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Integrated Care Processes Designed for the Future Healthcare System

Thomas Bürkle[a], Kerstin Denecke[a], Michael Lehmann[a], Erwin Zetz[b], Jürgen Holm[a]

[a] *Institute for Medical Informatics, Bern University of Applied Sciences, Bern, Switzerland*

[b] *GS1, Bern, Switzerland*

Abstract

Previous studies showed that a stronger focus on integrated care models is required, targeting at a seamless coordinated care reaching patients even at home and thus establish patient centered and patient driven innovation activities. Such integrated care model is important among others for ensuring traceability that is necessary when problems during treatment occur or in cases of product counterfeiting for ensuring patient safety. The objective of our work is to realize an efficient, continuous care process, considering an optimal, end-to-end treatment path. In this paper, we describe the process how to pave the way for developing technologies for realizing a cross-sector treatment pathway. Following a multi-stakeholder principle and by applying requirement analysis and world café methodology we designed first concepts and strategies.

Keywords:

Healthcare; Patient Safety; Telemedicine

Introduction

"Prognoses are difficult, especially when they concern the future", this sentence has been attributed to the Danish physicist Niels Bohr (1885-1962) in a lecture in Copenhagen. Nevertheless, prognoses for the future of hospitals, their organization and their technology have been made at all times [1]. In a recent report of the Spanish center for research in healthcare innovation management, two leading European university hospitals have been analyzed and a set of future challenges for such sites have been derived [2]. They include increasing demands combined with decreasing resources, smaller and more complex hospitals, the demand for new services such as personalized medicine and a future duplicate role providing complex care as well as acute services for the catchment area. The authors emphasize the need for knowledge driven redesign of efficient services, the requirement for distributed organizational structures and the trend towards technology driven healthcare service innovation. They foresee a stronger focus on integrated care models, a tendency towards seamless coordinated care reaching patients even at home and thus patient centered and patient driven innovation activities [2]. A strong focus on modern information technologies in hospitals is undisputed [2, 3]. In the UK, a future hospital commission has been funded by the royal college of physicians and finalized their report devoting a complete chapter to improved information technology [4, 5]. Some of the identified technology trends include connected medical devices, quantified health data, medical records on-the-go, on-call doctors via telehealth and 3-D printing [6]. In view of limited resources, prevention and early risk detection will become a prime focus and eHealth platforms may complement today's mostly curative approaches to medicine. New forms of care will emerge, in which the patient will make self-determined decisions and will be able to self-manage his personal health.

The institute for medical informatics (I4MI) of the Bern University of Applied Sciences BFH, and GS1 Switzerland, a non-profit professional association for optimizing value added process chains cooperated in a first project "Hospital of the future" to develop a concept for innovative future healthcare based on today's available information technology [7]. Now, the second project phase has been started under the title "Hospital of the future live". We follow the vision that information relevant for the treatment of a patient will be available to all authorized actors at the point of care in a secure, reproducible and appropriate manner. This includes not only an accurate documentation of the services and materials provided to the patients, but also improved workflows where resources and required materials will be available just in time for medical procedures.

We try to realize the vision of an integrated care model that reaches the patient already at home with a variety of projects along a typical treatment pathway. Results are implemented in our comprehensive I4MI medical informatics laboratory and in real environments to demonstrate an optimized treatment pathway and information workflow of the future. Here, we introduce the overall methodology of the project and demonstrate first results.

Methods

Both projects, "Hospital of the future" and "Hospital of the future live" have been organized as multi-stakeholder projects. The first project started in 2012 with a visionary brainstorming process focusing on the Swiss healthcare environment with the partners GS1 and *economiesuisse*, the holding organization of the Swiss economy organizations. Following the brainstorming process, an in-depth analysis was performed to determine the required medical activities for a virtual elderly and multi-morbid patient requiring hip surgery and implantation of a total endoprosthesis (TEP) for advanced arthrosis. The project maintained an advisory board with participants from hospitals, IT industry, pharmaceutic industry and medical product suppliers. Multi stakeholder table technology was employed to gain insights into the current and a possible future improved care process.

