A Software-Tool allowing for Departmental Hospital Operational Cost Estimation

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Abstract: The purpose of the present study was the development and initial implementation of a Medical Procedure Resources-Allocation and Cost-Capturing system. The system aims to provide for the acquisition of health-care delivery related data, based upon the actual Greek conditions, and to facilitate the estimation of Hospital operational costs in a way that will allow for in the future the prompt and easy transformation of the estimated data firstly to patients' treatment cost and secondarily to a rational Hospital's reimbursement schema.

Introduction

Substantial attempts have been made during the last decade by the Greek National Health System (G-NHS) in order for the Greek Medical Institutions to standardize an approach to their operational cost efficacy, and for the Greek Health – Insurance Organizations to adopt a more rational reimbursement system of the Hospitals.

Nevertheless, Greek Medical Institutions still suffer from evident limitations both in management planning and in financing [1] and they are still being compensated by the Health–Insurance Organizations according to a per diem (flat rate) reimbursement that, although it covers approximately a 34% of hospital revenues from insurance funds [2], is far below the actual cost of the services offered. Furthermore, there are obvious operational cost discrepancies between the hospitals in the two major cities (Athens and Thessaloniki), the rest of the mainland and the numerous islands, mainly due to uneven population and inefficient financing distributions.

It seems hence inevitable, as well as necessary, that, in order for these problems to be overcomed, the Greek Government will eventually proceed during the next years in a radical reform of the public-hospital financing system. The adaptation of the Diagnosis Related Groups (DRG) system by a significant number of the European Union Countries indicates that this future reform will ultimately follow this schema.

In any case, fundamental prerequisite for the adoption of DRGs or of any rational hospital financing system is the acquisition and process of health-care delivery related data, based upon the actual Greek conditions, and the realistic estimation of the cost of any single medical activity / process, according to this data.

This seems to be controversial since the central collection and process of economic and administrative data by the hospitals themselves is not yet a routine and standardized process and, even in the recent past, the administrations of the Institutions hesitated to make such data available to the scientific community. On the other hand, the collection of individual departmental cost data, as a contribution towards the full estimate of resource consumption within a hospital setting, appears to be more feasible, since the individual Hospital Departments / Units can relatively easy determine the cost components, i.e. resource categories, which overload them, and collect the economic data that are relevant, only within the specific Departments.

Thus, we have been led to the development of a medical procedure resources-allocation and cost-capturing system appropriate for use in all the major hospital Departments and Units. The conceptualization and initial design of the system was previously reported by our team [3-11]. In this article we report the actual development and implementation of the system as a means for facilitating the estimation of Hospital operational costs in a way that will allow for the prompt and easy transformation of the estimated data firstly to patients' treatment cost and secondarily to a rational Hospital's reimbursement schema.

Design Objectives

The design of the developed resources-allocation and cost-capturing system is based on the limitation that hospital operational cost data is currently very difficult to be acquired and processed. On the other hand, departmental cost data can be relatively easy defined and collected by the individual Hospital Departments / Units. This data, together with some elementary hospital's overheads and building maintenance cost data, can be processed in such a way as to allow for the estimation of a realistic cost of each medical procedure that takes place in each Department / Unit. Thus, the system developed allows for the analysis, estimation and appropriate correlation of the major cost components (resources) of any medical procedure in a Hospital Department / Unit.

The system developed is not an accounting program and it does not follow the formal accounting cost analysis methods. Instead, reasonable and simple statistical methods are used, offering a friendly interface that allows for the individual Departments / Units to enter the costs associated with the care they deliver.

Furthermore, since the developed system eventually estimates the statistical mean cost of any medical activity / procedure that takes place in every Department within a Hospital, it can be used in combination with a properly designed Electronic Patient Record (EPR) system that will record the medical actions and procedures associated with a patient's visit to a hospital, in order to offer a rational estimation of the actual patient's treatment cost. The systematic use of these systems from representative and appropriately selected hospital departments could offer valuable data which could be properly processed in order to form the basis for the design of a rational hospital reimbursement system.

In order to avoid incompatibility and interoperability problems between the developed system and the various commercially available EPR systems [12], the use of coded vocabularies and the conformity to appropriate international classification standards were deemed necessary for the development of the cost capturing system. The standards used are all approved and suggested by the Greek Ministry of Health and are the following:

- ICD9 (International Classification of Diseases Version 9) [13] for Diseases, Health Problems and Medical Procedures coding;
- ECRI (Emergency Care Research Institute) [14] for Medical Equipment and Materials coding;
- EDMA (European Diagnostic Manufacturers Association) [15] for In Vitro Diagnostic coding;
- ATC (Anatomical Therapeutic Classification System) [13] for therapeutic drugs coding.

