Identification and Hierarchy of Main Electronic Health Record Components in Occupational Medicine

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Abstract

Starting from the legal requirements relating to structuring of medical records in occupational medicine and international requirements regarding the certification of electronic health records we have focused on structuring and then evaluating an EHR model in occupational medicine that integrates the main functions and certification criteria required by the European and US certification bodies.

The application we designed, called Medmun, structured for use in occupational medicine practices based on the model of medical file provided by the Romanian legislation, integrates both necessary components of occupational medicine practice for administration of characteristic information related to socio-economic unit, work place, health surveillance as well as components of specific EHR functionality. The application has been submitted for free evaluation by specialist physicians of five counties over a period of nine months and subsequently assessed using a questionnaire on the usefulness of specific functional components in the EHR occupational medicine practice.

The model was positively evaluated after experimental employment by occupational health practitioners. They consider that absence of legislative support for EHR implementation in medical practice is the main obstacle to the use of such applications in occupational medicine practice.

Keywords: Electronic health record; Electronic patient record; Occupational medicine.

Introduction

Quality and efficiency of medical care impose the pysician's appropriate access to a large volume of varied information from different sources, medical or of other nature (administrative, professional, family) in due time.

Obtaining information about professional route, with specificity of positions, family history, all events related to employment but also outside of employment history, require that the occupational medicine specialist should communicate rapidly in compliance with enforced legislation, data on workers, shared primarily with the family physician but also with other providers of medical services, employers, inspection and control bodies, insurance systems, etc., which cannot be effectively performed as paper base medical records.

In Romania, applications that administer medical information in service units of occupational medicine are geared strictly towards practical purposes without being structured according to minimal requirements in terms of the applicable certification criteria currently applied at United States or European Union level, respectively the Certification Commission for Healthcare Information Technology in the United States [1] and European Union Institute for European Health Record, referring to Electronic Health Record [2]. Using an electronic health record with application in occupational health medicine which meets the requirements of those bodies, disregarding all health care providers and especially family physicians in the first place, is virtually impossible.

The objective of this paper is to present an Electronic Health Record software, i.e. Medmun application that should meet both the requirements of the Romanian legislation and certain international certification requirements mentioned above.

Material and Method

This section presents the main issues that the Medmun application was based on as well as the software tools employed

Electronic Health Record Structure

Structuring of information to be included in the medical record are provided by law [3] therefore realization of the electronic health records should be based on these legal provisions and allow listing of the identification sheet of professional risk factors, the actual medical records and the competency advice.

The medical record is divided into two main sections corresponding to the two types of information included in this file:

▪ General data on the socio-economic unit and the worker: representatives, addresses, places of work and positions with identified occupational risk factors in the employment application [4], in the risk factors identification file, but also in the medical file itself..

▪ Specific medical data: information on history, health status and its assessment, the worker's assessment and ability advice, the occupational specialist's recommendations.

General functional criteria for assessing the quality of Electronic Health Record in countries like United Kingdom, United States have to be synthetically added, while further integration of Romanian legal requirements and specific items of additional functionality for Electronic Health Record is imposed: i.e., medication management, health evaluation and diagnosis documentation, planning and sharing of medical care, documenting results, security, demographic services, alerts, notifications and reminders, technical aspects of data security [5]. Identification of functional components and user interface, result from these legal and functionality requirements.

The top bar presents six major groups of options

▪ **Definitions**: Allows users to define and update databases related to the healthcare provider of occupational health services, units, positions, patients. Defines the work as well as data entry exercise.

▪ **Documents:**

- **Consultations Registry**. This registry is specific for each defined medical unit, medical office or an authorized business or commercial companies providing medical care.

- **Programming** allows consultation programming both as individual patients and patient groups in a firm (time related to socio economic unit)

- **Statistics:** Listing of statistics related to socio-economic unit, patient, job or user-defined statistics: related to Risk factors Sheet, Medical File, Units, configured and predefined-in Expert reports

▪ **Nomenclature**s: Listings of the main nomenclatures: ATC classification of drugs, Classification of Occupations, CIM 999, ICD 10, ICPC2, CAEN codes, Procedures, Examinations, Biological agents, Chemical agents, Corporate type.

