication platform.

### 4.2.4 Information Management and Regional Communication Platform

The domain field of information management and regional communication platform is understood as a cross sectional domain field building the information management and information infrastructure foundation for application use cases within all domain fields of the network described above. In order to establish inter-organizational communication the eHealth. Braunschweig working group in the first place identified the inter-organizational information flows and specified an inter-organizational exchange data set between involved care givers (hospital (H), general practitioner (GP), medical specialist (MS), nursing home (NH) and mobile nursing service (NS)). In the first step the information exchange data set was determined bidirectional for the term of hospital admission (from GP/MS/NH/NS to the hospital) and discharge (from hospital to GP/MS/NH/NS). A working group consisting of hospital physicians, nurses, general practitioners, administrative and IT staff discussed the content of the exchanged data set extensively in numerous working group sessions. In case of a hospital admission the data set contains the following items: administrative patient data, admission diagnosis, existing indications and symptoms and present medication. With hospital discharge a discharge letter (containing diagnoses, examination and test results, therapies (incl. medication and further treatment suggestions) and other existing documents (images, findings, nursing discharge document and MRSA documents) are expected to be communicated to the follow-up institution. When available electronically to different care givers, the exchanged information will contribute to an effective and purposeful information flow especially at critical time points e.g. before weekend and should also help to reduce time-consuming telephone requests.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>MRSA exchange data set</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. patient name</td>
<td></td>
</tr>
<tr>
<td>2. birthdate</td>
<td></td>
</tr>
<tr>
<td>3. discharging institution</td>
<td></td>
</tr>
<tr>
<td>4. contact for callbacks</td>
<td></td>
</tr>
<tr>
<td>5. information about the present status</td>
<td></td>
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</tbody>
</table>
| – past MRSA colonization/infec-
tion |
| – MRSA colonization |
| – localization |
| – MRSA infection |
| – localization |
| 6. MRSA positive test results |
| – localization |
| 7. decontamination measures |
| – no attempts |
| – decontamination complete: successful / not successful |
| – decontamination in progress |
| – scheme |
| – current status |

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Concerning the admission and discharge management a significant task of information management, as a core part of transinstitutional health care management, performed by eHealth.Braunschweig was the process-related definition of the associated communication flows. Hospital admission and discharge are highly multifactorial activities involving different care giver professional groups inside and outside the hospital as well as patient relatives. Therefore a lot of problems, delays and lack of information emerge at this point. At the same time as the basis data exchange set the processes affected by this information should be aligned regarding a barrier-free information flow. Within the eHealth.Braunschweig project relevant information and communication flows were analyzed and target processes were specified in a bidirectional way between care givers in primary and secondary care as well as nursing care and home care for elderly people.

Accordingly comprehensive workflow support for transinstitutional medical, organizational and administrative processes within the eHealth.Braunschweig network has to be established in the long term. The entire interaction regarding one treatment case at different points of care (e.g. GP, hospital or home care) including medical, organizational and administrative tasks requires workflow monitoring and control mechanisms. Adequate trigger mechanisms within inter-organizational information and communication processes e.g. initiating the submission of patient to the network after discharge or informing a GP about the discharge of his patient and the availability of documents are expected to support the transinstitutional collaboration. In order to support the inter-organizational collaboration tasks and workflows described above the development of a transinstitutional information and communication platform is the major challenge of the project.

One of the critical success factors of regional health care networks is a systematic network management and development of sustainable business models. This success factor is fundamental for a continuous operation of the network after the termination of the initial funded period. These aspects often fall into oblivion in eHealth projects and a long-term success and even existence of such networks is endangered after the initial project term. Systematic network management in a regional health care network comprises different management tasks e.g. strategy definition, information management, patient and network participant administration, monitoring and controlling as well as reporting tasks. A major task of information management is the alignment of strategic goals of participating organizations and the corresponding information system architectures taking into account the specific characterization of health care networks e.g. non-hierarchical governance forms and collective vs. individual interests of network members [16]. To fulfill these tasks eHealth.Braunschweig considers the establishment of an independent organization that represents the participating network organizations.

A lot of research work has already been done by different research institutions in the last years within the domain fields covered by eHealth.Braunschweig. The ambient assisted living technology field is a good example of a growing research field which already shows considerable results e.g. in the area of wearable system architectures and detection of daily life activities [33, 34] or ubiquitous computing [35, 36]. Also fundamental research in the field of standardizing medical content and communication as well as building interoperable information systems has been in the focus of medical informatics for many years [37–39]. The initiative of eHealth.Braunschweig is less of the fundamental research character but rather a bottom-up practical application of the developed and established usable research results in a real setting of a regional health care network.

