Intelligent Aggregation and Adaptive Visualization: A digital health case study

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ABSTRACT[1]

One of the main objectives of digital health is to deliver the right health information at the right time to the right patient. This project aims to link the segregated IT solutions used in a local primary state-run hospital in Malta (Mater Dei Hospital) together with other external related datasets into one consolidated system. With the use of linked data, adaptive visualizations and machine learning algorithms, we hypothesize that information accessibility at the appropriate level of detail and usability should improve. This proof of concept takes the colorectal patient pathway section in the oncology department as a case study.

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KEYWORDS
Patient Pathways, Internet of Things, Big Data, Health Integration

PROBLEM DEFINITION

The public health sector is an integral part of any country; a sector in which a steady increase in the total expenditure of the country is invested. The use of IT solutions for everyday tasks helps the health sector to deliver the best possible care to the patient [1].

Administration staff at the primary state-run hospital (Mater Dei Hospital) in Malta uses different IT solutions to manage different departments and to identify ways to improve the overall performance of the hospital. The usage of e-health in Malta saw an increase of 681% from September 2015 to July 2016 in the total number of patients signed up to the Maltese e-health portal myHealth [2]. Furthermore, independent IT solutions have been developed through the years and implemented in different departments in the hospital. Some of these are [1]:

- *Clinical Patient Administration System (CPAS)* – This is the central system that the health sector uses in Malta. It stores the patient demographics, episode tracking and any other appointments in the Maltese health sector.
- *Colorectal Cancer Pathway (CCP)* – This is a standalone system in the oncology centre which is used to track patients' pathways. It is used for patients that are suffering from colorectal cancer.
- *iSoft (iSoft Clinical Manager/ICM)* – This database contains patient demographic data, visit history, order entry, results viewing and patient documentation.
- *RIS (Radiology Information System)* - used by the medical imaging department to address the radiology workflow needs and the reports conducted by the imaging staff.

Although all these IT solutions exist, the report produced by Azzopardi [2] states that only partial information is being communicated between the IT solutions in the studied oncology center, because the majority of the clinical documentation is still being kept on paper or inputting of data is done manually on each system [2]. According to the report that was published by the NAO, the reason behind this is the lack of usability in current systems [3]. Another report, conducted by the NAO to audit the IT infrastructure in the studied hospital and the oncology department, noted that the hospital, in general, should start digitizing their workflow. It also highlights the dysconnectivity of specific applications with the main IT solution and the need to integrate the different applications[1] :

"MDH is to consider integrating the various standalone IT systems..."

These remarks highlight the obstacles experienced in the day to day running of the health sector.

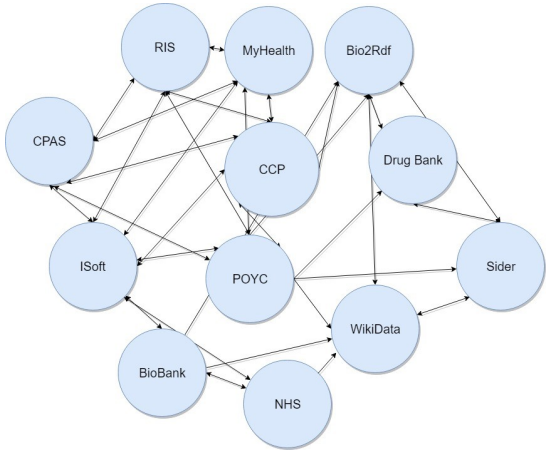

Figure 1 This image shows the proposed linkage of the internal and external datasets

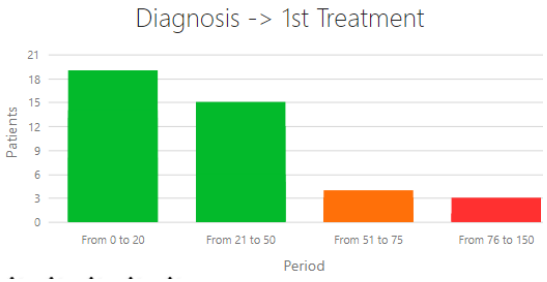

Figure 2 This image shows a snippet of the aggregated statistical patient data

There is a limited amount of interaction between the existing IT solutions. For example, CPAS contains the episodes for each patient acquired from iSoft, but details of the episodes are kept at iSoft. Similarly, iSoft contains some of the primary diagnosis acquired from RIS, but the actual imaging and detailed information for the diagnosis given is kept in RIS. CCP is a standalone system were the data is entered manually by a head nurse and monitored daily.

CURRENT WORKING ENVIRONMENT

The patient pathway system for colorectal in the studied oncology department produces the pathway for each patient by having one standalone IT system for clinical pathways called CCP. The oncology nurse must access different IT solutions such as CPAS, iSoft, and RIS to compile the pathway manually of each patient in CCP. At the time of writing, CCP staff routinely enter fields such as referral date, diagnosis date, investigation dates manually. The current system does not support any fields for treatments that the patient has received, therefore the head nurse must access a different system to determine the treatment dates for the patient.
Furthermore, the information in the information in the IT solution might be outdated since the data in CCP is inputted manually and this system has no connection to an external application such as CPAS or iSoft to update the data automatically.

PROPOSED SOLUTION

In this research, we propose that with the use of semantic web technologies, big data and artificial intelligence, we can link the dispersed nature of the current IT solutions into one consolidated system while also enriching the current data with open datasets as seen in Figure 1. With the use of web technologies, we provide an easy-to-use interface to inspect the aggregated data, while also seeing patient information as seen in Figure 2. Also, with the use of artificial intelligence, the user can extract trends or rules from the proposed system. We hypothesize that with this proposed solution we can increase the usability and information retrieval from the hospital's current segregated IT solutions while using the same data and other external datasets such as NHS statistics datasets, DrugBank and Bio2RDF.

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