Using DRG to analyze hospital production: a re-classification model based on a linear tree-network topology

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ABSTRACT

BACKGROUND: Hospital discharge records are widely classified by the Diagnosis Related Group (DRG) system; the version currently used in Italy counts 538 different codes, including thousands of diagnosis and procedures. These numbers reflect the considerable effort towards simplification, yet the current classification system is of little use to evaluate hospital production and performance.

METHODS: As the case-mix of a given Hospital Unit (HU) is driven by its physicians' specializations, a grouping of DRGs into a specialization-driven classification system has been conceived through the analysis of HUs discharging and the ICD-9-CM codes. We shall propose a physicians' competence-centred classification, based on the analysis of 1,670,755 Hospital Discharge Cards (HDCs) produced by Lombardy Hospitals in 2010; it consists of 32 specializations (e.g. Neurosurgery), 124 sub-specialization (e.g. skull surgery) and 337 sub-sub-specialization (e.g. craniotomy).

RESULTS: We shall offer a practical application of our classification, based on the production of a Neurosurgical HU; we shall observe synthetically the profile of production (1,305 hospital discharges for 79 different DRG codes of 16 different MDC are divided into few groups of homogeneous DRG codes), a more informative production comparison (through process-specific comparisons, rather than crude or case-mix standardized comparisons) and a potentially more adequate production planning (considering the Neurosurgical HUs of the same city, that produce a limited quote of the whole neurosurgical production, since the same activity can be realized by non-Neurosugical HUs).

CONCLUSIONS: Our work may help evaluate the hospital production for a rational planning of available resources, blunting information asymmetries between physicians and managers.

Key words: DRG, performance, hospital

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INTRODUCTION

Acute Hospital Inpatients can be classified, among others, with case-mix indicators. One of the most widespread classification systems is based on the DRGs (Diagnosis Related Groups)

system [1,2]. The latest DRG version, used in Italy since 2009, is the United States CMS DRGs 24th, which was adopted for the first time in the year 2007; Acute Hospital Inpatients are classified into 538 groups on the basis of 14,232 diagnosis and of 3,306 procedure codes of the ICD-9-CM (International Classification of Diseases, 9th Revision, Clinical Modification) [3]. The relatively low number of codes reflects the considerable effort towards simplification that lays behind the structure of the DRG classification system.

The authors of this paper argue that the number of DRGs is still too high to carry out reliable evaluations of hospital activity: nowadays, hospitals are free to classify their discharges by using an heterogeneous list of DRG codes. To this respect, the only existing DRG classification, the MDC (Major Diagnostic Category), which identifies 25 mutually exclusive categories of diagnosis, is of no help because it responds to clinical more than to organizational needs. These long lists of DRGs, the aim of which is to describe the activity produced within a given hospital or department, appear to be too detailed for synthetic evaluations and comparative assessments among different lists; the same holds true even if only the most frequent discharges of a given department are considered.

An informative classification system helps both managers and physicians evaluate the productivity of hospital departments and recognize where such productivity could be increased. There is strong evidence that resource allocation, rather than "linear" cuts, increase the rational use of limited resources in health care, thus making it sustainable [4]. The ideal classification system, for every given Hospital Unit (HU), should not only address the whole production, but it should also take into account the comparisons among different HUs; the analysis of the so-called "productive lines", a term that comes from the manufacturing production and which has already been borrowed in the hospital context [5].

It has to be added that the amount of production is often linked to quality, since the level of practice (which determines the volume of production) is directly correlated to the development of higher competencies [6]. Therefore, such a classification doesn't seem to be optional, but on the contrary urgently needed, not only for the sake of sustainability, but also for the sake of equity, in order to homogeneously offer adequate levels of hospital care.

The aim of this paper is to present a multiple-level classification system of DRG codes that takes into account the practitioner's competence and specialization, as the main driver of hospital production. We propose this classification as a tool to analyze and benchmark the hospital production for management purposes, to plan and allocate rationally the available resources and their supply, to consider the clinical activity and to increase the level of communication and of shared knowledge between physicians and administrators.

