Improving Integrated Care in Chronic Kidney Failure Patients with a Standard-Based Interoperability Framework

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Abstract. This paper introduces the evaluation report after fostering a Standard-based Interoperability Framework (SIF) between the Virgen del Rocío University Hospital (VRUH) Haemodialysis (HD) Unit and 5 outsourced HD centres in order to improve integrated care by automatically sharing patients' Electronic Health Record (EHR) and lab test reports. A pre-post study was conducted during fourteen months. The number of lab test reports of both emergency and routine nature regarding to 379 outpatients was computed before and after the integration of the SIF. Before fostering SIF, 19.38 lab tests per patient were shared between VRUH and HD centres, 5.52 of them were of emergency nature while 13.85 were routine. After integrating SIF, 17.98 lab tests per patient were shared, 3.82 of them were of emergency nature while 14.16 were routine. The inclusion of a SIF in the HD Integrated Care Process has led to an average reduction of 1.39 (p=0.775) lab test requests per patient, including a reduction of 1.70 (p=0.084) in those of emergency nature, whereas an increase of 0.31 (p=0.062) was observed in routine lab tests. Fostering this strategy has led to the reduction in emergency lab test requests, which implies a potential improvement of the integrated care.

Keywords. Comparative Effectiveness Research, Electronic Health Records, Integrated Care, Chronic Kidney Failure, Interoperability Framework, Archetypes.

Introduction

Patients suffering from Chronic Kidney Failure (CKF) are usually involved in haemodialysis (HD) treatment. Being compliant with the Integrated Care Process for HD patients defined by our regional health authorities [1], this process encompasses HD sessions, medical treatments, and follow-up sessions making use of lab tests.

The clinical process for these patients is triggered when they are assessed at the Virgen del Rocío University Hospital (VRUH) Pre-dialysis Unit, where a report is then sent to the VRUH Nephrology Department. Based on this report, nephrologists generate a HD treatment plan. Also, they evaluate whether the patient is stable enough to be transferred to an outsourced HD centre in order to undergo a HD treatment, since

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the resources available at the VRUH do not cover the complete CKF patients demand. If the patient isn't stable enough must undergo the HD treatment at the VRUH facilities otherwise. Afterwards, the VRUH Administrative Unit assigns the outsourced HD centre where patients will undergo their HD session, depending on their clinical condition and proximity to the HD outsourced centres. Once they are transferred to an external centre, a follow-up strategy for each patient takes place, leading to the generation of a session report every time the patient undergo a HD session [2].

At this point, also should be taken into account that patients could be transferred again to the hospital whether their health condition become unstable. Furthermore, patients' mobility must be considered in this scenario, taking into account holidays and long-term displacements away from their usual residence. This implies that patients should be transferred from their usual HD centre to another closer to their new location. Each new referral implies reports and lab tests sharing from the original HD centre to the new destination centre. This issue is also managed by the Administrative Unit.

Inherent to this process there is a bidirectional flow of reports and lab tests that need to be shared between the hospital and outsourced HD centres, because nephrologists from both healthcare providers need to keep track of patient response to HD treatment. In addition to these periodical lab tests, CKF patients also require urgent lab test whenever their health status worsens. Therefore, an improved integrated care will result in an optimal control of patient's health status, and this should lead to a reduction of urgent lab test requests. Although there were HIS and EHR systems in VRUH and in some of the HD outsourced centres, the communication between them was paper-based. This kind of communication has several well known drawbacks like privacy and security risks, communication delays, and lack of documentation traceability in general [3]. These issues make paper-based reporting prone to reduce patient's quality of care, since delays in sharing lab test results and clinical information between hospital and outsourced HD centres may burden continuity of care and increase the rate of emergency nature lab test requests, and the lack of traceability may fall for duplicating reports and lab tests and, therefore, increasing costs ineffectively [4]. The aim of this study is to assess the impact of the implementation of a Standard-based Interoperability Framework (SIF) on lab test requests related to patients with CKF undergoing a HD treatment making use of IHE profiles, HL7 standards, and ISO EN 13606 archetypes, integrating it with a Serviced Oriented Architecture (SOA).

1. Methods

1.1. Standard-Based Communication System

In order to overcome the aforementioned drawbacks, an interoperability framework was developed according to current health information standards:

- IHE XDS.b profile [5] for sharing clinical documents between hospital and outsourced HD centres.
- HL7 CDA documents [6] to specify the encoding, structure and semantics of clinical documents.
- HL7 v2.5 messages sent by the Laboratory Information System (LIS) including lab test reports.

- ISO EN 13606 archetypes [7] to define the data model in order to differentiate knowledge from information and take advantage of the reusability capabilities provided by archetypes-driven data models.

In order to create and edit archetypes, and to model transformations between distinct formats of knowledge representation, the LinkEHR-Ed tool was used [8].

According to these standards, three clinical reports were developed: HD session report, treatment report, and referral report. These documents were designed by nephrologists from the VRUH Nephrology Department in order to fully support the Integrated Care Process for HD patients. Lab test reports from LIS were also included in the SIF in order to be compliant with this Integrated Care Process and following nephrologists' indications. All these documents were implemented and integrated under the Andalusian Public Health Regional Service Oriented Architecture (SOA) [9] in order to integrate the SIF with the following regional services: User Data Base, Operator Centralized Access Module, and Centralized Clinical Data [2]. Therefore, demographic data, professional roles, and further clinical information from patients were also integrated in the SIF making use of the already deployed regional services. The correct utilisation of these regional services guarantees the SIF compliance with current information privacy policies.

