Connecting Primary Health Care: A Comprehensive Pilot Study

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Abstract- The collection of data within the primary health care facilities in Iran is essentially paper-based. It is focused on family's health, monitoring of non-infectious and infectious diseases. Clearly due to the paper-based nature of the tasks, timely decision making at most can be difficult if not impossible. As part of an on-going electronic health record implementation project at Tehran University of Medical Sciences, for the first time in the region, based on a comprehensive pilot project, four urban healthcare facilities are connected to their headquarters and beyond, covering all aspects of primary health care, for the last four years. Without delving into the technical aspects of its software engineering processes, the progress of the implementation is reported, selection of summarized data is presented, and experience gained thus far are discussed. Four years passed and if time is any important reason to go by, then it is safe to accept that the software architecture and electronic health record structural model implemented are robust and yet extensible. Aims and duration of a pilot study should be clearly defined prior to start and managed till its completion. Resistance to change and particularly to information technology, apart from its technical aspects, is also based on human factors.

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Introduction

The community health system in Iran is focused generally on the family, professional and environmental health. The cornerstones of the primary health care (PHC) service in Iran are the continuity of care and regulated follow-up procedures that are provided free of charge; its key areas include family health; focused on monitoring the health of the child, woman, elderly and occurrence of both infectious and non-infectious diseases. Started in the early 1970's (1) for the purposes of providing free and easy access to PHC (2), extended in later years (3), it even surprised the health workers in Mississippi USA recently (4) to find out that how the Iranian PHC model could remedy some of their local problems and perhaps even pave the way for further collaborations between the two countries (5). Despite the large number of 20,000 or so such rural and urban PHC facilities (6), till as recent as 2012 in a study of health centers in Tehran it was shown that the recording of information is still completely paper-based (7). Clearly due to the paper-based nature of the tasks, timely decision making at most can be difficult if not impossible.

The ISO/TR 20514 standard defines electronic health record (EHR) as a "repository of information regarding the health status of a subject of care, in computer processable form, stored and transmitted securely and accessible by multiple authorized users, having a standardized or commonly agreed logical information model that is independent of EHR systems and whose primary purpose is the support of continuing, efficient and quality integrated health care"(8). An extensible structural model of EHR is the key in dealing with the ever-running trials and studies that occur in the area of PHC, in other words, an effective EHR structural model acts as an "adapter" for the changes that take place in the field. In this paper, we present the outcome of an over four year running pilot project of implementing an EHR system in four urban PHC facilities. Briefly, client software installed in the clinic is used to record all needed information without the need of an Internet connection, copies of data gathered are sent out automatically, converted to

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EHR extracts and further processed for warehousing, mining, and visualization.

Because of the large overwhelming amount of information consolidated, a selection of summarized data is presented, and our experience with the pilot study is shared.

Materials and Methods

The client software installed in the clinics is a modular hospital information system (HIS) designed and developed by the author starting 14 years ago. It is written in mixed.NET languages, figure 1. The database of choice, connected to the client software, the main store, and analytics was that of the SQL Server 2008 R2.

Briefly, without delving into the design details, the client software's user-interface was largely based on a dynamically adaptable interface, so called data entry "forms" containing business rules and workflows. In other words, if the need for recording new types of information in the clinic, e.g. health trials, arose then there were no need to upgrade the software physically, new "forms" would be sent and stored in the clinic's database and used as when needed.

