The Role of Biomedical Engineers in the Introduction and Maintenance of Health Information Systems

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Abstract —**Health Information Systems (HIS) are the basis for planning, managing, and evaluating health care provision. However, many countries (both high- and low- income) face difficulties in introducing and adopting relevant eHealth applications in their clinical and technological environment. Health systems with limited resources are further challenged by the increasing demand for various electronic, especially facility-based, HIS and the fact that technical assistance on-site is often missing.**

In the Republic of Moldova, a Swiss Program has introduced an Information- and Management System for Medical Devices used in the area of Perinatology and Paediatrics and could thereby rely on trained Biomedical Engineers for the implementation and maintenance of the IT tool since 2009. In the target setting, five out of nine secondary and the tertiary level healthcare providers currently employ Biomedical Engineers, whereas specialised IT experts are rare and only make-up for 17% of the technical staff working at the hospitals.

To support the above mentioned tool and other HISs in smaller hospitals, Biomedical- or Clinical Engineers are often the only professionals present who act as interface between the technical and the medical world and provide valuable expertise. The adoption of various HIS applications at hospital level is thus an important task of Biomedical Engineers and this should be reflected in the professional education curriculum of the training institutions and in the job description of their employment.

Index Terms — **Health Information Systems, Biomedical Engineering, Medical Devices, Human Resources in ICT**

I. INTRODUCTION

Good information is the foundation for any kind of policy-making, planning, programming, and accountability. Health indicators are indispensable for public health action. Unfortunately, good information is rarely available in low- and middle income countries due to underinvestment in Health Information Systems (HIS) that are essential for data collection, analysis, dissemination, and use. Along with the institutional difficulties, common technical problems include poor quality of data; lack of common standards; data inconsistencies and inefficiencies; difficulties to analyze and aggregate the data. Furthermore, the information obtained through a HIS is no longer only relevant to the work of epidemiologists and public health experts, but also to communities and health care providers [1].

Due to that fact and because HIS is a very wide topic, it is important to break it down into groups or categories of applications. According to the Health Metrics Network, there is a basic distinction in HIS between two main sources of data:

- Population based data (e.g. a demography profile from Civil Registration)
- Health institution based data (e.g. disease records or health administrative data)

The present work deals primary with management of "Health institution based data" and the related tools and methods.

Typical Information Systems at institution- or facility level include: "Individual Records" (also referred to as Electronic Health Records- EHR) which store information around the patient and its treatment history. Further, there are systems to manage the "Service Records" which store essentially clinical and administrative services delivered and associated costs. Third, there are so called "Resource Records", which should help the institution to allocate the inputs (human resources, medical equipment, infrastructure, pharmaceuticals, or other consumables) [1].

With the technological advances in healthcare, the amount and complexity of data has increased steadily. This calls for new tools, methods and architectures to handle this data.

Obviously, one of the consequences (or causes) of this development is that there is a shift from paper-based to electronic processing and storage of information. Another implication is that there is trend from institution-centered hospital information systems towards regional and national HIS [2]. This also means that healthcare planners can no longer only focus on technical HIS problems but need to equally consider human resources allocation, change management as well as strategic information management.

This paper will focus on the electronic- or computer-based parts of the HIS and the institutional / organizational challenges of institution based data management. More specifically, on experiences made along the introduction of an Information- and

Management System for Medical Devices in the field of Perinatology and Pediatrics in the Republic of Moldova are presented herein.

Information Systems for Medical Devices are a special case because the topic is rarely mentioned in HIS literature. In an improved health information system however, medical devices information have to become a separate, well recognized and analyzed part of health institution and administrative data.

Furthermore, the authors think that findings are important for the future role of Biomedical- or Clinical engineers and that the lessons-learned are, to a certain extent, generalizable and should be considered when the country engages into further HIS implementations on the agenda.

II. METHODS AND TOOLS

Since 2009 two Moldovan-Swiss collaboration projects - REPEMOL (Regionalization of the Pediatric Emergency and Intensive Care Services in Moldova) and PERINAT (Modernizing Moldovan Perinatology System) - funded by the Swiss Agency for Development and Cooperation (SDC) are promoting the strengthening of the Health Technology Management (HTM) system of Moldova. The multifaceted initiative and related activities requires close collaboration with the Ministry of Health, Professional Associations and Agencies, the Technical University. However, to the largest part the project is directly targeting the partner hospitals (listed in Table 1).