System Description

As it was mentioned before, the developed resources-allocation and cost-capturing system aims to allow for the analysis, estimation and the appropriate correlation of the major cost components (resources) of any medical procedure in a Hospital Department / Unit. Although hospitals consume various resources, the most important of them [3] could be defined as:

- Medical Equipment
- In Vitro Diagnostic Reagents
- Consumables and Disposable Materials
- Therapeutic drugs
- Man-Power (personnel)
- Building and Infra-Structure Maintenance

In order for the estimation to become feasible the first four cost components were appropriately analyzed in a number of fundamental economical parameters such as purchase price, expected equipment life time, etc. that can be easily traced and entered into the system by anyone of the department's personnel, without being necessary for him / her to have special accounting skills, but merely good knowledge of the department's operational procedures. These parameters are appropriately transformed by the algorithm in such a way as to allow for the estimation of a daily / hourly maintenance cost and / or a daily / hourly virtual leasing rate of any item of the above mentioned cost components list that are actually used in a specific department.

Concerning the personnel cost component, the algorithm discriminates between Medical and other scientific Staff, Nurses, Technical, Administrative and Auxiliary Personnel and uses for the calculations the official monthly salary lists of the Ministry of Health.

Finally, the last cost component, i.e. the building and infra - structure maintenance cost, contributes to the medical procedures' cost estimation by a factor which is calculated by converting the approximate building value into a virtual annual leasing rate. This rate, together with the maintenance personnel salaries, the overheads and the outsourcing cost can be transformed first into a hospital's maintenance cost per square meter and second into a department's daily maintenance cost by the multiplication of the square meter cost with the department's area in square meters.

A detailed presentation of the economical parameters determined for each cost component is presented in the following figure (Figure 1).
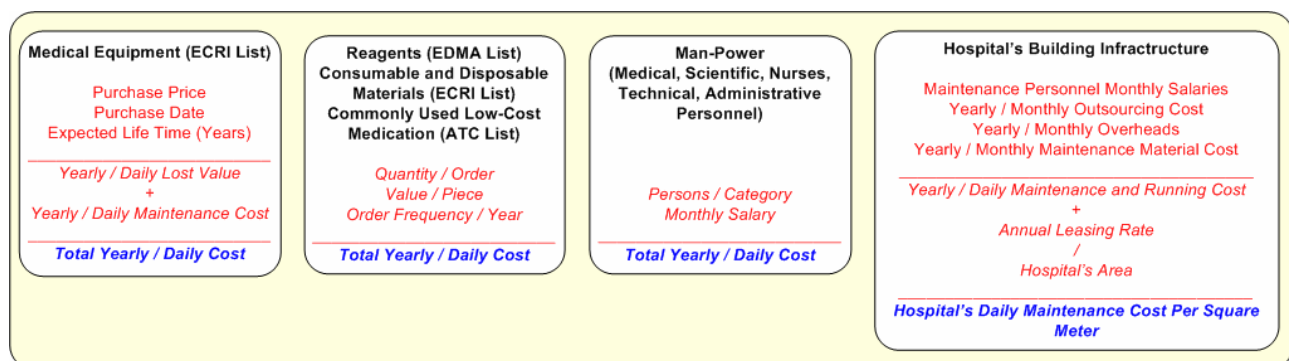

Figure 1: Cost components' elementary economical parameters

Once all the necessary input parameters are filled the mean actual daily department output is determined by entering into the system the mean daily frequency with which various medical procedures take place into the specific department.

Using all the above features as inputs, the approximate mean cost contribution of each cost component in every medical procedure is then estimated by equally distributing their daily leasing rate and / or daily maintenance cost into the total amount of the medical procedures that daily take place into the specific department. The actual flow diagram of the developed procedure is demonstrated in Figure 2.

The procedure described above is the first step for the medical procedures' cost estimation. A number of additional special features are also included into the developed system in order to satisfy specific demands of some Departments / Units. These features are, first, the sharing of resources across different departments, second, the definition of procedure – specific resources and, third, the handling of time-dependent procedures.

Thus, with the system developed the users have the option to define, when appropriately, a resource as being shared across different departments. In this case a percentage of usage, which is currently empirically determined by the users, is defined for each department and the cost of the specific resource is distributed accordingly across the relevant departments.

Furthermore, apart from the approximate mean cost contribution, a number of specific cost parameters can be also determined for some of the procedures, when for example some high-cost medication or material is explicitly used for a medical procedure and cannot be included in the mean calculation. Such instances are for example the implantable pacemakers and the orthopedic implants that are used in specific surgical procedures. Thus, the final medical procedures' cost estimation that the system exports is a combination of the mean and the specific cost estimations.