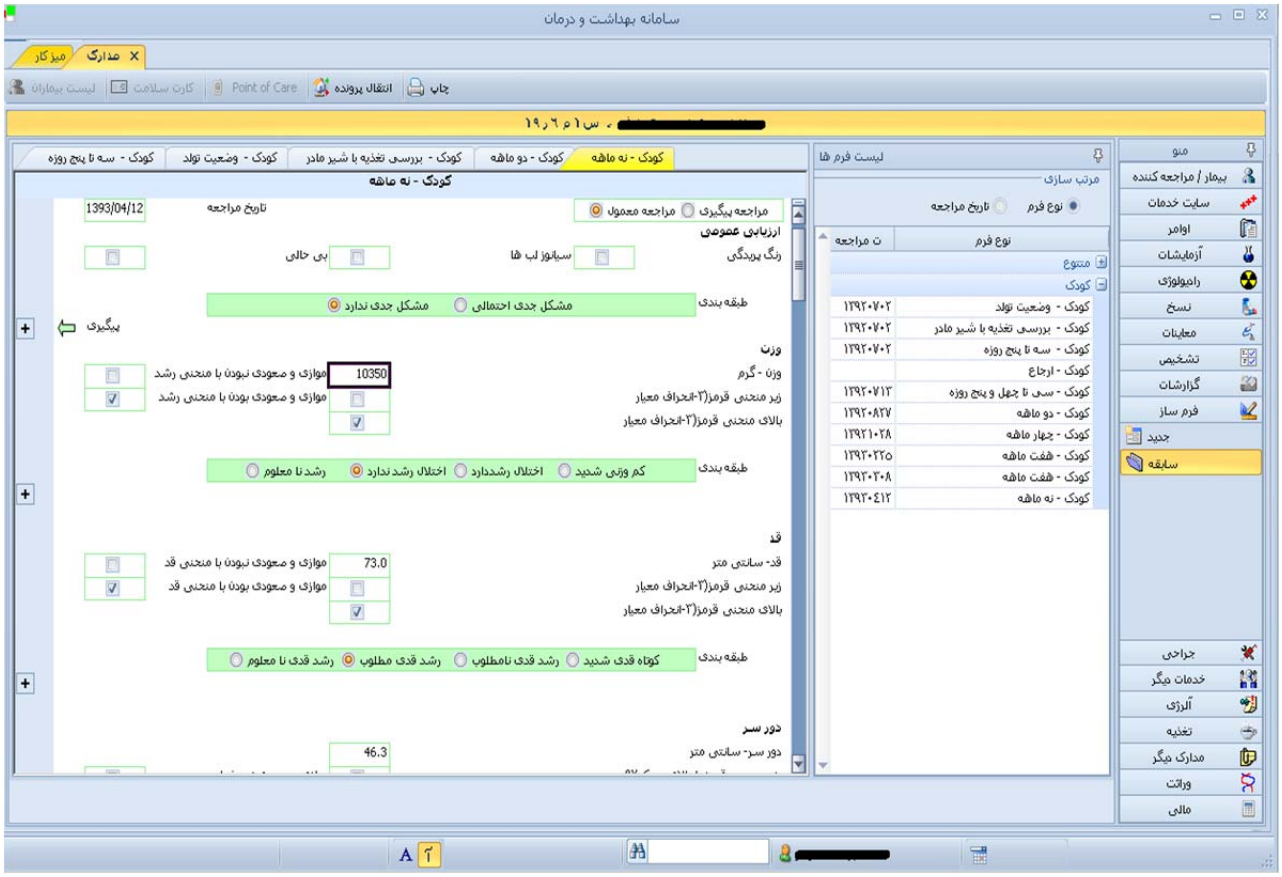

Figure 1. Screen capture of the integrated patient medical record module opened in the client software for an 18 months child, containing all the services given over his/her lifetime in that clinic

Following fifteen months of extensive consultations and collaboration with PHC experts at the Rey Health Care Network and the university, data entry forms were customized and validated according to the Iranian Ministry of Health PHC guidelines, some main types of information collected in the four clinics running the software are shown in table 1.

As shown in figure 2, after a user saves details of a service in a clinic by filling out validated data entry forms, data from the completed forms are extracted and sent securely to the broker located at the university and stored. It is then consolidated and transformed based on a physical structure model of EHR (details outside the scope of this paper) to fragments or extracts of EHR which are further subjected to transformation and prepared for analysis and visualization in a Web

dashboard (Figure 3).

