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## Development of Discharge Letter Module onto a Hospital Information System

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**Abstract:** Hospital Discharge Letter (DL) is an important means to communicate the information of the patient's hospital visit, treatments and care plans to the next caregiver and, possibly also, to the patient. Timely, precise and comprehensive discharge information transfer between patients care providers is critical for ensuring patients safety and effective care. A growing number of hospitals in Tanzania are implementing an open source system, Care2x as health information system (HIS). One of the weaknesses for Care2x is that it cannot generate an electronic discharge letter. The main objective of this study was to develop an electronic discharge letter module and integrate it into Care2x HIS. Nine (9) physicians from three (3) hospitals, who were users of the Care2x system, were interviewed using a qualitative structured questionnaire to obtain their views and opinions on the contents of the discharge letter and corresponding usability requirements. Thereafter, a literature review on the key terms was done for Hospital Discharge Letter, Hospital Discharge Communication, and Care2x system. The DL module was developed and the users' user experiences were collected on the use of the developed discharge letter. In this study, the users were very satisfied with the electronic discharge letter. The users saw that the discharge letter module solved many problems associated with the handwritten letter in terms of timeliness of production, the correctness of information, content, and legibility in hospitals which use Care2x. Further studies are required to incorporate also the patient's requirements in the DL and to improve the exchange of DL between hospitals regardless of the HIS in use. However, to make this information exchange possible, there should first be interoperability and integration of Care2x HIS with other organizations' patient information systems.

**Keywords:** Hospital Discharge Letter, Hospital Information System, Discharge Letter Module

### 1. Introduction

Hospital Discharge Letter (DL) is an important means to communicate the information of the patient's hospital visit, treatments and care plans to the next caregiver and, possibly also, to the patient [1]. Timely, precise, and comprehensive discharge information transfer between patient's care providers is critical for ensuring patients safety and effective care [2]. Lack of consistency in the content and poor communication of discharge letters may have serious consequences on patient's re-admission and may raise the risk of medical errors and adverse clinical outcomes [2,3]. In Tanzania, there is no any standardized template for discharge letter in use yet. In this study, 7 Tanzanian

hospitals were surveyed and only 1 hospital was using an Electronic Discharge Letter (EDL) while in the other 6 hospitals, handwritten discharge letters were in use. In this survey, only 2 hospitals were using similar DL forms. Each of the other 5 hospitals had its own DL form that were different in terms of contents and structure from the other hospitals. Some of the DL forms used were rich in content while other were very poor in content and were lacking crucial information. This situation observed in this study is similar to what has been reported in [4,5].

Handwritten DLs are prone to human errors including medicine information imprecision, omitted diagnoses, and undocumented pending test results at discharge. All these accounts for poor communication between inpatient and outpatient providers on the needs for follow-up care [6]. Discharge information communication breakdowns may put patients at risk, due to the missing information. It is reported that poor communication is the reason for a significant number of all preventable adverse events that occur soon after discharge [7].

A growing number of healthcare organizations are implementing health information systems (HIS) in Tanzania, an example of such HIS is the Care2x system. Currently, it is used by 7 hospitals in Tanzania and it is further developed and supported by Lutheran Investment Company (LUICO). The Care2x system cannot yet generate electronic discharge letter. Since Care2x is an open source system and the source code is given to the client, this creates an excellent chance to develop and implement a discharge letter, to standardize its content, and also create a possibility to gather, instantly major information components of a discharge letter at the time of hospital discharge [8]. With enhanced communication means today in the healthcare, discharge information can then be delivered in a variety of ways with minimal delay and alterations and thus improve health care and minimize the patient's risks.

### **1.1 Computerization of Healthcare in Tanzania**

The government of Tanzania has adopted District Health Information System version 2 (DHIS2), which is a generic open source and web-based platform, for reporting, analyzing and disseminating health data. DHIS2 is continuously developed by the Health Information System Program (HISP) network under the coordination of the University of Oslo [9]. Alongside DHIS2 there are also varieties of HISs in different health facilities in the country. Currently, there is no decision on a single HIS to be used, therefore various health facilities can select the HIS they want to use.