"Hospital of the future live" started in 2016 with initially 21 partners, including six Swiss hospitals, four major IT suppliers, IHE Suisse, IHE User Group Switzerland (http://www.ihe-suisse.ch) and eHealth Suisse, the coordinating body for the implementation of the Swiss eHealth architecture [8]. The project runs coordination meetings to define and prioritize punctual areas of activity along the patient pathway in shape of atomic work packages (WP). A total of 6 major coordination meetings with all participants have been scheduled until 2018 for this project. WPs are grouped into activities prior to hospitalization, WPs during hospitalization and WPs downstream when the patient has returned home. In the coordination meetings, the participants passed through parallel sessions in which an expert explains each WP. They had then to vote for the prioritization of the work, and commit themselves if they will participate actively in the respective WP. From this voting, we selected the most relevant WPs which in turn were condensed to projects which may comprise between one and six WPs.

These projects are further outlined and distributed to the more advanced students of the Bachelor study of medical informatics at the BFH. In shape of seminar and so called living case (practical courses) topics in which requirements from the relevant stakeholders are collected, including current processes and ideas on improved process flow, target states are specified and prototypes are implemented as basis for future product development.

Living cases will result either in a working prototype or an implemented piece of software, which is installed in the I4MI medical informatics laboratory to demonstrate a potential solution for the problem. Within seminar projects, the students have to analyze requirements in detail with the stakeholders, to develop a feasible IT concept to solve the determined interoperability problems and to describe and present this work. For the coordination of the different student activities, we use the world café methodology, which helps to identify future visions for selected processes.

Typically, a successful living case work may be continued towards the bachelor thesis which should result not only in an IT based implementation, but also in a formal evaluation of the developed solution in a real environment, e.g. a hospital department, a medical surgery, a rehabilitation center or a community care organization.

Results

First study

Results of the first study "Hospital of the future" included a document which described the patient's current clinical pathway from home to home across several care providers and institutions comprising many process gaps and inefficiencies in today's Swiss healthcare system and contrasted this with a visionary future clinical pathway avoiding most of these gaps and information loss [7].

The study demonstrated that Swiss hospitals are not sufficiently integrated into the entire information flow. Integration of data and processes towards the outpatient sector and the supplier is yet rarely realized. A closer look at the flow of information in the Swiss healthcare system demonstrated that, in many places, the knowledge about the patient is locked in single information systems instead of being integrated among systems to get the whole picture on the health of a patient which is necessary when making personalized clinical decisions. The study demonstrated the need for a better linkage between medical activities along the governing clinical pathway and accompanying processes starting from the admission into a hospital to discharge, including the supply chain. Particularly those processes were closely investigated, in which the dispensing of medication and / or medical equipment or consumables were involved.

In addition, interruptions in the logistic information flow for drugs or materials themselves, which would permit establishing a continuous supply chain, have been analyzed. Such traceability is necessary when problems during treatment occur or in cases of product counterfeiting for ensuring patient safety. In many Swiss hospitals, however, the supply chain for materials is broken between the different internal storage places such as ward cupboards for medical supply or drugs. Often it is unknown, when, where and how drugs, consumables or smaller devices are ordered, consumed or stored, potentially resulting in drugs with exceeded expiry date in stock or insufficient trace back of defects in instruments or devices. This can lead to serious consequences in security and patient safety.

To achieve a better common understanding of complex information flow e.g. in the medication process, an easy to understand process tool named IXPRA (Figure 1) has been developed to support process analysis tasks in a multi stakeholder environment [9]. IXPRA stands for Interface Cross Culture Process Analysis Tool and is a toolset which describes medical processes on a functional level with main processes, sub-processes and particularities, but also on an application level resulting in clinical use cases and on an interaction level comprising involved staff, involved IT systems and special challenges. The functional level describes the basic process steps, sub-processes and comments. The application level describes the use cases or a task description with the relevant process steps. The interaction level displays involved people, IT systems and special features. Using IXPRA, the problems and challenges within a process can be identified. The results of an IXPRA process analysis form the basis for discussions with involved people and for developing new solutions that improve the processes. IXPRA enables rapid focusing on the information gaps and information loss and supports especially weakness analysis. Besides the concrete process analysis, factors such as the possible influence of management decisions and the internal incident culture of the processes can be examined. Today, an IT based implementation of IXPRA is available from MID GmbH Nuremberg, Germany.

