Features and Applications of an Information System Developed for a Sleep Clinic

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Abstract: An information system for a sleep clinic was developed. The aim was to improve the efficiency and optimize the management and clinical practice of such a specialized centre; also to reduce the time consumed to perform all the tasks, to reduce staff training costs and to offer 24-hours support for personnel and customers. Some processes include: to assist customers, to clinically diagnose possible diseases, to educate and inform patients; to select, test, and deliver the appropriate treatment. The system has four main sub-systems: 1. an administrative system to manage all the day-to-day workflow activities, including e-commerce. 2. An electronic health record and a decision support system. 3. A staff training tool. 4. A call-centre manager. They are securely accessed according to the user’s privilege. The paper describes the features and applications of the system and how it can improve the efficiency of the clinics.

Key Words: Information Systems, Expert Systems, Sleep Disorders, Medical Diagnosis, Artificial Intelligence.

1 Introduction

A prototype of a health information system for the comprehensive management of a sleep clinic was developed by our laboratory [15]. The aim was to improve the efficiency and optimize the management and clinical practice of such a specialized centre. Also to reduce the time consumed to perform all the required tasks, reduce staff training costs and to provide 24-hours support to personnel and customers [15]. This system (as others [5, 6] have done) facilitates the process by which the system obtains, uses or displays a variety of basic resources to support the objectives of a sleep clinic, facilitates the decision-making process, the control of the administrative and other day-to-day workflow activities and the clinical management for the diagnosis and treatment of sleep disorders and related diseases. The availability of highly skilled and well trained staff who take care of customers and patients attending a specialized centre of this kind is particularly needed because sleep disorders are diseases that are widely ignored by most physicians and general population (at least in Venezuela) [16]. The processes include: to assist customers and patients by telephone, on site or by the website, to clinically diagnose a set of possible diseases, to suggest diagnostic tests, to evaluate several related diseases, to educate and inform patients and their family about the diagnosed diseases, proposed treatment and prognosis; to deliver the appropriate treatment (commonly mechanical ventilators), to test the effect of a mechanical ventilator and to fit it according to the side effects and benefits provided as well as the specific features of the machine, and to select the machine that the patient will finally use [7, 8, 9, 17]. The system has four main sub-systems, these are: a system to manage all the administrative and day-to-day workflow activities of the clinics; including e-commerce. [18] The second, is an electronic health record [9] and a decision support system [10, 11, 12], it suggests the physician a diagnostic–therapeutic plan (following standard and updated guidelines) for each patient [16, 19]. The third subsystem supports an educational program and training tool for the staff to assure that they will appropriately manage all the activities of a specialized centre for diagnosing and treating sleep disorders. The fourth subsystem was designed to manage a call-centre that can guide the customer into the information or appointment menus. All the subsystems are securely accessed by a log-in code and a personal password that permits and restricts access to different menus and subsystem according to the user’s privilege (for instances; nurses, sales
representative, doctors, patients, etc.). This provides confidentiality of the medical records and the know-how of the processes, and procedures as well as security for the financial operations. The methods followed to develop the system were described elsewhere [15]. This paper describes some features and applications of the system and how it can improve the efficiency of the clinic. Some conclusions and further research are also discussed.

2 Informatics in medicine

Nowadays the uses and applications of informatics in medicine are wide and common [2, 4, 5, 13, 14]. Most countries are using electronic health records for the primary care system as well as their hospitals [9]. Telemedicine had delivered specialized medicine regardless the distance where the patients or physicians are located. Digital imaging management has facilitated the availability of images throughout the whole healthcare system, dramatically reducing film-developing and other costs. It is the application and intersection of informatics science, computer science and health care. [22] Artificial intelligence, robotics, intelligent systems, information systems, expert and decision support systems, pattern recognition, signal processing, intelligent devices, nanoinformatics, image analysis, data bases, statistics softwares, networking are just a few of the multiple applications of informatics in medicine.

Unfortunately, in developing countries, the availability and usage of such systems is an exception instead of a rule. They are quite unaccessible, computers are not available in every medical centre and computational knowledge of doctors and other staff is poor. [1, 3] So efficiency and accuracy of the medical processes is greatly different than in those countries where these applications are available. It also generates a huge geographical inequity of the provided medical services. When in university tertiary hospitals a qualified and cost-effective health care can be delivered in remote hospitals or health care centres a completely different care could be offered. Regardless the costs of this non-efficient health care the effect on the morbimortality of the patients can be devastating. Great efforts are undergoing to spread the availability and usage of informatics in health care, developing cheaper and easier-to-use systems and devices; as well as creating a network of computer in most health care centres.