Table 1. Some of the key types of information collected in the four clinics running the pilot program

Domain	Types of information collected
Family planning	Initial consultation for a method of choice. Data collected periodically on Pap smear results, usage of the condom, tablets, injections, intra-uterine devices, tube legations, needed referral and its feedback.
Preconception care, peri- and postnatal care	Advice and monitoring of pre-conception care. Routinely collected data during pregnancy includes physical examinations, laboratory results, measurement of vital signs of the mother and fetus, needed referral and its feedback.
Child health	Monitoring all aspects of child's health including, growth status, feeding habits, vision, vaccinations, dental health from the age of three days to eight years, needed referral and its feedback.
Elderly health	Monitoring both the current physical and mental status, as well as style of living. The data collected includes cardiovascular, mental health, infectious and non-infectious disease and diet , needed a referral and its feedback.
Vaccinations	Dose dates of vaccines (such as BCG, Hep B, DT, DPT, Polio, MMR, Pentavalent), with their serial numbers and expiry dates.
Follow ups	Recording of reason for a selected follow up, and any number of related actions associated with that follow up
Newborn screening	Screening for PKU, thyroid dysfunction, and sickle cell anemia in the newborn based on the country's published guidelines.
Pharmacy (Health center only)	Recording of prescriptions and automatic calculations of costs based on the insurance type selected.
Laboratory (Health center only)	Recording laboratory requests and results. Automatic calculations of costs based on the insurance type selected.

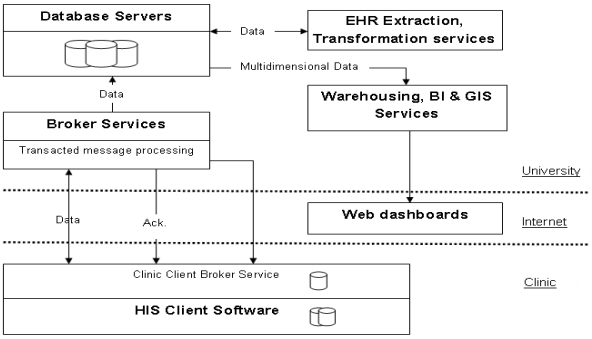

Figure 2. Basic block diagram of data flows between key components of the system. Any information recorded in the clinic is saved locally, and copies are sent securely to the broker located at the university using a messaging infrastructure. Following consolidation and conversion based on a physical structure model of EHR, physical multi-dimensional cubes are designed and made accessible via the web dashboard on the Internet.

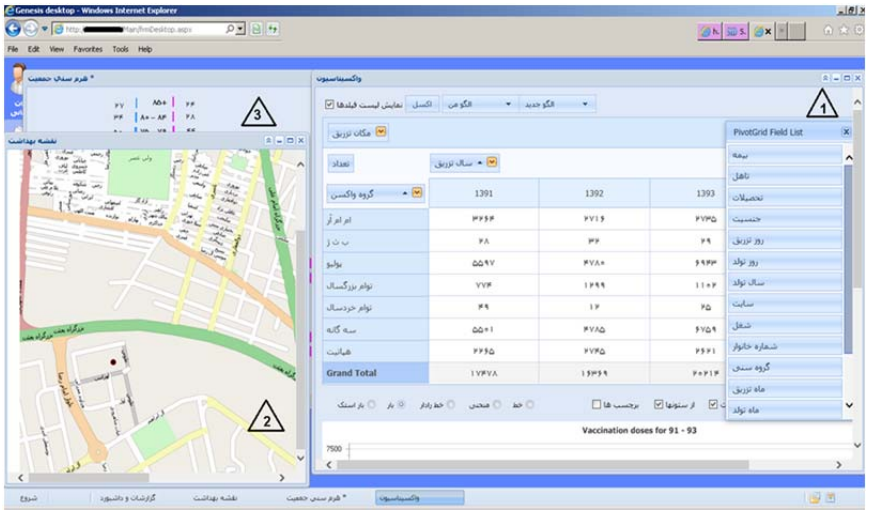

Figure 3. The EHR business analytics environment in the Internet Explorer dis playing; (1) vaccination pivot table with the ability to store user's configured data models, (2) an interactive view of an OpenStreet Map window with the capability of mapping disease signs and symptoms to the GPS co-ordinates of patients' addresses, (3) age distribution panel.

Results

Due to the lack of space and an overwhelming amount of information that have been consolidated over the last four years in the four clinics following the pilot study, only a small selection of summarized data is presented here.

