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Development of discharge letter module onto care2x hospital information system

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DEVELOPMENT OF DISCHARGE LETTER MODULE ONTO CARE2X HOSPITAL INFORMATION SYSTEM

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A Dissertation Submitted in Partial Fulfilment of the Requirements for the Master's in Information and Communication Science and Engineering of the Nelson Mandela African Institution of Science and Technology

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ABSTRACT

The 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 are implementing an open source system, Care2x as hospital information system (HIS) in Tanzania. 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 onto Care2x HIS. Interviews were performed with nine (9) physicians from three (3) hospitals, who were users of Care2x system, with a qualitative structured questionnaire to get their views and opinions on the contents of the discharge letter and on the corresponding usability requirements for it. Thereafter, a literature review on the following terms; Hospital Discharge letter, Hospital Discharge Communication, Care2x was performed. The schema of the new Discharge Letter module for Care2x HIS was developed and added to the existing Care2x schema. The DL module was implemented and 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 handwritten letter in terms of timeliness of production, the correctness of information, content, and legibility in hospitals which use Care2x.

DECLARATION

I, **Wambura M. Wambura**, declare that the dissertation Titled "**Development of Discharge Letter Module onto Care2x Hospital Information System**" is my own original work and that it has neither been submitted nor being concurrently submitted for degree award in any other institution.

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25th Feb 2019

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CERTIFICATION

The undersigned certify that they have read and found the dissertation titled, **Development of Discharge Letter Module onto Care2X Hospital Information System** qualify for acceptance by the Nelson Mandela African Institution of Science and Technology (NM-AIST) in Arusha, in partial fulfilment of the requirements for the degree of Master in Information and Communication Science and Engineering of NM-AIST.

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DEDICATION

To the memory of my brother, Msoba Raphael Wambura.

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LIST OF ABBREVIATIONS

ALMC	Arusha Lutheran Medical Centre
CIO	Chief Information Officer
CSS	Cascading Style Sheet
DHIS2	District Health Information System version 2
DL	Discharge Letter
EHMS	Electronic Health Management System
ERD	Entity Relationship Diagrams
FCMS	Finnish Christian Medical Society
GP	General Practitioner
GUI	Graphical User Interface
HIE	Health Information Exchange
HIS	Hospital Information System
HISP	Health Information System Programme
HL7	Health Level 7
HTML	Hyper Text Mark-up Language
ICD10	International Classification of Diseases revision 10
ICTs	Information and Communication Technologies
IDE	Integrated Development Environment
IS	Information System
IT	Information Technology
MD	Medical Doctor
LUICO	Lutheran Investment Company
OSS	Open Source Software
PCP	Primary Care Physician
PHP	HyperText Pre-Processor
SDLC	Software Development Life Cycle
SRS	Software Requirements Specifications
XML	Extensible Mark-up Language

CHAPTER ONE

INTRODUCTION

1.1 Background

Healthcare is of great importance to all countries. Unfortunately, the majority of health care domains in resource-limited countries are operating at a sub-optimal level, as the use of information systems is almost non-existent (Asemahagn, 2014). There is an utmost need to improve the current healthcare services using Information and Communication Technologies (ICTs).

ICTs interventions can effectively improve the efficiency of healthcare services. Improving hospital information systems (HIS) can not only reduce the number of hours spent going through disaster plans but also increase cost-effectiveness in workflows (Chaudhry and Saleem, 2006). At present, most of the government healthcare facilities in Tanzania do not have any HIS. The situation is a little better in private sector (Kimollo *et al.*, 2010).

HIS is "an integrated information system designed to manage all aspects of a hospital's operation, such as medical, administrative and financial issues and the corresponding processing of services" (Maglogiannis, 2012). As a modern method of storing and processing health information, HIS is a solution for improving quality, safety and efficiency of patient care and health system. However, the establishment of HIS requires a significant investment of time and money. While many of healthcare providers have very limited capital, application of open source software would be considered as a solution in countries with low income (Aminpour *et al.*, 2013). Therefore, the establishment of an open source HIS capable of modifications according to the national requirements seems to be inevitable in Tanzania.

As HISs which constantly expand to support more clinical activities and their implementations in healthcare organizations become more widespread, several communities have been working intensively for several years to develop open access and open source HIS software, aiming at reducing the costs of HIS deployment and maintenance (Maglogiannis, 2012).

Open Source Software (OSS) in digital healthcare can provide advantages in terms of the proprietary software cost, but the most important benefit is their openness and flexibility. The

open source HISs enable individual regions to adopt ICT to their own special needs and not be beholden to multiple commercial software vendors, thus allowing the establishment of regional healthcare networks (Peixot *et al*., 2012). Since small clinics and organizations with limited resources cannot afford huge annual expenses on software, they are more willing to adopt the alternative choice of open source HISs.

Furthermore, a crucial factor in using open source HIS is their free usage by the public and that they are not limited by licensing and ownership by any individual or entity. Therefore these products can be accessed and interactively altered by every authorized practitioner. The open source code can be modified to serve the individual needs of the users, providing opportunities to enhance the system architecture and technical features so as to comply with multiple operating systems and facilitate health information exchange (Drury and Dahlman, 2005).

As the counterpart to hospital admission, hospital discharge is a necessary process experienced by each patient. For all patients except those being referred to other hospitals, discharge is a period of transition from hospital to home that involves a transfer of responsibility from the inpatient provider or hospitalist to the patient and primary care physician. Kripalani *et al.* (2007a) in their research indicated that prescribed medications are commonly altered at this transition point, with patients asked to discontinue some medications, switch to a new dosage schedule of others, or begin new treatments. Self-care responsibilities also increase in number and importance, presenting new challenges for patients and their families as they return home.

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 (Kripalan *et al.,* 2007a). Often, DL is the only form of communication that accompanies the patient to the next setting of care. High-quality discharge letters are generally thought to be essential for promoting patient safety during transitions between care settings, especially during the initial post-hospital period. Timely, precise and comprehensive discharge information transfer between patient's care providers is critical for ensuring patients safety and effective care (Kripalani *et al*., 2007b). 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 for medical errors and adverse clinical outcomes (Kattel *et al.,* 2016).

In Tanzania, there is not yet any standardized template for discharge letter in use. In this study, 7 Tanzanian hospitals were surveyed and only 1 hospital was using an electronic discharge letter while in the other 6 hospitals handwritten discharge letters were in use. In this survey, only 2 of 7 hospitals were using similar DL forms. Each of the other 5 hospitals had its own DL form that was 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 is similar to what has been reported in earlier studies by Alper *et al*. (2014) and Ontario (2014).

Handwritten DLs are prone to human errors including medicine information imprecision, omitted diagnoses and undocumented pending test results at discharge, all these account for poor communication between inpatient and outpatient providers on the needs for follow-up care (Mcleod, 2013). 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 (Li *et al.,* 2011).

A growing number of health care organizations are implementing health information systems (HIS) in Tanzania, an example of such HIS is the Care2x system. Currently, it is used by more than 7 hospitals in Tanzania and it is further developed and supported by Lutheran Investment Company (LUICO). The Care2x system cannot yet generate an electronic discharge letter. Since Care2x is an open source system and the source code is given to the client, this creates an excellent challenge to develop and implement a discharge letter, to standardize its content, and also creates a possibility to gather, instantly at the time of hospital discharge, major information components of a discharge letter (Leary, 2009). 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.

1.2 Problem Statement

Various studies have shown that many patients do not understand their discharge medications and cannot recall their primary diagnoses. Patient discharge is variable, fragmented, and characterized by poor communication, leaving many patients unprepared to take care of

themselves or to know how or when to seek follow-up care. This, in turn, is a reason why rehospitalization occurs so frequently (Clancy, 2009).

The discharge letter comprises a vital component of the information transfer between the inpatient and outpatient settings. Unfortunately, discharge letters are often unavailable at the time of follow-up care and often lack important content (O'Leary *et al*., 2009).

There is also considerable variation across hospitals, and even from department to department within a hospital, in terms of how discharge letters and packages are assembled and delivered (Ontario, 2014). The increasing use of HIS in hospitals which facilitate electronic-generated DLs in standardized formats can address many of the problems with handwritten DLs.

1.3 Research Justification

There are many reasons for a low discharge letter finalization rate such as busy medical officers, inadequate provision of infrastructures such as computer systems and an inability to locate patient medical records after discharge. Nevertheless, it is clear that the absence of a discharge letter is associated with an observed increased risk of readmission (Li *et al.*, 2013).

Care2x system was selected as a target system in this study because it is widely used in our geographical area, open source offering good potential for further development.

1.4 Objectives

1.4.1 Main Objective

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.

1.4.2 Specific Objectives

i. To establish requirements for electronic discharge letter module.

ii. To design and implement electronic discharge letter module.

iii. To integrate the module into Care2x HIS.

iv. To validate the module.

1.5 Research Questions

i. What important information must be present in a hospital discharge letter?
ii. How can a module for electronic-generated discharge letter be developed?
iii. How can a module for electronic discharge letter be integrated onto Care2x HIS?
iv. Were the user's requirements met by the developed module?

1.6 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 (Nguyen and Mahundi, 2018). 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) (Nguyen and Mahundi, 2018). These architectures are made by integrating various information systems in a way that contributes to health objectives and outcomes.

The national eHealth strategy in Tanzania (Tanzania eHealth strategy, 2013-2018) provides the basis to guide the development of eHealth and the mission is to transform the Tanzanian healthcare system by leveraging IT to improve health and social welfare of all citizens. The strategy sets the goal to integrate district, regional and local systems with the national health IT architecture in such a way that local needs and requirements are fulfilled but also the national planning and follow-up of the national health care system is made possible and supported by statistical data from the health care system. The Tanzanian strategy also emphasizes openness and mobility of eHealth.

In more detail, the strategy lists the following goals to be achieved (Tanzania eHealth strategy 2013-2018):

i. Enable more efficient use of healthcare resources through replacing paper-intensive processes and providing better information,
ii. Enable the health sector to operate more effectively as a connected system, overcoming fragmentation and duplication of service delivery,
iii. Make patient care safe and effective by ensuring that the correct information is available in a timely manner where it is needed and to whom it is needed,
iv. Enable electronic access to appropriate healthcare services for patients in remote, rural, and disadvantaged communities,
v. Support improved multi-way communication and sharing of information among clinicians, patients, and caregivers within the health sectors and across partner agencies,
vi. Support evidence-based policy, investment, and research decisions through access to timely, accurate, and comprehensive reporting of healthcare system information.

The principles that guide the national eHealth strategy implementation are:

i. Guarantee the patient information rights, integrity, and confidentiality in line with emerging public health access needs,
ii. Cost-effective, efficient and benefit-driven solutions in a limited resources environment that lead to future growth potential,
iii. Exploitation of existing structures and use of an incremental approach,
iv. Technology development, standardization and convergence
    a) Focus on usability,
    b) Convergence on fewer and more reusable, cost-effective IT systems that are extensible, scalable and manageable,
    c) Common standards and terminology across information systems,
    d) Involvement of local partners in development and support of information systems.

In addition to the national eHealth strategy, in January 2016, The Ministry of Health, Community Development, Gender, Elderly and Children, published guidelines and standards for integrated health facility (2016). These guidelines are very relevant for the current situation and they set the minimum requirements for the HISs that can be used in Tanzania.

One potential HIS to be implemented is the Care2x, an open source, full hospital health information system, a networked system supported now by 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). The system is in use in hospitals like Arusha Lutheran Medical Centre (ALMC), St Elizabeth Hospital, Hydom 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.

1.7 Other HIS in use in Tanzania

A simple study was conducted to few hospitals in Tanzania as part of 'Contributing to capacity building of developing and using Health Information Systems in Tanzania' project by the Finnish Christian Medical Society (FCMS) to collect and analyze the user experiences and user opinions on the use of some of the current health information systems and needs for further improvement and wider adoption and deployment of these systems. This study focused on one hand on the users (medical doctors and nurses) of health information systems in hospitals and on the other hand on health IT professionals (IT managers and developers). The methods applied in this study was thematic interviews with questionnaires, one for the users (Appendix 1), and one for the health IT professionals (Appendix 2).