3 Features, nature and processes of a Sleep Clinic

A sleep clinic is a specialized centre where patients suffering sleep disorders or related diseases are evaluated. Sleep medicine is a new field in medicine and is widely ignored by most physicians as well as general population. Insomnia, excessive daytime sleepiness, snoring, fatigue are the most frequent symptoms why patients visit a sleep clinic [16]. Some of the processes include: to assist customers and patients by telephone, on site or by the website, to clinically diagnose a set of possible diseases (sleep disorders and several related diseases), to suggest which diagnostic test should be performed (regularly polysomnographies and other highly specialized studies), to evaluate several related diseases, to educate and inform patients and their family about the diagnosed diseases, the proposed treatment and the prognosis; to deliver the appropriate treatment (commonly mechanical ventilators), to test the effect of a mechanical ventilator and to fit it according to the side effects and benefits provided as well as the specific features of the machine, to select the machine that the patient will finally use, to sell or rent it to the patient [17]. Some internal processes are to train the staff, to provide 24-hours a day, 365 days a year accurate and problem-solving assistance to the personnel in any field, to comply with all the ethical issues related to patients care, confidentiality and good clinical practice. The final diagnosis of the sleep disorders is always done applying very specialized tests (polisomnographies and/or others) which most physicians do not know how and when to apply them, and what to do with a specific result. These tests are all computerized. Treatment of the most severe and frequent sleep disorder, sleep apnea, generally is the usage of a mechanical ventilator called CPAP (continuous positive airway pressure) during sleep [17]. Fitting these respiratory devices needs extensive usage of computational tools as well as knowledge on the electronic and computerized devices themselves. These devices have a wide range of features, clinical results and side effects that must be evaluated before deciding which will be the device that the patient will use for a long term period. This fitting process is frequently performed by technicians, nurses, or well trained personnel in order to decrease the medical costs related to specialist physician availability in every patient visit. The whole diagnostic and fitting process could require up to 8 or more visits. The training process of these personnel is very expensive. It requires the presence and the time-consuming educational activities and
teaching skills of the specialist. The cost of this process is at least equivalent to the amount that the specialist is able to generate in the same time period [20]. Ignorance of these diseases is so prevalent that appropriate information delivery is a must-to task of a sleep clinic. The knowledge of the information that the customers service personnel must manage could be as comprehensive as that of the specialist. The fact is that everybody will understand and accept the physician’s proposal of treatment if someone has an infection and the doctor suggest an antibiotic or if someone has a wound and the doctor suggest a surgery; but very few people (in our media) will understand when a doctor tells them that they will need to buy an expensive machine because they snore and their life is at threat. Very qualified information should be warranted to each unpredictable question that a patient could have. A secretary or a call-centre assistant will need to have a very long and highly specialized training in order to appropriately assist a customer. In our media the patients have to pay for all these services; so, to decrease costs while maintaining the quality is always desired but frequently impossible to achieve. That is why nowadays sleep medicine is available only for an elite population [16, 20].

4 Problem formulation
Sleep disorders are a global major cause of mortality and morbidity. They are highly prevalent (more than 30% of the general population has any kind of sleep related symptoms). Achieving the diagnosis of sleep disorders may be difficult in most cases, even for experts in the field. Treatment has proved to be very effective and dramatically reduce the morbimortality of the patient [16, 17]. We developed a Health Information System [15] due to the particular features of a sleep clinic and with the aim to improve the efficiency and optimize the management and clinical practice of such a specialized centre; also to reduce the time consumed to perform all the tasks, reduce staff training costs and provide 24-hours support for personnel and customers. This system should assist the user to effective and efficiently follow the guidelines that contain all the know-how (processes, procedures, activities, methods) of a sleep clinic (from how to clean and tidy up the facilities, or answering a phone call, up to a CEO position administrative or management rolls or the clinical practice a specialist can offer) and the clinical guidelines for diagnosing and treating every patient. We have proposed that all the support that the software confers would be automatically applied as part of the normal clinical, administrative or regular day-to-day workflow and at the time and place of decision making. Every single action or procedure done by any member of the staff should be executed using the assistance of the software. This all-in-one system should handle most of the activities without the need of multiple softwares and complexity levels.

4.1 General objectives:
To develop a prototype of a multifunctional health information system that comprehensively support all the tasks performed in a sleep clinic.

4.2 Specific objectives:
4.2.1 To learn about all the processes, procedures, activities, methods and tasks performed in a sleep clinic.
4.2.2 To follow the knowledge engineering methods in order to structure the knowledge applied for the management of a sleep clinic; from the customers assistance, going through all the administrative and clinical activities, up to the assessment and quality control activities.
4.2.3 To develop algorithms for the clinical decision support system, from clinical guidelines, evidence-based medicine and expert opinions.
4.2.4 To develop a health information system according to the knowledge needs, the available computational network, software, hardware and the diagnostic and therapeutic tools.

