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EHR System MojTermin: Implementation and Initial Data Analysis

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Abstract. Healthcare informatics has gained importance over the last several years. E-health systems on a national level have already been implemented in most European countries. Data generated by these systems are used to improve healthcare policies as well as health services. In this paper we present the system MojTermin (MyAppointment), as it evolves from a healthcare appointment engine to a complete national e-health system. We also present preliminary results from data gathered during the implementation of this system. In our analysis, we show how the system aided in the discovery of several specific socio-cultural phenomena, which led to governance changes in order to optimize resourses and raise the quality of the entire national healthcare system.

Keywords. MojTermin, National e-health system implementation, EHR system

Introduction

The Macedonian public health system is organized as a three-level referral-based system, as follows: **First level**: GPs (general practitioners), organized in small clinics of 1-3 doctors. 2.261 total clinics, with a total of 3.139 GPs and 2.996 nurses; **Second level**: hospitals, each containing 5-50 doctors. 429 total hospitals, with a total of 3.395 doctors; and **Third level**: University Clinical Centre Skopje, consisting of 51 clinics and institutes, with a total of 1.132 doctors.

The healthcare system mostly relies on public healthcare facilities (on all three levels), all funded by the National Health Insurance Fund (NHIF). Most citizens are insured by the fund (~95%), thus having access to the public healthcare sector. The system is organized as a workflow, beginning on the first level and passing patients to the higher levels and back, based on official paper medical documents (referrals, medication prescriptions, hospitalization admission forms, discharge letters, etc.).

Over the past 15 years, in order to digitize the paper system, several independent systems were deployed in hospitals and GP clinics, mainly to organize their internal operations and records. During this period there were several unsuccessful attempts to procure an entire national e-Health system. Over the past 3 years, steps were taken to develop several systems for organizational purposes, starting in 2012 with an

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appointment system for second and third level healthcare, called MojTermin. This system became the cornerstone for the development of an initial national e-health system (in 2013 and 2014). This system is currently still in development, progressing toward a complete national e-health and EHR system. The concept of an e-health system, from the patient perspective, is shown in Figure 1.

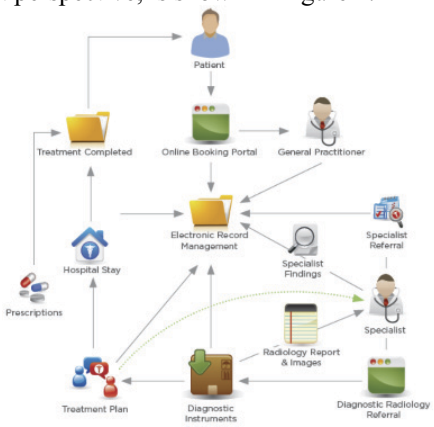

Figure 1. The e-Health system - patient perspective

The development and implementation strategies for the e-health system are in line with most EU strategies that are reported in [4]. Current implementation includes: electronic prescriptions, a patient ID, a professional ID, a citizen card and an initial EHR patient summary. The short term strategy targets are a full EHR patient summary, and a telehealth and remote evaluation system (mostly incorporating financial assessments and reimbursement), as defined in [4]. Long term strategy targets are implementation of standards (for national usage), similar to the case in Turkey [2], ultimately progressing to a full interoperability on a European level, like epSOS [6,7].

1. Methods

System implementation. MojTermin was first introduced in 2012 and has since managed the Macedonian healthcare system. Implementation was incremental and initially featured only an appointment module. Currently, MojTermin provides modularised, integrated solutions for healthcare management, predominantly covering records management of patients' visits. These records consist of: issued referrals, prescriptions, hospital admissions, and discharge letters.

Challenges that are present in developing such national systems are the integration/replacement of currently deployed software solutions, user adoption/rejection, and proper user support and training. MojTermin addressed this issues in phases. The first phase was very simple, as it represented a web solution that integrated all GPs and a pilot Second level hospitals, followed by web service based access, for integration of all existing GP information systems provided by over 50 different vendors (see Figure 2). In the next phase, all three levels of healthcare providers were involved, making it a full national appointment/referral e-health system. This approach made the user and software adoption very smooth, making it very easy for further development into a full national e-health system. The slow start also made it easier for the Ministry of Health (MH) to establish a good user support/training system, as well as to tune the

performances of the system much easier. This approach also resulted in dramatic cost reductions and thus a more cost effective software development process.

