An activity-based costing approach for detecting inefficiencies of healthcare processes

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Abstract

Purpose – The purpose of this paper is to set out a methodological framework to investigate how the integration of an activity-based costing (ABC) logic into the pre-existent accounting system supports healthcare organizations in identifying the inefficiencies related to their diagnostic therapeutic pathways (DTP) and related reengineering interventions.

Design/methodology/approach – The BPM-ABC methodological framework has been applied to the case of a specific surgery pathway, at the Orthopaedic Division of a University Hospital in Italy.

Findings – The case-study described in the paper points out: first, how the Business Process Management (BPM)-ABC methodology is able to produce significant information about consumed resources and the costs of the activities, useful to highlight opportunities for DTPs improvement; second, the barriers related to a pre-existing accounting system based on cost centres that can hinder the implementation of the BPM-ABC model.

Practical implications – The case study points out the role of the ABC as a management tool for supporting decision-making processes. The ABC allows inferring information for two purposes. First, ABC supports a cost containment process as it allows highlighting the most cost-consuming activities and resources. Second, the ABC allows identifying reengineering paths, distinguishing between incremental and radical ones.

Originality/value – This study represents a remarkable reference raising the awareness of the pivotal role accounting systems play in the management of the organizational processes.

Keywords Case studies, Healthcare, Activity-based costing, Business process reengineering

Paper type Case study

1. Introduction

The achievement of relevant and accurate cost information to ground the decisions concerning strategy, pricing and management is a fundamental issue for policy makers who face hospital financing and reimbursement problems, for hospital administrators who pursue internal cost management purposes, and for health policy scholars (Cardinaels et al., 2004; Gil and Hartmann, 2007; Eldenburg and Krishan, 1997; Pettersen, 2001; Hovenga, 1996). This premise implies the critical role of the design and implementation of cost accounting systems in healthcare organizations.
The literature outlines the increasing investment in sophisticated cost-accounting tools and systems in healthcare organizations, such as activity-based costing (ABC) (Ross, 2004; Cappetini et al., 1998; Chan, 1993; Udpa, 1996). Furthermore, a growing amount of information on the use of ABC in detecting the costs related to the inefficiencies of organizational and productive processes is available (Krug et al., 2009; Arnaboldi and Lapsley, 2005; Caroli, 1996; Udpa, 1996; Canby, 1995; Ramsey, 1994; Baird, 2007). The ABC is particularly well suited in healthcare organizations to compare the reimbursement tariff with the sustained costs of different health services. In several countries (e.g. Australia, USA, Switzerland, Spain, Italy) healthcare organizations currently apply the Diagnosis Related Groups (DRG) reimbursement system to fund hospital activities (Blein et al., 2006). The general idea behind the use of the DRG system is that diagnoses with similar therapeutic protocols engage similar resources (Blein et al., 2006; Fetter and Freeman, 1986). Each DRG is characterized by a standard unit price representing the reimbursement that is provided by the National Health System for the healthcare services. The healthcare service comparable to the DRGs included in the reimbursement system is defined as Diagnostic-Therapeutic Pathway (DTP) (Lega, 1997). A DTP identifies all the services needed to diagnose and treat a specific disease from the first access of the patient into the healthcare system. The systematic adoption of DTPs in healthcare organizations fosters the implementation of a managerial perspective based on processes, with obvious positive effects on the efficiency of the organizations (Rohner, 2012; Benyoucef et al., 2011; Snyder et al., 2005). The ABC allows managers to have proper data on the amount of resources used by each activity included in the DTP and on the overall costs of the DTP. The cost information of each DTP is essential for the financial stability of a healthcare institution. If the organization does not have accurate cost information, it is at financial risk when making decisions regarding current operations as well as long-term plans. In addition, more precise cost information allows managers to redesign the DTP to make it more adequate to clinical purposes (Jacobs et al., 2004). According to the aforementioned literature, the ABC has a fundamental role in cost accounting systems as it can detect inefficiencies in performing DTPs and, consequently, it could suggest interventions for process improvements (Englund and Gerdin, 2008; Malmi and Granlund, 2009).

This paper aims at contributing to the literature on the use and implementation of ABC in healthcare organizations, exploring, in particular, the benefits that the adoption of the ABC could produce in terms of valuable information for processes management. A case study will be presented and discussed in order to outline how the use of ABC could integrate the information produced by pre-existent accounting-informative systems in order to support improvement or reengineering interventions on healthcare delivery processes.

