Healthcare of the Future 2022
T. Bürkle et al. (Eds.)

doi:10.3233/SHTI220328

An Interoperable Resuscitation Registry for the University Hospital of Bern

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Abstract. During resuscitation, the patient is the primary focus with the documentation of actions and outcomes being secondary. In most cases, a cardiac event leads to further treatment or hospitalization, in which complex patient pathways, independent documentation systems and information loss represent the key challenges for successful quality management. Hence, the need for a system that takes all these aspects into account. Market research, system analysis and requirements engineering for such a solution were performed and a prototype was created. A complete reference architecture for a web-based electronic data capture system was developed and implemented that enables healthcare professionals to enter resuscitation-relevant data uniformly and store it centrally in compliance with human research legislation. A qualitative evaluation concerning the process flows of the as-is and the to-be situation suggests that there is potential to achieve benefits in the form of improved data quality and quantity.

Keywords. resuscitation registry, electronic data capture, quality management

1. Introduction

With 8,500 cases per year, cardiovascular arrest is a common occurrence in Switzerland. The guiding principle "It takes a system to save a life" shows how important it is for various actors in the rescue chain, i.e., emergency call centers, emergency services (ES), emergency departments (ED) and the intensive care unit (ICU), to operate using coordinated measures [1]. The electronic documentation of all resuscitation activities represents a critical success factor for patient survival, as well as process and outcome quality assurance in the treatment process [2]. Tablet or even app-based systems have been presented previously [3,4,5] and demonstrated positive effects on accuracy [3,4] and completeness of data [4] with the potential to improve cardiopulmonary resuscitation [5]. There is however a lack of interoperability with other IT systems and registries. Jensen et al. report on a Danish electronic pre-clinical medical record which is interoperable with the ED information system [6]. Other commercial systems, e.g., NaProt by pulsation IT and MedicalPad by WEINMANN Emergency Medical Technology, focus mostly on the pre-clinical part of the rescue chain.

As a result, clinicians are often confronted with fragmented data in different IT systems and forced to compile additional comprehensive data sets, e.g., for the follow-

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up of resuscitation patients (RP) in registries for quality assurance. At the University Hospital of Bern (Inselspital), these sources include several different ES and clinical professionals from various departments, e.g., the ICU, whose data forms are as heterogeneous as their respective medical fields. Pre-clinical data from local ES is collected in the Swiss resuscitation registry SWISSRECA. In addition to digital documentation in the ED system, the Inselspital ED collects internal paper-based documentation. Other patient-relevant information for RPs is collected in the primary systems of the respective departments. The complete data of the resulting rescue chain is collected retrospectively by study assistants and transferred to the German Resuscitation Registry (GRR) of the German Society of Anaesthesiology and Intensive Care Medicine in conformity with the international standards of the Utstein-style protocol [7].

In this situation, the Inselspital ED requested support to implement a mobile tablet based application which should replace parts of the separate documentation and result in an ED registry for RPs with an enriched dataset including preclinical data from the different ES. The registry should include clinical follow-up data and support internal quality benchmarking and export to the GRR.

2. Methods

Initially, the process flows of the rescue chain at the Inselspital were analyzed and modelled in Business Process Model and Notation (BPMN).

Different IT system architectures suitable for real-time operation were examined and discussed with the partner hospital and the Swiss Society for Intensive Care Medicine (SGI), because the future system should be made available to other Swiss EDs as well. As a result, it was decided to use a REDCap database for the ED registry, which could potentially be hosted at the SGI for all Swiss EDs. No patient data is stored locally or outside of REDCap. The resulting final IT architecture is given in Figure 1.

The next step comprised extensive dataset mapping activities. The continuing care dataset WV-CAC version 1.0 from the GRR [8] was used as the future core dataset following in-depth analysis and extensive comparison with its predecessors. Assignable data fields between the WV-CAC and the SWISSRECA dataset were analyzed and mapped to ensure interoperability. Local data fields for adaption to an individual ED were devised.

The IT architecture was implemented using the agile software development method Scrum and consists of several components. These include: a Node.js backend, a NGINX web server, an encrypted PostgreSQL user database for local authorization management, a KeyStore, an initialization script and the web application written with the JavaScript framework Angular and the Angular Material UI design library. Systematic tests were conducted with a focus on plausibility mechanisms, correct data persistence and consistent data import. In addition, an internal safety audit was carried out.

To evaluate the potential benefits, the time spent for gathering the different data items today for the data entry into the GRR was measured and contrasted with the future workflow, which was also modelled in BPMN.

3. Results

The resulting client-server architecture called ReaReg can be seen in Figure 1. It comprises the REDCap database for the clinical data, a ReaReg web server to connect the tablets and PCs in the ED and the import interface for ES data. The use of REDCap as the central data storage ensures, that highly sensitive patient data can be saved securely. The web server and middleware can be deployed in the hospital network, whereas the REDCap instance could be hosted with a neutral third party such as the SGI for use by other institutions.