EHR components. According to the report presented in [3], most commercial EHRs consist of six groups of key components. The following are implementation stages of the key components of MojTermin according these groups.

Administrative System Components. Patients' personal, demographic, employment and insurance information is provided by the NHIF database. Registration is via unique randomly generated referral ID. Admission, discharge and transfer of hospitalized patients is still in development, and scheduled to be operational in 2015.

Laboratory System Components. Only referrals of patients to a laboratory by physicians is currently implemented electronically. Ordering of specific tests and electronic submission of results is planned for 2015.

Radiology System Components. The MH has purchased a new RIS in 2014 with implementation in all major radiology centres in the country planned for 2015. Integration with MojTermin will follow implementation, also in 2015.

Pharmacy System Components. Electronic generation, transmission and filling of medical prescriptions is fully functional and integrated with MojTermin.

Computerized Physician Order Entry. Fully electronic for the first level of healthcare. Integration with MojTermin for the remaining two levels is currently in progress and is scheduled to be completed by the end of 2015.

Clinical Documentation. Partially implemented. Clinical e-documents for outpatients have been implemented and integrated with MojTermin, with implementation for inpatients scheduled for 2015 and 2016.

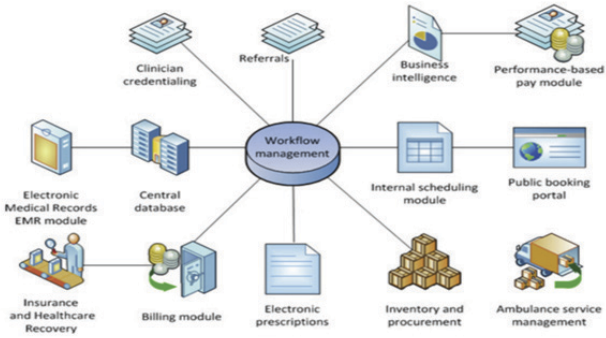

Figure 2. Modular and Integrated e-Health System

2. Results

According to data from the last Census (2002), the population of Macedonia is 2.022.547 residents. According to an estimate by the Macedonian State Statistical Office generated on 30.06.2013, the country has 2.064.032 inhabitants and the density of population is 80,3 inhabitants per square kilometre [5].

The data presented below reflects the ~95% of the population which have state health insurance. Table 1 shows the referrals per patient from first level physicians to the second and third levels, for the first six months of this year (01.01.2014 - 30.06.2014).

The data show 790.705 patients were referred to a specialist and there were 2.392.238 referrals into the second or third levels of the healthcare system. This represents an extremely high number when compared to the total population (38,31%). The age distribution of the referred patients is shown in Table 2. The percentage of patients within age brackets declines with rising age until the age of 24, when it starts to increase. The average number of referrals per patient roughly follows this trend.

Table 1. Number of patients referred to a specialist within the 2nd or 3rd levels of the healthcare system

Referrals per patient	Number of patients	Number of referrals
1	292.741	292.741
2-3	275.312	655.696
4-6	145.643	692.014
>6	77.009	751.787

Table 2. Age distribution of patients referred to specialists in the 2nd or 3rd levels of the healthcare system

Age	No. of referred patients	No. of residents (% of population)	% of ref. patients	No. of referrals	No.of referrals per patient
0 to 4	46.057	116.214 (5,36%)	39,63%	115.380	2,505
5 to 14	73.389	232.202 (11,24%)	31,61%	161.783	2,204
15 to 24	74.429	293.083 (14,19%)	25,40%	166.217	2,233
25 to 44	182.544	626.695 (30,34%)	29,13%	480.153	2,630
45 to 64	241.595	541.847 (26,23%)	44,59%	813.637	3,368
65+	172.691	255.728 (12,38%)	67,53%	655.068	3,793

Referrals were analysed by specialty, comparing ICD-10 codes between the referral and the resultant specialist report (Figure 3). Emergencies were excluded as these appointments generate referrals during report generation. 'Same ICD-10 code' indicates a matching diagnosis between referral and report; 'Same ICD block' indicates a 'near miss', and 'Different ICD block' indicates a misdiagnosis. Radiology referrals were the most reliable, with a generally low percentage of misdiagnoses overall.