1.7.1 Electronic Health Management System

Electronic Health Management System EHMS is a closed, commercial patient information system, deployed since 2012 and developed by GPITG, Information Technology Consulting Firm based in Dar es Salaam (http://gpitg.com/node/38). The company provides technical support for the system during its use. The system and the interface are not modifiable by the user, only by the supplier. It is an integrated healthcare management system which is in use in Kairuki and in Sanitas hospitals that were included in this study. EHMS uses ICD10. The system can be used via a tablet. The system uses health site specific patient numbering, identification generated by the system. Barcode based or biometric identification is not supported. Patient data exchange with other health organizations is not supported, referrals

and discharge letters, are done manually. Patient demographic data, patient problem lists and medication lists are supported, but not patient allergies or vital signs recording. Laboratory test results are provided by the system. Patient longitudinal medical history is provided. Appointment scheduling is not yet supported, neither patient data longitudinal storage. No clinical decision support provided. Reports are produced in digital format, they are customizable, produced at the facility level. The statistical reports for the Ministry are generated. Patient-specific medication reports for the patient are produced. Laboratory test orders and prescription orders are generated digitally. In security issues, user authentication, role-based access control, audit trail and event log files are supported as well as analysis of audit trail reports. The system supports Windows operating system.

1.7.2 JEEVA system

JEEVA is a closed, commercial health information system, developed by Napier Healthcare Systems in India (http://www.napierhealthcare.com). The system has been deployed since 2005 and it is a full hospital information system. The system is further developed by the hospital and the company together. The system is in use in Muhimbili National Hospital. The system uses ICD10 and local coding systems for drug coding. Laboratory test coding is based on the ISO-standards. The system is modifiable by the user in a minor extent, the supplier controls all adaptations. The system can be used via mobile devices, tablets, and mobile phone. Patients are identified with system-generated patient numbers. Barcodes are used in laboratory samples. Electronic patient referrals as XML-files can be generated and used with the regional hospital, not with other organizations. The system maintains patient specific allergy lists, patient problem lists and allergy lists of patients. Laboratory lists are produced and results transferred automatically. The clinical summaries of the patient are generated and some drug interactions are managed. Patient data is stored for 10 years after the last visit. Clinical decision support is not provided. Patient data can be exchanged in digital form with other departments inside the hospital. Prescriptions are in digital form. The system supports XML messaging and to some extent also ISO and HL7 standards. The reports are customizable and the reports to the Ministry are generated quarterly and annually. Facility-specific reports are generated to each clinic and medication reports for the patient. In security issues, user authentication with username and password, access control based on activities, audit trail and trail report analysis are supported as well as an automatic database back up.

1.7.3 MEDIPRO system

MEDIPRO is in use in Muhimbili Orthopedic Institute(MOI). MEDIPRO is an enterprise resource planning (ERP) platform dedicated to health information. It is a closed, commercial system developed by Maxcom Africa Limited in Dar es Salaam (http://maxcomafrica.com/fully-integrated-hospital-management-information-system). The system is in pilot use in Muhimbili and all modifications will be done under the contract with the supplier. The system is usable via mobile devices, a tablet and a smartphone. The system applies ICD10 coding system and also local coding, e.g. the unique patient identification system inside the hospital. Use of barcodes is supported. Patient data is stored: patient demographic data, patient problem list, medication lists, vital signs, laboratory test results. Discharge letters are generated. For private patients in the departments patient lists are generated. Also educational level information materials are produced for the patients. Clinical decision support is implemented in the form of clinical guidelines, alerts and reminders. Data exchange with other health IT systems or with other healthcare organizations is not supported. Digital images are exchanged inside the hospital and laboratory test results. No data transmission to district health information system (DHIS2). The reports are customizable, and Ministry reports are produced automatically. Prescriptions are generated in digital form. Security is organized with user authentication, role-based access control, audit trail and log files and their analysis. The database back up is planned to be done every 12 hours in the future. Operating system supported is Windows, database in use is Oracle, a relational database.

1.7.4 Government of Tanzania Health Management Information System

GOT (Government of Tanzania) HMIS (Health Management Information System) is a full hospital information system in use in Tumbi regional referral hospital. HMIS is a closed system which is used via a network. The system uses ICD10 and standard drug coding and international laboratory test codes. The system can be used via tablets and mobile phones. The patient identification used is a patient id number generated by the system. The system records patient information: summary of medical history, demographic data, medication lists, allergy lists, vital signs and laboratory test results. The system generates discharge letters and supports appointment scheduling. Clinical decision support is not provided. Patient data exchange is supported inside the hospital, not with external health organizations. This is also the case for electronic prescriptions, supported inside the hospital. HMIS is able to

communicate with the DHIS2. Reports generated are customizable, and can be exported to DHIS2. Also provision of the Ministry reports and statistics are supported. Patient-level reports and facility-specific reports are generated. Also medication reports, cards, are produced for the patients. Security covers user authentication, role-based access control, audit trail and event logs and their analysis. The system is web-based and uses MySQL database.

Users had many wishes how the systems could be improved, concerning for example, additional functionalities, and better usability. The most important improvement issue raised by most of the interviewed persons was interoperability and integration of the current systems with other organizations' patient information systems in such a way that critical information can easily and seamlessly be exchanged. For instance, referrals and discharge letters could be exchanged when the patient is transferred from one to another health organization. This would enable seamless care and decrease the manual data exchange of patient data.

CHAPTER TWO

LITERATURE REVIEW

Introduction

This chapter describes two similar systems that are being used worldwide. Then, it highlights, from related research work, the importance of hospital discharge letter as a means of communication between inpatient and outpatient caregivers and the extent to which electronic DL enhances quality and standards of discharge communication. An overview of Care2x HIS is then given. Finally, the role of OSS in health care is discussed.

2.1 Similar Systems

2.1.1 MAXIMS

The MAXIMS is a modular suite of clinical and administrative software products which are reputable throughout the UK and Irish healthcare sectors (http://www.imsmaxims.com/solutions/products). It allows healthcare providers to substitute paper-based systems with an electronic one that is accurate, fast, and efficient so as to improve patient safety.

By using the full functionality MAXIMS clinical patient administration system (PAS), healthcare providers can create a single patient record that contains all the relevant information about every aspect of their care. The system will code any diagnosis, procedures, allergies or co-morbidities using any external taxonomy adopted by the organization. This includes historical notes, all correspondence, past and future appointments and care details.

By recognizing that paper-based inpatient discharge systems are slow and fraught with problems, the MAXIMS Discharge System provides a fast, accurate, secure and simple-to-use alternative. Clinical data can be captured on electronic forms at any stage of a patient's stay, as a permanent record of their care and to inform further decisions.

When the patient is discharged the appropriate staff fills in the remaining details, providing a complete, brief care record in a format designed for the hospital's needs. The discharge letter, including future care plans and details of medication, can then be printed or emailed to other relevant healthcare professionals.

2.1.2 SystmOne Hospital

SystmOne Hospital is a complete solution for an entire hospital which is widely used in England. It is designed to improve efficiency and to reduce costs of healthcare (http://www.tpp-uk.com/products/systmone). At the heart of SystmOne is a detailed Electronic Patient Record (EPR) that can be shared in real time with other services. The SystmOne Hospital modules are designed to cover every activity within a hospital from e-prescribing to emergency admissions providing a complete integrated solution. The modules also include location management tools and dashboards for the effective management of activity across a hospital.

SystmOne e-Discharge is a quick and easy method for the writing and electronic sending of letters, enabling the 24-hour target to be easily met. Letters can be created, reviewed and amended at any stage of the hospital attendance and automatically populated with the most accurate information.

2.2 Discharge Letter

A report (Ontario, 2014) stated that clearly communicating important information that patients need to know the moment they leave the hospital seems sensible but is often not done in practice for a variety of reasons. There is also considerable variation across hospitals, and even from department to department within a hospital, in terms of how discharge letters and packages are assembled and delivered. Poor communication of discharge instructions to patients has been identified as an important care gap. Standardizing the elements of the discharge process may help to address the gaps in quality and safety that occur when patients transition from the hospital to an outpatient setting (Halasyamani *et al*., 2006).

Patient discharge letters are the most common means of communication between inpatient and outpatient providers. However, numerous studies have shown that discharge letters often fail to provide important administrative and medical information, such as the primary diagnosis, results of abnormal diagnostics, details about the hospital course, follow-up plans, whether laboratory test results are pending, and patient or family counseling (Kripalani *et al.*, 2007b).

The DL should be available to the Primary care physician (PCP) at the time of the patient's initial hospital follow-up visit and provide a brief summary of the hospital course, including

presenting symptoms, significant examination, laboratory, or radiology findings, treatment rendered, and consultant recommendations. Additional information that is critical for preventing miscommunication includes that conveyed to the family about the illness, an updated medication list, and specific plans for care after patient discharge, including tests requiring follow-up (Key-Solle *et al*., 2010). Good communication between inpatient and outpatient healthcare teams has been shown to decrease hospital readmission, the risk of medical errors, and adverse clinical outcomes (Key-Solle *et al*., 2010).

Identifying what should be included in a discharge letter is the first step in the process of using discharge letters as a marker of quality of care. However, it is not sufficient to simply identify if a component of the letter is present or not when deciding whether a letter is good (Wimsett *et al*., 2014). The adequacy of the components rather than just their presence or absence should also be considered when assessing the quality of discharge letter.

Various studies (Karaksha *et al*., 2010; Gardiner, 2016; Lenert *et al*., 2014; Li *et al*., 2011) have shown that low discharge summary finalisation rate is due to factors such as busy medical officers, inability to locate patient medical records after discharge, not prioritizing DL, and lack of understanding of the importance of completing the DS promptly and on its entirely, inadequate provision of infrastructure (computers).

Kripalani *et al*. (2007a**)** did a study to characterize the prevalence of deficits in communication and information transfer at hospital discharge and to identify interventions to improve this process and they found that deficits in communication and information transfer at hospital discharge are common and may adversely affect patient care. They proposed interventions such as computer-generated letters which are in standardized formats to facilitate a more timely transfer of patient information to primary care physicians and make discharge letters more consistently available during follow-up care.

Alderton and Callen (2007) did a study to assess general practitioners' (GPs') satisfaction with the quality of information in electronic discharge letters and the timeliness of their receipt of the letters. It was concluded that the majority of GPs agreed that the electronic discharge letter was an improvement over the manual discharge letter but further developments in the safe and secure electronic transfer of DL information needs to be addressed to meet the information needs of GPs. They recommended education be provided

junior doctors on the importance of documenting clear instructions for the GP, so as to assist with the ongoing patient management following discharge from the hospital.

EDLs have many advantages, including the ability to standardize format, use existing information in the health information record, and immediately finalize the summary at the time of discharge (Baillie *et al*., 2014).

2.3 Care2x

Care2x is an open source HIS and its development is broad-based and fast. Bugs and security holes can be detected quickly since stability and reliability are tested by a large community of software programmers in an open source community. Customization for the hospital's special needs can be done by the hospital's IT staff. All major components are free i.e. Apache web server; PHP scripting engine; standard Care2x scripts; MySQL database; Internet/Intranet Browser (Gödert and Latorilla, 2016).

It has modules for the different functions and departments. The current beta version of Care2x supports the MySQL database and uses a standard database language, currently, SQL. It uses the PHP and JavaScript scripting languages. All program modules are server-side processed and all program modules and functions follow the same design philosophies and user navigation principles. The GUI design is consistent throughout the whole network and program functions are accessed via a standard browser. Care2x is highly flexible and configurable and supports multiple languages. It can be accessed via the internet since it uses standard internet protocols (Gödert and Latorilla, 2016).