- **Tools**: relating to Maintenance, Saving, Data Restoratio, Configuration: of background image (background) and printer application, visualization of execution errors, Web editor, source-initiated program editor, MIAD space. Users and Roles Update, Update of items and label related dictionary.

- **Help:** documentation, technical support, email, information about application

Firstly, objectives of Electronic Patient Record employment in occupational medicine and Electronic Health Record general and functionality requirements lead to prioritization of Electronic Health Record components [6]. Given the nature of occupational medicine activity which is focused on prevention, the health evaluation and work capacity criteria, documentation of diagnosis and the results are essential. Furthermore, from the point of view of computerized exchange they have to be standardized under specific encodings: ICD 10, ICPC-2, CAEN, COR, etc. Demographic services in occupational health are customized: they refer primarily to the worker but will always be associated and will have to include similar data of a worker's socio-economic unit, of his/her workplace within the unit. Data security is shared, with possible partial access of three main players: employers, worker, doctors, the last with full access to all the data. Planning and sharing of medical care, medication management, alerts and notifications are important elements of functionality without being essential components in occupational medicine. For the occupational physician the elements that allow the decision-support in health evaluation are essential: employment components, the worker's past and present health status as well as elements that led to the diagnosis. Equally important to the occupational physician and the other two key actors of the Electronic Patient Record, the worker and the employer, is the ability advice and the accompanying recommendations.

Electronic health records must include the following identifiers: the current record, the patient, medical care provider, the doctor [7]. Through the information content, an employee's Electronic Patient Record is also owned

and expresses the interrelations with a specific socio economic unit [8]. This brings forth an additional identifier: that of a specific socio- economic unit. Identification Data: unit, employment, worker, physician, date of medical care, have to be added at the worker's personal health data: historical-subjective and objectified through various documents, present-history, clinical, laboratory and various medical specialties in relation to the characteristics of employment and positions within the socio-economic unit for future recommendation of the worker's activity.

- Components of health evaluation and diagnosis documentation: episode of care - generally corresponding with the medical examination and opinion of a of fitness; history, symptoms, signs, recommendations and results of referrals [9]. In occupational medicine this component has particular aspects arising from interference with risks of different employments: accidents, occupational diseases, symptoms related/not related to work, temporary incapacity through leave records or conditionings related to a specific activity.
- Component of planning and sharing medical care with planning of medical activities
- Component of results documentation with the terminology employment and specific encodings
- Administrative Components / Demographic Services: worker -name, first name, identification data, address, type of medical examination, appointments
    Socio Economic Unit: name, address, manager, industry
    Unit providing medical care: name, address, work, doctor, type of user in the medical care: supervisor, guest user
- The components of the additional examinations, of screening or specialty / laboratory results, enquiry and results entry/recording.
- Electronic prescription components: recipes, reference, medical letters
- Securing data -shared access by defining the user type
    The "Exercise" for a certain period: the period of exercise used for document introduction (it will only be introduced or modified in order to create a new unit and is automatically incremented/updated upon exercise closing). After exercise period completion, it is filed and there is no possibility of modification of input closing data. Although not a facility for physicians, in terms of legal requirements regarding the accuracy of records, this is an element of absolute necessity.
- Alerts, notifications and reminders
- Reports / Statistics complying with the law, the Department of Public Health, employer, employee
- Transfer of data-communication component
- Technical maintenance component, utilities: how to configure the application, printers, data saving and maintenance.
    For occupational health medicine, starting from specific practice in the field, components can be identified which - although by comparison with the general structure of electronic health records, can be integrated in the components of health assessment or administrative components, through their share in the medical care episode that resulted in the competency and a recommendation advice for a specific job - require separate grouping:
- Employment component, separate from the administrative one, containing elements that define the job / position within a specific unit and its specific aspects: employer, form of organization, specific risk factors, number of workers-for example for the relative risk calculation, the attributable etiologic fraction, etc [10,11].