Health systems in Tanzania are commonly characterized by a fragmented landscape of information systems (IS), severely restricting the ability to effectively share information among healthcare providers. The existence of many, different systems makes the targeted national

interoperability a challenge. In many cases, national guidance is needed to present the principles and minimum requirements for the health IT systems that are adequate to be taken into use. To deal with this critical situation, national efforts are underway for designing large-scale health information architectures for health information exchange (HIE) [9]. These architectures are made by integrating various information systems in a way that contributes to health objectives and outcomes. The Ministry has already published guidelines and standards for integrated health facility (2016) [10], these guidelines are very relevant for the current situation and they set the minimum requirements for a HIS that can be selected.

One potential HIS to be implemented is Care2x, an open source, full hospital health information system, a networked system supported now by Lutheran Investment Company (LUICO). All major components are free i.e. Apache web server; PHP scripting engine; standard Care2x scripts; MySQL database; Internet/Intranet Browser. Care2x has been in deployment since 2004, and the source code is given to the client (<http://www.care2x.org/>). In Tanzania, the system is in use in Arusha Lutheran Medical Centre (ALMC), St Elizabeth Hospital, Hydrom Lutheran Hospital, Makiungu hospital, Mbeya Referral Hospital, Mirembe hospital and Kibong'oto hospital. Care2x uses the ICD10 coding system, but no standard drug coding or laboratory test codes. The system interface is customizable and usable via a tablet and a mobile phone. Care2x supports Windows and Linux. In connection with Care2x, the users use a File System to store the patient data. The main objective of this study was to develop an electronic discharge letter, both to design its content and structure and to develop the DL software module and to integrate it into Care2x HIS. Care2x system was selected as a target system in this study because it is widely used in our geographical area and it offers good potential for further development.

## **2. Materials and Methods**

### **2.1 Data Collection**

Qualitative structured interviews for collecting the users' requirements for a DL were conducted in February 2017 and the interview sites and persons are listed in Table 1. The interviews sought to gather information on the data required to be included in DL, the structure of the DL, the intended users and access levels of the DL, and the technical requirements on the design of the DL. Technical requirements include means of collecting patient data for DL from Care2x HIS and defining security levels on user access on DL.

## 2.2 Sites where user requirements interviews were carried out

Arusha Lutheran Medical Centre (ALMC) is a hundred bed hospital opened in 2008 to serve the growing medical needs of Arusha, Tanzania. Together with its sister hospital, Selian Lutheran Hospital (SLH), there are over two hundred beds, seven operating theatres, and 550 staff employed. ALMC uses care2x HIS. In ALMC, 3 physicians were interviewed with a qualitative structured questionnaire to get their views and opinions on what should be the contents of the discharge letter and on what are the usability requirements for it.

St. Elizabeth Hospital has been serving the municipal of Arusha since 1975. It is owned by the Catholic Archdiocese of Arusha. The hospital has just over one hundred beds and provides in and outpatient care. Care2x is HIS in use. As in ALMC, 3 physicians were interviewed here.

Makiungu Hospital started in 1956 by Medical Missionaries of Mary. It is located 31 km southeast of Singida town, Tanzania. The hospital has 5 main wards, a private block, isolation section and special care nursery. The official number of beds is 154. Makiungu hospital also uses care2x as HIS and 3 physicians were interviewed for this study.

