S-Grouper: A Semantic Approach to Increase Quality Performance by Innovating Information Systems in Healthcare Organizations*

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Abstract

In Italy, as in many other countries, hospital acute activities are classified and measured using the DRG system. DRG system was originally created in the early 80's within the MEDICARE scheme of USA HealthCare System. DRG system is even used, at least partially, to finance hospitals.

The measuring process implemented by many hospitals is based on a specific software, well known as DRG-Grouper, (Grouper) that, starting from clinical records, is able to automatically generate the specific DRG code. The efficacy of the coding process requires a direct involvement of physician in collecting and analyze clinical records. Clinical data needed for classification are collected on the base of clinical records measured by physicians that are often required to manually codify diagnosis and clinical procedures under the international ICD-IX-CM standard.

As it not difficult to imagine, physicians do not appreciate administrative activities because they consider administration as a waste of clinical time. For this reason, in many cases, the measuring process leading to DRG identification is characterized by lot of mistakes and to serious problems for public hospitals. These problems are related both to economic issues and to quality issues.

Focusing on quality two elements should be highlighted: a) On a first basis quality of the administrative process. Classification mistakes lead to conflict with financing bodies and agencies that end in a relevant increase in not planned control activities within hospital organizations and in a waste of value; b) On a second basis clinical quality. Classification mistakes are often related to elements such as effectiveness of care, appropriateness of care and outcome evaluation of hospital activities directly affecting the overall quality of care.

The paper, based on the results of an in site research project carried out by Trento University with GPI and Expert System, aims to analyze and measure how DRG classification processes can be improved and sped up by implementing and integrating semantic analysis in traditional information systems. Semantic analysis is, in fact, a tool that let automatically emerge from traditional documents the information that are useful and needed to implement an automatic process for monitoring and verifying the quality and relevance of their content in order to classify DRGs.

Keywords
DRG; Hospitals; Coding Processes; Semantic analysis; Information Systems; Healthcare Quality

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1. Diagnosis Related Groups System (DRGs) and its characteristics

DRG system is a iso-resources classification system for patients discharged from acute hospitals.

It is based on homogeneous diagnosis groupings reflecting the complexity of care provided for patients.

Many other countries also use DRG system as a base for financing hospitals. DRGs are defined based on information contained into hospital discharge documentation (SDO), and in particular on the base of: main diagnosis, secondary diagnosis; surgery; patient's age; patient's discharge status.

The number of DRGs amount approximately to 500 categories of hospitals admissions, significant and clinically homogeneous in terms of resource consumption and in terms of production costs. The process leading to the determination of the DRG associated with each hospital admission takes place from the drafting of the discharge letter when physicians retrieve information about the treatments done to the patient and identify the more appropriate ICD-9-CM code related to each procedure and diagnosis. According to the primary discharge diagnosis, every patient is assigned to one of 25 Major Diagnostic Categories (MDC). MDCs group exclusively all the possible diagnosis contained in the ICD-9-CM reflecting the universe of medical specialties. When a surgical procedure occurs, the patient is assigned to a surgical subgroup, if no surgical procedure occurs the patient is assigned to a medical subgroup. Surgical patients are further classified according to the type of surgery/procedure to which they have been subjected (in the case more than one surgical procedure has been done only the main intervention, the one requiring the large amount of resources is considered). Medical patients are further classified according to the main diagnosis. In order to select the most appropriate codes describing every hospitalization episode, physicians have to spend lot of time in administrative activities related to this stuff. Hospitals normally have computerized systems to support physicians in these activities. These systems navigate a tree decision and identify the most appropriate codes for the treatments done. In any case, physicians are responsible for the final choice and for the identification of the specific DRG associated to every discharged patient. The most common application is a software called Code finder. Code finder is an expert system able to guide physicians in the choice of codes. It has more than 60000 keywords and more than 45.000 logical rules leading to the choice of the appropriate code. By using these software physicians still remain responsible of the choice done but the use of manuals and other papery tools is minimized as well as the number of coding error.