METHODS

The study sample consists of 1,670,755 Hospital Discharge Cards (HDCs) from acute HUs, produced throughout the year 2010 by hospitals located in Lombardy, Italy's most populated (ten millions inhabitants) and developed region.

The DRG version considered is the one mentioned above (24th edition); however, the classification system used by Lombardy, although based on the same version, counts 601 DRG codes, since the diversification of some DRG codes has been introduced.

As stated above, the physicians' specific knowledge and skills determine much of the production diversification for any given department, especially for those Hospital Units dealing with a broad spectrum of diseases, as for instance Internal Medicine and General Surgery. Even when considering more sectorial HUs, as Neurosurgery, the physicians' skills, or sub-specialization, may play a role in determining the types of discharges: for example, when comparing neurosurgery HUs having expertise in spinal column surgery versus neurosurgery HUs whose neurosurgeons are very skilled in skull surgery, hospital discharges are likely to be different. In addition, different procedures or diagnosis, concurring to determine the so-called sub-sub-specialization [7], diversify the case-mix: for example, in a Neurosurgical HU (specialization), mainly focused on the surgery of the spinal column (sub-specialization), the prevalence of discharges for spinal fusion or for disc herniation (sub-sub-specialization) can help evaluate more closely the neurosurgeons' specific skills.

The three-folded analysis, consisting of specialization, sub-specialization and sub-sub-specialization may adequately describe the production process of any given HU and the skills of the related physician.

Specialization

Specialized physicians normally work in those hospital HUs corresponding to their specialization degree, mostly in accordance with a localistic approach that dates back to Morgagni (XVIIIth century).

In our classification, every given DRG code was attributed to the specialization of that HU in which at least two thirds (67%) of the hospitalizations with the same DRG code was produced. The choice of using 67% as cut-off to assign DRG codes to a specific specialization was arbitrary, but seemed reasonable for the purpose: in order to screen the 601 DRG codes adopted in Lombardy and to attribute them to the related specialization, we needed a simple yet sufficiently wide categorization to characterize each DRG, then followed by confirmation through a medical criterion, based on the correspondence between a given DRG code and the specialization needed to produce it.

In most cases, DRG codes met the established 67% threshold and were easily attributed to their corresponding specialization: for example, hospital discharges with "DRG 002 – Craniotomy, age>17 years, without complications" were produced by Neurosurgery departments in 89.09% of the cases, therefore this DRG code has been included in the DRG codes belonging to the specialization of Neurosurgery.

There were relatively few cases where the threshold was not met because of a scarce representation of the respective department; in this case, we directly applied the medical criterion and we attributed the DRG codes to the natural correspondent specialization: for example, hospitalization for "DRG 090 - Simple pneumonia and pleuritis, age> 17 years, without complications", which took place mainly in internal medicine (68.71%) and more rarely in the fewer pneumology departments (15.62%), was attributed to Pneumology.

Moreover, four ad hoc specialization classes were created for those specific production processes performed by a variegated pool of physicians: Transplantation Surgery, Endocrine Surgery, Hemodynamic Cardiology, and Trauma & Poisoning.

It is worth noticing that surgical departments can produce appropriate medical DRG codes and vice versa: for example, “DRG 069 - Otitis media and upper respiratory tract infection, age> 17 years, without complications” is a medical DRG code, but in 73.11% of cases it is produced by ENT (Ear Nose Throat) surgical departments.

Sub-specializations

Sub-specialization classes classify diagnosis and interventions into specific production processes, within each specialization class. Meetings with specialized internal doctors and with specialized surgeons were scheduled, so that their organizational knowledge could be used to define the production lines corresponding to a sub-specialization.