**Table 1:** Summary of the sites where user requirements interviews were carried out

SN	Hospital Name	Region	HIS in Use	Respondents
1	Arusha Lutheran Medical Center [ALMC]	Arusha	Care2x	3 physicians
2	St Elizabeth	Arusha	Care2x	3 physicians
3	Makiungu	Singida	Care2x	3physicians

## 2.3 Literature Survey

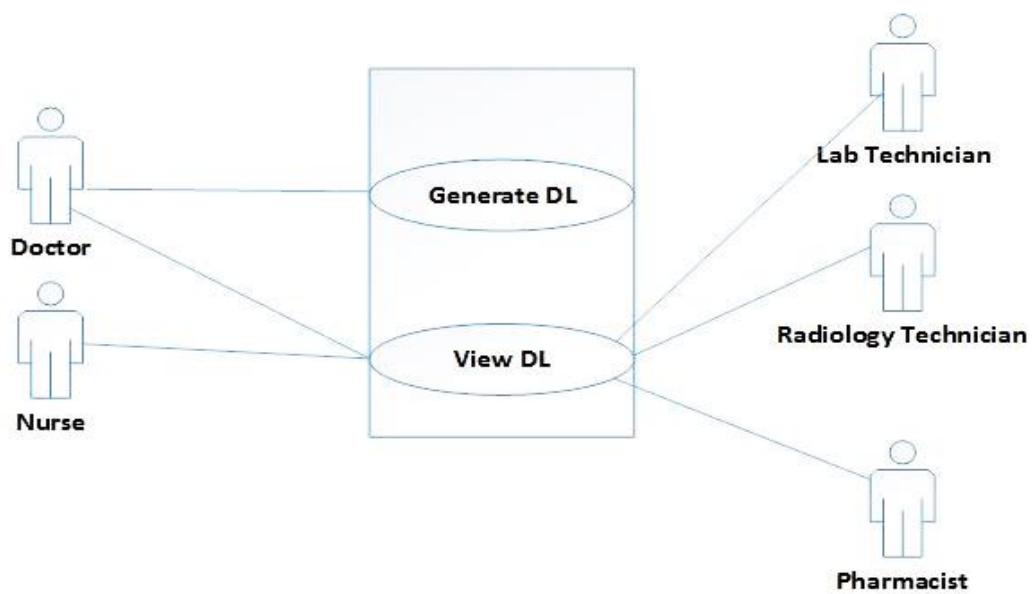
Google Scholar was used to search published English language literature between 2006 and 2016. The following terms were used for searching; Hospital Discharge Letter, Hospital Discharge Communication, Care2x. The survey showed that a discharge letter should provide the brief summary of hospital course, including the reason for hospitalization, significant findings, procedures and treatment provided, patient discharge condition, updated medication list, significant plans for care after patient discharge, including tests requiring follow up, and attending physician's signature.