2.4 OSS in Healthcare

Effah and Abuosi (2013) report their experiences from Ghana where they compared the standard proprietary software with free open source software. The basic differences between these two were that proprietary software is delivered with closed source code and under a commercial license, at a high cost, that restricts the users to modify and customize the software. Open source software, instead, is delivered with open source code with full possibilities for modification and customization. Concerns about lack of standardization and security have, however, limited the use of OS in healthcare. This reported Ghana experience resulted in that standard proprietary software succeeded in meeting the uniform information needs at the national level but failed to support heterogeneous information needs at regional

and district levels. It also failed to support integration and interoperability with other software systems and applications. On the other hand, open source software gave possibilities for local small enterprises to participate in the development and installation project and thus increment their expertise.

Paré *et al*. (2009) did a survey to find out barriers to open source software adoption in Quebec's health care organizations in Canada. They found that lack of internal IT resources and expertise, internal and external political pressure, lack of reliable information about open source products, conservative nature of healthcare CIOs, lack of a responsible third party, individualistic and competitive culture, and hidden costs of open source products as the key factors for not adopting open source solutions.

Luna *et al*. (2014) reviewed the challenges faced by developing countries to achieve sustainable implementations in health informatics and possible ways to address them. They found that resource and infrastructure limitations, lack of use of common interoperability standards, and lack of a trained workforce to be the main challenges. They proposed solutions such as adoption of open source software, international standards society intervention so as to reach consensus for the common and consistent use of standards, and implementation of educational programs or use of a partnership with trusted institutions as the possible ways to address these challenges.

Bagayoko *et al.* (2010) studied the use of open source software for health information management in Mali, Africa. The study resulted in practical recommendations for successful health IT system implementation: to identify organizational realities, to improve local technical skills and IT project management skills, to be aware of the limitations of the information system and to prepare a well-planned implementation plan. They also found in their study that it is important in developing countries to pay attention to local information management culture which has so far been focused on administrative and accounting tasks. A shift should be made to medical knowledge and collective improvement of care practices. Another important aspect is the local implementation strategy which requires the development of strong local expertise.

Sfakianakis *et al*. (2007) studied the role of open source in health information system interoperability. Interoperability is the ability of two or more software systems or components of the system to exchange information and to make use the information that has been

exchanged. It is a necessity to the establishment of an active durable HIS. HIS interoperability requires the consistent implementation of open standards- standards that are publicly available, are developed, approved, and maintained by a collaborative and consensus-driven process-, and an OSS community that enables their consistent implementation and widespread adoption. Open standards are important when diverse systems need to collaborate to support clinical workflows and to facilitate the exchange of patient information when and where needed, to reduce medical errors, and to protect patient safety. They concluded that OSS has several characteristics that enhance software quality and may act in support of interoperability. However, an aspect of OSS that can be a critical point to its wide adoption is the ability to form an OSS community with adequate capacity and knowledge to provide development support, sustain high software quality, and support OSS evolution. Fig.1 shows OSS lifecycle.

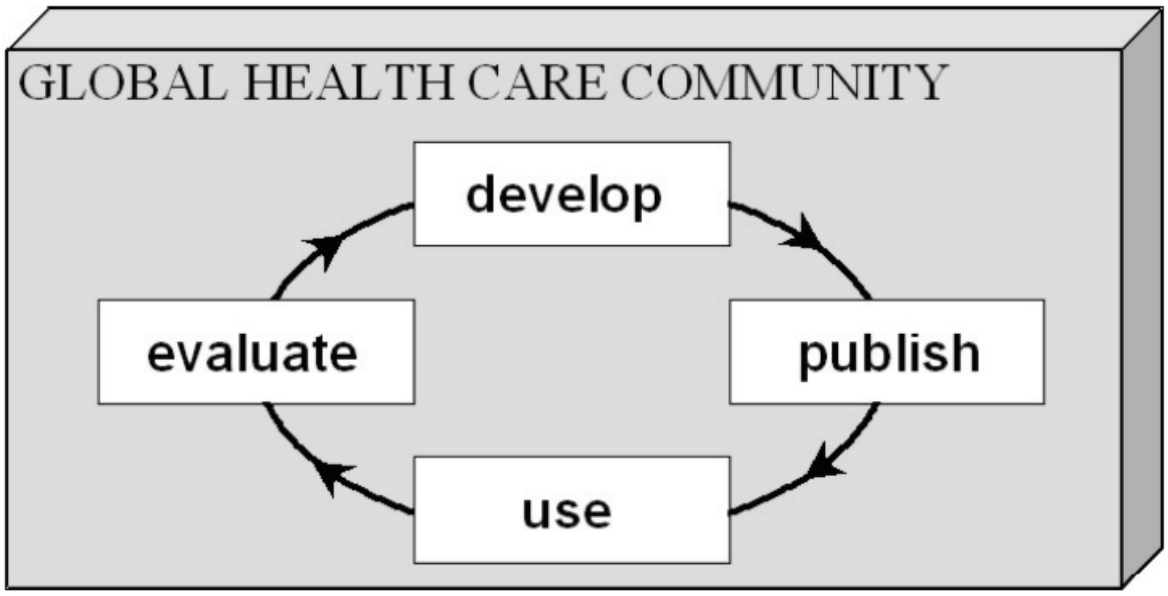


Figure 1: OSS lifecycle (Sfakianakis et al., 2007)

CHAPTER THREE

MATERIALS AND METHODS

3.1 System Development Methodology

Software Development Life Cycle (SDLC) model adopted in this study was Waterfall model. This is a sequential model in which the output of each phase becomes the input of the next phase (Bassil, 2012). This model was chosen because it's easy to implement and the resources required to implement it are minimal. Essentially, the Waterfall model comprises five phases: Analysis, design, implementation, testing, and maintenance.

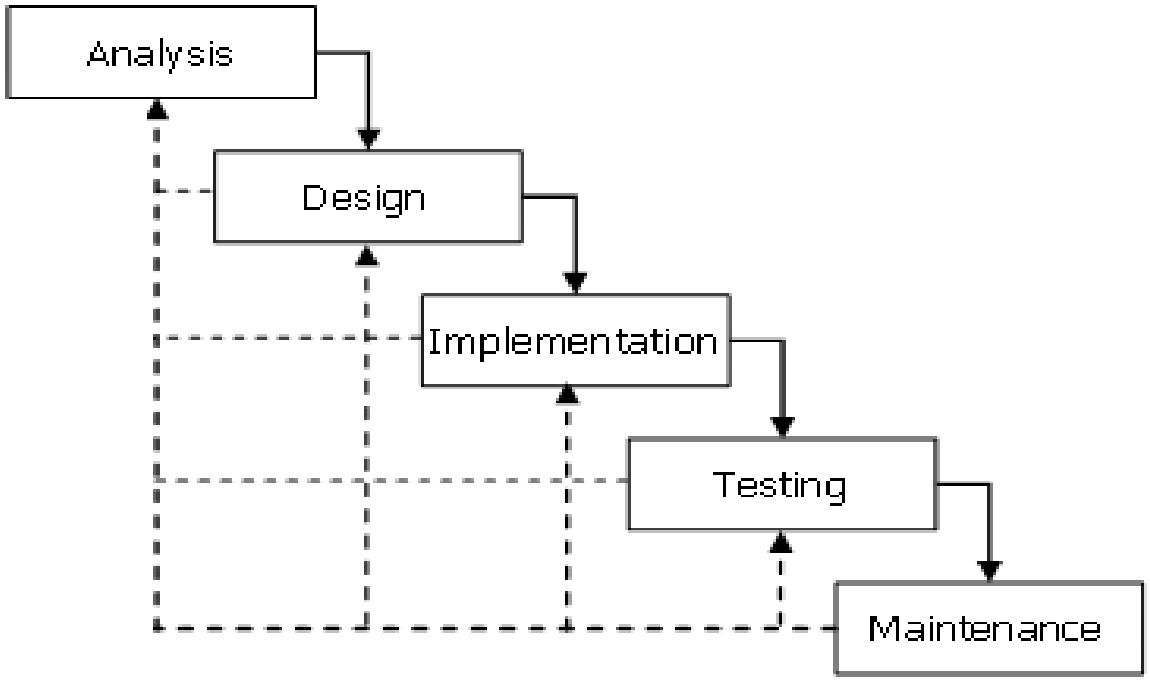


Figure 2: Waterfall model(Bassil, 2012)

3.1.1 Analysis Phase

This phase is also known as Software Requirements Specification (SRS) phase. It is a complete description of the behaviour of the software to be developed (Scacchi, 2002). This is where functional and non -functional requirements are defined.

3.1.2 Data Collection

i. Interviews

Qualitative structured interviews (Appendix 3) for collecting the users' requirements for a DL were conducted in February 2017 and they are summarized 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 pulling patients data for DL on Care2x HIS and security levels on user access on DL.

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. ALMC uses care2x HIS. Three (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 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, three (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. Three (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

The most important things that all users wanted to include into a discharge letter are 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.

They 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 are able to access the patient's DL.

ii. Collecting Discharge Letters

DL forms from 7 hospitals were collected and studied. In this survey, only 2 hospitals were using similar DL forms. Each of the other 5 hospitals had its own DL form that was different in terms of contents and structure from the other hospitals. Some of the DL forms used were rich in content (Appendix 4) while others were very poor in content (Appendix 5) and were lacking crucial information.

Study of other HIS in Tanzania and see how Discharge Letter Module works

A simple survey was conducted to few hospitals in Tanzania to see how DL module works.

Table 2: Surveyed hospitals using other HIS

Hospital Name	Region	HIS	Discharge letter
Muhimbili	DSM	JEEVA	Handwritten
MOI	DSM	MEDPRO	System generated
Kairuki	DSM	EHMS	Handwritten
Sanitas	DSM	EHMS	Handwritten
Tumbi	COAST	GOT(HMIS)	Handwritten

iii. 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, Discharge Letter, Hospital Discharge Communication, Care2x. The survey showed that a discharge letter should provide a 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 signature.

3.1.3 System Requirements

i. Functional Requirements

Functional requirement specifies a set of functions that a system should be able to perform. These are those requirements that specify the inputs to the system, the outputs from the system, and behavioural relationships between them (Glinz, 2007). Usually, functional requirements are defined by means of use cases which describe the users' interactions with the software. The developed discharge letter module should allow the doctors to generate discharge letter, and nurse, pharmacist, lab technician, radiology technician and doctors to view the generated discharge letter.

ii. Non-functional Requirements

Non-functional requirements refer to the various constraints, criteria, limitations, and requirements imposed on the design and operation of the software system rather than on particular behaviours. It includes such properties as reliability, testability, availability, maintainability, scalability, security, performance, and quality standards (Bassil, 2012). Users emphasise the security, accuracy, and usability on the module to be developed.

3.1.4 Use Case Diagram

According to Bassil (2012), use cases diagrams usually referred to as behavioural diagrams, they describe interactions between users and the system, focusing on what users need to do with the system. Use cases are a set of actions, services, and functions that the system needs to perform. They represent functional requirements of the software system and can be used during the early stages of the development process. Fig. 3 presents a use case diagram for discharge letter module.

Use Case Diagram Symbols and Notations Basic

i. System

System's boundaries are drawn using a rectangle that contains use cases. Actors are placed outside the system's boundaries.

ii. Use Case

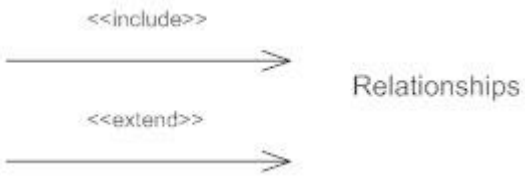
These are ovals which are label with verbs to represent the system's functions.

iii. Actors

Actors are the users of a system.

iv. Relationships

Show relationships between an actor and a use case with a simple line.