The remainder of this paper is organized as follows. Section 2 offers a review of the literature relating to the relevance of ABC for healthcare organizations. Section 2 outlines that the implementation of ABC could imply not only a precise cost assessment of healthcare processes, but also the availability of relevant information complementing processes’ performance measures, thus contributing to an effective management of organizational processes according to the continuous improvement perspective. Furthermore, a short review of the barriers encountered in the adoption of ABC is presented. Section 3 describes the methodological framework adopted to apply the ABC technique on a DTP and shortly the case study’s design. Section 4 illustrates the case under investigation. Section 5 reports the results of the case study and
discusses some implications for practice. Finally, conclusions and directions for the further research are presented in Section 6.

2. Background

The relevance of ABC for healthcare organizations is well highlighted in the literature stream of process reengineering. Snyder et al. (2005) outline that health system should be oriented to promote continuous improvements, using effectively the information in order to monitor costs and quality of care.

Several are the benefits related to the implementation of ABC:

- promotion of initiatives for cost reduction though the identification of value added and non-value added activities (Brimson and Antos, 1994);
- a better awareness of accountants on how the service works, providing visibility on where and why the costs arise (Kirton and Hazlehurst, 1991); and
- supporting “what if” analyses, providing a good guide to managers in decision-making processes (Williamson, 1988).

ABC is also a useful tool for improving accounting performance measures in a process perspective (Kohlbacher, 2010). In their literature review on process orientation, Kohlbacher and Gruenward (2011) claim that one of key dimensions of the process orientation is related to process performance measurements and, concerning cost performance, they suggest the use of ABC to capture costs horizontally in line with business processes.

In an international comparative study, Jacobs et al. (2004) showed that clinical professionals are sensitive to cost and performance information, even if the level of access to such information is not always adequate. This kind of information is perceived as inadequate since it has been designed according to corporate and regulatory organizational requirements rather than to support clinical performance. Another study (Pizzini, 2006) proved that healthcare managers are convinced that the usefulness of cost information is directly proportional to the availability of details, and that, if properly managed, it can help professionals to improve their performance. The above studies suggest the importance of designing and implementing refined and innovative costing systems in healthcare, in order to increase the effectiveness of accounting information in hospitals, apart from the assessment of the economic effect of processes and activities.

The purpose of this paper is to explore more in depth the benefits coming from the use of ABC not only as a costing technique, but also as a structured method to produce valuable measurements of processes performances (the ABC can contribute to enhance the accuracy and he interpretative power of economic performance indicators). To this aim a single exploratory-pilot case study will be presented and discussed, referring to the implementation of the ABC in an Italian healthcare organization.

In Italy, hospitals are remunerated through a DRGs system. DRGs are set by regional governments (according to indications provided at ministerial level) and periodically reviewed. This remuneration system gave rise in the last decade to a remarkable attention towards the benefits coming from the implementation of ABC, even if the experience of ABC (some of the applications of ABC in Italian healthcare organizations are reviewed in Cinquini et al., 2009) is limited to individual cases of experimentation. Furthermore, since 2013 regional governments have been requested (according to the ministerial decree 68/2011) to define standard costs and standard
requirements for health sector, in order to ensure a gradual and final overcoming of the allocation criteria laid down by Law 662/1996. These costs will represent the reference standard requirements for funding regional health organizations; as a consequence, a larger implementation of ABC in Italian healthcare structures is expected in the next future.

One of the reasons why the ABC is not currently implemented in healthcare structures is that the implementation of ABC requests to overcome a set of cultural, organizational and technical barriers (Duh et al., 2009; Waters et al., 2001; Lee and Mahenthiran, 1994). Cultural obstacles are usually related to the lack of (Baird et al., 2004, 2007; O’Reilly et al., 1991; Velmurugan, 2010; Nair, 2002): outcome orientation, culture of change, innovation orientation, accuracy on control of activities and costs.