2. Controls about DRG determination and finding appropriateness

Checking the appropriateness of DRG determination and finding is crucial because DRG system is used for essential purposes within hospital management. DRG system is, in fact used for:

a) Financing hospital activities;
b) Benchmarking hospitals with regard to specific parameters directly associated to it such as the average weight of admissions
c) Evaluating the complexity of hospital admissions
d) Ranking hospitals.

These issues may induce hospitals and their managers to behave in a very different opportunistic ways leading to the need of activate different types of control activities related to measuring and coding issues. In the Italian Health care System, controls apply to all types

of public and private providers and to all kinds of admissions. Main controls are the following ones:

Regional controls: these controls evaluates DRG correctness with regard to specific information within medical records. Regional controls are random controls based on overall hospital activities and admissions. They focus on specific aspects emerging from the analysis of hospital outputs and medical treatments provided at the regional level or at the national level (for instance the percentage of hospital re-admissions or the incidence of caesarian childbirths).

Internal controls: providers directly manage these controls when both patients are discharged and medical records are closed and/or following specific requests coming from regional authorities or other financing agencies.

Internal controls are further classified into:

Formal controls aimed at verify the completeness of medical records and the coherence between aspects such as sex and diagnosis; age and diagnosis and so on. These controls are usually based on automatically planned checks at the hospital and/or at the regional level.

Controls on coding and inefficiencies: aimed at identify opportunistic behaviors for getting higher revenues from financing agencies or to justify inappropriate admissions and inappropriate medical or surgical procedures.

Controls on organizational appropriateness aimed at evaluate specific issues such as duplicated admissions; splitted admissions (in which the admission is improperly split into multiple logins in a relatively short period); re-admissions and other of such phenomena.

Controls on clinical appropriateness aimed to evaluate clinical behavior with regard to issues such as the coherence between clinical guidelines and/or best practices and clinical protocols actually adopted by hospitals and/or physicians.

Implications for hospitals (and for the entire system) of these controls are relevant and obvious.

Large implications are related to:

a) Relevant internal costs generated by control activities. These activities may be considered as not value added activities; neither they contribute to increase outcome results for patients.
b) Relevant physician's time absorption,
c) Increase the organizational culture bureaucracy level (completely in contrast with physician's and other healthcare professional's values).

Anyway, these control activities must be done considering the evidence of the existing and relevant number of coding mistakes as well as the existence of relevant opportunistic behaviors both at hospital and at physician's level.

Referring to the Italian situation, the most common kinds of mistakes are those related to formal elements within medical records. Elements such as mistakes in measuring patient's personal data and data related to the admission process are very often wrong.

If we move our attention to the hospital level, the most relevant mistakes are those related to specific professional issues such as "wrong trauma" or "wrong hospital building". A study made on the analysis of about 11 million hospital discharge records found errors related to "wrong trauma" in 870.000 records and errors related to "wrong hospital building" in 550.000 records. Mistakes related to patient's personal data are very numerous too. The main mistakes, in these cases, are those related to missing data (in more than 50% of analyzed records). Normally missing information concern elements such as patient's "level of education", "priority class", "clinical booking", and "presence of other external causes".

Mistakes distribution within Italian Regions varies significantly. Less virtuous regions are Calabria, Trento Province and Puglia. In these Regions, for every 100.000 records the incidence of mistakes is about 76% in the first case, 60% in the second case and 50% in the third case. Most common mistakes are related to the following items: wrong hospital building, Day Hospital admissions and “wrong trauma”.

Anyway, as already seen, these types of mistakes are widespread all over the Country and, in the best performing Regions (such as Emilia - Romagna, Sardinia and Liguria) amount at about 7%.

