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An IHE-conform telecooperation platform supporting the treatment of dementia patients

Abstract: Ensuring medical support of patients of advanced age in rural areas is a major challenge. Moreover, the number of registered doctors—medical specialists in particular—will decrease in such areas over the next years. These unmet medical needs in combination with communication deficiencies among different types of healthcare professionals pose threats to the quality of patient treatment. This work presents a novel solution combining telemedicine, telecooperation, and IHE profiles to tackle these challenges. We present a telecooperation platform that supports longitudinal electronic patient records and allows for intersectoral cooperation based on shared electronic medication charts and other documents. Furthermore, the conceived platform allows for an integration into the planned German telematics infrastructure.

Keywords: telemedicine; telecooperation; IHE; dementia

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1 Introduction

Today, Germany's health system has to cope with an aging population especially in rural areas, the concentration of healthcare professionals in conurbations, and hence deficient medical support in rural areas [12]. Due to the advanced age of the population in those locations and their increasing immobility, providing them with sufficient healthcare becomes a major challenge as fewer healthcare professionals, specialists such as neurologists in particular, are available in their proximity [2, 11]. Therefore, technological means such as telemedicine and telecooperation should be considered to enable remaining healthcare professionals to maintain a high level of medical support and guidance. Telemedicine allows them to interact remotely with other healthcare professionals, resolving current boundaries in interprofessional communication, and minimizing the patients' need to travel.

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We present the concept of an electronic telecooperation platform to tackle these challenges using the example of dementia treatment. We outline how our platform is built upon the international collection of IHE profiles for sharing patient related data and documents between different healthcare professionals. We illustrate the central use case of our platform, a shared medication chart, and how it supports general practitioners, specialists, outpatient nurses, and pharmacists all taking care of a certain patient. Our platform enables comprehensive and location-independent access to a patient's medication, diagnosis, discharge letters, and other dementia-specific documents, such as test results and nursery reports. Overall, our platform facilitates a tighter integration of different types of healthcare professionals and supports institution-spanning patient care.

The paper at hand is organized as follows. To begin with, Section 2 elaborates on how we combine the concepts of telemedicine, telecooperation, and IHE profiles to tackle the challenges outline above. Then, based on two use cases, Section 3 explains in detail how our concept allows for telecooperation of different healthcare professionals. Subsequently, Section 4 presents our demonstrator that prototypically implements our concepts and outlines currently ongoing development. Finally, Section 5 summarizes the content and contribution of this paper.

2 Combining telemedicine, telecooperation, and IHE

A central step towards intersectoral and interprofessional patient care and cooperation is to support communication and exchange of medical documents among different types of healthcare professionals and their associated institutions, such as hospitals or nursing homes. Although the application of telemedicine concepts is a general step towards this direction, it requires further means to accomplish a structured and extensible exchange of medical documents. Therefore, we propose a telecooperation platform that is based on IHE profiles (Integrating the Healthcare Enterprise) [7], providing structured templates and an underlying infrastructure for cross-platform exchange of

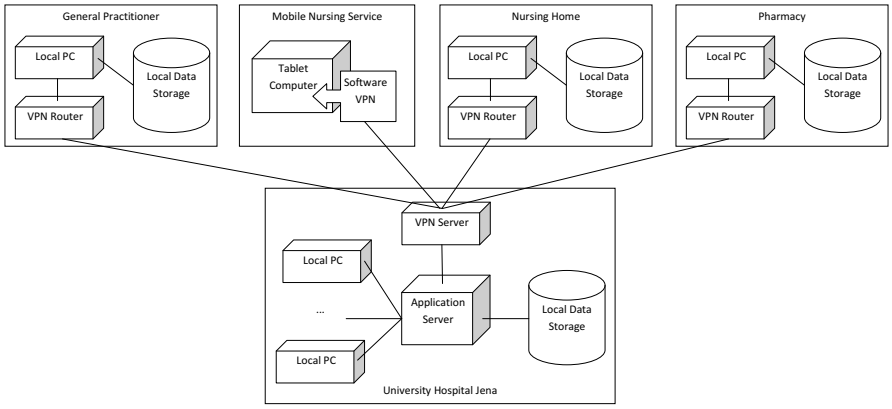

Figure 1: The general architecture of the telecooperation platform.

medical information. IHE supplies distinct profiles for different medical domains while simultaneously addressing aspects such as scalability, security, access-control, data integrity, etc..

Overall, our IHE-based telecooperation platform currently supports the following kinds of electronic medical documentation:

1. Medication charts based on a DCGMA proposal [1].
2. Discharge letters based on the VHitG proposal [3].
3. Image and laboratory results.
4. Results of cognitive ability tests, such as MMST [4, 9] and DemTect [8].