In healthcare organizations cultural barriers are strictly related to the strong professional autonomy of physicians, which makes them distrustful towards the managerial tools aimed at controlling and driving clinical decisions. This behaviour, of course, influences the way in which clinical staff perceives cost management and activity information (Jacobs et al., 2004). In particular, this occurs in those healthcare organizations in which a cost-accounting system based on cost centres is already implemented. In this case some difficulties arise due to the need for the coexistence of two different accounting logics, one focused exclusively on the analysis of the costs allocated to the various accountability units and cost centres, and the other focused on the analysis of the costs of healthcare services and processes. The coexistence of the two logics within the same organization is a critical aspect in the management of healthcare organizations, since it is requested to manage the accounting information for different purposes. The accounting logic based on cost centres gathers information on costs of each cost centre (cost centres correspond to organizational units in most cases). This information is useful for managers to control costs emerged in the organizational units. Otherwise, the organizational units perform activities that are absorbed by health services in different ways. The accounting logic based on activities allows to allocate the costs to healthcare services in a more precise manner through the computation of the cost of activities absorbed by healthcare services. The accounting logic based on activities is, therefore, the most suitable for computing the cost of DTPs and to compare it with the corresponding DRG tariff. The coexistence of these two accounting logics imply the implementation and management of an accounting system able to switch from a focus on cost centres to a focus on the activities. The implementation of this system requires overcoming organizational and technical barriers. Organizational barriers are related to the functional structure of healthcare organizations, and to their intrinsic complexity, which entails to consider the organizational unit as a black box. This complexity is also generated by the presence of distinct teams characterized by different aims, interests and expertise. The barriers concerning the technical aspects are generated by the inability of cost accounting systems in healthcare organizations to: first, foster the effective and efficient management of the organizational activities; second, identify the time, the place and the drivers of resource consumption; third, elaborate and modify data in a timely manner; fourth, exploit synergies among the expertise of different specialists; and fifth, avoid huge cross-subsidies across services (Kaplan and Porter, 2011).

The case study presented in this paper, through a pilot application of ABC on a DTP carried out in an Italian hospital, aims at showing which kind of information on clinical processes the implementation of ABC can generate; furthermore, the case study outlines some of the barriers discussed above.
3. A methodological framework to compute the cost of a DTP

3.1 Theoretical assumptions

The cost accounting literature suggests the integration of the existing accounting system based on cost centres with a proper information system that could effectively support healthcare managers in the identification of where and why resources are consumed (Baker, 1995; Hoyt and Colin, 1995; Jones, 1999; Canby, 1995; King et al., 1994; Ramsey, 1994). Ramsey (1994) claims that such an integrated accounting system (cost centres accounting system and coherent information system) should support managers in using resources efficiently through an improved management of processes. Recently, Kaplan and Porter (2011) suggested to implement the time-driven activity-based costing (TDABC) in health organizations to overcome the poor cost measurements which lead “the providers to misunderstand their costs” and, consequently, “to link costs to process improvements or outcomes, preventing them from making systemic and sustainable cost reductions”. Based on the perspective of an integrated accounting system and on the advantages of implementing the ABC in healthcare organizations (TDABC is an improved version of ABC), we have designed a methodology based on ABC technique to detect the cost of a DTP in order to make it comparable to the corresponding DRG tariff. In order to evaluate potential profit or loss related to a specific DTP, the concept of “minimum DTP cost” has been introduced. The DTP cost results from the sum of activity cost pools needed to perform a DTP. Generally, an activity cost pool is the sum of the costs in terms of human, material and immaterial resources absorbed by an activity. On the contrary, downtime of human resources and waste of resources are not considered in computing the minimum DTP cost. Indeed, each human resource is allocated to the activities based on the time one spends on them, without considering downtime.

A comparison between the minimum DTP cost and the DRG allows managers to identify the typology of improvements (incremental vs radical) required, and the profit or loss related to a DTP. As shown in Figure 1, if the minimum DTP cost is lower than the corresponding DRG tariff, the organization may have a profit (area 1) or a loss (area 2).

In area 1, the DTP cost is lower than the DRG tariff. The DTP is performed in an efficient way and improvements are not needed.

In area 2 the DTP cost is higher than the DRG tariff, despite the minimum DTP cost being less than the DRG tariff. The DTP is not performed in an efficient way and...
improvements are necessary. In this case, we can suppose that the inefficiency depends on how the DTP is carried out. A process reengineering could be sufficient to overcome the waste and to move into the area 1. This improvement is incremental because the waste is overcome by redesigning some phases of the process.

If the minimum DTP cost is higher than the DRG tariff, the organization suffers a loss (area 3). Placing a DTP in this area implies that the resources considered in the minimum DTP cost are higher than resources connected to therapeutic protocols considered in the computation of the DRG tariff. In this case, managers should make a radical rethinking of the whole process in order to change the cost structure of it. Only radical interventions on the DTP are useful to move from the area 3 to the area 1.

3.2 The methodological framework

The methodological framework describes how activities of a DTP are identified, how many cost drivers are used and how to reassemble cost information on activities and resources to support the reengineering interventions. The methodological framework has been articulated in two phases: “DTP Mapping” and “DTP Cost Assessment”. To carry out these phases, we have performed a data-gathering process described in the case study design section.