3. Healthcare administrative processes related to DRGs

On the organizational side, DRGs determination requires the design and implementation of specific healthcare and administrative processes. These processes are related to the collection of patient clinical data, to the drafting of discharge letters, to internal control processes. Organizational practices vary a lot on these topics from hospital to hospital, but, usually, collecting data processes are structured into the following phases:

a) Patient admission: in this phase, patient data and clinical data are collected. Relevant data are related to admission diagnosis and to many different administrative items.
b) Hospital stay: during this phase medical are recorded.
c) Hospital discharge: all data about medical history during hospitalization, data about treatments and cures done and data about the discharge mode are collected. After analyzing all these data physicians responsible for every patient identify the appropriate ICD-9-CM code and the corresponding DRG. The identified DRG code is added to clinical records. During this phase physicians have the responsibility to write the discharge letter for the patient.

All these data represent input for the following internal and external control processes.

On the base of what exposed it is not difficult to understand how DRG appropriate identification is strictly connected with medical record collection and with the attention and time physicians dedicate to data collection and to data analysis.

Where organizational processes are supported by adequate computerized medical data records a reduction of time related to data collection and coding is possible as well as an increase in the accuracy and reliability of data. In these contexts, physicians responsible of writing the discharge letter may find in an easier way all the data they need to identify the most correct ICD-9-CM code.

Where, otherwise, hospitals have a lower level of computerization it is necessary to adopt manual coding processes requiring a large amount of time of medical staff in order to identify appropriate and correct DRGs codes.

It is, then, very important, in any case to support organizational processes with an adequate technology in order to obtain a fluid and error free process for collecting data, for verifying health procedures actually done, and for defining DRGs codes.

Academic literature related to information systems and to business process reengineering is full of evidence about the organizational impact of technology on managerial processes. Lot of attention has been given in recent years on the interdependence between practices, technologies and business processes. Is in fact very relevant to study and better understand relations between activities carried out at the organizational level and processes design as well as the degree of acceptance and utilization of information tools by the company staff.

4. Patient classification systems and quality.

In recent years in Italy, as well as in many other Countries, big emphasis has been given to quality improvement issues and to healthcare spending containment. Within the healthcare sector, quality may be considered on three different perspectives:

- Managerial quality,
- Professional quality;
- Perceived quality (customer satisfaction within a strong information asymmetry)

In Italy, at the moment, major attention is still posed on evaluation and improvement of managerial quality (essentially aimed at efficiency, cost containment and productivity improvement) as well as to perceived quality in terms of customer satisfaction.

Medical records represent the most complete and accurate data of Italian hospitals information systems and they are the main source in order to obtain the large majority of information about professional quality, and about quality medical practice. Authors such as Barbieri et al. (2004, 2004a) and Lattuada and Burba (2004), warn against mistakes and omissions in recording and coding and about the extreme variability in the process of selecting codes.

These mistakes may, in fact, provide valuable clues in terms of lack of appropriateness or underutilization even taking into consideration the presence of unsatisfied needs in high-specialized areas of intervention and the existence of not appropriate procedures and admissions in low specialized areas of intervention (Morosini e Palumbo, 2004).

In order to use medical records for professional quality evaluation it is appropriate to rely on the Disease Staging system and to the so-called APR DRGs (APR 2013) that represents a more detailed analysis of the original DRG classification system.

Anyway, it is important to remember that quality indicators coming from administrative sources should be considered only as screening tools able to suggest the need of further investigations.

5. S-Grouper: an instrument to improve measuring an coding processes

S-Grouper is an expert system for integrating semantic analysis into traditional information systems. The system allows to find out from any unstructured source (all kind of documents related to patient's hospitalization like medical records, nursing journal and surgical registry) all information useful for automatically code and define the relevant DRGs.

S-grouper is the results of an applied research project sponsored by Trento Province and jointly carried out by Department of Economics and Management (DEM) – University of Trento and 2 companies operating in the sector of information systems: GPI and Expert System.

S-Grouper is based on a semantic engine integrated in a software module easily linkable with hospitals information.