For instance, within the General Surgery DRG codes, 10 types of sub-specializations were grouped: anal surgery; surgery for appendicitis; gold-bladder surgery; skin surgery; surgery for herniation; liver, pancreas and bile duct surgery; bowel surgery; breast surgery; gastric and esophageal surgery; skin diseases”. Within the Orthopedic Surgery, 9 types of sub-specializations were identified, most of them corresponding to a big joint, others indicating a generic procedure, such as prosthetic surgery, traumatic surgery, soft tissues.

Sub-sub-specialization

The sub-sub-specialization phase was elaborated by managers only, mainly taking into account the average duration of hospital stay and the average case weight, which are two of the most used productivity indexes.

Sub-sub-specialization classes, corresponding to the type of main procedure or diagnosis, were shaped by grouping together those DRG codes with similar production processes. On the contrary, when different production processes were observed within the same DRG code, the DRG code itself was split into different categories, to take into account such differences.

Merges occurred for procedures and diagnosis

with the same production process: for example, DRG codes referring to fractures, sprains, strains and dislocations of the locomotive system (DRG 235-237; 250-255) were put together. Most merges of medical and surgical procedures and diagnosis occurred when DRG codes were differentiated only by the patient's age, or by the presence or absence of complications.

Spin-offs occurred for procedures and diagnosis with different production processes: for example "DRG 286 - Surgery on adrenal gland and pituitary gland", was divided into two DRG codes, pertaining respectively to General Surgery and Neurosurgery, due to the physician's specialization.

The final result of our proposed classification system is articulated into 32 groups of specialization, 124 groups of sub-specialization and 337 groups of sub-sub-specialization, for a total number of 613 codes, of which 538 came from the DRG system in its 24th version, 63 were added by Lombardy and 12 were identified by this study (Table 1).

The proposed classification results in a network, which can be analyzed within the theoretical framework of Ravasz and Barabasi (2003) for hierarchical organizations [8].

From a methodological point of view, and in order to make the proposed ontology applicable to health informatics databases, the proposed classification system is based on a grouping of the 613 DRG codes in use into a semantic network [9] where the specialization is the parent node (32 nodes) and the sub-specializations (124) and sub-sub-specializations (337) are the child nodes.

The semantic network analysis of the resulting hierarchical organization has the form of a tree [10] with a linear degree distribution [8] of 3.88 sub-specialties (median 3.00) for each specialty, and a degree of 2.97 (median 2.59) sub-sub-specialties for each sub-specialty. In synthesis, each original DRG Code was grouped with an average of 19.16 DRG Codes per specialty (median 16.00, second quartile 16.00, third quartile 21.25) and there are on average 0.26 (median 0.27, second quartile 0.27, third quartile 0.33) sub-specialties and 0.62 (median 0.59, second quartile 0.59, third quartile 0.69) sub-sub-specialties per DRG Code.

The resulting scale properties of the number of edges per node and their relationship with the original DRG Codes Classification are visualized in Figure 1 with the RStudio (version Version 0.98.501) function scatterplot3d() on the basis of the classification data from Table 1.

RESULTS

The analysis of a case study is presented, to give a practical application of our physicians' competence-centered approach, highlighting its crucial role in production analysis, production comparison and production planning.

Production analysis

A Neurosurgical HU of a hospital in Milan has been selected.

Its hospital production for the year 2010 counted 1,305 hospital discharges for 79 different DRG codes of 16 different MDC: that is a long list of different types of discharges that doesn't help understand and evaluate what exactly this HU, and its physicians, do.

The proposed physicians' competence-centered classification clearly detected that the DRG belonging to the Specialization of Neurosurgery covered only 50.1% of the 1,305 hospital discharges produced by the analyzed Neurosurgical unit, showing that half of the product is not related to the HU's mission.

Thanks to the second level of the classification, that is the sub-specialization, we observed that 59.6% cases (390 out of the 654 total cases) belonged to Skull Surgery and only 37.3% cases belonged to Spinal Column Surgery, this being already informative on the production of this hospital ward.