4.3 eHealth.Braunschweig Architectural Challenges

The challenges in terms of referential integrity, interoperability, information management, terminology and others are still ongoing within transinstitutional information systems. The eHealth.Braunschweig network as a part of the regional health information system is facing these problems when trying to introduce an inter-organizational information infrastructure to support network collaboration.

In order to support the domain fields described above a cross-institutional communication infrastructure needs to be established in the Braunschweig region and technical and organizational challenges have to be met on the way to the transinstitutional information system architecture. The internal workflow of the participating health care institutions will be adapted in order to enable collaboration and information exchange. Beyond that, the existing clinical, administration and documentation application systems will be integrated with the regional information infrastructure. Due to these requirements it is considered to apply technical standards according to the integration profiles of the IHE (Integrating the Healthcare Enterprise) IT infrastructure technical framework. A schematic view of the planned architecture is given in Figure 2. At the local level a local application node within the health care infrastructure of the particular institution will be inserted. This local application node implements the IHE profiles for cross enterprise document sharing and the document repository, source and consumer actor role. At the regional level infrastructure one centralized community node located at an independent eHealth organization will be implemented. This node will provide a regional master patient index and a document registry for the affiliated community.

Initially the exchanged documents will be represented as HL7 CDA level one documents (e.g. CDA embedded PDF documents or JPEG images), since most currently used data delivering and consuming application systems are not yet capable of generating or interpreting structured information. In case of radiologic images DICOM series will be directly exchanged between XDS-1.b capable PACS systems or to PACS connected XDS-1.b adapters. Once the basic infrastructure has been established it could be possible to enhance the infrastructure with regard to semantic interoperability step-by-step by replacing CDA level one documents with CDA level two and level three documents in case...
source and target application will be able to create and process structured information.

In Figure 3 the main IHE principles of registering and receiving documents over the communication platform is shown. IHE compliant source adapters connected to the local clinical application systems are responsible for registering shared documents in the community node.

The physical document storage remains generally at the source institution. In some cases it could be required to create a temporary or permanent central document repository, e.g. if a general practitioner or a nursing home cannot provide permanent system and data availability. For document retrieving the consumer adapter is sending a request for existing documents regarding one particular patient ID and receives the list of registered documents for this patient. Selected documents are retrieved from the source application or from the central document repository. The central components located at the community node provide web service interfaces which can be addressed directly by clinical applications itself, if they are capable of accessing the service, or by the integrated source and consumer adaptors. In future this type of architecture on regional level could also be embedded at federal, national or even international level. Equally composed IHE compliant architectures of other regional networks or the hierarchically super-ordinated national telematics architecture could be interlinked using the community node components.

As one part of the national eHealth strategy the German electronic health card and the health professional card will provide unique patient and health care provider identification for safe and secure authentication within German health telematics architecture. The basis rollout of card reading devices is expected to take place until the end of the year 2011. From the beginning of the last quarter of 2011 the health insurance companies will start to equip their members with the electronic health cards. It is expected that at least 10 percent of the patients will be holding the new electronic health card by the end of the year. Once the electronic health card has been established nationwide, the national patient index will be used for the patient identification within the presented eHealth communication platform. Until then the patient index will be generated from patient metadata in combination with the health insurance number of the patient. An integration of presented eHealth platform with the future German health telematics architecture is intended and an integration concept is currently being developed.

Furthermore besides urgently required interconnection of primary and secondary health care institutions future integration of home telematics platforms and sensor-enhanced data with health information systems and applications of health care providers will be a major challenge in the context of regional health and social care networks. Numerous telemonitoring and telehealth services as well as personal health records will be available in future to the patients and elderly people and thereby more data will be able to be collected and preprocessed by the patient. Therefore patients’...
home as well should be considered as an important institution within a regional health care network.

These architectural considerations should certainly be made with regard to data safety and security which are basic requirements in a distributed information and communication infrastructure dealing with sensitive patient data. As mentioned above the presented architecture is intended to seamlessly interact with the national telematics architecture in order to apply the national security architecture standards and to provide information and communication services and a real value and benefit for health care providers. The data safety and security requirements specified for the national telematics infrastructure – access authorization, encryption, patient consent and other – are considered analogically for the regional eHealth architecture proposed in this paper.

The architectural challenges have been specified with respect to literature research [40] and were aligned with the architectural requirements of participating health care providers, usually hospitals. A technical working group consisting of IT staff members from hospitals, the IT department of the association of physicians and medical informatics from the research area are constantly working on the specification of architectural requirements in order to meet the balance between feasible and affordable but at the same time standardized, future-oriented and future-proof solutions. Some projects and initiatives worldwide are following the IHE principles and guidelines and are on their way to build transinstitutional information system architectures based on these principles (e.g. [19, 41, 42], however this way is long, tedious and anything but free of stumbling blocks, which can only be cleared by patience and perseverance.