Adopting S-grouper allows hospitals to:

a) integrate existing information systems related to medical records in order to incorporate unstructured data needed as input for the semantic engine;
b) elaborate these data and propose to physicians one or more possible DRG codes;
c) compare suggestions offered by the semantic engine with the ICD-9-CM codes previously defined by physicians involved in the coding processes
d) find out mistakes and errors related to documents analysis;

e) effectively report analysis results in a dashboard application customized for different level of responsibility within hospital organization and/or for Regional authorities and for external control bodies;
f) evaluate the performances of the semantic system itself (in terms of accuracy of the analysis, correctness of ICD 9 CM classification and resolution of any ambiguity in documents contents);
g) measure benefits generated by the semantic tool (process time reduction, increase in hospital revenues, increase in the accuracy and quality of medical records);
h) provide performance indicators related to data flows (appropriateness indicators, coherence indicators as well as Key Performance Indicators) used for managerial controls, for clinical controls and to support managerial decisions.

S-Grouper implementation requires a restructuring of healthcare and administrative processes related to DRG coding as defined in the previous part of this paper. S-Grouper implementation may be discussed referring to three possible scenarios

1. As a tool to support physicians to define ICD9 CM and for DRG coding. In this scenario S-Grouper is used as an intelligent tool able to support and integrate medical practices used for classify diseases and related performance according to ICD-9-CM. It is important to highlight that S-Grouper do not aim at completely replace medical skills and competences but it is a tool allowing a higher efficiency and effectiveness in the coding process and allowing a greater acceptance of these activities by physicians also the healthcare professionals. In this scenario S-Grouper may support both cross checking activities of data entered by doctors into medical records and assisted compiling of medical records.
2. As a tool supporting clinical data controls internal and external control as well as mandatory or voluntary controls. In this second scenario S-Grouper may be used as a tool to verify the accurateness and coherence of DRG's selection when medical data collection and DRGs coding processes are done. In this scenario automatic and massive control of all clinical data and all medical records is possible and effective. S-Grouper makes possible and easy to find out mistakes and opportunistic behavior in coding selection and also to discover information deficiencies in analyzed documents when codes are coherent with clinical records but these latter where incomplete or patchy. In this scenario S-Grouper may support both internal quality controls and internal controls related to specific regional directions. S- Gropuer suggestions support internal controllers in modifying diagnosis and clinical procedures selection previously defined by physicians in order to make them more coherent with evidence coming from medical records. Finally, S-Grouper plays an important role in implementing continuous quality improvement processes providing a rich set of performance and process indicators.
3. As a tool supporting Regional Authorities to confirm or contest hospital medical records both for financing reasons and for appropriateness reasons. In this third scenario S-Grouper supports external controllers for automatic and massive control activities of clinical information provided by all public and private hospitals financed. In this case controls are directed to investigate the coherence of hospital record with regional guidelines.

In all the scenarios S-Grouper value proposition can be found in process quality improvement, in cost and time containment related to operating, professional and control activities. Product innovation related to the application of semantic technology to the analysis of clinical data and documents also generates a very relevant process innovation. In a more detailed view, value generated by S-Grouper implementation is related to the following benefits:

a) reduction in the physician time needed for compilation of medical records and DRG determination;
b) reduction in the time needed for internal control activities related to verify regional guidelines;
c) effectiveness in immediately discover errors and inconsistencies between diagnosis done and DRG coded;
d) effectiveness in checking appropriateness and coherence between medical records and DRGs;
e) quality increase of medical records textual contents;
f) standardization of medical records among all hospital departments,
g) benchmarking physicians performances as well as physicians clinical quality;
h) provision of evidence about clinical errors supporting both clinical risk management processes and clinical educational programs within hospitals;
i) overall quality improvement in data quality and in statistical and epidemiological analysis;
j) better and more effective revenue identification for interregional patients mobility;
k) cost reduction related to fewer mistakes and consequent less litigations with regional authorities or other financing bodies.