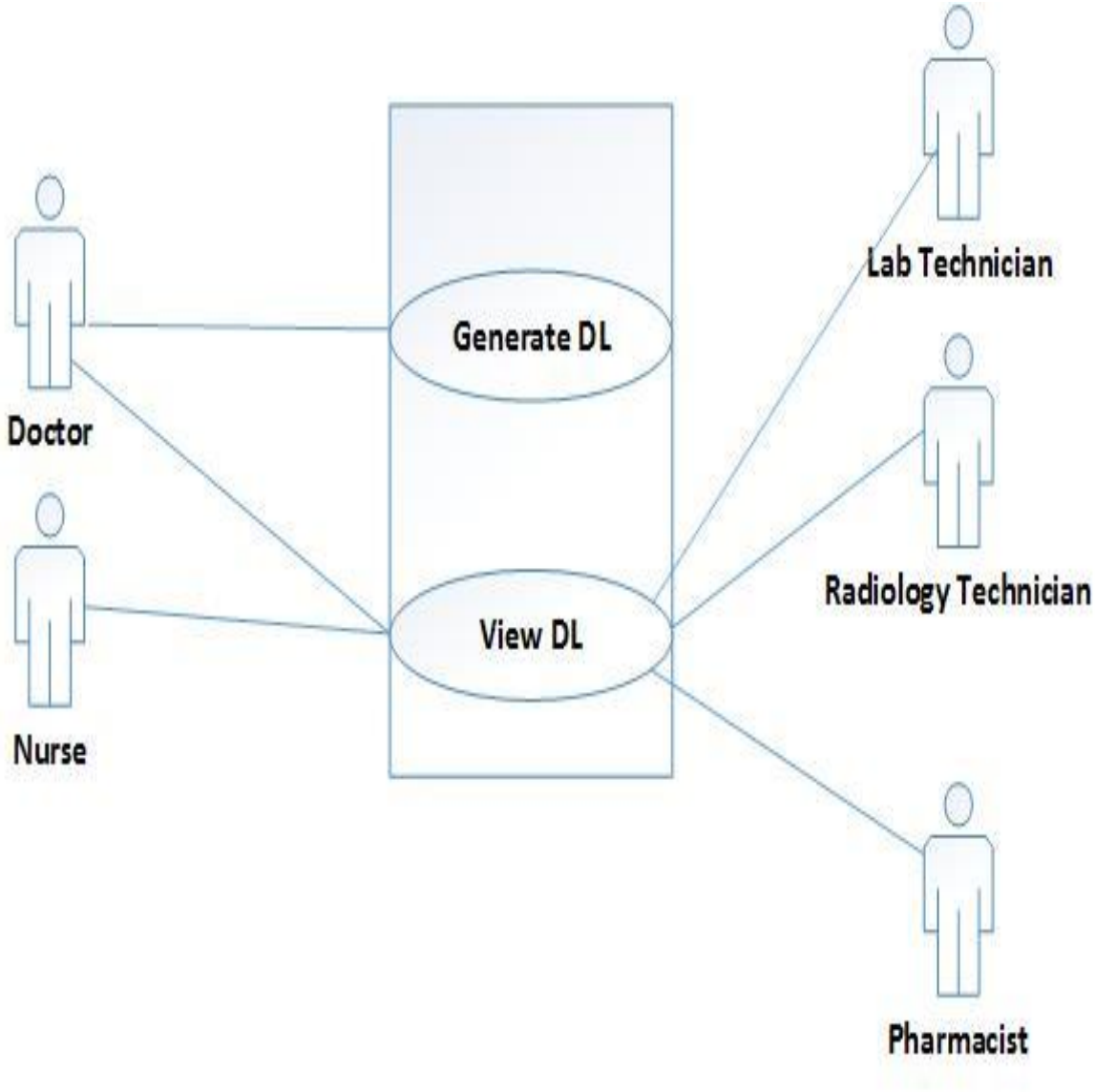


Figure 3: Use case diagram for DL module

Use Case Description

i. Generate DL

Introduction:

This use case describes how a medical doctor can generate a DL for a discharged patient.

Actor(s)

Medical Doctor (MD)

Precondition:

Medical doctor must be logged on to the system before starting to generate DL

Post-condition:

If this use case is successful, a medical doctor will be able to Generate DL for a discharged patient. Otherwise, the system state will remain unchanged.

Basic flows

- The use case begins when an MD wishes to generate a DL for a discharged patient;
- The system will request a user to enter file nr of a patient whose DL is to be generated
- If a patient is not yet discharged, an error message will appear
- If a patient is discharged, DL form will appear with some fields already populated with information from the database
- The system will also request an MD fill the remaining fields
- Once an MD select Print button, this use case is executed;

ii. View DL

Introduction

This use case describes how users can to view the generated discharge letter.

Actor(s)

Nurse, Pharmacist, Lab technician, Radiology technician and Doctors

Pre-condition

Actor must be logged on to the system before starts to view patients DL.

Post-condition

If the use case is successful, an actor will be allowed to view DL of specific patient.

Basic flows

- The use case begins when a user wishes to view patients DL.
- The system will request a user to enter file nr of a patient whose DL is to be viewed.

Latest DL for a selected patient will appear in pdf format.

3.2 Module Design

System design is the process of planning and problem solving for a software solution. It involves defining the architecture, interfaces, modules and data for a system to satisfy specified requirements (Marsic, 2013).

3.2.1 Activity Diagram

An activity diagram visually presents a sequence of actions and the flow of control in a system (Marsic, 2013). An activity diagram is represented by shapes that are connected by arrows. Arrows run from activity start to completion and represent the sequential order of performed activities. Rounded rectangles represent performed actions, which are described by text inside each rectangle. A diamond shape is used to represent a decision, which is a key activity diagram concept. Fig. 4 shows an activity diagram for DL module to generate DL.

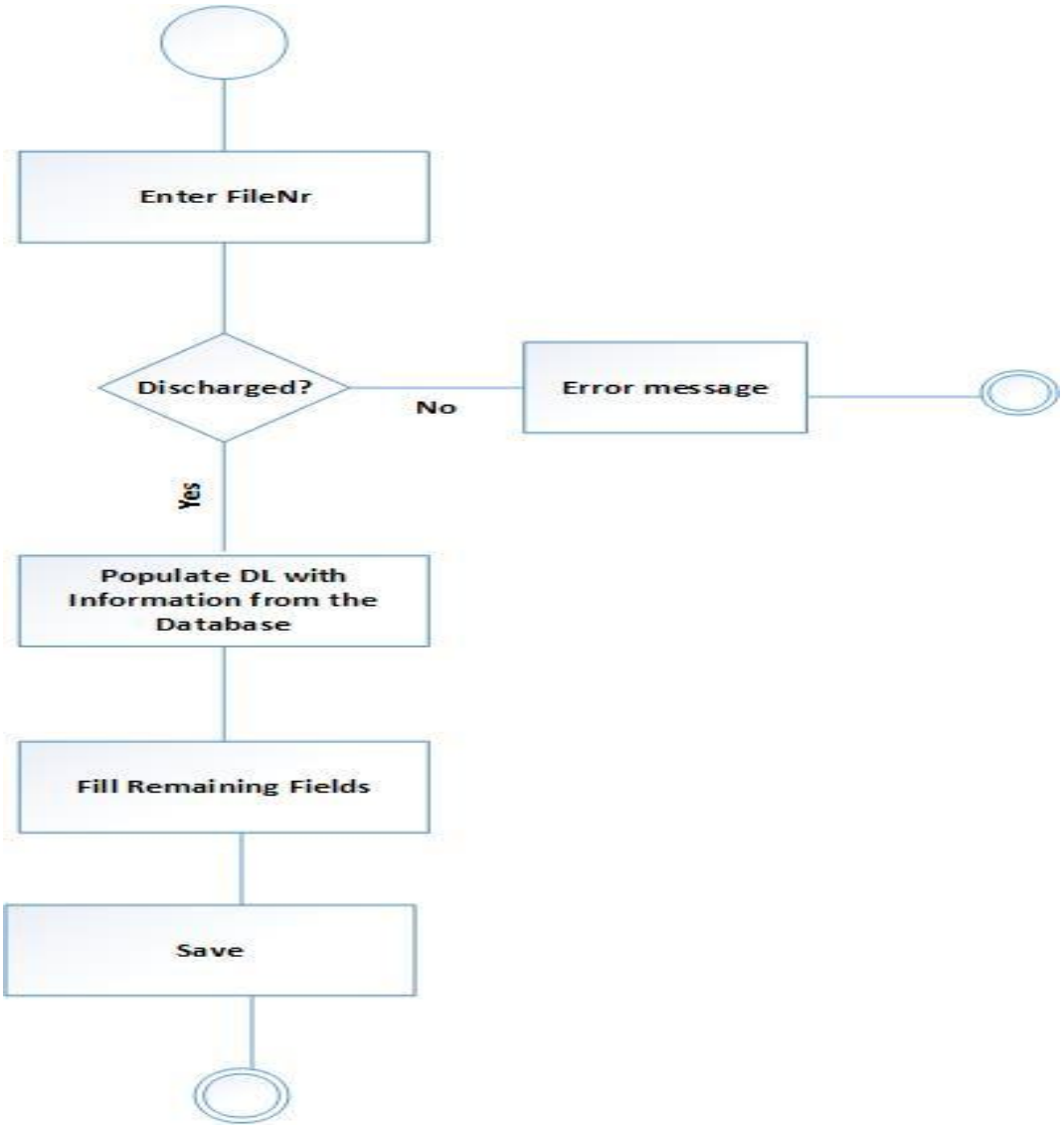


Figure 4: Activity diagram for DL module

3.2.2 Entity Relation Diagrams (ER-Diagrams)

An entity relationship diagrams (ERD) shows the logical structure of databases. It illustrates the entities and their attributes and the relationships of entities with each other (Purchase *et al*., 2004). The discharge letter module ERD is presented in chapter 4.

3.3 Implementation and Unit Testing

3.3.1 Using PHP Scripting Language for Designing User Interface

Hypertext Preprocessor (PHP) was used for designing the user interface and implementing the functions of the DL module. PHP is a widely used, open source, and powerful server-side scripting language for creating dynamic and interactive web pages (Boronczyk *et al.,* 2009). PHP was preferred in this study due to the following reasons:

a) It is free
b) It is easy to learn
c) PHP supports a wide range of databases
d) PHP runs on various platforms (Windows, Linux, Unix, Mac OS X, etc.)
e) PHP is compatible with almost all servers used today (Apache, IIS, etc.)

3.3.2 Using HTML and CSS

HTML stands for Hyper Text Markup Language. It is the standard markup language for creating web pages and web applications. Cascading Style Sheets (CSS) is a language that describes the style of an HTML document. CSS describes how HTML elements should be displayed. According to Boronczyk *et al.* (2009), HTML and CSS ensure that texts and images are formatted in a way that they appear on browsers.

3.3.3 Using MySQL for Database Development

A database is a collection of logically related data. A database management system (DBMS) is a computer software application for creating and managing databases. It provides users and programmers with a systematic way to define, create, querying, update and manage data. MySQL is the leading open source database management system used for web-based applications. MySQL was selected to be used in this study because it is fast, reliable, and easy to use. MySQL uses standard SQL and compiles on a number of platforms (Boronczyk *et al*., 2009)

3.3.4 Integrated Development Environment (IDE)

An Integrated Development Environment (IDE) is a graphical user interface (GUI)-based application designed to aid a developer in building other software applications with an integrated environment combined with all the required tools at hand. Normally, an IDE contains a code editor, a compiler, an interpreter and a debugger. NetBeans was used as an IDE in this study because it is a free and open source. NetBeans provides a great set of tools for PHP, CSS, HTML and other programming languages (Jensen and Scacchi, 2005).