The total number of personal details recorded were 46900 of which 37833 were registered in the coverage areas under study. The population age distribution (n=37833) based on gender for the coverage areas appear to peak around "1-4" and "30-34" years, Figure 4, with the calculated median at 10118 people per site.

The pattern of doses given for common vaccines (n=54061) for the last three Iranian calendar years is shown in Figure 5, with polio and combined DPT vaccines having relatively higher doses due to schools' vaccination requirement prior to admission.

Table 2 lists the newborn birth classification (n=4331) based on gender over the last four Iranian calendar years in the coverage areas, with three times cesarean section than natural delivery types. The total number of new pregnant mothers annually appear to be increasing over the last four Iranian calendar years, the literacy distribution is shown in Table 4 for 15-54 years old of both sexes combined (n=22260) is listed in Table 4, with 65% reaching the secondary education and 23.6% having schooled for 5 years or less. Finally, a summary of services given, excluding the vaccinations, over that last two calendar years (n=43988) presented in Table 5 with the notable overall decrease in the family planning services in line with the strange directive, from Iran's policy makers towards the demand, for an increase in the total fertility rate (9).

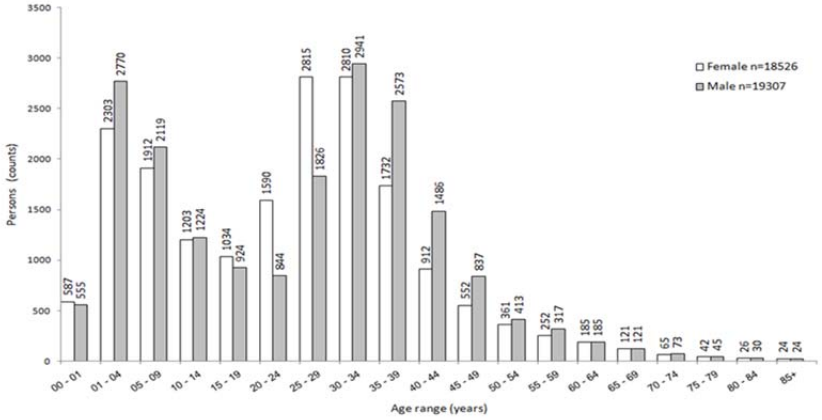

Figure 4. Population age distribution based on gender in the coverage areas of the four clinics (n= 37833) with two peaks around 1 to 4 and 30 to 34 years old

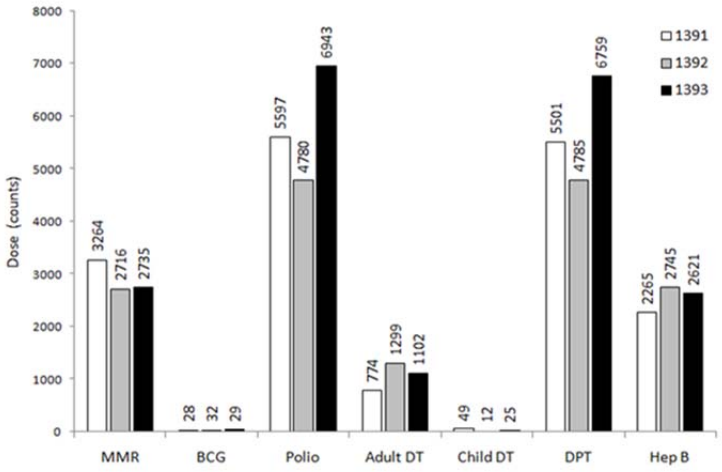

Figure 5. Vaccination doses given over the last three Iranian calendar years in the coverage areas of the four clinics (n=54061)

Table 2. Birth weight classifications based on gender over the last four Iranian calendar years in the coverage areas of the four clinics (n=4331)

Delivery type	Gender	1390	1391	1392	1393	row grand total
cesarean section	Female	318	381	354	457	1510
	Male	471	472	401	423	1767
Total cesarean n (%)		789(24.1)	853(26.0)	755(23.0)	880(26.9)	3277
Natural	Female	130	139	103	140	512
	Male	154	138	113	137	542
Total natural n (%)		284(26.9)	277(26.3)	216(20.5)	277(26.3)	1054
column grand total		1073	1130	971	1157	4331