## 2.4 Module Design and Integration

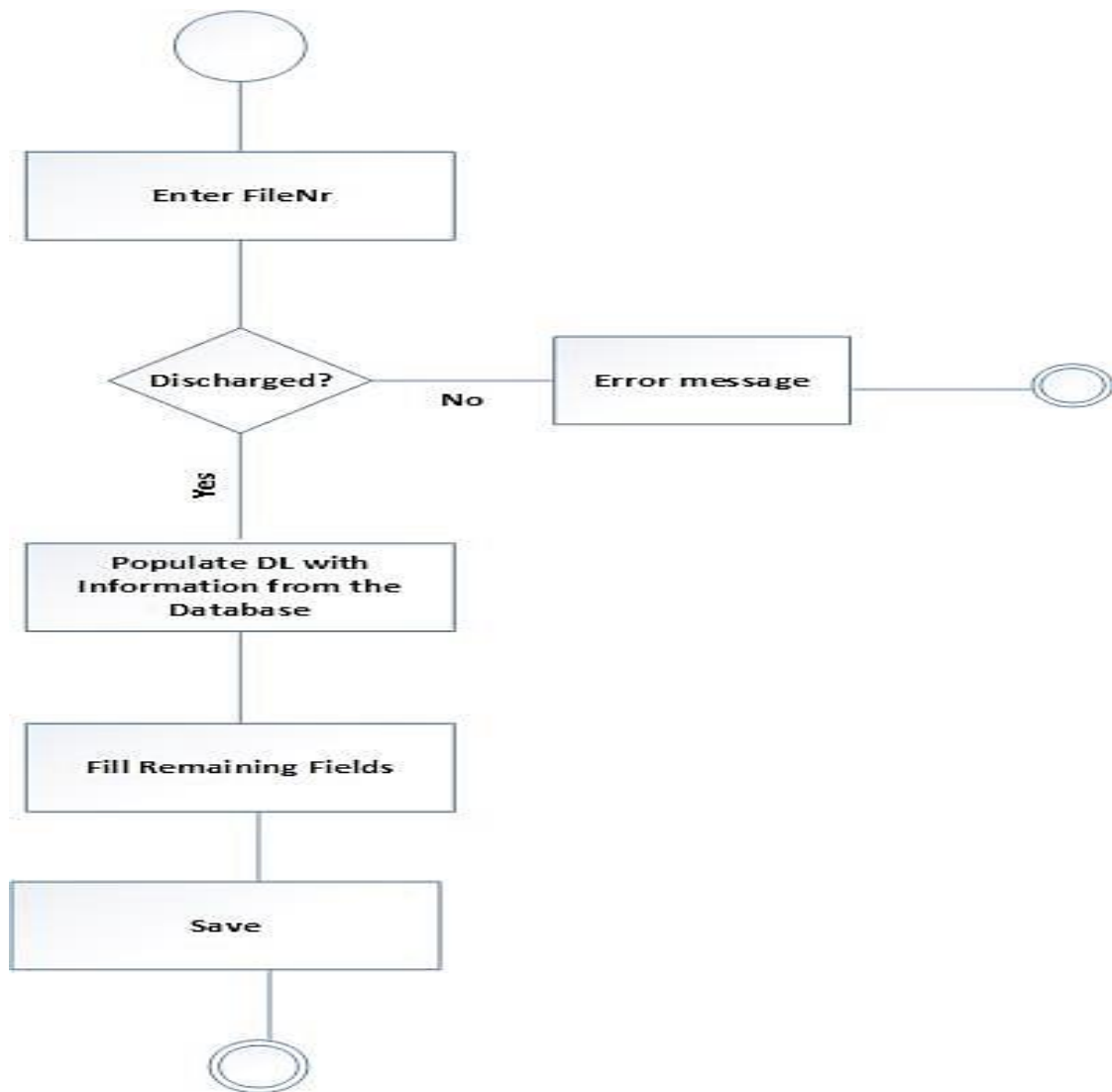
Data obtained from the interviews and literature survey was analyzed. Data that most users wanted to be included in DL was established. The most important things that users wanted to include in a discharge letter were discharge diagnosis, results of investigations, treatment(s) received in the

hospital/healthcare organization, medication information at the point of discharge, patient condition on admission and on discharge, and follow up required.

Users wanted the DL to be structured in a way that it is understandable, easy to generate and that it contains just the right amount of information. The users had the opinion that only those who are involved in the specific patient's care have the right to access the patient's DL. After these steps, the first version of a DL was produced. This incorporated opinions of the majority of the interviewed physicians. Thereafter the authors studied the Care2x HIS processes and database to know whether and where each data element that needs to be included in the DL can be accessed. The use case and activity diagrams were developed for a DL module (Figures 1 and 2).