In addition, the security component of shared access to files as well as forensic aspects of medical decision impose item ranking according to importance.

Results

Employed Software

Medmun application was created using the programming language Visual FoxPro v. 9. It represents a system of relational database management with its own language, support of an expanded core of relational SQL language, commonly used, fast, modularized, flexible, without requiring very large computing resources, by combining procedural with descriptive programming it allows the management of large amounts of data, easy-to-do queries, construction and use of Web components and services, building complete database applications for end-users, ensuring integrated XML support.

Hardware configuration required for Medmun application execution and operation: free hard disk space 300MB, IBM compatible PC with PIII 750 MHz or higher processor, minimum 256 MB RAM, 800x600 or 1024x768 resolution, optional: printer of any type, Internet connection.

Software configuration required: Microsoft operating system Windows 98/ME/2000/XP/2003 Server/Vista/2008 Server, Microsoft Internet Explorer 5.5 or more recent browser is recommended.

Interface and Functionality Components

The image presents the interface and functionality components synthetically (Figure 1).

A. The **"Definitions"** module allows defining characteristics of actors involved: health unit, doctor, patient, social and economic unit, job / positions, work period.

The "documents" module with "records of consultations" is specifically defined for each medical facility, medical office or an authorized practice of a medical or commercial society providing medical care. Through this the patient's electronic medical record sheet is accessed with all fields related to the general identification data.

Definitions section is structured starting from the necessity of defining each actor involved in the episodes of medical care: physician, social and economic unit, the patient. The application has two types of work intervals: period and exercise. The section "Details" allows "Exercise" definition.

Exercise: A period equal to one calendar month can be chosen. Choosing a period from a closed (archived) exercise will not permit introduction, modification or removal of documents during that period. In order to view the reports from closed exercises there is no need to amend the work period, as the report period can be modified directly from the report generation screen. "Work Period" allows visualizations, data processing without allowing any new data entry outside the exercise.
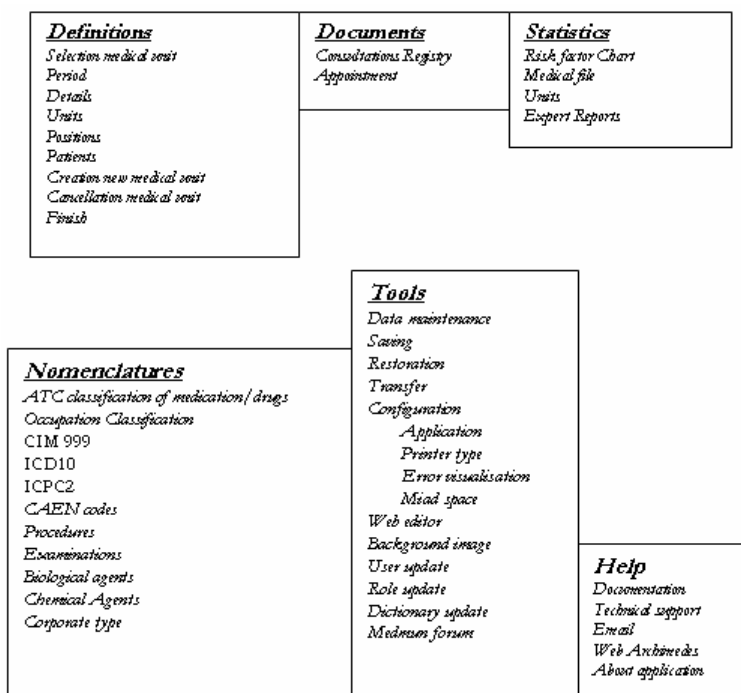
Figure 1. Interface components

The tax identification data, location, industry coded using CAEN, legal representative and for the healthcare provider also the occupational physician will be defined in this section for both the healthcare provider and receiving units of occupational health services. Next, the general data of the employer will be completed with the definitions of positions, and then the patients or workers of these units.