Figure 2 presents a description of the needed actions and their outputs for each phase of the methodological framework.

The first phase maps the pathway of the patients inside the organization. Flowcharts are used to draw the processes. The second phase computes the costs of the activities represented in the flowchart through an ABC model. The DTP mapping phase uses field observation and interviews to key actors as information sources to reproduce the processes.

The DTP mapping is articulated in the steps reported in Table I. This table summarizes the tools used and the results obtained for each step.

The output of this phase is the DTP inter-functional flowchart. It represents the input for the following phase: DTP cost assessment. For the DTP cost assessment phase, the information sources are: field observation, interviews to key actors and accounting books. They all generate the inputs for specific matrixes used to identify cost drivers.

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<th>DTP Cost Assessment</th>
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<td>Flow charts</td>
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<tr>
<td>i. Computation of activity cost pools</td>
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Figure 2.
Methodological framework for DTP assessment
In Table II, a description of the tools and of the results are reported for each step of DTP cost assessment. In this case study, drivers are inferred by interviews to key actors, field observation and documents.

The output of this phase is the computation of activity cost pools, whose sum is the minimum indirect cost of the DTP. The minimum DTP cost is obtained by adding to the minimum indirect cost the costs of direct resources. This cost can be compared with the DRG, and a gap analysis can be performed. The gap analysis allows managers to identify critical areas, on which it is possible to intervene to efficiently perform the DTP process.

3.3 Case study design
The aim of the present work is to explore the usefulness of the ABC applied to DTPs in terms of impact on processes improvement or reengineering. To this aim a pilot (Tellis, 1997) exploratory single case study (Yin, 1994) is performed. The case study is

<table>
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<th>Tools</th>
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<td>Interviews to experts</td>
<td>Selection of the DTP according to availability of data and low level of organizational complexity</td>
</tr>
<tr>
<td>Identification of DTP activities</td>
<td>Field observation and interviews to key actors. The field observation helps to triangulate information from interviews. Through interviews the researcher can obtain explanations on how organizational unit activities are carried out</td>
<td>Activities of DTP and their description</td>
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<tr>
<td>Analytic reconstruction of DTP</td>
<td>BPM tools such as interfunctional flowcharts. Through this tool, it is possible not only to map all care pathway’s activities but also to show in which organizational unit an activity is carried out</td>
<td>Interfunctional flowchart of the DTP process</td>
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<td>Validation of DTP reconstruction</td>
<td>Interview to key actors to suggest proofreading to interfunctional flowcharts</td>
<td>Redesign of interfunctional flowchart of DTP</td>
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<th>Steps</th>
<th>Tools</th>
<th>Results</th>
</tr>
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<tbody>
<tr>
<td>Individuation of resources</td>
<td>Interviews to key actors to identify the nature and the amount of resources absorbed by activities</td>
<td>List of indirect resources and list of direct resources. The indirect resources are allocated through ABC Costs of resources</td>
</tr>
<tr>
<td>Individuation of resources costs</td>
<td>Involvement of planning and control staff to gather the costs of resources Interviews to key actors, field observation, and consultation of accounting books to identify and to compute the causal link between resources and activities (a link that explain how the resource is consumed by the activity)</td>
<td>Computation of cost drivers that link resources to activities</td>
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Table 1. DTP map: steps, tools and results

Table 2. DTP cost assessment: steps, tools and results
exploratory as the objective of research is to analyze more in depth the implications for processes management of the application of ABC in the specific context of diagnostic therapeutic pathways (DTP). The final aim is to identify suitable propositions to be tested in future research. The case is a pilot case study because the ABC was not previously applied in the context under investigation; as a consequence, a methodological framework to apply the ABC to a specific DTP has been tested. Due to the pilot character of the study and due to the time requested to design and to apply the ABC to a DTP, a single case has been adopted.

A multidisciplinary team was assembled to design the ABC data-gathering process as well as the interpretation phase aimed at understanding how the cost information can support management in the analyzed context. The team was composed by three researchers in accounting systems, one physician, and three planning and control staff representatives. Accounting researchers participated to the whole process while the physician was involved in the description of the activities of the selected DTP, as well as in the identification of the drivers. Planning and control staff provided costs and technical information related to the consumption of resources. The research was conducted in 2012 for a period of six months. In this period we made three observations and analyses of the same DTP.