3.3.5 Unit Testing

Unit testing is a software development process in which each unit (the smallest testable part of an application), together with associated control data, operating procedures and usage procedures, is individually tested to determine whether it fit for use (Runeson, 2006). The discharge letter module was tested to make sure that it works as planned.

3.3.6 Integration and System Testing

System integration is a software development phase concerned with joining different subsystems or components as one large system and ensuring that subsystems function together as a system (Brucker and Julliand, 2014). DL module was integrated into Care2x HIS. Then integration testing, a level of software testing in which individual modules are combined and tested as a group was done.

Figure 5: Care2x architecture

CHAPTER FOUR

RESULTS AND DISCUSSION

The schema of the new Discharge Letter module for Care2x HIS developed in this study is shown in Fig. 6.

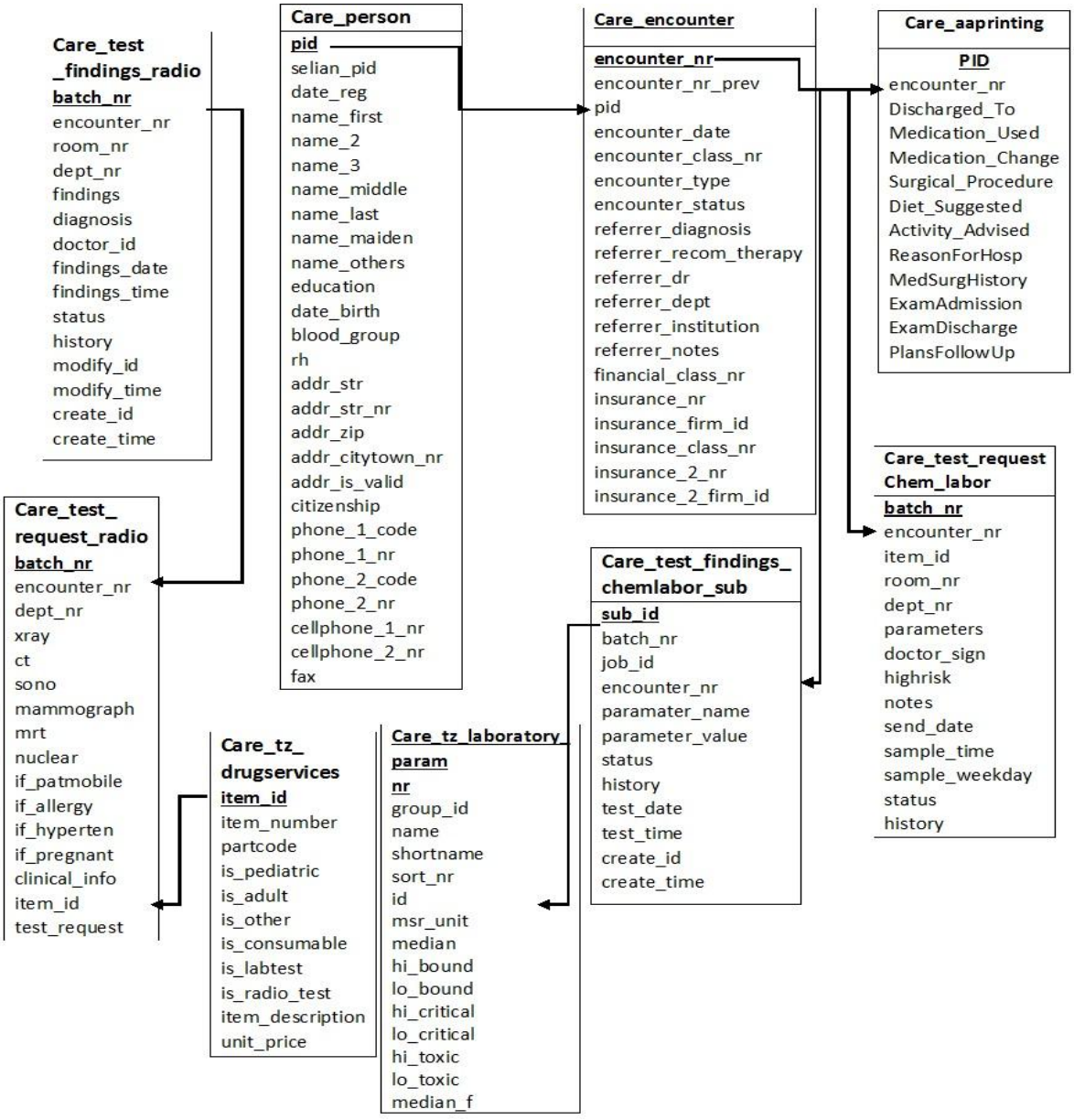


Figure 6: ERD for DL module

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

4.1 DL Module Description

A user can access this module by clicking “Discharge Letter” from the main menu of Care2x HIS. When a user clicks this link a new window will appear (Appendix 7). Here a user will be required to enter a file number of a patient whose discharge letter is to be generated or viewed.

If a user tries to generate or view a DL without entering file nr, an error message “Enter Registration No!” will appear as shown in Appendix 8.

If a user wants to generate DL of a patient who doesn’t exist or is not discharged yet, or when a user wants to view patient’s DL which has not yet been generated, an error message, as shown in Appendix 9 will appear.

When a user enters file nr of discharged patient, a form shown in Appendix 10-13 will appear. In Appendix 10, all the information to be filled will be accessed from Care2x database.

Appendix 11, demonstrates where a patient is discharged to, and then the reason for hospitalization and significant physical examination findings have to be entered manually by the discharging physician.

Appendix 12, demonstrates that the discharge diagnosis and medication used during hospitalization have to be entered manually by the discharging physician. Other information are accessed from Care2x database.

Appendix 13 shows that the plans for follow up, diet suggested and activity advised have to be entered manually by the discharging physician. Pending test results and follow up visit date and department are accessed from 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 what was the reason for hospitalization, the significant physical examination findings, the discharge diagnosis, the 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 and sent electronically to the discharged health facility if electronic exchange of patient data is possible between the two systems.

4.2 Module Evaluation

In a test phase, 5 DLs from the Care2x system were generated, their contents were evaluated and the test 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 (Appendix 14). 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:

i. They all (9) agreed that it is understandable.

ii. They all (9) agreed that information included is correct.

iii. 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:

i. Three physicians said that information included is enough, not too less, and should remain as it is.

ii. One physician said that the patient’s past medical history should be included in the form.

iii. One 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.

iv. One 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.

v. Two 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.

vi. One 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.

The results demonstrate that the discharge letter module developed in this study is very useful and will help the physicians to produce better discharge summaries 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 (Ministry of Health, Community Development, Gender, 2016). This would facilitate a smooth exchange of discharge letters among healthcare providers and healthcare professionals.

Atsma *et al*. (2004) evaluated the usefulness of a DL dedicated module for the Cardiology Information System (CARIS) that was developed to aid the physician in making the patient discharge letter 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*. (2009), did a survey to evaluate the effect of a newly-created electronic discharge summary in an Australian hospital which implemented an 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 timelines 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 a suboptimal transfer of information at discharge after the implementation of the EDL.

Various studies have reported that electronic discharge letter improves time of availability and completeness of content (Alderton and Callen, 2007; Leary, 2009; Taylor *et al*., 2015), but does not necessarily have impacts on the quality of care (Kattel et al., 2016). 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 we improve the quality of HIS systems and their databases, build good security controls on data access from the HIS systems 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 (Lehnbom *et al.,* 2014). Our 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 (Alper *et al.,* 2014), 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 that important information elements in the DL on where a patient is discharged to, 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 (Coleman *et al.*, 2013), not necessarily English, and should be clearly presented.

This rather small study showed, however, 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, is 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 system is in use in the healthcare organization.

4.3 Limitation of the study

Only 9 physicians were interviewed and each one had own opinion on what should be included in the DL and how it should be structured, and on 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 are 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.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 General Conclusion

The 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. 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 for medical errors and adverse clinical outcomes. This study has proposed standardized format, both for the content and for the structure, of the discharge letter.

The most important things that physicians wanted to include into a discharge letter are 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. They 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. They emphasised on security, accuracy, and usability on the module to be developed.

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.

5.2 Recommendations

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 HIS systems 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' HISs. 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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APPENDICES

Appendix 1: User Evaluation Questionnaire

QUESTIONNAIRE ON THE USE OF ELECTRONIC MEDICAL RECORD (EHR)/ HOSPITAL INFORMATION SYSTEM (HIS)

I Respondent

What is your profession?

Are you doing clinical work with patients?

Are you using the EHR or other information systems in your current work?

- EHR system?
- other systems?

How long have you been using this system/these systems?

Did you use another EHR system before the current system?

Did you have some training / courses to help you to use the EHR?

II How often you use EHR/HIS to assist you with the following tasks?

Task	1	2	3	4	5	A	B
	Never/ almost never	Seldom	about half of the occasions	Most of the occasions	Always / almost always	Our system does not support this task	This task does not apply to me
Review the patients problems							
Seek specific patient information from EHR							
Follow the results of a particular test/investigation of a patient							
Enter daily notes from a patient							

Task	1	2	3	4	5	A	B
	Never/ almost never	Seldom	about half of the occasions	Most of the occasions	Always / almost always	Our system does not support this task	This task does not apply to me
Order laboratory tests							
Receive the lab test results							
Order X-ray, ultrasound or CT investigations							
Receive the results from X-ray, us or CT							
Order other supplementary investigations							
Refer the patient to other departments /specialists							
Write prescriptions							
Write sick-leave notes							
Give written individual information to patient, e.g. on medication, disease status							
Collect patient information for discharge letters							
Register to EHR diagnosis codes, or performed procedure codes							

Use of EHR to transfer patient information to other health care organizations (as printings, emails)							

III. How has the EHR/HIS in your opinion changed your performance in the following tasks?

Task	1	2	3	4	5	A	B
	Significantly more difficult	Slightly more difficult	No change	Slightly easier	Significantly easier	I don't know	Not possible in my system
Reviewing patient's problems is							
Seeking patient's information from EHR is							
Ordering x-ray/us/CT is							
Following the patient's X-ray /us/CT investigation results over time is							
To order lab tests is							
To receive the lab test results is							
Referring patient to other health organisations/ specialists is							

Task	1	2	3	4	5	A	B
	Significantly more difficult	Slightly more difficult	No change	Slightly easier	Significantly easier	I don't know	Not possible in my system
Writing prescriptions is							
Producing sick-leave forms is							
Giving written individual information to patient is							
Collecting information for the patient's discharge letter is							
Registering diagnosis codes or performed procedure codes is							

IV How satisfied you are with your current EHR/HIS system?

	1	2	3	4	5
	Never/ almost never	Seldom	About half of the time	Most of the time	Always / almost always
Content					
How often does EHR provide precise information that you need					
How often the information content meets your needs					
How often does the reports provided meet your needs					
Does EHR provide sufficient information to support your work					
Accuracy					

Is the system accurate						
Are you satisfied with the system accuracy						
Format						
How often is the information presented in a useful format						
How often is information clear						
Ease of use						
How often you think EHR is user-friendly						
How often you think the system in easy to use						
Timeliness						
How often you get the information you need in time						
How often EHR provides up-to-date information						
Security						
Can you trust that information is safe and secure						
Are there problems in patient data confidentiality and privacy						

V. Your summary assessment of EHR/HIS in use

	1	**2**	**3**	**4**	**5**	**6**
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	I do not know / no opinion
System is worth of time and effort to use it						
I am satisfied with the current system						
With the use of EHR/HIS our department has become more efficient						
With EHR/HIS our department is more						

cost-effective						
EHR/HIS has made my work more efficient						
EHR/HIS has helped me to use more time with patients						
EHR/HIS is useful in my clinical work						
The quality of the department work has improved with EHR/HIS						
I am satisfied with training I have received to use EHR/HIS						
EHR/HIS is useful in producing good patient documentation						
I think safety and privacy of patient information is well covered in EHR/HIS						

Any other comments on current EHR/HIS, your wishes to improve the EHR

Appendix 2: IT Supplier Questionnaire

Thematic interview for the EHR suppliers

General information on the system

Name of the system

Number of months/years system has been in deployment

Current system version

Current system – open source / closed system

Scope of the current EHR system

disease-specific… disease area supported / primary health care / full hospital health information system

Is the EHR used on a stand-alone computer or on a network of computers

System ownership?