With the third level of the classification (sub-sub-specialization) Craniotomy appeared to be the most common type of treatment, while Intracranial Vascular Operations ranked lower; similarly, among the DRG codes of Neurosurgery of the Spinal Column (sub-specialization), only few types of hospitalization for Spinal Fusion were counted, while the majority was represented by surgery on Spinal Disk and Spinal Canal, completing the profile of the considered hospital ward.

The results of the physicians' competence-centered classification are shown in Table 2, where we observe at a glance what exactly the production characteristics of the HU are and therefore the skills and performance of its physicians.

TABLE 1

RESULTS FROM THE THREE-LAYER GROUPING PROCESS. THE GROUPS OF SUB-SUB-SPECIALIZATION ARE ALMOST HALF THAN THE TOTAL NUMBER OF THE DRG CODES, REFLECTING THE ACTION OF THE PHYSICIANS' COMPETENCE-CENTERED GROUPING

	SPECIALIZATION	DRG CODES	SUB-SPECIALIZATIONS	SUB-SUB-SPECIALIZATIONS
SURGERY	01. Cardiac Surgery	9	3	6
	02. Lymphohematopoietic Surgery	7	3	4
	03. Endocrine Surgery	12	2	7
	04. General Surgery	74	10	33
	05. Thoracic Surgery	9	3	5
	06. Vascular Surgery	16	5	11
	07. Gynecology	18	5	13
	08. Neurosurgery	21	4	8
	09. Ophthalmology	15	4	10
	10. Orthopedic Surgery	64	9	24
	11. ENT[a] Surgery	26	4	18
	12. Urology	43	5	21
	13. Maxillofacial and Oral Surgery	6	3	5
	14. Transplant Surgery	6	1	6
MEDICINE	15. Hemodynamic Cardiology	19	2	9
	16. Cardiology	19	6	11
	17. Dermatology	5	3	3
	18. Hematology	16	3	11
	19. Gastroenterology	22	3	11
	20. Endocrinology	8	3	5
	21. Nephrology	9	3	5
	22. Neurology	28	7	18
	23. Oncology and Radiotherapy	33	2	16
	24. Pneumology	21	6	10
	25. Psychiatry	13	4	12
	26. Rheumatology	5	2	3
	27. Resussitation	9	3	5
	28. Infectivology	20	2	11
	29. Nursery, Neonatology and NICU[b]	7	2	7
	30. Obstetrics	17	3	11
	31. Trauma, complications, allergies	24	7	9
	32. Anomalous DRG codes	12	2	9
	TOTAL	613	124	337

[a]ENT: Ear Nose Throat
[b]NICU: Neonatal Intensive Care Unit

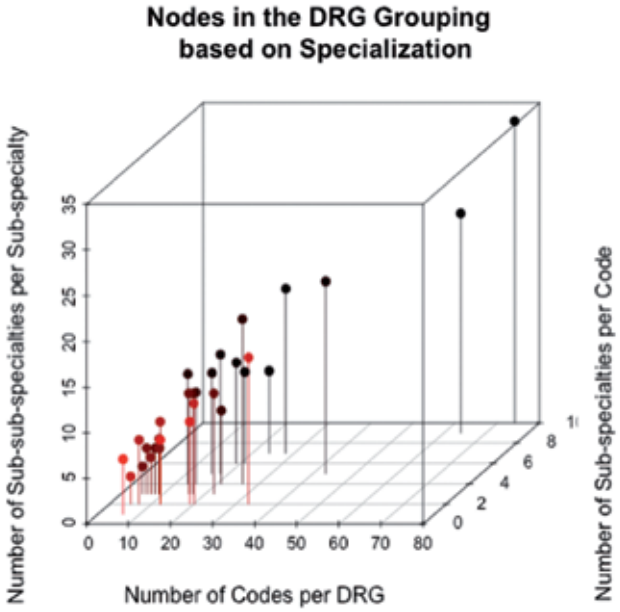
Production comparison

The already considered Neurosurgery HU was compared to other Neurosurgical HUs in Lombardy, with regard to the average length of stay (Hospitalization > 1 day).