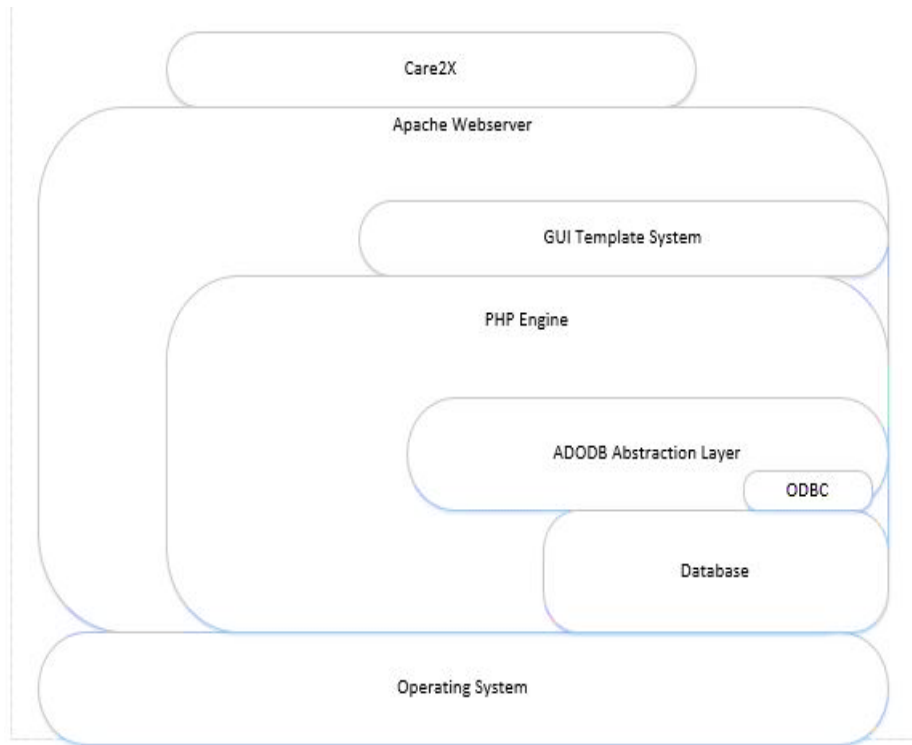


**Figure 1:** Use case diagram for DL module



**Figure 2:** Activity diagram for DL module

The software module was then developed using PHP, HTML, CSS software tools and MySQL database management system and the module was integrated with the Care2x HIS. These tools were selected because the current Care2x version is web-based and supports the MySQL database and uses a standard database language, currently, SQL. It uses the PHP and JavaScript scripting languages. Care2x architecture is shown in Figure 3.



**Figure 3:** Care2x Architecture

### 3. Results

The structure and contents of the developed DL are presented in Figure 4. The contents and structure have been defined using the results of the users' interviews and the literature survey.



## HOSPITAL MANAGEMENT SYSTEM



### Patient discharge summary

#### PATIENT DETAILS

Name	
File Nr	
Age	
Sex	
Hospital Name	
Hospital Reg No	
Department	
Ward	
Admission Date	
Discharge Date	
Discharge to	

#### PRESENTING COMPLAINTS/REASON FOR HOSPITALIZATION

#### SIGNIFICANT PHYSICAL EXAMINATION FINDINGS

On Admission	On Discharge
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#### VITAL SIGNS

On Admission			
Date	Type	Unit	Notes
On Discharge			
Date	Type	Unit	Notes

#### WORKUPS

Laboratory test		
Test Date	Parameter name	value
Radiology test		
Requested Date	Test Description	Test Findings

#### ADMISSION DIAGNOSIS

Date	Case	Diagnosis	Type	Comment
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DISCHARGE DIAGNOSIS					
MEDICATION USED DURING HOSPITALIZATION					
DISCHARGE MEDICATION					
S/N	Drug/Prescription	Singe Dose	Times Per Day	Days	Total Dose
PROCEDURES PERFORMED					
S/N	Date	Procedure	Notes		
PENDING TEST RESULTS AND PLANS FOR FOLLOW UP					
Laboratory test					
Date	Test Description				Notes
Radiology test					
Date	Test Description				Notes
Plans for follow up					
DIET SUGGESTED					
ACTIVITY ADVISED					
FOLLOW UP VISIT DATE AND DEPARTMENT					
Visit Date	Department		Appointment		
Name of Discharging doctor : .....					
Signature : .....					
Date : 2017-07-19 Time : 16:02:31					