Work order for data entry is units-positions-patients: the unit must be defined first, and then position or positions within the unit and subsequently the patient data are entered (Figure 2). Forced positions, vicious positions, and professional gestures allow free text memorization; osteo-muscular-articulatory strain, visual, hearing, stress, manual handling of loads, also allow you to choose the field integration into overstrain –checked field, or strain absence - unchecked-field.

Risks include accidents and can be chosen through checking. For risks not covered by the predefined fields, other risks may be specified in the free text format.

Operations performed by the worker allow free text description. Chemical agents are selected from a list. This list is legally included in the Government Decision no. 1218 of 06/09/2006. This option was preferred in order to allow comparable and interoperable statistical data processing in time. By clicking "List of chemical agents" the window "chemical agents" is opened and at its bottom bar the "noxious agent" is selected that will display a window with the list of classifications prescribed in Government Decision no 1218/2006. With regard to powders,

the powder may be mentioned by name text field with corresponding tick if the maximum permissible value is exceeded. The same method of data storage is used on the fields "air temperature", "air pressure", "humidity", "type" - non-ionizing radiation. The working place may be artificially, naturally or mixed lit with the special mention "enough" or "insufficient".
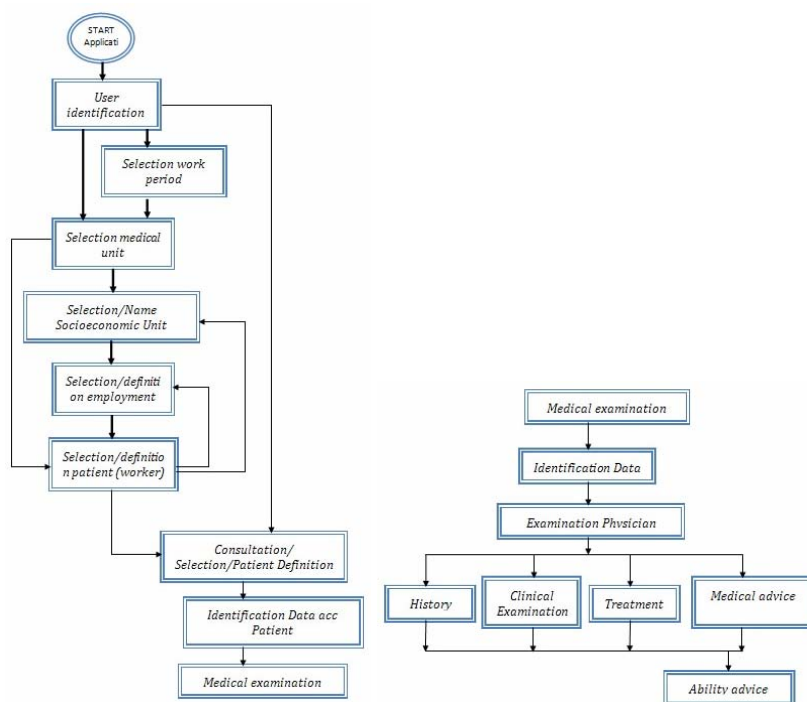

Figure 2. Logical scheme of data entry/access

Workplace biological agents can be chosen from their corresponding legally provided nomenclature: Government Decision no. 1092 of 16.08.2006 on the protection of workers against risks related to exposure to biological agents at work.

Patient entry may request your name, social security number and employer.

B. "Documents" has two subgroups: "*Consultations Registry*" and "*Appointments*"

In this section a module of "appointments" of consultations is provided per day, duration, time, patient or companies.

Consultations Registry. This registry is defined specifically for each medical facility, medical office or an authorized practice of medical or commercial medical care provider.

Fields including under "identification data", ID data, allow renaming by right clicking, such as "Name", within the "worker" allowing label adaptation to possible changes in terminology.

Access of the consultation field leads to the proper medical records. For "work accidents" the data referring to the event year, Injury, Location, Name are introduced, classified according to the FIAM form and classification of the same event in terms of ICD 10.