The crude mean duration of hospitalization appeared 17.1% higher than the regional level (hospital mean duration = 11.4 days; crude regional mean duration = 9.7 days). It is well known that the crude mean duration of hospitalization is influenced both by

FIGURE 1

NUMBER OF NODES IN THE DRG LINEAR BASIC TREE-NETWORK TOPOLOGY GROUPING BASED ON SPECIALIZATION



production efficiency and production case-mix [11]; in order to separate the two components, thus taking into account production efficiency only, we computed the case-mix standardized mean. Case-mix standardized results showed an average length of stay 2.0% higher than the regional average (standardized regional mean duration = 11.2 days). Yet, it is not possible to assess whether the performance is the result of compensation between different lengths of hospitalization for each type of discharge production, or if all types of hospital discharges are 2.0% higher than the regional average.

Our classification uses the case-mix standardized results without losing the identification of these differences: for example, we found that the average length of stay of the hospitalization for Intracranial Vascular Surgery is much higher than the regional average (+30.1%), as well as for the Interventions for Dorsal, Lumbar and Cervical Spinal Fusion (+12.5%), while Craniotomy is lower (-7.4%).

Other examples are available in Table 3.

Production planning

In Milan, for the year 2010, we found 10 Neurosurgery HU that produced 11,268 hospital discharges. The case-mix was represented by 127 different DRG codes (of which 20.6% medical DRG codes), from 21 different MDC codes, thus not differing from the typical long list of different types of hospitalization. However, our classification made it possible to realize that only 7,532 cases out of the 11,268 total ones (68%) belonged to the Specialization of Neurosurgery. Moreover, the proposed classification detected that in the same city the total number of cases related to the specialization of Neurosurgery were 10,462, of which 2,930 (28%) produced by 94 non-Neurosurgical HUs.

Considering the DRG codes belonging to the Neurosurgical specialization, the analysis by type of sub-specialization also showed a wide diversity of activities. For example, as reported in Table 4, Hospital A, which produced the largest number of cases relating to the specialization of Neurosurgery, ranked first in the sub-specialization area of Spinal Column Surgery (38.8%), but sixth in the sub-specialization area of Surgery on the Skull (4.8%). Conversely, Hospital C, which was third for the total number of cases, ranked fifth in the sub-specialization area of Spinal Column Surgery (6.2%), but second in the sub-specialization area of Surgery on the Skull (24.6%).

These examples could suggest that the analysis of a specific production process is

TABLE 2

PROPOSED CLASSIFICATION OF THE PRODUCTION OF THE EXAMINED NEUROSURGERY WARD

RANK	SPECIALIZATION	N	%
1	Neurosurgery	654	50.1%
	Skull surgery	390	
	Craniotomy	344	
	Intracranial vascular surgery	46	
	Spinal column surgery	244	
	Surgery on spinal disk and spinal canal	185	
	Dorsal and lumbar spinal fusion	47	
	Cervical spinal fusion	12	
	Spinal cord surgery	20	
2	Neurology	377	28.9%
3	Non-attributable DRG codes	72	5.5%
4	Orthopedics	63	4.8%
5	Oncology & Radiotherapy	51	3.9%
6	Endocrine Surgery	39	3.0%
7	Ressucitation	15	1.1%
8	Vascular Surgery	15	1.1%
9	General Surgery	9	0.7%
10	Ophthalmology	3	0.2%
11	Endocrinology	3	0.2%
12	Thoracic Surgery	1	0.1%
13	Infectivology	1	0.1%
14	ENT Surgery	1	0.1%
15	Dermatology	1	0.1%
	TOTAL	1,305	100%

poorly representative if limited to the discharges of the respective HU (Neurosurgery, in our case), since the same activity can be realized by different HUs and since each HU only produces certain types of activity.

Since the target is the activity performed, it seems necessary to study the related production rather than the related HU.