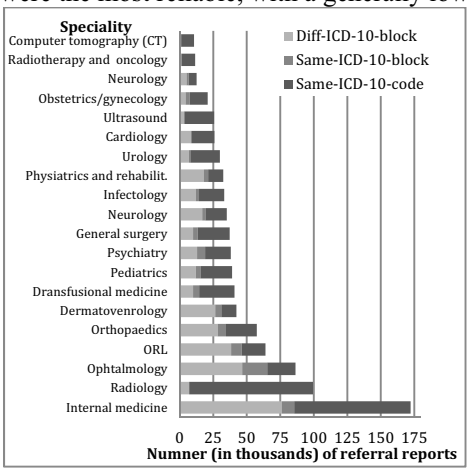

Figure 3. Top twenty specialties by number of referral reports

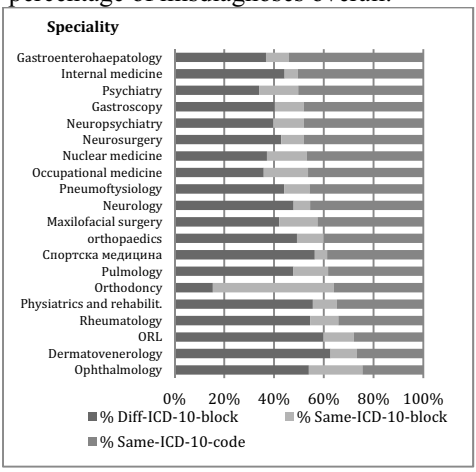

Figure 4. Top twenty specialties by % of different ICD code/block

Figure 4 shows specialties with over 1.000 referrals over the period analysed. The aim of this analysis was to determine whether the referrer's diagnosis is confirmed by the follow-up appointment with a specialist. The figure shows only referrals leading to a specialist appointment and report. There are 2.392.23 such referrals and 1.860.563 reports, indicating that ~21% of appointments were missed.

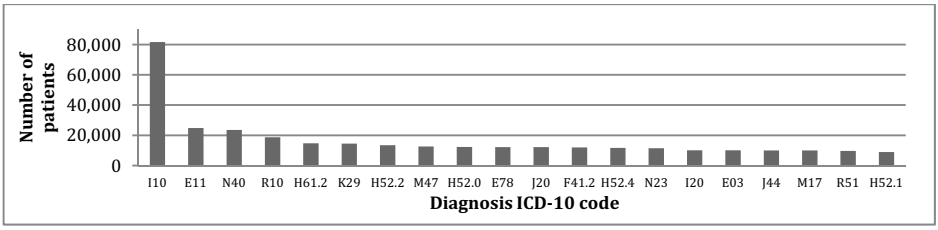

Figure 5. Top twenty diagnoses by number of completed referrals to specialists

Figure 5 presents the top 20 diagnoses generating referrals to a specialist. These diagnoses generate 23,06% of all referrals to specialist. The most common referral leading to a specialist appointment is I10 (Hypertensive diseases), alone accounting for 5,62% of all specialist referrals. It is followed by E11 (type 2 Diabetes). Both leading diagnoses are linked to a modern lifestyle in developed countries. This data indicates primary diagnoses only and further research will examine underlying patient conditions.

3. Discussion

The strategy of the MH is to provide a comprehensive national e-health system. The plan for executing this strategy is broken into three stages: 1. Implementation solely of an appointment module; 2. Integration of all healthcare institutions (GPs, hospitals, pharmacies, NHIF, Agency of drugs); 3. Integration of laboratories, a RIS, the institute for public health operations, preventative medicine systems (vaccination and immunization, an e-health card for pregnant women, and tracking of radiation exposure), hospital inventory, in order to build a complete EHR.

The system is currently at the end of the second stage of this plan. Studies to date that have analyzed data from EHRs have used approximate statistical methods with a certain percentage of bias [1]. The unique advantage of analysis of the MojTermin system is that exact data are generated on a national level. Our initial analyses have opened many new avenues of investigation which will be pursued in further work.

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