The multidisciplinary team selected a DTP whose activities were mainly carried out in the same organizational unit, thus facilitating the mapping of the DTP and the data gathering. The data-gathering process was articulated in three steps. First of all, several interviews were carried out to break down the process into activities, and then to record them in a flowchart. The physician identified the key people to interview. The key people were: the nurse which manages the admission and the opening of clinical record, the nurse which manages the stay in hospital period, the physician involved in the anaesthesiological test, and the physician belonging to the multidisciplinary team. Field observation helped to identify the activities. Finally, the revision and validation of the flowchart was made by the key people involved in the data-gathering process.

The interviews were based on unstructured questions, as their aim was to understand the activities needed to carry out the DTP. The interviews were also useful to obtain a thorough description of each activity. The description, in turn, helped in the identification of cost drivers, as suggested by the techniques most commonly used. In the second step, structured interviews were used to identify the nature and the amount of consumed resources and the time needed to complete each activity. The typical questions asked were “What resources are usually used to perform this activity?” and “How long does it take to perform this activity?” – The first question was needed to identify the resources used (i.e. human resources, maintenance, drugs, etc.), while the second question allowed to obtain information that could not be inferred from technical books. Instead, technical information needed to compute drivers was gathered through interviews to the planning and control staff of the multidisciplinary team, to the physician, and to the pharmacy employees. The process characterizing the second step was an iterative process, aimed at identifying information gaps, and mistakes or misinterpretations that were recorded during the interviews. Furthermore, this step allowed the identification of proper cost drivers explaining the causal link between resources and activities, and between activities and cost objectives. The third step focused on collection of information on the unit cost of resources used. This information was mainly provided by the planning and control staff.
4. The case study

4.1 Context description

The research took place in a hospital operating in the Campania region (southern Italy). In Italy a mixed public-private system provides healthcare services for all citizens and residents. The public provider is the National Health Service (under the responsibility of Italian Ministry of Health). The administration of Public Healthcare System occurs at the regional basis through Local Health Authorities and public hospitals. Local Health Authorities are responsible for financial organization and management of health services (prevention, treatment and rehabilitation) at the local level, while public hospitals provides treatments of acute stage patients. In-patient care and general practitioner services are free of charge, but co-payments are generally required on pharmaceuticals, diagnostic procedures and specialist visits. The funding of Regional Health Systems is based on the share of the National Health Fund assigned to the region, on the balance of interregional patients mobility, and on an additional contribution established by the region in the regional health plan. The criteria for the distribution to providers are:

- the remuneration rate of the services provided in the case of hospitals; and
- the weighted capitation for all levels of care (with the exception of prevention, primary care and other community care) for Local Health Authorities.

The specific context of the analysis is an Italian public large hospital (named the hospital for privacy concern) operating in southern Italy. The hospital actively performs national and regional programmes in several areas (such as emergency care, primary prevention, secondary early diagnosis, tertiary of neoplastic and chronic degenerative diseases, protection of mothers and children, liver transplants, biotechnology research, and training). In addition, it hosts the Emergency Department, the most important emergency department of southern Italy.

The medical and nursing care can be provided as ordinary hospitalization, day hospital or outpatient. The reimbursement of these services is based on the DRG system. The accounting system is based on a cost centre architecture that, coherently with the organizational and accountability chart, is arranged in accountability centres and cost centres (Ippolito and Viggiani, 2013). This accounting system easily provides information on performed services, resources used, and accountability flows. The typologies of cost centres in the hospital are the following:

- **production cost centres**, ordinary organizational units for admission, that consume resources and perform services for the inpatients;
- **intermediate cost centres**, organizational units providing horizontal services both for the other organizational units of the hospital, and for the outside patients (such as outpatient activities); and
- **support cost centres**, organizational units that exclusively support the other organizational units of the hospital.

Survey and data analyses are made through final statement reports, which are elaborated every six months. These reports are developed by a centralized management and planning control system. Reports provide information on activities and costs for cost centres, but they do not allow to assess the degree of achievement of their aims.

This point of weakness makes it difficult to compute the cost associated to DTPs, because the focus is on cost centres rather than on pathways. In addition, the architecture of the cost centres determines a cultural barrier to the introduction of new...
accounting models that affect the planning staff. Surprisingly, the physicians were very impressed by the results of the ABC application. Both the flowcharts and the presentation of results in graphical forms raised their enthusiasm to the novel accounting model. Despite this interest, they do not have the power nor the role to drive the organization into the adoption of the ABC model.