The general architecture of our platform is conceived in a classical client-server manner as illustrated in Figure 1. Healthcare professionals can connect to the platform either through VPN routers installed in their institutions (e.g. pharmacies) or through software VPN, when they are using mobile devices (e.g. mobile nursing services). It is important to note that every healthcare professional and institute still remains in control of its local data (e.g. everything stored in the local hospital information system) and decides which data they are providing via the telecooperation platform, thus retaining complete data sovereignty. Likewise, the usage of IHE for document sharing and management removes the need for a centralized storage, thus additionally catering the request for data sovereignty.

Finally, we outline how our platform and the concepts weaved into it facilitate their later integration into the planned German telematics infrastructure. First, our approach provides means to utilize KV-Connect [10] or KOMLE [6] connections for data exchange, which are already parts of the planned infrastructure. Second, with the applied concept of longitudinal electronic patient records, we are compatible to the electronic patient record that is scheduled to become a full-fledged application of the current German "elektronische Gesundheitskarte" [5].

3 Comprehensive telecooperation

In the following, we elaborate on how our platform facilitates the cooperation of different types of healthcare professionals (nurses, doctors, pharmacists, etc.) based on the two main use cases of our platform: a shared electronic medication chart and a patient news stream.

3.1 Electronic medication chart

Based on a comprehensive survey of Thuringian healthcare professionals' needs, a shared electronic medication chart was among the most frequently issued demands to improve interprofessional treatment of mostly elderly patients suffering from dementia.

The resulting electronic medication chart that was developed to cater those needs is based on the specification of the Drug Commission of the German Medical Association [1]. This electronic medication chart provides healthcare professionals with a unified view of a patient's current medication, lists the drugs currently prescribed, and helps to check for unintended side effects more easily. An exemplary medication chart is illustrated in Figure 2.

We are currently supporting version 2.0 of this proposal that provides slight improvements in terms of data encoding, data reduction, and data economy. Likewise, we support the special print and scan features that were introduced in version 1.6 and allow for converting the medication chart into a matrix barcode that is added to any printed copy of the chart and allows for fast and reliable

Drug Name	Trade Name	Strength	Form	Morn	Noon	Eve	Bed	Unit	Notes	Duration	Prescribing Cause	Prescribed	Prescribing Physician	Last Recipe	Last Package
donepezil	Aricept	10 mg	caplet	1	0	0.5	0	pcs.		until discontinuation	dementia	17-Dec-2010	psychiatrist Dr. Müller	20-Aug-2014	N3
pipamperone	Dipiperon	40 mg	tablet	0	0	0	0.5	pcs.	p.r.n.	until discontinuation	sleep disorder	20-Aug-2014	psychiatrist Dr. Müller	20-Aug-2014	N2
hydrochlorothiazide	HCT-dura	25 mg	tablet	1	0	0	0	pcs.		until discontinuation	hypertension	12-May-2010	GP Dr. Schmidt	1-Aug-2014	N3
simvastatin	Simvalip	20 mg	caplet	0	0	1	0	pcs.		until discontinuation	eleveated blood lipids	12-May-2010	GP Dr. Schmidt	1-Aug-2014	N3

Figure 2: A screenshot of the demonstrator, illustrating the electronic medication chart.

Drug Name	Trade Name	Strength	Form	Morn	Noon	Eve	Bed	Unit	Notes	Duration	Prescribing Cause	Prescribed	Prescribing Physician	Last Recipe	Last Package
~~donepezil~~	~~Aricept~~	~~10 mg~~	~~caplet~~	~~1~~	~~0~~	~~0.5~~	~~0~~	~~pcs.~~		~~until discontinuation~~	~~dementia~~	~~17-Dec-2010~~	~~psychiatrist Dr. Müller~~	~~20-Aug-2014~~	~~N3~~
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simvastatin	Simvalip	20 mg	caplet	0	0	1	0	pcs.		until discontinuation	eleveated blood lipids	12-May-2010	GP Dr. Schmidt	1-Aug-2014	N3
ramipril	Ramipril STADA	5 mg	tablet	1	0	0	0	pcs.		until discontinuation	hypertension	3-Sep-2014	GP Dr. Schmidt	3-Sep-2014	N3

Figure 3: A screenshot of the demonstrator, illustrating the *diff*-feature of our electronic medication chart.

transfer back into the electronic form. However, there is still no final official decision on how the chart should be structured, which is why we store the actual medication content in a tabular manner inside of a CDA document.