TABLE I. LIST OF HOSPITALS INVOLVED IN THE PROJECT

HOSPITAL	LEVEL
MCHRI	3
CMH no.1	2
MH Balti	2
SM Bălți	2
SMC "V.Ignatenco"	2
SR Orhei	2
SR Soroca	2
SR Cahul	2
Ciadir-Lunga	2
Hincesti	2

In the secondary level and tertiary level hospitals, the project supports the establishment and endowment of maintenance workshops, QM procedures, user training, and other initiatives. In the sense of strengthening technology and information management, the project has also invested in building- up of an Information System for "resource records", in this case medical equipment.

Besides reporting of the experiences from introducing and running this Information Systems in the facilities, the study also investigates on the availability, the educational background, the age, and exposure to Health Information Systems of technical heath workforce at the hospitals listed in Table 1.

The qualitative data originate mainly from the project progress reports and field visits. Information on human resources is also routinely collected by the project - as part of the monitoring system. Additionally, it was verified by phone interviews with each of the hospitals prior to the publishing.

III. RESULTS

Every introduction of a new processes and management systems is confronted with challenges. In the case of Moldova, it was difficult to identify hospital staff workers with the relevant job profile and computer skills. In the beginning in 2009, hardly any formally trained Biomedical Engineers were present in the hospitals. The health workforce available was often not familiar with the information to be collected (administrators, or computer clerks) or they had the technical understanding of the subject matter but were lacking experience in using computers in their daily work. Consequently, the data was entered only sparsely, there was no follow-up and the quality of the data was poor.

Ideally, trained Health Informatics Specialists or similar professions are present at least in secondary or tertiary level institutions. The expertise of such professionals would have been much needed in the planning and design phase of HIS, the infrastructure upgrading, data management and the training and technical support of users at the facility level.

Although the Republic of Moldova has, with its e-Transformation program [3] initiated a number of targeted centralized services for citizens, the investment in IT skills and capacities at local/facility level remains a challenge; if such specialists with the relevant skills exist in the public sector, they work for the central government or at major healthcare institutions. In the case of Moldova, it must be mentioned that the salaries of IT professionals employed in public hospitals compare very badly to the remuneration of an equivalent position in the private sector.

Thus, for the introduction of the HIS, it was clear that the project could not rely on working only with IT- or health informatics specialists.

In 2010 to 2012, more hospitals could employ biomedical engineers. To investigate on the human resources issue more quantitatively, the project has made the following findings:

TABLE 2. AVAILABILITY OF TECHNICAL EXPERTS IN SELECTED MOLDOVAN HEALTHCARE INSTITUTIONS IN 2012 (BY ABSOLUTE VALUES, PERCENTAGE IN BRACKETS)

	PROFESSIONS				
	BIO. ENG.	ENG.	IT	OTHER	TOTAL
TOTAL	**10 (0.43)**	**5 (0.22)**	**4 (0.17)**	**4 (0.17)**	**23 (1)**
2ND LEVEL (9 HOSP.)	6 (0.6)	3 (0.6)	4 (1)	2 (0.5)	**15 (0.65)**
3RD LEVEL (1 HOSP.)	4 (0.4)	2 (0.4)	0 (0)	2 (0.5)	**8 (0.35)**
MALE	10 (1)	4 (0.8)	4 (1)	4 (1)	**22 (0.96)**
FEMALE	0 (0)	1 (0.2)	0 (0)	0 (0)	**1 (0.04)**
Ø AGE [Y]	24.0	47.2	27.0	55.8	**35.1**
HIS EXP.	9.0 (0.9)	1.0 (0.2)	4.0 (1)	0.0 (0)	**14.0 (0.61)**

Table 2 shows that 43% of the currently employed technical staff in the target hospitals has a degree in Biomedical Engineering from the Technical University of Moldova (TUM). At the same time, only 4 IT professionals (17%) are under contract by the 3rd and 2nd level facilities surveyed (ref. Table1). It stands out that regarding the gender of the technical staff; only one female (an Engineer) comes on 22 males. The average age of the biomedical engineers (10) at the hospital is 24 years, while it is 47,2 for engineers (5) and 55,8 years for

other professions such as mechanics or artisans (4). This is evident given the fact of the introduction of the discipline of Biomedical Engineering only few years ago.