Pathologic history is mainly recorded by year of appearance, name as free text, disease classification according to ICD 10. The field "medical leave" allows recording when it refers to periodic medical examinations and not employment examination, of data on sick leave, including CIM and ICD 10 classification, of the allowance code. In addition to Government Decision 355/2007 fields, boxes are provided for known allergies, treatments performed with ATC codifications of associated procedures. At clinical examination procedures, ticking a box implies normal relations, unchecking it displays those fields for completion. When entering the "medical examination" field, for ease of use, they are checked. Whenever pathological aspects are found, the doctor records them in text format by unchecking that field/box.

The box "Additional Tests" has several groups of investigations: - "paraclinical and laboratory examinations," "special examination", "Other tests", "Audiometry", "Ventilation Samples", "private occupational health examinations", "Paraclinical and laboratory examinations".

It contains all toxicological investigations under Government Decision 355/2007 but other types of

investigations can be added. For the specialty consultation, the specialty is selected through the list of medical specialty display, the diagnosis as well as the ICD 10 code attached, as well as recommendations made by the specialist, "Recommendations" - in the form of free text. In addition, the profession graph is provided, MHL, cardiovascular functional tests, mention being made of other methods that are not included in these fields in the form of free text. Alerts on treatment are also activated if the history included allergies - "see Allergies" is displayed in the treatment box.

C. The **"Statistics"** display allows listing and sending to the browser, based on input, of the following:
▪ *Risk factors sheet*
Medical-File: paraclinical reference letter, reference letter to specialist, BP1 signaling sheet, skill sheet, Medical Letter, medical prescription
▪ *Units* allow listings according to the chosen unit interval and the reports to: employers, insurers, the Department of Public Health, employer with medical control, nominal, general.
If the employer provides the average number of employees in the reporting period, then the statistics of morbidity with temporary disability frequency and severity morbidity appears, otherwise it will show the initial number of medical certificates and the duration of sick leave during that interval, respectively
▪ *Expert Reports*- allows defined reports by user through predefined queries.

D. The section **"Nomenclatures"** allows listing of the major catalogs used: *ATC classification of drugs, Classification of Occupations, CIM 999, ICD 10, ICPC2, NACE codes, procedures, examinations, biological agents, chemical agents, corporate type*
Classification standards of the data used are: NACE rev1 classification, the revised version of economic activities in the European Community version of CAEN
▪ International Standard Classification of Occupations ISCO-88 International Classification of variant COR
▪ International classification of professional status , according to ILO and FIAM
▪ Diseases: according to International Classification of Diseases 10 Ed.
For classification of medical procedures and investigations: Australian Classification of Health Interventions in the field of Health, the International Statistical Classification of Diseases and Health Problems, Tenth Revision, Australian Modifications (ICD-10-AM),
ATC-code, Anatomical Therapeutic Chemical medical treatment
▪ Classification of symptoms according to ICPC-2. International Classification of Primary Health Care, 2nd Edition, Classification of specific data used for research on FIAM labor accidents, employer-identification data.

E. The **"Utilities"** allows definition of the roles of supervisor, or a guest user to access the application with full configuration rights, modification of data and visualization for the supervisor; from modification and visualization rights for the user to the right only to view data for guests. Likewise, the "Transfer Data" module can perform direct data transfer (import and export data) on a user defined time interval: that of a unit, worker, and position (Figure 3).

F. The **"Help"** section has the following features: ▪ Documentation: the documentation web page opens; ▪ Technical Support - Frequently Asked Questions relating to the application; ▪ Email: - sending electronic messages through the interface provided by program.
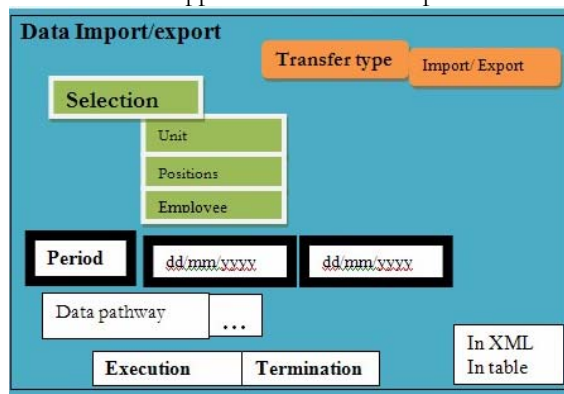About application: information about the application and its developers.