4.2 DTP map description
The analyzed DTP is the “total substitution of the knee” performed in the orthopaedic unit of the hospital. The case concerns a patient in good health without any kind of complications. The map description has been developed through both interviews to staff and physicians, and through the direct observation of some phases of the process (except for surgery or other delicate phases). The mapping of the whole process has been made following this model, starting from the admission of the patient to his discharge.

The care pathway starts with a preliminary examination at the Outpatients Orthopaedic Department. If the patient needs surgery, he goes through a pre-surgery examination phase. This phase is made up of three preliminary activities:

1. admission and opening of clinical record;
2. blood tests; and
3. radiographic tests.

The blood tests are carried out at the clinical laboratory, which is a different organizational unit of the hospital. The radiographic tests are carried out at the orthopaedic unit. Then the patient is finally admitted. During the admission, there is an anaesthetiological test. Surgery occurs after this phase. All the materials needed for the surgery are requested to other centres. These materials are drugs, medical devices and haematological materials. The activity concerning the request of the materials is not considered in the ABC model, but it has been included in the flowchart to outline the interaction between different organizational units. This information could be useful if the hospital undertakes a reengineering activity. A period of hospital stay follows the surgery, a period in which other materials are needed, and the patient undergoes new blood and radiographic tests. The entire process ends with the discharge procedure.

The DTP map aims at outlining the degree of interaction among different organizational units. As a consequence, inter-functional flowcharts were used to highlight in which organizational units the activities were performed in (Figure 3).

In the flowchart only the main phases are reported, whereas in the ABC application some phases have been represented with their constituting activities.

During the mapping phase, each activity was thoroughly described in order to obtain information about resources used and extra accounting data, such as the time duration of the actions. In the ABC application, the analysis focused only on the activities carried out by the orthopaedic unit because the activities performed in the other organizational units were very few and not significantly relevant. More in detail:

- **Pre-surgery examination breakdown**: admission, blood sample, blood sample transport, anesthetiological test.
- **Surgery breakdown**: patient transport to surgery, surgery, cleaning of the surgery room.
- **Hospital stay breakdown**: post-surgical therapy, hospital stay, and medical care.

Details on each element of the DTP are provided in the Appendix.
Figure 3.

The DTP flowchart
4.3 DTP cost assessment description

A phase of data retrieval is needed to effectively apply the ABC. This phase is extremely difficult because it is necessary to get information about accounting and extra-accounting data. In this case-study, the chief of the planning and control unit of the hospital, the physician involved in the team, and the pharmacy employees were interviewed. Based on the information obtained in the DTP mapping phase, resources used and activities for this specific DTP were identified. Table III shows a matrix in which the rows represent the resources and columns the activities. The “x” in a cell of the matrix implies that a specific resource is used by that activity.

As it emerges from the resource-activity matrix, the cost of the laboratory and imaging tests are directly obtained from the accounting information system and not inferred from the ABC application. Finally, the cost drivers in the allocation of indirect costs to the activities are identified. Cost drivers justify the causal relationship between resources and activities. In the computation of activity cost pools, only the amount used by the DTP is allocated as a cost to DTP activities. Indeed, the aim of this analysis is to compute the minimum cost of the specific DTP, and, consequently, it is not relevant to find out the amount of resources used by other activities. Usually, the application of the ABC raises the following question: “Which activities absorb this resource and how?”. To answer this question, the whole cost of a resource is allocated through a cost driver to all the identified activities, but this cost is due to both operative actions and non-value added actions, such as downtime. On the contrary, our case raises the following question: “Which resources are absorbed by DTP activities and how?” In order to answer this question, it is possible to isolate the cost of the resources used by activities of a specific DTP from the cost of resources for activities related to other DTPs and by non-value added actions. Therefore, it is not necessary to know all the activities carried out in the orthopaedic unit, but rather only the activities related to a certain DTP, making the ABC application easier. The cost drivers are mainly expressed in terms of amount of time the patient used an activity, in order to track the duration of clinical processes for individual patients. “Time” as cost driver is used in the “Time Driven Activity Based Costing”, the improved version of ABC, and it is a useful measure to compare the same DTP performed in different organizations.

A brief description of each cost driver follows.

- Electric energy – water – heating – laundry – cleaning: mathematical product between square metres of space in which activities are carried out and time used for each activity.

- Employee: time used for a specific activity.

- drugs, medical devices, meals: directly allocated to the activities.

- Stationery: the mathematical product between the number of employees of the cost centre and the time used for each activity.