DISCUSSION

In OECD countries (Organisation for Economic Cooperation and Development), private and public health care expenditure reached in 2009 an average incidence of 9.6% of the Gross Domestic Product [12]; with the economic crisis and the subsequent slowdown or negative growth in health spending per capita from 2010 on, health care expenditure declined in 2012 to an average incidence of 9.0% of the GDP [13]; yet, in many EU countries, these costs are becoming increasingly difficult to sustain.

It is therefore critical to manage our health care system, not only in terms of qualitative and quantitative production, but also in terms of economic sustainability. Methods capable of measuring the results achieved are urgently requested, to assess whether the provided services are appropriate to their demand, and whether they are effective and efficient, with respect to resource consumption [14].

Pursuing public purposes does not imply renouncing to an adequate use of resources, because this would inevitably lead to the jeopardization of the fulfillment of the expectations of the public and, ultimately,

TABLE 3

COMPARISON OF LENGTH OF HOSPITALIZATION BETWEEN THE CONSIDERED WARD (X_i) AND THE REGIONAL AVERAGE ($\bar{X}$)

SPECIALIZATION - NEUROSURGERY	X_i	$\bar{X}$	$X_i-\bar{X}$	$X_i-\bar{X}$ %
Skull surgery	**14.0 days**	**14.6 days**	**-0.6 days**	**-1.4%**
Craniotomy	12.5 days	14.1 days	-1.5 days	-7.4%
Intracranial vascular surgery	25.0 days	18.8 days	+6.2 days	30.1%
Spinal column surgery	**7.7 days**	**6.4 days**	**+1.2 days**	**21.6%**
Surgery on spinal disk and spinal canal	5.9 days	5.3 days	+0.6 days	92.4%
Dorsal and lumbar spinal fusion	13.1 days	10.5 days	+2.6 days	28.1%
Cervical spinal fusion	13.0 days	7.3 days	+5.7 days	12.5%
Spinal cord surgery	**11.2 days**	**7.4 days**	**3.8 days**	**51.5%**
Spinal cord surgery	11.2 days	7.4 days	3.8 days	51.5%

TABLE 4

PRODUCTION OF HOSPITAL ADMISSIONS IN THE NEUROSURGICAL DEPARTMENTS OF A CITY OF LOMBARDY, WITH THE PROPOSED CLASSIFICATION

	TOTAL PRODUCTION %	SPINAL COLUMN %	SKULL %	SPINAL CORD %
HOSPITAL A	38.3%	4.8%	7.5%	24.2%
HOSPITAL B	9.7%	29.4%	20.9%	17.6%
HOSPITAL C	6.2%	24.5%	10.4%	13.2%
HOSPITAL D	3.7%	18.0%	22.8%	10.1%
HOSPITAL E	4.1%	11.4%	4.9%	6.9%
HOSPITAL F	5.2%	5.5%	8.0%	5.5%
HOSPITAL G	8.2%	1.1%	1.7%	5.2%
HOSPITAL H	6.5%	2.2%	2.3%	4.7%
HOSPITAL I	5.9%	0.1%	2.1%	3.5%
HOSPITAL J	3.3%	2.2%	3.1%	2.9%
OTHERS	8.9%	0.8%	16.3%	6.3%
TOTAL	100.0%	100.0%	100.0%	100.0%

of equity [15]; this is particularly true for the health sector, where it has been shown that there is not always a correlation between high quality and high costs [16].

Among the organizational changes affecting health care, the most important one regards the hospital sector [17]. Over the last twenty-five years the number of beds has declined of a third in Europe, and a similar reduction has also affected the length of stay, resulting in a halving of hospitalization rate. Moreover, the cost per unit seems independent from the size of activity and from the efficiency indexes, such as the comparative index of performance for standardized case mix [18].