Licensing model

System details and standards

Uses a standardized coding system/classification e.g. ICD10, SNOMED, LOINC

Uses a standard drug coding / listing system

international / national standard

Uses a standard lab test coding / listing system

international / national standard

User friendly system prompts and appropriate error messages with clear corrective action

if no, what is the problem

Customizable user interface (forms and fields)

Built-in backup and restore features implemented

Usable via mobile devices (tablets, phones, etc.)

Baseline demographic and clinical health information

Unique patient identification system in use

if yes, what kind of identification

Biometric, Bar Code support implemented

Supports electronic patient referrals to other health care organizations

How is this functioning

Records patient demographic data

Maintains up-to-date problem lists per patient

Maintains medication lists per patient

Maintains allergy lists per patient

Records vital signs

Incorporates lab test results

Generates Patient lists for doctors/departments/units

Patient education/information materials accessible

Generates clinical summaries /discharge letters

Provides a longitudinal view of a patient's medical history

Manages drug interactions

Manages adverse drug reactions

Supports Appointment scheduling set up, update and management

Patient data storage – longitudinal storage – how long – how is it organized?

Clinical decision support

Incorporates clinical decision guidelines

Generates alerts to support clinical decision making

Generates reminders for users on certain aspects

Exchange of electronic information

Exchanges clinical information and patient summaries with other systems

Electronically transmits prescriptions

Electronically transmits and receives laboratory orders and results

Electronically transmits and receives digital images

Is able to display images via EHR

Electronically transmits aggregate information to DHIS2 (district health information system)

Supports HL7 messaging

Supports XML generation and messaging

Health reporting

Customizable Reports

Export/import of external reports

Generates MoH required reports and statistics

Generates Patient level reports

Generates facility specific reports

Generates patient-specific medication reports/cards for a patient

Order-entry

Generates prescriptions orders

Generates lab orders

Generates referrals

Security and confidentiality

Supports user authentication

Supports role based access control

Audit trail / event log files supported

Supports analysis of audit trails reports

Manual and automated database back up

Integration

Client operating systems supported, which

Database supported, which

System programming language

User interface type supported

Appendix 3: Questionnaire on Patient Summary

I Respondent

What is your profession?

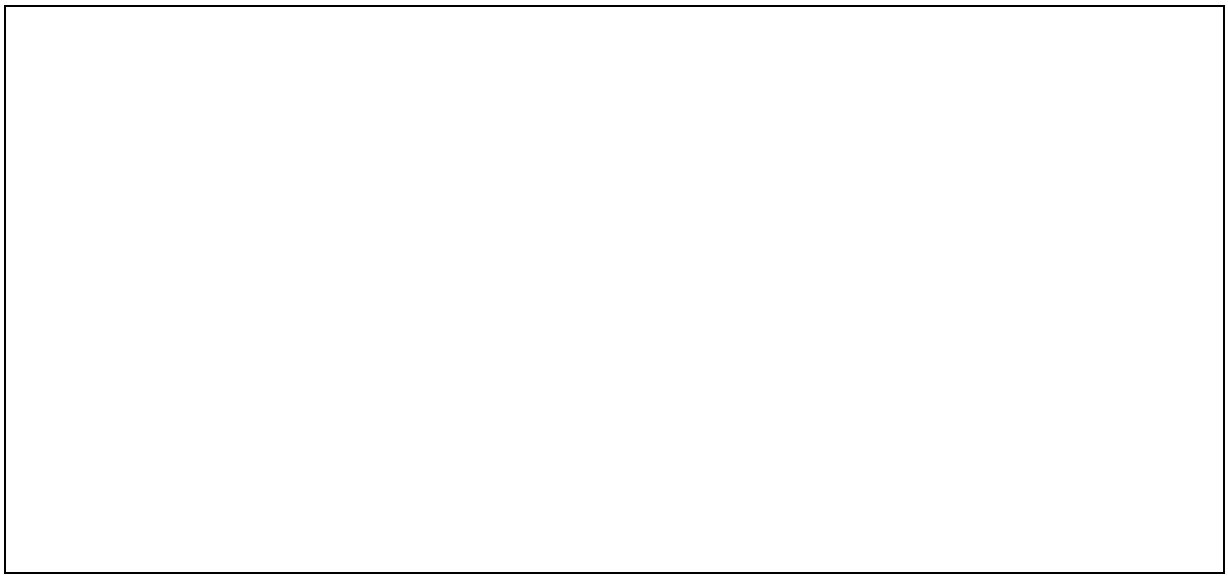
Are you doing clinical work with patients?

Are you using Care2x HIS in your current work?

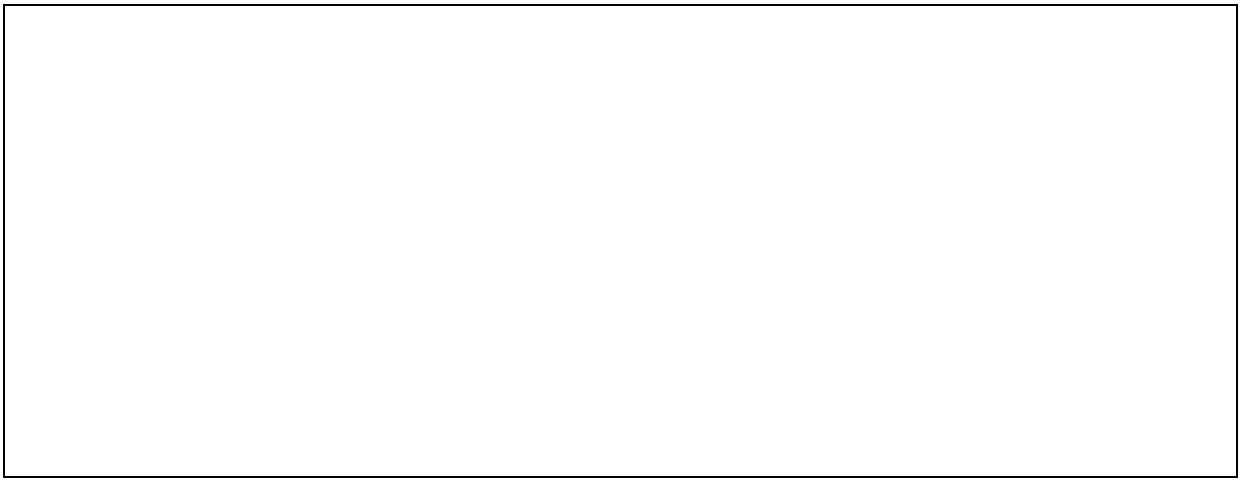
How long have you been using this system?

Patient Discharge Letter

What data need to be included in DL?



How should DL be structured and presented?



To whom is the DL delivered?

When is DL produced?, for what purposes?

Where is DL saved?, for how long?

Where do you get data for the DL?

Is care2x capable to provide all needed data for DL?

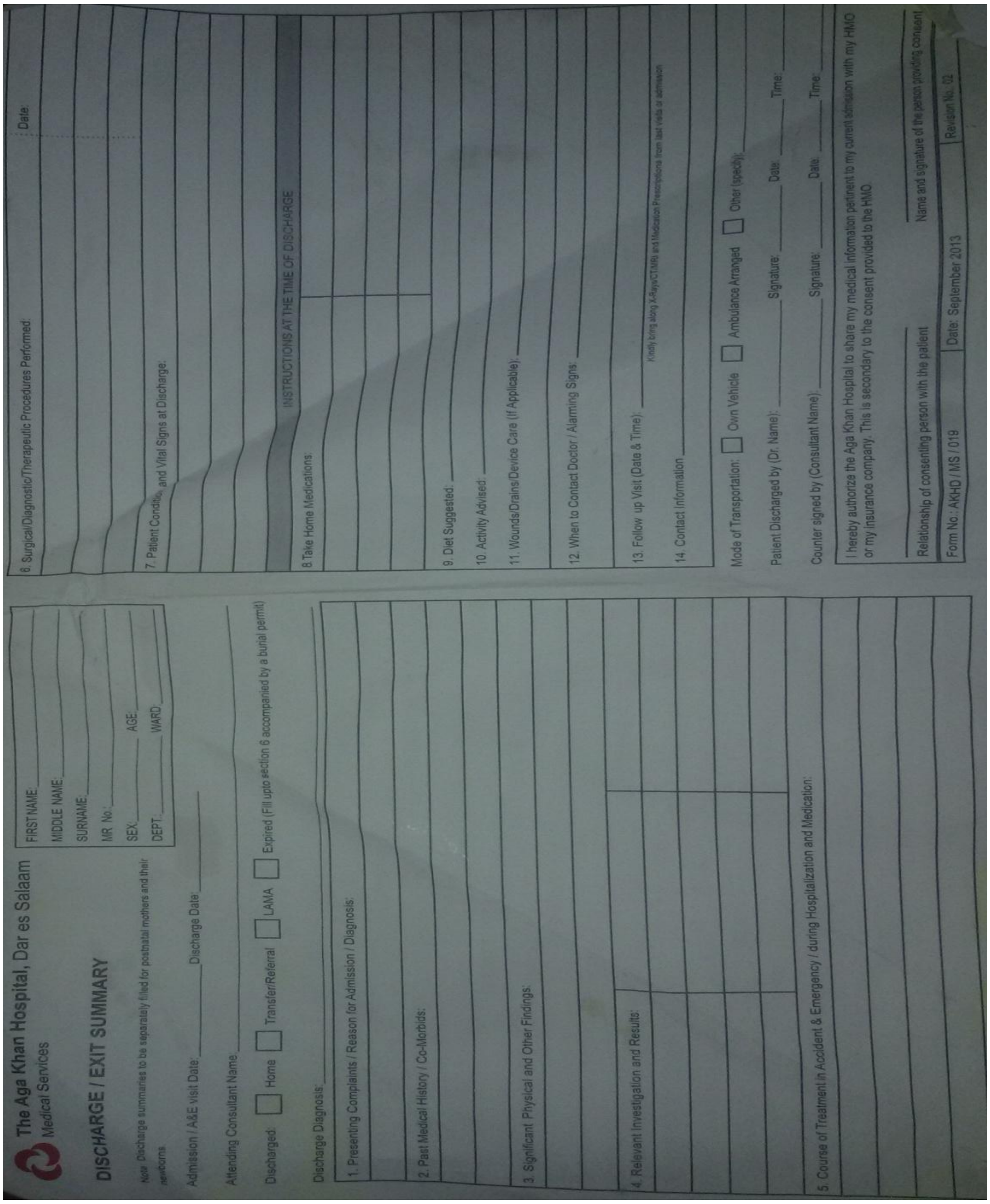
Who can access/ disclose DL?

Any additional comments on current DL?

Thank you for your participation!

Your answers are confidential and your identity will not be revealed.