1.2. Evaluation study

We conducted a prospective, quasi-experimental, pre-post intervention study by means of the evaluation of lab test reports during fourteen months, where control and intervention groups were the same sample of patients.

The inclusion criteria were:

- Patients suffering from CKF undergoing HD.
- Patients being treated at any of the 5 HD outsourced centers included in the study.

The exclusion criteria were:

- Patients without lab test requests in both periods of the study.
- Patients deceased during the study.
- Patients undergone a surgical transplant.

The main outcome was the number and type (routine or emergency) of shared lab test reports between the VRUH and 5 outsourced HD centres regarding to CKF patients being treated in these centres.

Data are presented as average ± standard deviation. In order to test the hypothesis that the number of lab tests requests would drop after fostering a SIF, a non-parametric analysis was performed (Wilcoxon signed-rank test).

2. Results

The SIF has been developed and successfully deployed in the regional SOA infrastructure. In the Figure 1, a schematic description of the SIF and its integration is shown. A deeper explanation of the SIF can be found on [2].
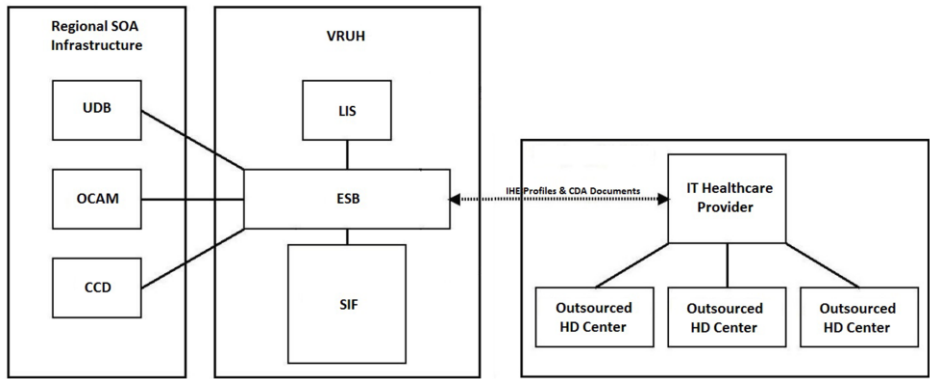
Figure 1. SIF integration with the regional SOA architecture, VRUH systems, and HD outsourced centers.

A total of 488 patients suffering from CKF undergoing HD treatment at outsourced centres were identified. 109 patients were excluded from analysis due to the lack of information of lab test requests in both periods (58), died during the study (3), and renal transplantations (48). Therefore, lab test reports belonging to 379 patients were included in this study, 141 (37 %) women and 238 (63 %) men, with an average age of 66 years.

In table 1, pre-post study results are shown classified by emergency and routine requests per patient. Both periods (before fostering SIF and after fostering SIF) are seven months length each.

Table 1. Lab test reports per patient shared between VRUH and the 5 outsourced HD centers classified by emergency and routine requests.

Study Period	Before fostering SIF	After fostering SIF	P-value
Routine requests/patient	13.85 ± 4.20	14.16 ± 6.10	0.062
Emergency requests/patient	5.52 ± 9.94	3.82 ± 6.79	0.084
Total requests/patient	19.38 ± 11.78	17.98 ± 10.63	0.775

The inclusion of a SIF in the HD Integrated Care Process has led to an average reduction of 1.39 laboratory test requests per patient over a period of seven months. Lab test requests nature analysis yields an average increase of 0.31 in routine lab test requests per patient, whereas emergency lab test requests has been reduced in 1.70 per patient.

3. Discussion

A SIF has been designed and successfully deployed in order to support the HD Integrated Care Process. This SIF has been developed with the ability of replace the previous paper-based communication system. Data models and report communications have been developed according to current health information standards in order to provide a fully interoperable communication system. The SIF have been successfully integrated with the regional SOA infrastructure, including the VRUH Laboratory Information System (LIS), allowing lab test reports being shared automatically as they are released with 5 outsourced HD centers. This integration allows a seamless interoperability with currently deployed regional services.

The deployment of a SIF in this scenario has well-known benefits derived from moving from paper-based health records to EHR such as privacy, data protection, better information management, reduced delays due to reports exchange, improved traceability and, therefore, reduction of duplicities in lab test requests. These benefits have a direct impact on the quality of care perceived by patients.

The SIF evaluation shows that it might impact on patient outcomes. The result shows a no significant reduction in lab tests requests related to patients with CKF and HD treatment in 5 outsourced HD centers, while a reverse trend between routine and emergency testing is appreciated. This reduction may have implications for patient safety since emergency tests are more likely associated with complications in patient health. Furthermore, reduction in the number of emergency tests is associated with an increased efficiency due to planning capabilities in laboratory that would result in reduction of costs.

The authors are aware of the limitations related to this analysis, including the seasonality inherent to the study periods, which may be considered a biasing factor. In this sense, future work will address the extension of the analysis to a period of two years length, one year each, and is envisaged to include the impact on economic outcomes associated with drops in lab tests. If these early results are then endorsed, they will provide a proof strong enough to promote the implementation of SIFs to support Integrated Care Processes in cross-enterprises environments.

Future work will also address the inclusion of treatment, referral, and HD session reports coming from outsourced HD centers in this SIF. This would led to real improvements in patients' integrated care, since their clinical information would be continuously updated at both emplacements (hospital and HD outsourced centers) that will provide a better follow-up of the patients as well as improvements in care delivery in case of urgent interventions.

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