To further enhance the applicability of the electronic medication chart, our platform provides a *diff*-feature to compare subsequent versions of a patient's medication chart in order to outline recent changes in terms of added, modified, or discontinued prescriptions (see Figure 3). Additionally, it is possible to display the evolution of a patient's medication in a graphical history view, illustrating the beginning, end, and the type of drugs taken at a specific point in time or during a specific time period.

These features enable healthcare professionals to easily identify, comprehend, and react to changes introduced by their colleagues. Studying the evolution of a patient's medication chart in turn allows them to draw further conclusions on a patient's medical condition, e.g. by relating sudden changes in a patient's mental health score to preceding medication events.

3.2 Patient news feed

When different healthcare professionals are involved in the care of one patient, they are likely to introduce frequent changes to the patient's medication, medical documentation, etc., of which others have to be aware of. For example, a nurse should be aware of altered medication or new test results of a certain dementia patient without having to consult the responsible doctor on a daily basis, or to manually search for information in our platform or in any other information system. Hence, such information must be made available to healthcare professionals in an automated fashion and on the fly.

In order to provide healthcare professionals with an overview of recent events and changes in regard to a certain patient, all those events are automatically compiled into a *patient news stream* that provides a comprehensive, yet concise, summary of such events. Figure 4 illustrates our patient news feed. It can be extended to encompass various patients at once, and it can be filtered for a distinct patient, for distinct types of events, etc. Moreover, the timespan that is covered by the stream can be adjusted to only focus on recent events.

The news stream further allows to view patient-related events as a timeline, thus providing "historical context" that might provide a better understanding and decision support.

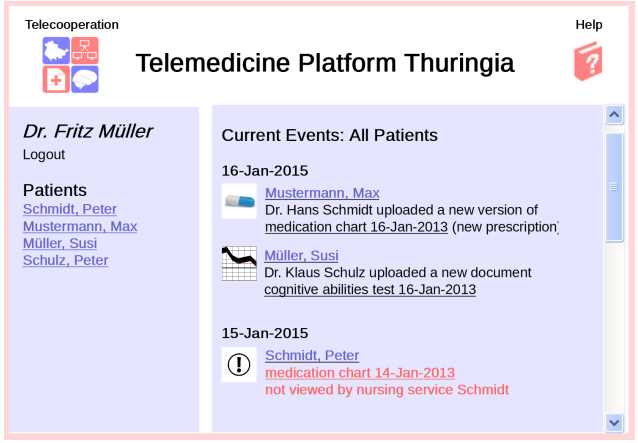

Figure 4: A screenshot of the demonstrator, illustrating the patient news feed.

4 Software demonstrator

In this section, we illustrate the device-independent implementation of our demonstrator that realizes our telecooperation platform and lays the foundation for the planned final application. Likewise, we elaborate on the current status of our demonstrator and outline future development.

Our current demonstrator already provides the shared medication chart, generates the patient news feed, and allows for submitting and viewing various types of IHE-based documents, such as doctoral letters or results of cognitive ability tests (Project website: http://www.tu-ilmenau.de/index.php?id=23956&L=1).
The demonstrator is implemented as a web-based client and is thus independent of the underlying operating system and hardware. The client can be deployed on stationary PCs as typically found in GP practices or hospital departments, as well as on mobile devices such as laptops, tablets, and even smartphones. Hence, our client allows healthcare professionals, such as mobile nursing services, to access the platform and the patient-related data on demand, either in hospitals, nursing homes or at the patient's home itself and to obtain updates from colleagues on the fly.

Further development will focus on expanding the cooperation features of our platform by introducing means for asynchronous and synchronous communication via email, notifications, and video conferences, respectively. Likewise, a tighter coupling of our telecooperation platform and existing hospital and physician information systems is sought by providing adapters to interconnect them, thus allowing for faster and easier data exchange.

5 Conclusion

The established telecooperation platform can improve the interdisciplinary treatment of patients with diseases like dementia, unhindered by any geographical distances or parallel activities. The shared electronic medication chart as a central use case of our current platform allows healthcare professionals to improve the quality of patient treatment, and to perform inquiries about a patient's medication more easily and with reduced communication overhead. The infrastructure for archiving and exchanging medical documents can also serve as a basis for further telemedicine services offered to other health care institutions or to patient pools with other diagnoses.

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Author's Statement
Conflict of interest: Authors state no conflict of interest. Material and Methods: Informed consent: Informed consent has been obtained from all individuals included in this study. Ethical approval: The research related to human use has been complied with all the relevant national regulations, institutional policies and in accordance the tenets of the Helsinki Declaration, and has been approved by the authors' institutional review board or equivalent committee.

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