Finally, the system provides for the special treatment of some hospital departments, in which the medical procedures that take place present such differences in their completion time that is necessary for the corresponding cost calculations, to be made by taking into account their time duration.

The most representative example of such a department is the Operating Room, which can be committed from several minutes to many hours, depending on the type of the operation procedure. On the other hand, there are departments, as for example the In Vitro Laboratories, in which the majority of the corresponding procedures have statistically the same time duration, while, in any case, multiple procedures are executed at the same time. Thus, even in the case of the most time - consuming procedures, the department can not be considered as committed for their execution, since other procedures are executed simultaneously.

In the case of a "time-dependent" department the user must enter into the system the department's running hours and the mean time duration of the medical procedures that take place in it. The daily leasing rate and / or the daily maintenance cost of the cost components are not then equally distributed into the total amount of the daily executed procedures, but they are instead distributed into them according to their time duration.
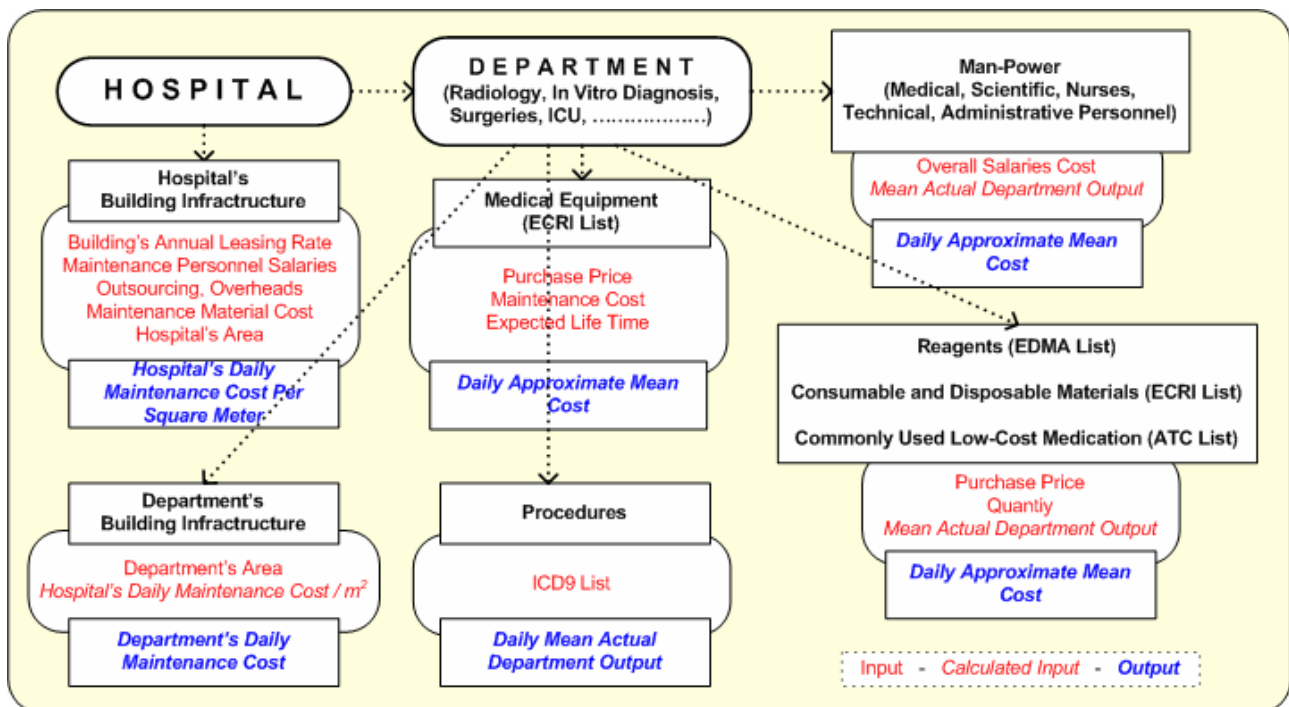