6. S-Grouper Implementation in a Public Italian Hospital: Evidence from the Field

In this paragraph we report the results obtained in a pilot S-Grouper implementation project in a Piemonte Region based public Hospital: Santa Croce Hospital in Cuneo. Santa Croce Hospital is a highly computerized hospital with computerized medical records. Hospital organizational culture is strongly focused on the issue of DRG control. Finally Santa Croce hospital has a strong and sophisticated managerial control system lead by a physician formerly very involved in Regional controls on DRGs.

S-Grouper experimentation in Cuneo involved two medical assistants in charge for random medical records controls regarding both the coherence with regional guidelines and internal control issues. Experimentation was oriented to test S-Grouper with regard to its ability to support Medical Records recovery and to correct mistakes in previous coding decisions. Once more the ability of the semantic interface to suggest new and more appropriates codes starting from the semantic analysis of clinical data.

In order to ensure transferability to the pilot project clinical data were selected between those coming from general medicine and general surgery hospital departments. These departments have, in fact, been judged as the best departments in terms of quantity, quality, variety and relevance of medical records and their related DRGs codes. A sample of 526 discharge letters has been selected in order to run the experiment. Medical records were related to 2012 and 2013. In addition, they were selected according to regional criteria used for external controls.

S-Grouper has been used in order to verify the ability of the tool in identifying mistakes and suggesting codes that are more appropriate. The first experimentation has been used for defining a specific set of semantic rules to identify the appropriate DRGs codes starting from the analysis of discharge letters.

Then a second sample of clinical records (about 200) has been selected in order to have a system feedback on suggested codes or an indication on from an expert (that is a physician or a nurse involved in the existing process) about the correctness of S-Grouper coding suggestions. This second analysis highlighted a significant number of relevant suggestions usable by physicians for substitute not appropriate codes formerly defined. (The majority of errors was related to a wrong interpretation of medical records).

Experimental results have been monitored on the base of various indicators aimed at:

a) Define measures actually not present in hospital internal control systems. These measures are related to the degree of accuracy of the semantic engine, on the impact of coding corrections compared to the amount of clinical data, on times needed to identify and solve suggestions coming from the semantic engine. All these measure have been judged very useful in order to evaluate the real effectiveness of S-Grouper.
b) Evaluate on a qualitative basis (using specific questionnaires administered to existing users) the satisfaction of professionals already involved in the actual process about issues such as coding process quality improvement, time needed, appropriateness of suggestions, semantic tool friendliness and so on.

The reported measures highlighted S-Grouper ability and effectiveness related to:

a) code coverage. That is the degree of codes identified by the system compared to the data contained in the discharge letter;
b) define the economic impact related to errors and mistakes in coding;
c) classify regular errors and mistakes into specific categories, This classification makes it possible to define semantic rules for an early recognition of mistakes useful even for the development of teaching programs to help professional to increase their coding abilities;
d) support physicians and other professionals in improving quality of medical records;
e) identify codes not considered in the existing process;
f) identify new rules for more effective internal controls.

7. Conclusions

The analysis of S-Grouper implementation in the pilot Hospital highlights the actual ability of the semantic tool in order to improve measuring, coding and controlling processes of operational activities in hospitals.

However, we should say that pilot hospital is an evolved business context and that it is not completely representative of the organizational conditions qualifying (on an average base) Italian hospitals.

Whilst it is true that, in organizations characterized by lower levels of computerization, by an organizational culture less control-oriented and by clinicians with fewer skills in terms of coding, one can expect larger benefits from the adoption of a semantic tool like S-Grouper than those encountered in the pilot experiment, is, at the same time, true that the implementation of such tools may require in these contexts larger and very relevant implementation and change management costs.

It is our conviction that benefits generated by this system are very much higher than cost related to their implementation, but in context like the Italian one where public policies are mainly based on spending review needs, investments in innovation, in software tools as well as those in personnel education could not be enough appreciated or, worse, completely delayed.

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