The architecture supports real-time documentation through a web application and standardized storage compliant to the WV-CAC dataset [8]. An import interface adds pre-clinical data from SWISSRECA, provided by surrounding ES using the secure Swiss medical communication network (HIN). Record linkage is achieved using the unique mission number, hereinafter referred to as the protocol number that is given to each Swiss RP by the ES. During ED and inpatient treatment, clinicians document activities and outcomes on the tablet and receive additional support in the form of assistance functions and plausibility mechanisms. Special data security precautions were taken to prevent unauthorized access, e.g., a KeyStore that can only be accessed by a trusted party.

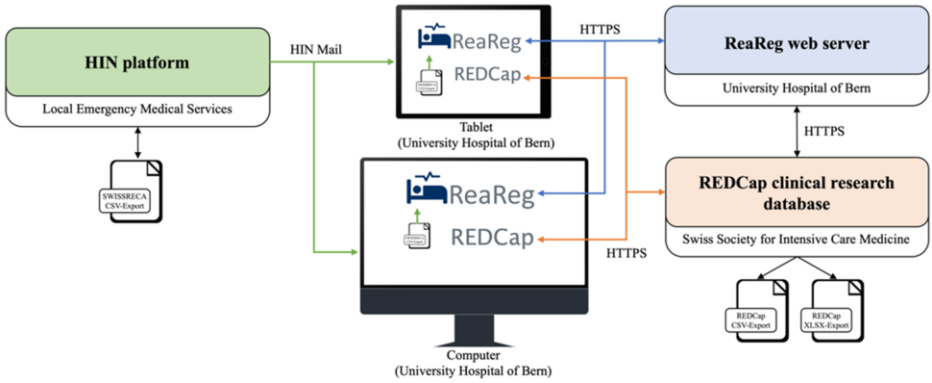

Figure 1. System architecture of ReaReg.

The as-is and to-be BPMN documentation workflows have three parts, “patient admission/patient transfer”, “hospital-internal care” and “dataset completion”. For “dataset completion” the ED staff currently spend an average of 19.6 minutes per RP (n=15). This will be considerably reduced by means of the future automated data export to the GRR. Improvements in documentation quality may be expected due to the automated record linkage of imported data from the external ES using the protocol number, which is also used for export to the GRR. In the workflow “hospital-internal care” we could pinpoint three examples which result in better data quality and quantity: a) the web application enables real-time documentation of resuscitation-relevant measures and outcomes using mobile devices in the ED and ICU, b) data is ubiquitously accessible independent of the primary systems, c) information currently lost for the reanimation registry can be persisted through documentation in ReaReg. The latter concerns, e.g., ECG data, which is currently only available on paper for ICU patients. Furthermore, data quantity within ReaReg will profit from the import of the pre-clinical care protocols from SWISSRECA which are available earlier. In addition, ReaReg can support data analysis and descriptive statistics using REDCap functionalities.

4. Discussion

Today ReaReg has been fully implemented for testing, but not deployed at the Inselspital as the required web server is missing. Therefore, we do not yet have proof for success.

The concept presented here aims for a workflow where the tablet should accompany the patient during his stay, e.g., to the ICU. The decision not to integrate with the different IT systems of the ED and ICU was made deliberately. Fortunately, the number of patients arriving in an ED under resuscitation is limited. Our goal was the reconstruction of patient pathways to support retrospective studies for research and enable better treatment quality. More often than not, the data quality for such research is not contained in the clinical information systems. But before real-time usage, we will not know if the duplicate documentation will be accepted. The plan is to engage senior students with this task. It may be necessary to establish appropriate incentive systems to ensure that data collection is carried out consequently.

Similar work focuses on ensuring data quality and quantity using tablet or web-based solutions that are not or only partially connected to other systems [7], i.e., mostly in the pre-clinical setting, but without connections to registries [4,5]. The ReaReg system provides added value with import and export interfaces and semantic mapping from SWISSRECA and towards GRR. Currently, GRR cannot yet import WV-CAC, but plans its realization. ReaReg has the potential to eliminate the need for error-prone retrospective manual data collection and transfer to registries.

As soon as registries such as the GRR provide import interfaces for continuing care datasets, considerable time savings and improved data quality can be achieved and collaboration across the rescue chain can be enhanced. With the introduction of a web-based data collection system, the objective of improved outcome and process quality for patients under resuscitation may come closer. ReaReg has been published open source under the GPLv3 license. Thus, we would like to stimulate its use and further development in the hope of qualitative and empirical evaluation of the system regarding time savings and error reduction.

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