Appendix 4: Agha Khan Discharge Letter



The Aga Khan Hospital, Dar es Salaam
Medical Services

DISCHARGE / EXIT SUMMARY

Note: Discharge summaries to be separately filled for postnatal mothers and their newborns

FIRST NAME:
MIDDLE NAME:
SURNAME:
MR No:
SEX: AGE:
DEPT: WARD:

Admission / A&E visit Date: Discharge Date:

Attending Consultant Name:

Discharged: Home Transfer/Referral LAMA Expired (Fill upto section 6 accompanied by a burial permit)

Discharge Diagnosis:

1. Presenting Complaints / Reason for Admission / Diagnosis:

2. Past Medical History / Co-Morbids:

3. Significant Physical and Other Findings:

4. Relevant Investigation and Results:

5. Course of Treatment in Accident & Emergency / during Hospitalization and Medication:

6. Surgical/Diagnostic/Therapeutic Procedures Performed: Date:

7. Patient Condition and Vital Signs at Discharge:

INSTRUCTIONS AT THE TIME OF DISCHARGE

8 Take Home Medications:

9. Diet Suggested:

10. Activity Advised:

11. Wounds/Drains/Device Care (If Applicable):

12. When to Contact Doctor / Alarming Signs:

13. Follow up Visit (Date & Time): Kindly bring along X-Rays/CT/MRI and Medication Prescriptions from last visits or admission

14. Contact Information:

Mode of Transportation: Own Vehicle Ambulance Arranged Other (specify):

Patient Discharged by (Dr. Name): Signature: Date: Time:

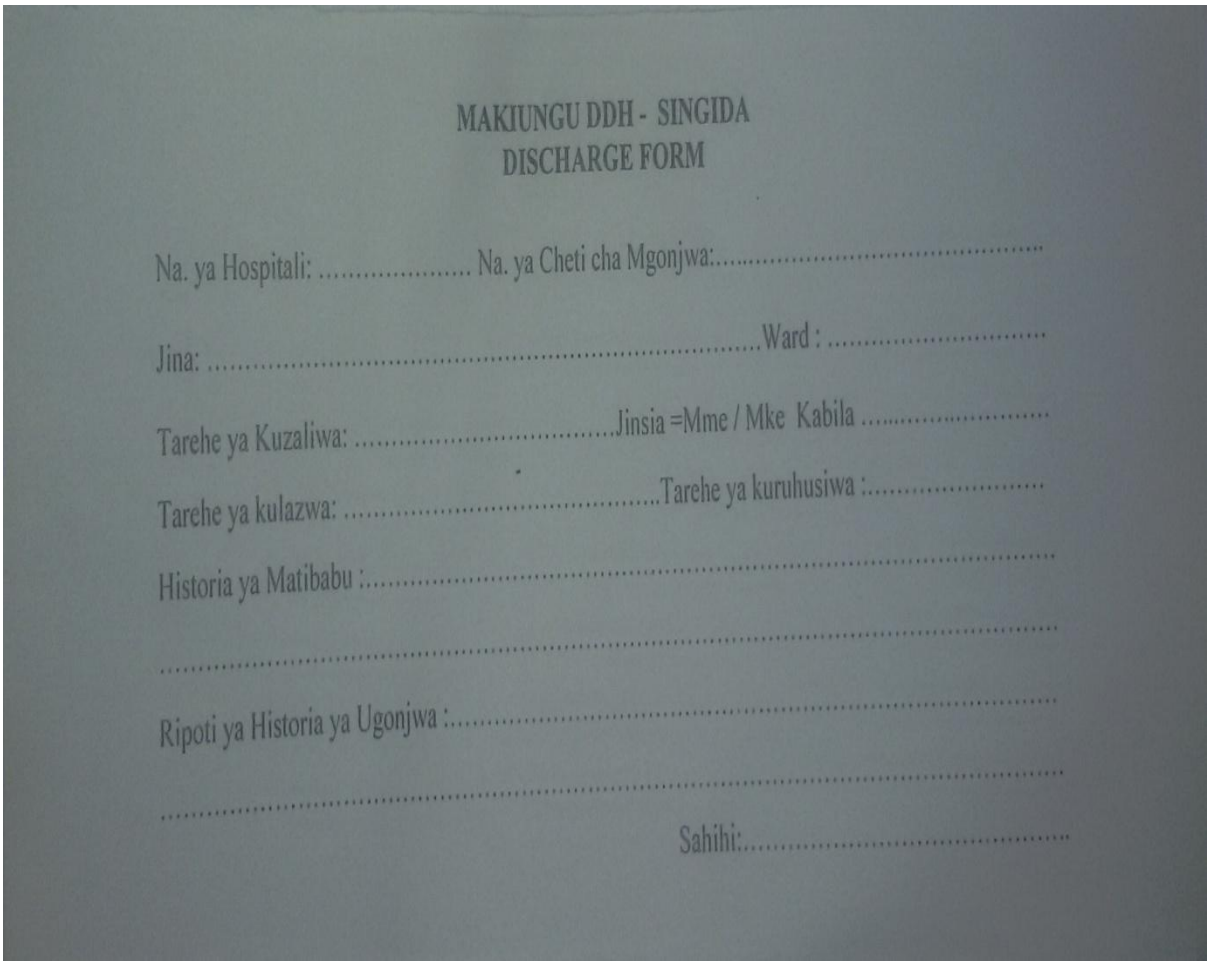
Counter signed by (Consultant Name): Signature: Date: Time:

I hereby authorize the Aga Khan Hospital to share my medical information pertinent to my current admission with my HMO or my insurance company. This is secondary to the consent provided to the HMO.

Relationship of consenting person with the patient Name and signature of the person providing consent

Form No: AKHD / MS / 019 Date: September 2013 Revision No. 02

Appendix 5: Makiungu Discharge Letter



MAKIUNGU DDH - SINGIDA
DISCHARGE FORM

Na. ya Hospitali: ..... Na. ya Cheti cha Mgonjwa:.....

Jina: .....Ward : .....

Tarehe ya Kuzaliwa: .....Jinsia =Mme / Mke Kabila .....

Tarehe ya kulazwa: .....Tarehe ya kuruhusiwa :.....

Historia ya Matibabu :.....

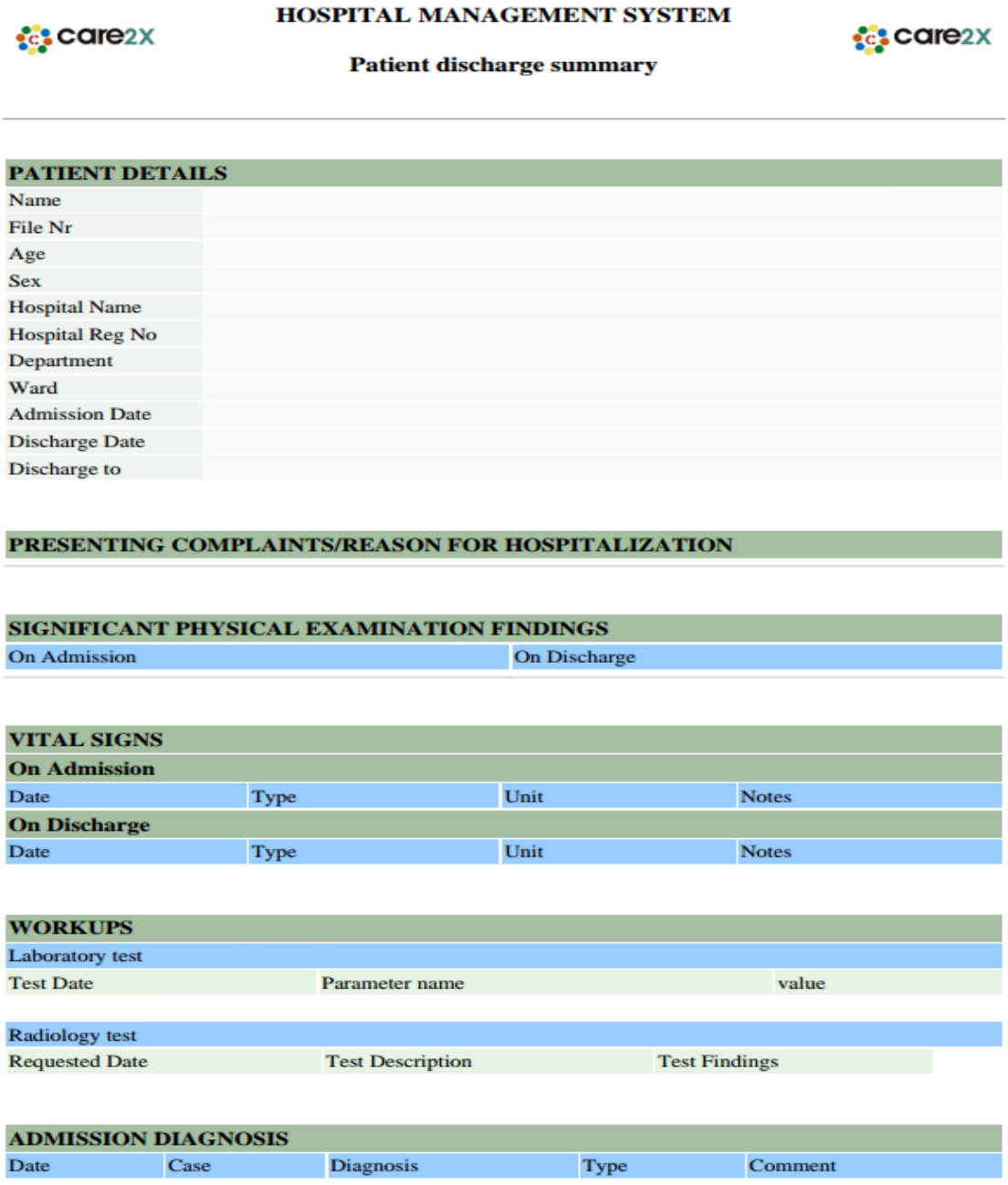
.....

Ripoti ya Historia ya Ugonjwa :.....

.....

Sahihi:.....

Appendix 6: The DL Structure and Content



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

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

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

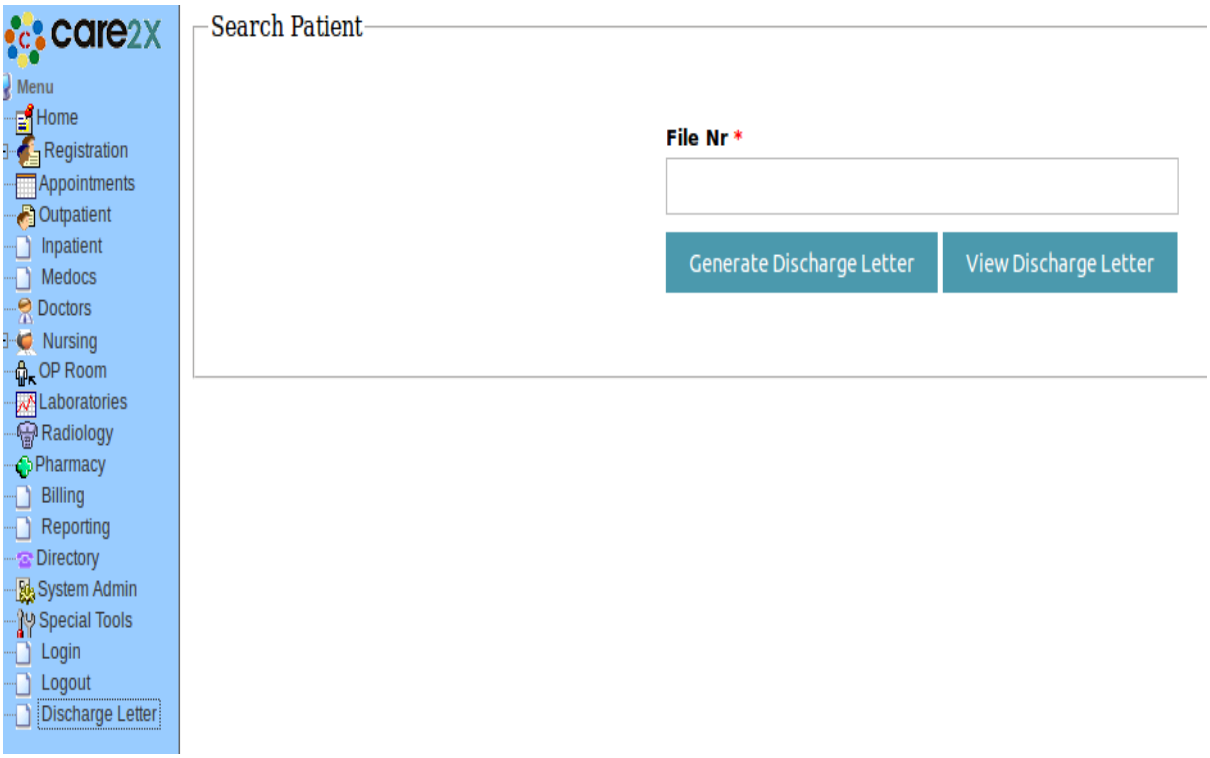
Visit Date	Department	Appointment

Name of Discharging doctor : .....