Within the first study "Hospital of the future", IXPRA has been repeatedly used to analyze e.g. weaknesses in the medication process at hospital partners such as the Spital Thurgau AG and Spitalzentrum Biel. We found considerable weaknesses in the investigated workflows, e.g. concerning the medication process. Currently, the information flow is broken in different dimensions as it was identified for the care process in the outpatient sector: information on the patient him/herself; information on instruments / material is collected – if at all – in separate information systems. This causes a high risk for patient safety, outcome quality and limits efficiency of workflows. In tangible terms, our goals for the second study are:

1. Realizing a cross-sector treatment pathway,
2. Integrating eHealth and demonstrate potentials of eHealth and
3. Realizing new use cases and derive business cases.

Second study

The second study "Hospital of the future live" started in June 2016 and is planned to last for two years, thus only preliminary results are available at the time of this paper. The second study builds upon the results of the first study including the detected weaknesses. So far, two of six planned multi stakeholder coordination meetings have been completed, the first one in July 2016. In this meeting, a set of 59 WPs has been jointly defined and finalized. They include:

- 18 WP prior to hospitalization. An example is the following WP: Given the situation that a patient suffers from arthrosis and also from diabetes. How can his diabetes management at home be improved using the future Swiss eHealth environment (new legislation for a countrywide electronic patient record in Switzerland)? This includes setting up a connected diabetes monitoring platform on mobile devices and establishing appropriate monitoring mechanisms to avoid hyper- and hypoglycaemic episodes.
- 21 WP center around hospital care and treatment. An example WP deals with the information flow between acute hospital care and rehabilitation care for the remobilization of the patient. The task is to examine and demonstrate which data and information can be transferred in a structured fashion across the Swiss eHealth environment between both institutions.
- 14 WP deal with the patient's downstream home activities and the logistics linkage. It can be expected that stronger efforts will be made to support citizens to continue living in their home environment, aided by AAL (active and assisted living) activities such as an intelligent wardrobe in their home environment [10]. As an example of this type, consider a WP where we will examine the required activities and information workflows for the re-initialization of the home environment digital devices when the patient returns and may have different gait patterns which should not lead to unnecessary alerts of the fall detecting floor in his/her apartment.
- 6 remaining WPs enable us to build the required infrastructure within our medical informatics laboratory to support those activities. Within one WP, we will establish a generic middleware for connected sensor technology.

With the methods outlined before, we aggregated a first set of 28 highly prioritized WPs into 12 student projects (Figure 2).

A preliminary result concerned the preoperative handover between GP, orthopedic specialist and hospital. The current outpatient care process was analyzed with the goal to eliminate weaknesses and to derive an innovative IT-driven process. The result of the process analysis is shown in Figure 3. Several limitations could be identified in this care process:

- Referral forms are filled by hand and sent by fax.
- Reports from the orthopedic specialist are sent by fax and re-entered into software at the GP.
- Image data is transferred by the patient (manual transport of discs).
- Reports from the hospital are sent by mail.

These issues lead to information loss. Within the student project, several improvements have been identified:

First, the information system at the general practitioner (GP) could be enabled to recommend appropriate specialists, rehabilitation centers, hospitals and pharmacies, which are specialized for the medical problem of the given patient. Relevant criteria might be distance to the patient's home location, experience in treating hip arthrosis, free capacity, and information about the available surgeon(s). This would save resources in searching for relevant specialists.

Second, using an eHealth platform with access for all relevant persons of the care team can help avoiding such limitations. Each report and examination result can be made available through the platform and authorized persons can access the data directly from there. Third, appointments with the orthopedic specialist could be made directly with IT from the GP's place. Fourth, patients could rate the treatment for each provider through an online portal. These ratings could be made publicly available for decision making and quality assessment.

Discussion

The digital transformation is finding its way into the various national healthcare systems. E-Health strategies have been developed in the last years in multiple European countries such as Germany, Switzerland or Austria [11]. These strategies aim at improving the availability of treatment-related patient data beyond sectoral borders. But even before these goals are reached, we see the emergence of new requirements such as personalized medicine, big data, or intelligent self-monitoring devices with a yet unexploited potential to detect diseases earlier and prevent adverse events.

On the other side, all civilized nations are faced with ever increasing healthcare costs, an ageing population and the breakup of traditional family structures. We need to use the potential of modern information technology to ease these effects and to enable elder citizen to stay in their familiar home environment as long as possible.