Figure 2: Flow diagram of the Developed Procedure

Methods

Microsoft Visual Basic was used for the development of the user interface and for the calculation algorithms, while a relational model was developed, using Microsoft Access. According to this model the main tables include the hospital's and department's identifications and linked tables save each department's input data, while others include medical procedure lists (ICD 9 coded), medication list (ATC coded), reagent list (EDMA coded), equipment and materials list (ECRI coded), etc. In Figure 3 a part of the entity-relationship (ER) database diagram is displayed.
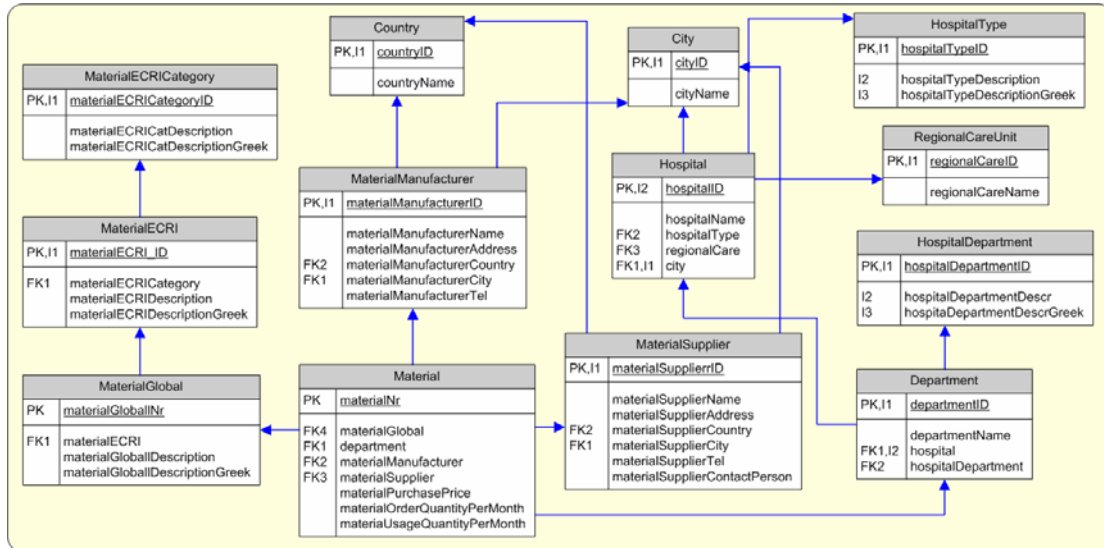

Figure 3: Part of the entity-relationship (ER) EPR Database Diagram

The cost-capturing program is password protected and every user is encountered with a specific role, which determines the department(s) and the service(s) in which he has access, together with his privileges. All the users' screens (example in Figure 4) have a combination of structured and free text and are grouped for quick entry and updating, while drop down and check boxes are used in order to reduce data errors and enforce consistency.

Since the developed cost-capturing system utilizes standard coded vocabularies it could be easily synchronized with any EPR system, using even a simple script that would export the medical procedure code and the corresponding calculated cost estimation, while another script would import them in the EPR database. This way, together with the patient's medical record a financial record would be developed, allowing for patient's treatment cost estimation.
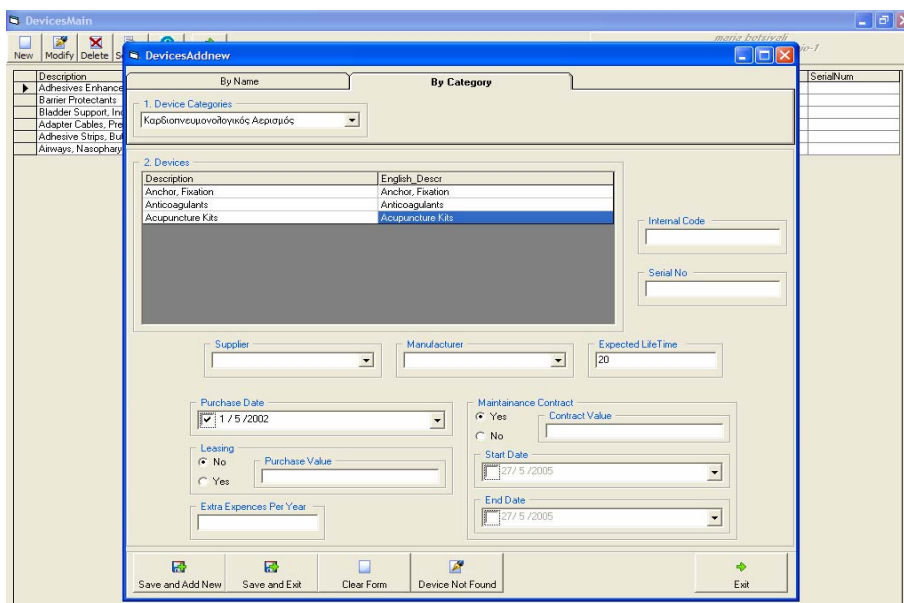

Figure 4: Example of Medical Devices entry

Implementation and Evaluation

The system developed was tested in our laboratory with cost data collected on site from Operating Rooms (OR) and Intensive Care Units (ICU) of a representative group of collaborating hospitals, including a Regional University Hospital, a Provincial Hospital on an island, and a Private Hospital in Athens.