Figure 3. Data transfer module

Discussion

The software package "Occupational Health v1.0" was structured to meet legal requirements as well as requirements referring to certification of electronic health records[12] [13] [14]. Its structuring was not necessarily oriented toward ease of use since its goal is not commercial. For similarity with Romanian legislation, data fields with the same names have been maintained for evidence of employments and data on specialty consultation in occupational medicine with the advice of competency.

The Medmun application was posted free download and evaluation at the following web address: www.arhimedes.ro/medmun with attached questionnaires for specialty physicians. Opinions of users outside of the two questionnaires could be posted at the www.arhimedes.ro/forum.

The current application exploits encoding for main nomenclatures from the point of view of occupational medicine practice in order to facilitate data exchange recommended by some authors [15], without details of archetypal reference of their language encoding [16-18]. Identification and prioritization of key components of the Electronic patient Sheet in occupational medicine allows construction and further harmonization of generic classes of a Reference Information Model for the integration of electronic information exchange, generating the EHR elements [19].

Employment of data encoding in fields representing the actual medical records as recommended by some authors, commonly associated with free text without obligatory introduction of both variants, allows flexibility of use and the data can be retrieved from the database according to the filter used [20,21].

Testing of Medmun application, after a period of 9 months was realized through application distribution and questionnaire-based evaluation by specialist physicians of functional criteria for assessing the quality of Electronic Health Record mentioned above, the benefits, ease of performing information management activities, ease of use, factors that may facilitate implementation of such Electronic Health Record in professional medicine practice, physician strategy for future Electronic Health Record implementation in clinical practice. The paper presented an application software for electronic health records for occupational health. This application was tested in 52 occupational health outpatient clinics in the counties of Cluj, Bihor, Maramures, Satu Mare, Salaj on questionnaire-based utility assessment in medical practice of functional components mentioned and its use has been positively assessed by users.

Critical issues raised relate to the extra time needed for data entry, especially of encodings, the lack of legislative support that made the use of electronic media possible. Without this legislation, the use of Electronic Health Record should be conducted concurrently with the paper-based Electronic Patient Record that actually means a time-consuming dual recording.

"Reports" Section meets statutory and requirements for legal reporting and in addition, allow integration of prescription modules and transmission of documents in electronic or printed format. The "Expert Reports" section allows generation of additional reports through data-base interrogation on user-defined criteria. Interoperability is also highlighted by visualization and transmission of data and documents in bulk or in part, by connecting to the Internet browser, as dbf format, xml, doc. The application, being installed and having the database on the user's computer with security elements included, virtually eliminates frequent concerns about data security, unlike in the case of Internet distributed databases.

Conclusions

The application targets the occupational health practice where by the collection, processing and integration of primary data and by carrying out their medical circuit, it represents the fundamental unit of information in occupational medicine. Other structures are integrated into the flow of information, starting from and addressing activities and information carried out in the occupational medicine practice. In the absence of practical data interoperability with various healthcare providers, primarily with the health insurance system, any construction of an electronic health record in occupational medicine that should ensure all its functions according to requirements and definitions remains restricted to the occupational medicine electronic file/sheet.

The structuring of patient's Electronic Patient Record in occupational medicine for ensuring data interoperability of data even further, allows employment of the term electronic health record in this context

The model of a worker's Electronic Patient Record /sheet presented, through the possibility of creating reports in the browser, of integrated Internet functionalities, of using encodings for better interoperability, of integrating an expert reports module allowing variations by predefined queries in the database, of the possibility to create XML file statements, actually represents in the restricted meaning, the definition of an electronic health record. Functioning

of an authentic Electronic Health Record in the complete meaning of the term would involve reporting to all actors in the health care system.

The Electronic Health Record components perform the Electronic Patient Record functions in occupational medicine are in compliance with national legislation besides being integrated in the above mentioned general requirements for Electronic Patient Record certification of functionality at international level.

Conflict of Interest

The authors declare that they have no conflict of interest.

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