5 Features and applications of the system
The applications are related to the sleep clinic processes (Fig 1). There are: customer care, administrative, clinical and educational processes (Fig 2). We will mention some of the features of these applications.
5.1 Administrative subsystem
A tool designed to support the management of all the administrative and day-to-day workflow activities of the clinics; including e-commerce. Some of the available modules are: departments, inventory, purchase orders and billing, providers, doctors, customers, appointments, and scheduling (Fig 3). It is possible to: create a new one, check, edit, print, or send an already existing one. (Fig 4) Electronic payments are also possible with this module.

Figure 3. Administrative processes

5.2 Electronic Health Record and clinical decision support system
An electronic health record and a decision support system are applications of one of the subsystem. The clinician assesses a patient and fulfils the clinical record (Fig 5 & 6). All the clinical data is used by a knowledge database and an inference engine developed from decision support algorithms. A set of clinical possible diagnosis (Fig 8) are them provided to be tested through diagnostic test (polisomnography or others). Then a final diagnosis is offered by the system and a therapeutic plan is also proposed. The clinical record and recipes are printed or sent as needed (Fig 7). Electronic communication and connectivity, reporting and health statistics, database management for clinical trial or other scientific purposes are some of the features and applications of this subsystem.

Figure 4. Creating a New Invoice with the system

Figure 5. Electronic health record

Figure 6. Fulfilling the record (symptoms)
5.3 Educational and training tool

As mentioned in chapter 3, staff training is mandatory in a sleep clinic setting. Staff training related costs make a sleep clinic a non-profitable business. But low qualified personnel make a sleep clinic a life-threatening institution. So this tool is one of the most important contributions of the system.

Guidelines and operation manuals (easy to follow instructions for executing tasks while working and doing them), computer-assisted staff recruitment process (web-deployed employment offers with detailed information about working conditions, responsibilities and activities, attitude and skills requested; web-based application submission, on-line psychometric tests and assessment [21], interviewing, automatic exclusion of non-compliant aspirants and replying them with a denial letter, preliminary selection and scheduling for personal interviewing or further assessment), a staff training module (offers support for teaching and learning, for tests and evaluations, for managing and monitoring the entire educational process by means of multimedia presentations, descriptive text, images and graphical displays, video sequences and sounds, tests, surveys, etc.), a computer-guided call centre (for assessing, informing, scheduling and teleconsulting patients or any other information seeker; feeding a clients and suppliers database), computer-assisted administrative management processes; among others are some of the applications of these modules.

5.4 Security and confidentiality

Confidentiality of the operation manuals is extremely important for a healthcare centre. Violation of patient’s clinical data confidentiality is not only an ethical issue but a legal one too. Privacy and appropriate security of the business procedures and administrative activities is mandatory (taxes, etc.) and organizational necessary. Restricted accessibility provides multiple levels according to the user’s privilege and duties. The administrator of the software (director of the clinic) has the right to restrict, revoke, or blockade the access to a particular user according to their labour status. Each user has a unique code and a confidential password, both of which are needed to log into the system. The privileges assigned to a user determine which module, actions and information are available for him/her. The user's code is associated with any actions performed while they are logged in and/or securely guarantee privacy of personal data for
patients and financial or any other confidential information for the staff.

6 Discussion
The developed system is a prototype. We have not performed any evaluation of the accuracy, or effectiveness and safety of the system yet; but currently it is going on an evaluation of this kind. The modules, that have been explained, have the following performance features:

6.1 The administrative subsystem is performing as well as similar ones that are regularly been used in our media. It has less features and tools but most of them are not useful for our clinic. It has the ability to help the user in the processes that must be done. It means that is linked to the educational module.

6.2 The electronic health record is adapted to the special needs of a sleep clinic. So, many features (items, medication prescribing options, etc.) are lacking. We are planning to link or interconnect our system to other one that has these features. Developing the same features as others in our system would be very expensive and mostly unnecessary if it is possible to interconnect it with other systems.

6.3 The clinical decision support system has incorporated several sleep disorders rules for guiding diagnosis and treatment. Some other highly prevalent diseases related to sleep disorders have been included as well (hypertension, diabetes, obesity, etc.). Many other diseases and their rules must be incorporated and we are working on this while evaluating the rules that are now available.

6.4 Security and confidentiality have been a major issue in our system. We are trying to achieve the same security level that a bank has. Encrypted data and very safe access would be our goal.

7 Conclusions
It has been presented the applications and features of a prototype of a health information system for the comprehensive management of a sleep clinic. It is a friendly environment for working within this important clinical area. The system handles administrative activities, Electronic Health Record and clinical decision support system and has an educational and training tool. It also has considered the security and confidentiality requirements in systems using patients and clinical information.

It has been used and tested and has shown its capabilities and new areas that can be incorporated in the system using computational and clinical knowledge.

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References