A specific problem in the healthcare sector is that the treatment process consists of complex workflows, where many actors and IT systems are involved to achieve the most efficient and effective treatment of a patient. The processes in this workflow extend beyond the classical clinical pathway which covers the workflow within a single institution such as a hospital. Instead, it is essential to include also processes outside the hospital such as early diagnosing at the general practitioner, and collection of personal health information in the intelligent home, as well as downstream processes and the interlinked logistic activities. Benefits of such an integrated care process are manifold and can include:

- Individuals become actively involved in the treatment processes and become able to self-manage their health.

- The family medicine, pharmacy, rehabilitation or nursing services profit from new, integrated IT processes.
- Healthcare providers are provided with more support in treatment planning and better provision of pharmaceuticals and materials.
- The entire logistics chain and the participating industrial partners achieve more transparency regarding the flow of goods and consumption of goods.
- The administration can improve cost center accounting.
- The hospital as a whole benefits from optimized processes and efficiency improvements, which are an additional competitive advantage.
- The ICT industry partners are enabled by mapping future workflows that involve mobile devices and other upcoming technologies within ICT healthcare system.

We are confident that these results as well as the IXPRA method will help us to focus on promising improvements within the treatment chain. The WPs and subprojects of our efforts will result in the development of prototypical IT installations in our medical informatics laboratory, which help to understand the effect and the extent of the potential improvement which can be achieved. We can perform IT development, evaluation and verification of processes and technologies in this environment without causing harm to any person.

Obviously the next step must be a practical evaluation also in real environments and this is a declared goal for the project "Hospital of the future live" which shall give good indicators which of our innovative ideas may come up to our expectations.

Physicians and healthcare professionals may have (legitimate) reservations against new technologies workflow alterations, often in the interest of their patients. Introducing new treatment paths with support of modern IT technology requires careful action and a change management approach. We need to demonstrate and verify the potential improvement first before asking for change and our approach should enable us to do so.

Conclusion

The triggering question in this work is: How can medical informatics influence the care process and the care network positively in the next five years? We address this question by developing innovative ideas for the future healthcare processes and by showcasing them in a living lab. In this paper, we provided an overview on a suite of projects targeting at 1) identifying limitations in processes of current healthcare systems and 2) developing solutions for designing the future healthcare system. Our goal is not only the improvement of the care process by enabling a continuous management and data integration, but also the transparent integration of the supply chain with the care process. The upcoming results of the WPs will be presented to the stakeholders and wherever possible, the results will be implemented in the real world after comprehensive testing in our labs.

References

[1] J. Haycock, A. Stanley, N. Edwards, and R. Nicholls, Changing Hospitals, *BMJ* (1999) 319 (7219):1262-4.

[2] J. Ribera, G. Antoja, M. Rosenmöller, and P. Borrás, Hospital of the Future, *IESE Center for Research in Healthcare Innovation Management*, Barcelona 2016, available under https://www.accenture.com/_acnmedia/PDF-7/Accenture-Hospital-of-the-Future.pdf

[3] P. Attfield, The Hospital of the future, *The Globe and Mail* May 2nd, 2016, available under http://www.theglobeandmail.com/report-on-business/industry-news/property-report/the-hospital-of-the-future/article29823293/

[4] T. Evans. Future Hospital Commission: the time for action. *Br J Gen Pract* (2013) Nov;63 (616):571-2.

[5] The Future Hospital Commission. Future hospital: Caring for medical patients. Royal College of Physicians 2013. ISBN 9781860165184

[6] J. White. 5 technology trends that will affect hospital care, *Healthcare Business & Technology* Aug 6th, 2015, available under http://www.healthcarebusinesstech.com/ technology-future-hospitals/

[7] Spital der Zukunft (Hospital of the future) https://www.gs1.ch/gs1-system/gesundheitswesen/spital-der-zukunft (last access: 17.12.2016)

[8] C. Lovis, A. Schmid, and S. Wyss, ehealth Suisse – coordinating e-health in Switzerland, *Healthcare IT Management* 6(3) (2011): 46-47.

[9] GS1 and Bern University of Applied Sciences, Interface Crossculture Process Analysis Tool. http://ixpra.ch/

[10] P. Schaad, S. Basler, M. Medini, I. Wissler, T. Bürkle, and M. Lehmann, The "intelligent wardrobe", *Stud Health Technol Inform* (2016) 225:213-7.