5. Discussion

5.1 Related Research

Related research and activities in the context of regional health care information systems and networks can be found all over the world. A lot of research work concerning architectural approaches and interoperability [43, 44], inter-organizational information and communication systems [45, 46] and national or regional work in eHealth projects [47, 48] could be observed in the past years. A few examples of regional initiatives are e.g. eGesundheit.nrw in Germany [49], ELGA in Austria [50] and MedCom in Denmark [51]. The German eGesundheit.nrw is an initiative of the federal state of North Rhine-Westphalia, which is operating in different projects regarding electronic health card and health professional card as well as inter-organizational electronic patient record (ePR) and electronic case record (eCR). The aim is to establish a health care provider centric
Electronic patient record based on the technical specification of the eCR [52] focusing on cross-institutional secure document communication for one particular case. The Austrian national initiative ELGA concentrates on establishing nationwide basic components like patient index, HCP index, document registry and core health applications like electronic medication and electronic vaccination record.

The most advanced national initiative is the Danish national healthcare data and information network MedCom, which has been developed over the last 15 years and now is considered as a leader initiative in Europe in the field of health information system integration. The MedCom network connects all actors in health care and social care sectors in Denmark and performs about 70% of the communication electronically between these parties [53, 54].

Other projects are smaller with a distinct regional context and often concentrate on technology or standard oriented research questions concerning the communication between hospitals, within the primary care sector or between primary and secondary care providers. Very few regional eHealth projects include nursing and home care as well as social care or house building companies and handcraft with the background of assistive systems and health care into regional eHealth network activities.

Compared with other projects eHealth.Braunschweig characteristically follows the patient-oriented integrated approach – starting with patient’s home environment and aspects of personal health, across all health care sectors and aspects of eHealth and closing with population centered public health aspects. In particular the involving of nursing care services, nursing homes, public health authorities, building companies and the patient’s home environment into particular projects is a characteristic benefit of eHealth.Braunschweig.

All requirements are derived in a close cooperation with network participants operating in working groups following a strict bottom-up approach in order to meet the real needs of participating members. This way seems to be the most acceptable approach of cooperation between different regional institutions.

5.2 Evaluation

Since the eHealth.Braunschweig project is still in progress and currently at the beginning of the actual development and introduction of the regional infrastructure components, the investigation of the effects and impacts of the eHealth infrastructure is still due. The following evaluation questions should be planned for evaluation:
- What impacts does the introduction of inter-organizational communication have on the quality of information processing between the health care providers within eHealth.Braunschweig network?
- What impacts does the introduction of inter-organizational information and communication services have on the quality of patient care?
- What impacts does the introduction of health enabling technologies and services have on the quality of living of elderly people?

The research questions mentioned above contribute to the empirical research on the effects of information and communication technologies in regional health information systems. The results could help to design and implement reasonable and useful application systems in health care.

5.3 Conclusions and Outlook

The importance of inter-organizational collaboration and positive effects of information processing in regional health care networks have often been pointed out and partly found realization in regional projects of integrated care networks. Nevertheless the core problems of integration, interoperability and workflow support are still existent and the introduction of new solutions into daily health care practice is still missing. In the regional health care network eHealth.Braunschweig the described domain fields are elaborated in cooperation with network members from all organizations in order to identify substantial, relevant and significant collaboration processes and to introduce applications and technologies supporting these processes. Evolving sustainable and lasting information system architectures which will be embedded into the regional health information system is the major objective of eHealth.Braunschweig. The main aim is to establish inter-organizational health care processes which support and help care givers in their daily work facilitating easier information exchange and reducing the time spent on data searching and request.

After two years of network activity the network has been systematically built up and extended, the main domain fields and their functional and technical requirements for several application use cases have been specified and an agreement on an architectural approach for the regional information and communication platform with the involved network participants has been achieved. Functional requirements for cross-institutional communication of discharge letters between hospitals and general practitioners, nursing care summaries especially MRSA summaries between hospitals, emergency services, rehabilitation clinics, nursing homes and nursing services, images and findings between hospitals within trauma care have been specified in a bottom-up approach. Architectural requirements have been derived based on functional requirements and technical demands of participating institutions. The architectural approach is specified as a decentralized communication platform with central components for patient identification, authorization policy, document registry and logging modules and locally placed adapters connected with the main clinical application as document source and consumer. The required organizational structure to provide, operate and maintain central architecture components is intended to be realized by creating a new independent organization with the main network participants as board members.

The future work will concentrate on the realization and evaluation of the eHealth infrastructure in order to examine the impacts of the regional information and communication infrastructure on the quality of information processing and quality of care within the regional health care network.
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References

41. Fernandez-Bayo J. IHE profiles applied to regional PACS. Eur J Radiol 2010
49. eGesundheit.NRW. Available at: http://www.egesundheit.nrw.de. Last access: January 25, 2011.