**Figure 4:** The DL structure and contents

### 3.1 The DL Module Description

In the DL form that is produced by the system, all the patient’s demographic data, vital signs, workups, admission diagnosis, discharge medication, procedures performed, pending workups and follow up visit date and department will be accessed from the Care2x database. The discharging physician has to enter manually the information on where the patient is discharged to, activity advised and diet suggested because Care2x cannot provide this information. Also, the physician has to enter manually what was the reason for hospitalization, significant physical examination findings,

discharge diagnosis, and medication used during hospitalization because Care2x database is not structured to provide this specific information.

After all information has been collected to the discharge letter it can be printed as a pdf-file, and given to the patient. In the future, the DL will be exchanged electronically between the healthcare organisations.

### **3.2 Module Testing and Evaluation**

In a test phase, 5 DLs from the Care2x system were generated, their contents were evaluated and confirmed that the content corresponds to the patient's data in the health record of the Care2x. After this technical testing, user acceptance evaluation interviews were performed with 9 physicians from the same 3 hospitals which use Care2x (3 physicians from each hospital) to collect their opinions and to find out if they are satisfied with the generated DL. In these user acceptance evaluations, users were asked if the DL is understandable, if it includes correct information, if it easy to use/generate, whether the summary includes too much/too little information and if the DL module is helpful and useful for their clinical work. This is the summary of their responses:

- They all (9) agreed that it is understandable.
- They all (9) agreed that information included is correct.
- They all (9) agreed that it is easy to use/generate.

But when asked if the information included in the form is too less/ too much they had different opinions:

- 3 physicians said that information included is enough, and should remain as it is.
- 1 physician said that the patient's past medical history should be included in the form.
- 1 physician said information included is too much. He suggested that medication dosage and duration, radiology test findings, procedure notes, diet suggested and activity advised should not be in the form.
- 1 physician said that there should be a place in the form to indicate if the referral letter was written for the patient. He also suggested that only discharge diagnosis should appear in the form. Admission diagnosis should be removed.
- 2 physicians shared the opinion that radiology test findings should not be in the form. They also suggested that admission diagnosis should be typed by the discharging doctor.
- 1 physician suggested that radiology test findings and admission diagnosis should be typed by the discharging doctor.

They all agreed that this DL module is very helpful and it will save their time. All physicians that were interviewed are satisfied with it, subject to minor changes that they proposed individually.

#### **4. Discussion**

The results demonstrate that the discharge letter module developed in this study is very useful and will help the physicians to produce better discharge letters promptly because most of the information that needs to be included is accessed automatically directly from the Care2x system. Users consider the DL as a very useful and helpful means of communication in their clinical work. If this discharge letter form could be adopted by other HIS systems in use in Tanzania, it would facilitate the standardization of the discharge patient information. This is very well in line with the guidelines of Ministry of Health, Community Development, Gender, Elderly, and Children. The guidelines were published in 2016 and one of the goals is to standardize the contents of clinical documentation [10]. This would facilitate the smooth exchange of discharge letters among healthcare providers and healthcare professionals.

Atsma and colleagues [11], reported the evaluation of the usefulness of a dedicated DL module for the Cardiology Information System (CARIS). The module was developed to aid the physician in making the patient discharge letter by allowing the semi-automatic generation of 70% of the discharge letter content. CARIS is a central Oracle database server and a client application that was developed at Leiden University Medical Center, The Netherlands. They found that computer-assisted generation of patient discharge letters is feasible, contain a complete information compared to handwritten letters, and leads to significant decreases in the time needed to generate the letter as well as in time from discharge to reporting to the general practitioner. In addition, the method allows the rationalization and streamlining of the entire administrative process.