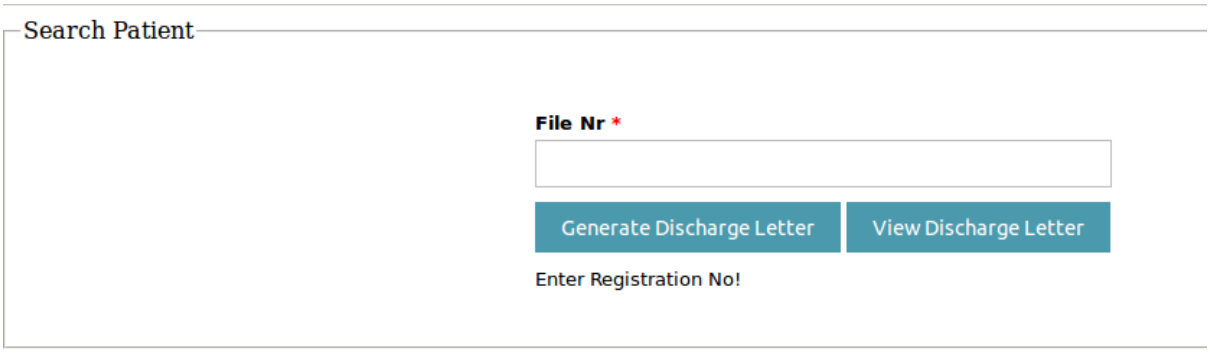
Signature : .....

Date : 2017-07-19 Time : 16:02:31

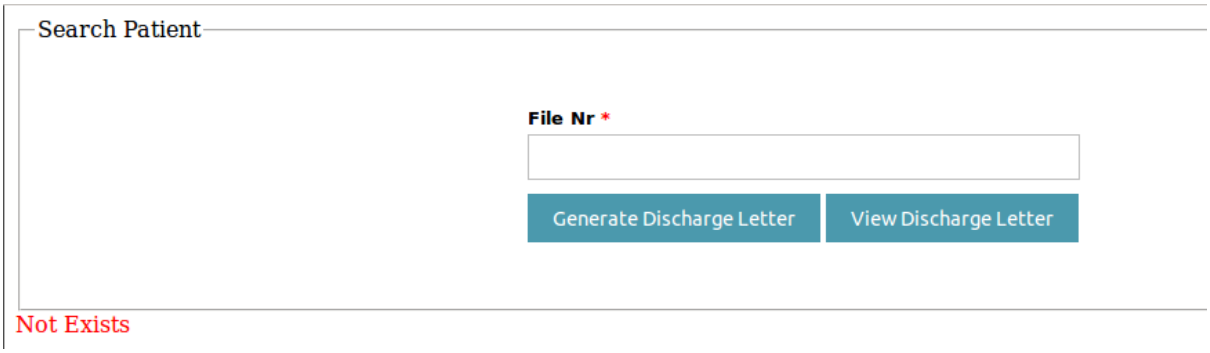
Appendix 7: A place where user can access DL module



Appendix 8: Error message when a user tries to generate or view DL without entering file nr



Appendix 9: Error message when incorrect file nr is entered



Appendix 10: DL Form '1'

Print

Full Name *

Last

File Nr *

Sex and Age*

Sex

Age Years

Hospital Name *

Hospital Reg No *

Department *

Appendix 11: DL Form '2'

Ward *

Admission and Discharge Date*

Admission Date | Discharge Date

Where a Patient is Discharged to *

1. Presenting Complaints/Reason for Hospitalization *

2. Significant Physical Examination Findings *

On Admission	On discharge

3. Vital signs *

During Admission			
Date	Type	Unit	Notes
During Discharge			
Date	Type	Unit	Notes

Appendix 12: DL Form '3'

4. Workups *

Laboratory test		
Test Date	Parameter name	value

Radiology test		
Requested Date	Test Description	Test Findings

5. Admission Diagnosis *

Date	Case	Diagnosis	Type	Comment

**6. Discharge Diagnosis*

7. Medication used during hospitalization *

8. Discharge medication *

S/N	Drug/Prescription	Singe Dose	Times Per Day	Days	Total Dose

9. Procedures performed (if any) *

S/N	Date	Procedure	Notes

Appendix 13: DL Form '4'

L0. Pending test results(if any), and plans for follow up *

Laboratory test		
Date	Test Description	Notes
Radiology test		
Date	Test Description	Notes
Plans for follow up		

L1. Diet suggested(if relevant)*

L2. Activity advised (if relevant)*

L3. Follow up visit date and Department*

Visit Date	Department	Appointment

Appendix 14: Evaluation Questionnaire on Patients Summary

I Respondent

What is your profession?

Are you doing clinical work with patients?

Are you using Care2x HIS in your current work?

How long have you been using this system?

Patient Discharge Summary

Is it understandable?

Is information included correct?

Is it easy to use/generate?

Is the information included too less/ too much?

Is it helpful?

Are you satisfied with it?

Any additional comments?

Thank you for your participation!

Your answers are confidential and your identity will not be revealed.

RESEARCH OUTPUT: Journal Paper

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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 not yet any standardized template

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for discharge letter in use. 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 forms 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 health care 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 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 (IS) 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 system 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, Hydom 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).

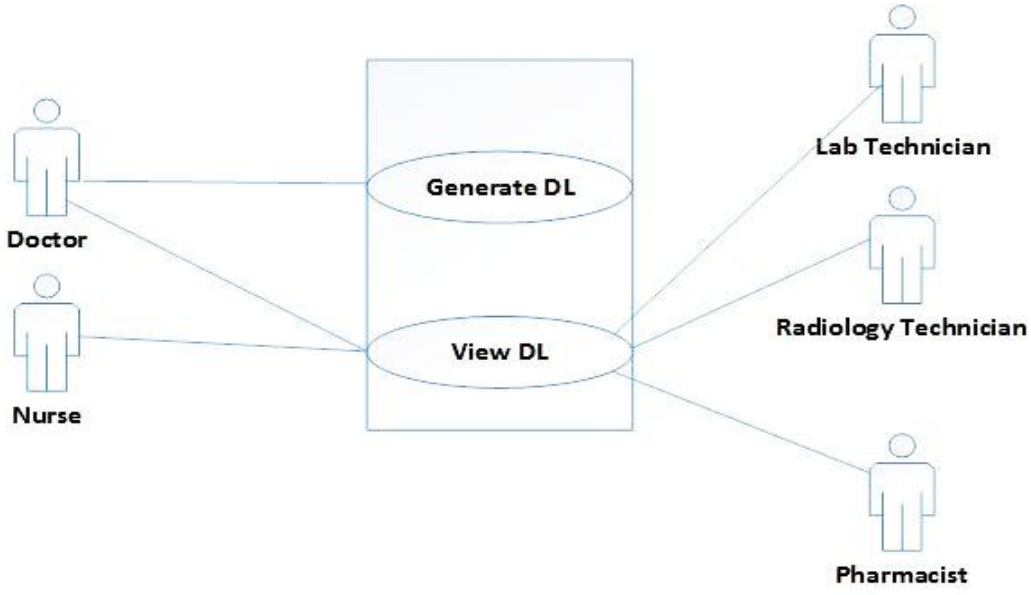

Figure 1: Use case diagram for DL module

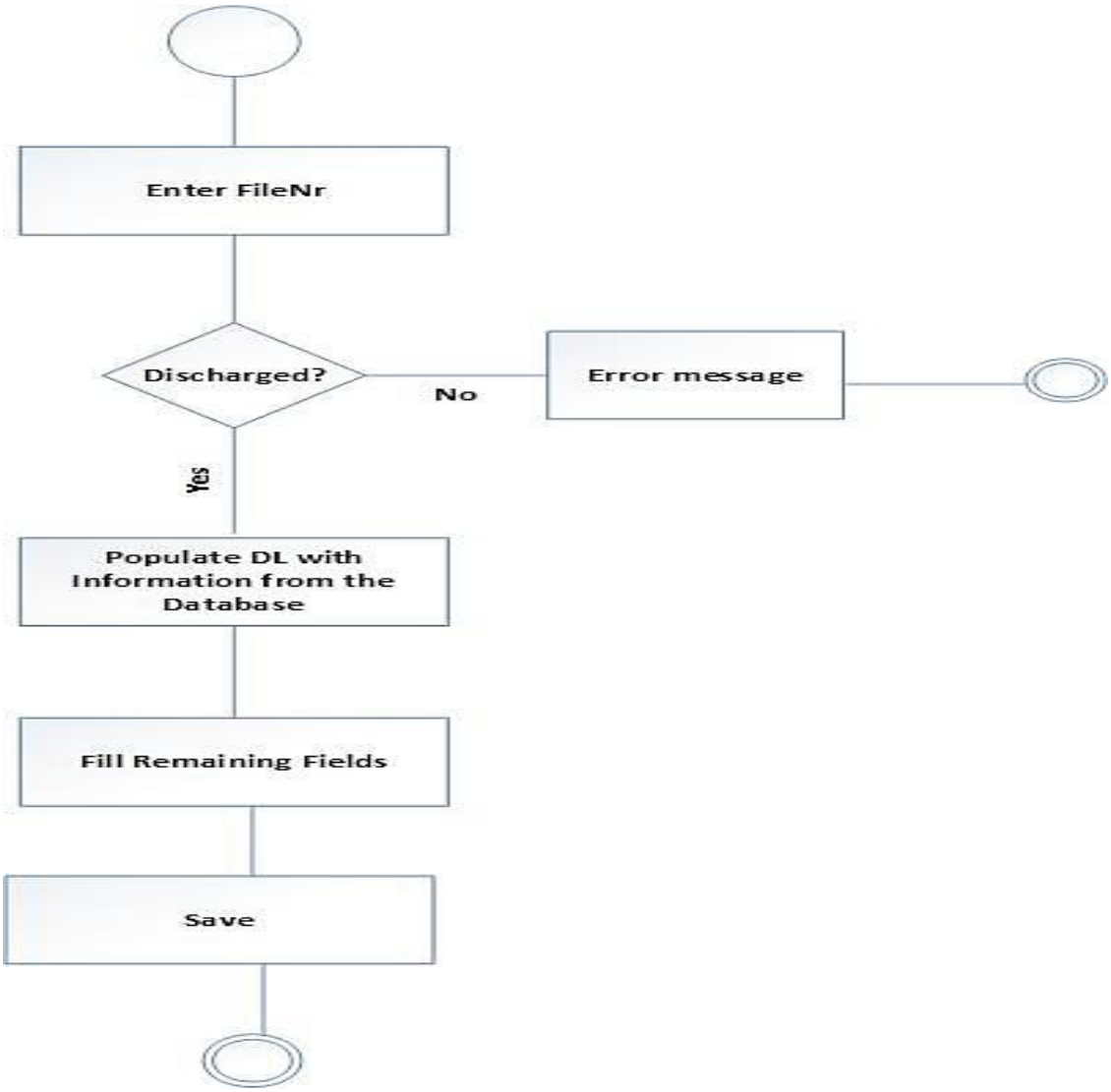

Figure 2: Activity diagram for DL module

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

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

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, not too less, 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 HIS systems and their databases are improved, build good security controls on data access from the HIS systems 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 rather small study showed, however, 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 system 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 HIS systems 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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