At the same time, it shows that Engineers and other professionals are – partly considering their age – less likely to use or even support computer-based systems in their daily work. There was even no utilization of Information Systems at all in the category "other staff". On the other hand, thanks to the Information and Management System, 90% of Biomedical Engineers employed in hospitals were already exposed to information systems.

In total, 14 people (61%) of all technical professionals have been involved in the introduction of the HIS. Those people did not only bring benefit to the system itself but they have gathered useful practical expertise in key issues (infrastructure, human resources, data availability, data and quality) relevant for the introduction of health information systems in hospitals.

FIGURE 6: EMPLOYEES IN THE OFFICE OF A 3RD LEVEL MAINTENANCE WORKSHOP IN CHISINAU, MOLDOVA.

In our case, those hospitals have managed to keep the information system more updated, complete and maintain better data quality. What has further helped in accomplishing the task was the technical background and – in this particular case – the good understanding of the nature of the work (data on medical devices infrastructure).

Another benefit was also the better availability of computers or workstations at the newly established maintenance workshops which have (in most cases) also internet connection.

To generalize this finding, it can be said that in the long run, the task of entering and managing HIS data electronically must be decentralized, i.e. brought to the respective department or user and have HIS become part of the routine work processes.

Based on the experience made, the role of technical staff, namely biomedical engineers, at the hospital in the introduction and maintenance of information systems were the following:

- Specifications and requirements writing
- Software installation and acceptance
- Infrastructure installation and maintenance (network, server, etc.)
- Documentation and data management (including data quality)
- Training and education of other users

As in all medical disciplines, collaboration with Universities, technical high schools and post-graduate training institutions is also very important. In the case of Moldova, the herein mentioned Information System has only performed well in the field, because the respective faculty of the Technical University of Moldova (TUM) has taken up the topic in their curriculum. A dialogue with other relevant training institutions (in our case, the medical faculty, the informatics studies, etc.) is indispensable for changing the way information systems work in a country.

IV. CONCLUSION

It is confirmed in other case studies, deploying health information systems within facilities and districts requires dedicated human resources, training and career development. Only if this is given, improvements in the quality of data reported and in the understanding of its importance by health care workers can be achieved [4]

As it was shown in our example, the adoption of HIS applications at hospital level in Moldova depends on the availability of Biomedical Engineers rather than IT experts.

Taking this into account, a key task for health system planners at central and local level is to make sure such resources are available and to establish a respective policy and monitoring framework.

Additionally, the theoretical background on HIS and hospital networks should become integrated in the education of Biomedical Engineering or related professions. It is already part of standard works in relevant textbooks. Topics or chapters like: "The integration and convergence of Medical and Information Technology" [5], "Medical Information Processing and Communication" [6] or "Biomedical Engineering and Information Systems – IT Tools and Applications" [7] provide valuable technical references.

The specific skills of the Biomedical Engineers are even indispensable where there is an interface between IT systems and medical devices such as for X-Ray systems and PACS or Lab analyzers and the electronic information exchange between analytical instruments (AIs) and laboratory information systems (LISs)[8].

According to the experience of the project, the new workforce has also brought significant support to other areas of information management at the hospitals such as Telemedicine systems or Clinical Skills Lab and related information processing.

A stronger involvement of Biomedical Engineers in Health Information Systems in general is needed in assuring access and understanding clinical- or service data from institutions. It shall provide the engineers with relevant evidence for investment planning (e.g. for how many tests does a certain instrument have be specified? Or: what is the number of patients per year needing this type of ventilation?)

For all those reasons, the presence of well-trained Biomedical- or Clinical Engineers in small or mid- size facilities is critical – not only to assure the adoption of Health Information Systems but to effectively profit from the large range of information technologies for health care per se.

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