O'Leary et al. [8], performed a survey to evaluate the effect of a newly-created electronic discharge summary in an Australian hospital which implemented an Electronic Medical Record(EMR) and computerized physician order entry (CPOE) system, and they found that key discharge summary elements, specific discussion of follow-up issues, pending test results, and information provided to the patient and/or family, were present more reliably after the implementation of the electronic discharge letter. Satisfaction with timeliness and content improved significantly after implementation of EDL. They also found that fewer outpatient physicians reported 1 or more of their patients having a preventable adverse event as a result of the suboptimal transfer of information at discharge after the implementation of the EDL.

Also, other studies have reported that electronic discharge letter improves time of availability and completeness of content [8,11–13], but does not necessarily impacts the quality of care [3]. This is because when information in the DL is collected automatically from the system there is a possibility that wrong/invalid information will be included. However, this can be omitted if the quality of HISs and their databases are improved, build good security controls on data access from the HISs and always confirm the patient identity before accessing any of his/her data. Health-related data is very sensitive and confidential and it has to be protected from corruption and unauthorized access and disclosure.

The ministerial guidelines also express a desire to automate the DL and to include all information such as past medical history. This may, however, lead to a big document which is full of text and long [14]. This study showed that it is vital to include into the DL the list of all diagnoses and medication since they will help the next physician to make informed decisions. Patients want detailed information that is specific to their own situation[4]; therefore the physician should be involved in filling patient-specific information in the form. In the module, designed and implemented in this study, it was found important pieces of information on where a patient is discharged to, the reason for hospitalization, significant physical examination findings, discharge diagnosis, the medication used during hospitalization, activity advised and diet suggested fields, have to be filled by the discharging physician. Patient-specific discharge instruction should be filled in the language which patient understands[15], not necessarily English, and should be clearly presented [3].

This small study showed that the use of the developed discharge letter module will improve patients' and physicians' awareness on hospital visit, give information on diagnostic test results, pending lab and radiology test results, follow up information on appointments and discharge medication- which is very crucial for safe continuity of care. The discharge letter can be printed and given to the patient at discharge and be required to take them at the next hospital visit so that critical information is not missed. The next step, of course, would be that the electronic discharge letter could be sent electronically to the next hospital or healthcare organization where the patient is discharged to and that this information exchange should be made possible independent on which HIS is in use in the healthcare organization.

#### **4.1 Limitation of the study**

Only 9 physicians were interviewed and each one had own opinion regarding what should be included in the DL, how it should be structured, about the resulting version of DL and a module to produce it. Interviews with a larger number of physicians from more hospitals would have given more requirements and user acceptance feedback, but that was impossible in our healthcare

environment where physicians were very busy attending long queues of patients. Also, patients were not included in our study to get their viewpoint on what they want to see on the DL. Despite these limitations, all of the interviewed physicians were very satisfied with the developed module, subject to minor improvement that each one proposed individually.

## **5. Conclusion**

Hospital Discharge Letter (DL) is an essential document for communicating patient's hospital visit, treatment and care plans to the next caregiver and also to the patient. This study has proposed standardized format, both for the content and for the structure, of the discharge letter.

Based on the user acceptance evaluation, the discharge letter module developed in this study has potential to solve many problems associated with manual DL in terms of time taken to finalize the letter, content, and legibility in hospitals which use Care2x; and if this form could be adopted nationwide, it would standardize the content of DL. This, in turn, would allow the DL to be shared electronically across health facilities using different HISs when the patient is transferred to another health care organization and hence to improve the whole process of health care.

However, to make information exchange possible there should be interoperability and integration of Care2x with other organizations' patient information systems. Future bigger studies are needed to define first the needed improvements to the operational, local health IT systems that they can provide and receive discharge letters automatically, and second, the national repository, database, and infrastructure that is capable to utilize information from these discharge letters, and to apply information in national planning and monitoring of the health system. This version of the DL produced in this study is not yet the final one. More research is needed in order to incorporate also the patient's requirements in the DL.

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