Table 3. Number of new pregnant mothers over the last four Iranian calendar years in the coverage areas of the four clinics who were provided with professional perinatal care

Count	1390	1391	1392	1393
New mothers	288	291	325	328

Table 4. Literacy distribution for 15 to 54 years old for both sexes combined in the coverage areas of the four clinics (n=22260)

Age range (years)	Type 0	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Row grand Total
15 - 19	2	90	450	1059				1601
20 - 24	13	21	165	1849	83	65		2196
25 - 29	26	67	353	3282	302	349	23	4402
30 - 34	47	148	586	3855	273	517	63	5489
35 - 39	91	234	716	2579	175	305	31	4131
40 - 44	147	233	571	1199	40	124	17	2331
45 - 49	176	191	402	521	19	34	10	1353
50 - 54	197	112	212	215	10	8	3	757
column grand Total n(%)	699(3.1)	1096(4.9)	3455(15.5)	14559(65.4)	902(4.0)	1402(6.3)	147(0.7)	22260

The levels of education reported were as follows: Type 0: none (self declared), Type 1: Incomplete elementary (less than 5 years), Type 2: Elementary (5 years), Type 3: Secondary (12 years), Type 4: Higher national diploma (14 years), Type 5: Baccalaureate (16 years), Type 6: Master's degree (18 years)

Table 5. Summed up services, excluding the vaccinations, recorded (n=43988) over the last two Iranian calendar years in all four clinics

Service group	Type of service	1392	1393	Row grand total
Family planning	routine	3641	2233	5874
	consultation	1796	1250	3046
Total family planning n(%)		5437(61.0)	3483(39.0)	8920
Maternal health	routine	1294	1231	2525
	with follow up/referral	764	883	1647
	postpartum	1008	1067	2075
	postpartum with follow up/referral	230	84	314
	preconception	83	81	164
	prior to delivery with follow up/referral	54	25	79
Total maternal health n(%)		3433(50.5)	3371(49.5)	6804
Elderly health	routine	104	96	200
	with follow up/referral	177	166	343
Total elderly health n(%)		281(51.7)	262(48.3)	543
Child health	1-2 years old	4951	4147	9098
	2-5 years old	1049	1185	2234
	5-8 years old	544	333	877
	< 1 year	4995	7248	12243
	1-2 years old with follow up/referral	1130	1375	2505
	2-5 years old with follow up/referral	379	241	620
	5-8 years old with follow up/referral	84	60	144
Total child health n(%)		13132(47.4)	14589(52.6)	27721
column grand total		22283	21705	43988

Discussion

Despite the established history, extent of coverage size and the annual budget spent on PHC in Iran, the method of information collection in the urban health care facilities and health houses are still paper-based. Therefore, any timely decision making, for example, in relation to the assessment of the quality of services, performance indicators, early detection of spread of disease both infectious and non-infectious would be ineffective.

We reported in this paper pilot implementation of an EHR system which has been running in four clinics over more than four years and showed a small selection of summarized reports. If time is any important reason to go by, then it is safe to accept that the software architecture, EHR structural model implemented are robust and yet extensible with usability in the field. The architecture has provided the immunity from the unstable Internet services in Iran. Furthermore the method of dynamic data entry "forms" has made on-demand requirements for new health trials a reality. The EHR structural model developed has been pivotal in the survival of the program thus far, as it is not affected by frequent changes in types of information collected that take place in the field.

So why the long delay in the extension and deployment to the other urban PHC clinics at the university?

Any information technology project needs to start with clearly defined aims, milestones, evaluation procedures and with its management being integral to the whole business process. The costs of poor software designs and bad project managements is well documented (10,11). Some of the key reasons for resistance to change, in our case at the lower management level, included; uncertainty about the future, misunderstanding about the need for change, lack of competence necessitating changes in skills, feeling not being consulted, changes in the status quo, for example, frequent audit visits to clinics are no longer required leading to lower extra pay cuts. The human factors of resistance to change are also important and need to be taken into account when planning information technology projects.

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