At this point, it is possible to compute activity cost pools. Table IV shows a numerical example of “Post-Surgery Therapy and Hospital Stay” activity cost pool computing. As the second level analysis (from activities to cost objectives) is not available, Table IV includes both indirect and direct resources. For direct resources, such as medical devices, the cost absorbed by the activity can be computed knowing the amount of each resource needed to perform the activity. For example, the cost of gloves is equal to €2.20 and the package contains 40 gloves but the amount absorbed is equal to 20 gloves: the
## Table 3. Resources-activities matrix

<table>
<thead>
<tr>
<th>Activities</th>
<th>Preliminary examination</th>
<th>Pre-surgery examination</th>
<th>Surgery phase</th>
<th>Therapy post-surgery and stay in hospital</th>
<th>Blood tests</th>
<th>Radiographic tests</th>
<th>Discharge phase</th>
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<tbody>
<tr>
<td>Electric energy</td>
<td>X</td>
<td>X</td>
<td>Costs obtained by accounting system</td>
<td>Costs obtained by accounting system</td>
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<td>Water</td>
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</tr>
<tr>
<td>Heating</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nurses</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physicians</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administrative staff</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health staff</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drugs</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical Devices</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stationery</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laundry</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleanliness</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meals</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Detecting inefficiencies of healthcare processes
cost of the resource “gloves” absorbed by the activity is equal to €1.10. For indirect resources there are drivers based on time (i.e. employee) and drivers based on space and time (i.e. electric energy).

Table V summarizes the activity cost pools obtained. The total cost of the surgery phase is the sum of costs of all the activities that are strictly linked to surgical intervention.

The minimum cost of the analysed DTP is equal to the sum of the costs of all the activity cost pools obtained; in this case €5,208.

5. Results
The results of this study show how the cost of a DTP and of its activities can be used to efficiently manage the DTP itself. Furthermore, it identifies the main barriers and advantages presented by the application of an ABC methodology.

Table 4.
Numerical examples of cost drivers

<table>
<thead>
<tr>
<th></th>
<th>Cost</th>
<th>Amount in package</th>
<th>Amount absorbed</th>
<th>Cost absorbed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Medical devices</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drip feed set</td>
<td>€1.20</td>
<td>1</td>
<td>1</td>
<td>€1.20</td>
</tr>
<tr>
<td>Needle pipe</td>
<td>€0.78</td>
<td>1</td>
<td>2</td>
<td>€1.56</td>
</tr>
<tr>
<td>Syringes</td>
<td>€0.09</td>
<td>1</td>
<td>7</td>
<td>€0.63</td>
</tr>
<tr>
<td>Gloves</td>
<td>€2.20</td>
<td>40</td>
<td>20</td>
<td>€1.10</td>
</tr>
<tr>
<td>Absorbent cotton</td>
<td>€3.60</td>
<td>1</td>
<td>0.75</td>
<td>€0.90</td>
</tr>
<tr>
<td>Gauze</td>
<td>€0.03</td>
<td>1</td>
<td>10</td>
<td>€0.30</td>
</tr>
<tr>
<td>Band-aid</td>
<td>€0.56</td>
<td>1</td>
<td>1</td>
<td>€0.56</td>
</tr>
<tr>
<td>Peroxide (glass bottle)</td>
<td>€0.24</td>
<td>1</td>
<td>1</td>
<td>€0.24</td>
</tr>
<tr>
<td>Disinfectant</td>
<td>€0.50</td>
<td>1</td>
<td>0.2</td>
<td>€0.10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Cost/minute</th>
<th>Driver: time in minute spent for a specific activity</th>
<th>Cost absorbed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registered nurse</td>
<td>€0.40</td>
<td>230</td>
<td>€92.00</td>
</tr>
<tr>
<td>Health staff</td>
<td>€0.38</td>
<td>126</td>
<td>€47.88</td>
</tr>
<tr>
<td>Physicians</td>
<td>€1.02</td>
<td>90</td>
<td>€91.80</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Yearly cost/ square metre</th>
<th>Driver: product between size of the room and time spent</th>
<th>Cost absorbed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric energy</td>
<td>€36.09</td>
<td>20</td>
<td>7 days</td>
</tr>
</tbody>
</table>