Over 500 operations covering all surgical specialties have been processed and evaluated and the ICU cycle has been evaluated for nine months. The obtained data is presented in details in another paper in this conference [16] and in all cases, the system proved to actually offer a simple, effective and time efficient method for the evaluation of Departmental operational cost.

The applied algorithms confirm that there is an enormous discrepancy, between the high actual mean costs in the OR (Figure 5), and the relatively very low Health Insurance remuneration of the Hospitals (Figure 6).
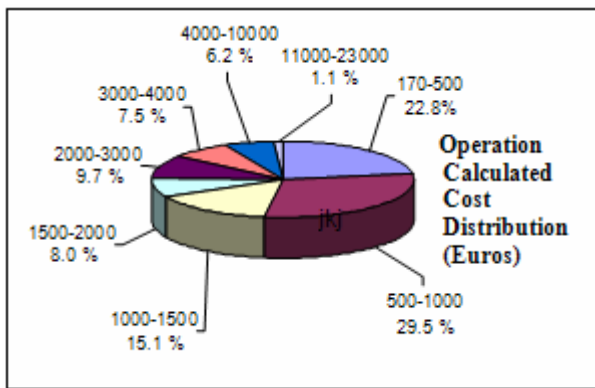

Figure 5: The Distribution in 8 cost classes of the Calculated Cost in Euros for 535 Operations covering all specialties.
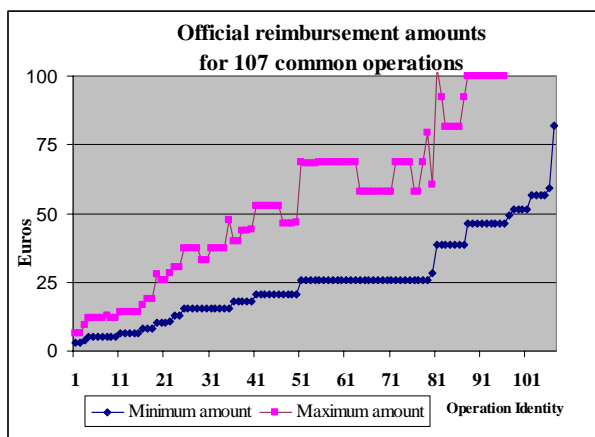

Figure 6: The official minimal and maximal nominal Reimbursement amounts for 107 frequent types of Operations.

Concerning the ICU, the official daily reimbursement amount per patient, hardly covers the mean fixed cost per day (Table 1), since the usually very important average variable cost per patient remains uncovered.

Table 1: Some indicative cost data for the ICU.

Mean Costs	Euros (€)
Mean fixed cost per day	120.00
Average variable cost per patient	1,651.00

Main sources of cost	%
Human resources	42.6
Supporting services	21.2
Drugs	16.7
Overheads	8.6
Disposables	5.1
Equipment employment	4.2

The calculated values, although presently not very precise, seem to offer a good estimation of the actual medical procedure's cost, which respectively approximates to the corresponding values determined by other European countries. Thus, the developed system could indeed be used in combination with a properly designed Electronic Patient Record (EPR) system in order to offer a rational estimation of the actual patient's treatment cost.

Furthermore, as indicated by the above presented table, the developed system, apart from estimating the cost of medical procedures, is also able to provide an estimation of the contribution of each cost component to the final cost. This functionality can assist the hospital's management team in their effort to control cost and become more competitive.

Nevertheless, the system must be further improved, especially by the further addition of special procedure-specific features, while the next step will be to launch a pilot project of the system in an entire hospital setting, in order for the system to be refined, to cover all hospital departments and to test its interoperability with an electronic patient record system.

Conclusions

The collection of individual departmental cost data as a contribution towards the full estimate of resource consumption within a hospital setting appears to be a feasible method for the acquisition and process of health-care delivery related data, based upon the actual Greek conditions and for the realistic estimation of the

cost of any single medical activity / process that takes place within a hospital.

The Medical Procedure Resources Allocation and Cost-Capturing System that was developed by our team was tested with data collected from a number of collaborating hospitals and the exported calculated values indicate that it could be a very useful tool for the estimation of Hospital operational costs in a way that will allow for the prompt and easy transformation of the estimated data to patients' treatment cost. However, only after long – term employment of the system in in a larger and more representative, concerning the randomness, group of hospitals the accumulated data should allow for the introduction of a more rational Hospital reimbursement schema.

Acknowledgements

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