[11] KA. Stroetmann, J. Artmann, and VN. Stroetmann, European countries on their journey towards national eHealth infrastructures (Final European progress report), January 2011, http://ehealth-strategies.eu/report/eHealth_Strategies_Final_Report_Web.pdf (last access: 17.12.2016)

Address for correspondence

Prof. Dr. Thomas Bürkle

Bern University of Applied Sciences

Quellgasse 21, 2502 Biel, Switzerland

thomas.buerkle@bfh.ch

Figures and Graphs

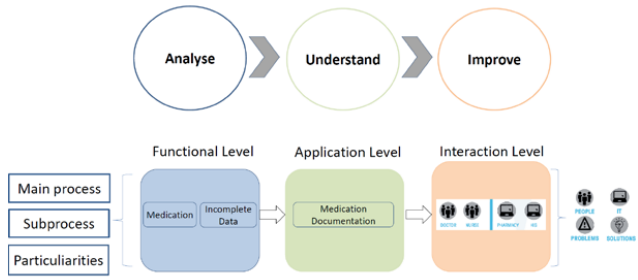

Figure 1 – IXPRA main process analysis steps. The process analysis tool supports multi-stakeholder tables.

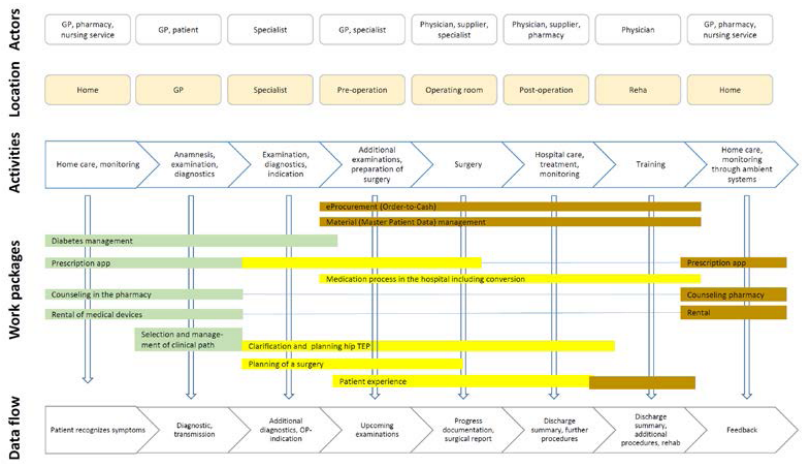

Figure 2 – Student projects started in the first time period. The clinical pathway (blue) extends from home to home and includes several care providers (orange). WPs prior to hospitalization in green, WPs during hospitalization in yellow and downstream WPs in brown. The data flow is shown at the bottom.

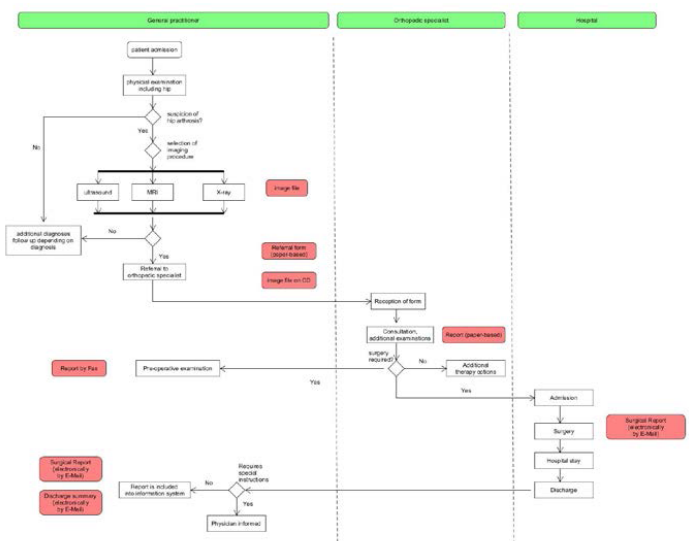

Figure 3 – Diagnosis process for patients with hip arthrosis in the ambulatory sector. Data transferred are shown in red. The general practitioner, an orthopedic specialist and the hospital are involved in this process.