If there is production inefficiency, then it should be possible, within the same hospital network, to produce the same amount of hospitalizations with a smaller number of hospitals; in the United States, however, the result achieved by the merging of hospitals, in this case private ones, proved to be modest in terms of prices and costs [19-21]. In England, between 1997 and 2006, a radical program of closure of small hospitals through merges was undertaken resulting in a drastic reduction of both personnel and business volumes. However, neither clinical quality improvements nor production capacity ones were achieved, while waiting lists increased dramatically, leading to the conclusion that large scale merges reduce the chance of competition and threaten the realization of better services [22].

The literature on health reform suggests that under certain conditions (regulated prices and observable quality) competition can improve quality [23]; this evidence seems to be confirmed by a more recent British hospital

reform, based on a competitive strategy, which seems to accomplish both clinical quality [24,25] and management of hospitals, which in turn ameliorates the outcomes [26].

A recent study has demonstrated that production inefficiency might be due to the lack of an appropriate system of measurement, which is an essential condition for the increase of competitiveness. When such a measurement system has been available, it was possible to identify areas for improvement and to discuss it with professionals, thus increasing the efficiency of the organizational processes, with effective collaboration at clinical level [27].

The introduction of classification systems of hospitalizations, including the most common DRG system, has certainly led to a significant improvement in the analysis of hospital production but, as we have pointed out in this research, it is still not enough in terms of significant management directions. As we have already said, the production of hospitals and HUs is usually a long list of DRG codes, the interpretation of which is difficult and their comparison often impossible, because the sets of DRG codes, obtained by grouping DRG codes according to the producing departments, are never homogeneous and therefore not comparable. Moreover, as shown in the case-study, the standardization process is useful at a descriptive level, but ineffective at the organizational level, because too synthetic.

The results of this study seem to confirm that the DRG grouping based on the physicians' specialization makes it possible to identify typical production processes of each HU or of entire hospitals, too. Other studies, although offering a different categorization [28] have confirmed this hypothesis.

It could be argued that the correlation between HU discharges and the type of production (or the physicians' specialization) is unwarranted, because the final discharge DRG may be the result of several transfers among different HUs [29]; it's worth noticing that this happens every time a HU is evaluated. Moreover, from a performing point of view, it is important to assess whether a given HU produces types of hospitalization that differ from its specialization.

The application of the proposed classification facilitates the analysis and comparison of the production activity among different clinical settings. As stated above, we focused on the physicians' competences to analyze production and with the case study we proved the validity of our reasoning.

For a given HU, we first identified a throughout profile of production, which indicated how many production lines there were, and how much production was obtained for each line: this could already give information on the HU's working approach and on the amount of practice, thus expertise, related to every single production line (for instance, a HU could be highly specialized in few productions, thus resulting in a high level of practice of each production line, or it could have a broader spectrum of specialized production, but with poor activity in each production line).

The profile of production was then used to compare the given HU with the regional average; we performed process-specific comparisons, which are more informative than the commonly used case-mix standardized comparisons: indeed process-specific comparisons allow the Hospital management and the HU Director to locate exactly the critical production lines and consequently their related issues.

Thirdly, we studied and compared different HUs with similar production processes, thus delivering informative evidence to the central decision-making bodies: an effective evaluation of the production activity allows the hospital to streamline the supply side, to define production standards and to set reliable targets for performance, as already achieved by the best performers: available resources are therefore allocated according to a verifiable criterion. In addition, the possibility of using benchmarking, and thus of enhancing competition, is a valuable opportunity in health care, where the professional reputation is the most effective leverage to activate change, while hierarchy often has little influence on the professionals' behavior [14].

CONCLUSION

In a critical time for the financial sustainability of health care, when efforts to rationalize hospital care are required, yet without giving up equity in the offer of high-quality health care, the chance to take knowledgeable action on the production processes of hospitalization may represent an important step forward. If interventions can be readily intelligible both to physicians

and managers, by contributing to blunt the information asymmetry, a typical element of health care activity, collaboration can become more and more fruitful; in other words, our work suggests a possible way out from self-reference, that often, in health care, is the first obstacle to change.

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