Table 5.
Activity cost pools

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary examination</td>
<td>€10</td>
<td></td>
</tr>
<tr>
<td>Check in</td>
<td>€12</td>
<td></td>
</tr>
<tr>
<td>Blood sample and transport</td>
<td>€10</td>
<td></td>
</tr>
<tr>
<td>Blood and radiographic test</td>
<td>€232</td>
<td></td>
</tr>
<tr>
<td>Anaesthesiological test</td>
<td>€15</td>
<td></td>
</tr>
<tr>
<td>Surgery (drugs and medical devices, patient transport, surgical intervention)</td>
<td>€4,305</td>
<td></td>
</tr>
<tr>
<td>Therapy post-surgery and stay in hospital</td>
<td>€559</td>
<td></td>
</tr>
<tr>
<td>Blood and radiographic test post-surgery</td>
<td>€45</td>
<td></td>
</tr>
<tr>
<td>Discharge</td>
<td>€20</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>€5,208</strong></td>
<td></td>
</tr>
</tbody>
</table>
Referring to the usefulness of the cost information obtained by the implementation of the ABC, two levels of analysis can be performed. First, a comparison between the DTP cost and the DRG tariff, which identifies a possible profit or loss. In the proposed case study, the minimum DTP cost is equal to €5,208 and it does not exceed the corresponding DRG current tariff, which is €7,920. According to Figure 1, it is possible to conclude that the specific DTP is carried out efficiently, and radical improvements are not needed.

A more accurate analysis of activities and resources can help in detecting opportunities for incremental improvements. Second, by analyzing the information on the cost of the activities, it is possible to classify the activities according to the cost of the absorbed resources. The activities with higher costs are defined as critical.

A reengineering process could focus only on these activities, simplifying incremental reengineering interventions and making the reengineering process faster. In fact, the reduction of the costs of critical activities entails a significant reduction of the whole DTP cost. Figure 4 shows the percentage of costs absorbed by each activity in the analyzed case study. Specifically, it highlights that the activities of the “Surgery phase” and “Hospital Stay phase” cover 77.34 per cent of the cost of the DTP (cost of surgery and cost of hospital stay are, respectively 40.51 and 36.83 per cent of DTP cost). Remaining activities justify the 22.66 per cent of the cost. According to the Pareto analysis, the incremental reengineering interventions may focus only on the “surgery phase” and inpatient activities. In order to make all the activities comparable, the cost of surgery has been considered without the cost of the orthopaedic surgical device, as the cost of orthopaedic surgical device considerably impacts the total cost of this activity (the total cost is €4,305 vs the cost without prosthesis, €3,690).

As critical activities have been identified, the impact of the cost of the resources on the total cost of each critical activity supports the detection of critical resources. According to the Pareto analysis, critical resources are those that justify about 80 per cent of the total cost of a certain activity. Reengineering interventions can be directed exclusively to these resources through an in depth analysis of downtime and waste. Figure 5 shows the percentage of costs of each resource absorbed by the “Surgery phase” activity, referring to the presented case study. The cost of the orthopaedic surgical device has not been considered in computing the cost of the surgery, because it is independent from the way in which the activity is performed, and it cannot be reduced through improvement actions.

![Figure 4. Weight of activities on PDT (without cost of prosthesis)](image-url)
As Figure 5 highlights, the “medical device” resource explains the 86.88 per cent of the total cost of the activity. An in depth analysis of waste could be performed on this resource.

In the case of the inpatient activity, about 80 per cent of the cost is justified by the employee (44.24 per cent), by meals (24.95 per cent), and by laundry (11.76 per cent). Further analysis aimed at improving the efficiency of the DTP may focus on the downtime of employee as meals and laundry are services carried out in outsourcing. (Figure 6).

Finally, the information obtained by applying the ABC approach to this specific case suggests that the managers of the hospital could focus exclusively on two critical activities and on two resources to find opportunities to increase the efficiency of this specific DTP.

In a process perspective, the contribution of this case study on the application of ABC can be summarized in the following aspects:

(1) The case study shows as ABC is a technique able to infer the cost measure associated to each activity, thus contributing to processes performance measurement. In particular, the measure proposed in this study, namely the
minimum DTP cost, could be used to identify the typology of process reengineering actions to be implemented. A value of the minimum DTP cost lower than the corresponding DRG tariff could imply incremental reengineering interventions, while a value higher than the DRG tariff implies radical reengineering actions.

(2) With respect to the cost containment process, the application of ABC highlights the activities and resources characterized by an higher cost, giving a detailed picture of cost structure on which managers could intervene to reduce the DTP cost.

The main barrier encountered in the DTP cost assessment is represented by the functional logic that characterizes several health organizations based on cost centres accounting systems. This logic is reflected in the information system that is based on cost centres and not on the horizontal care processes. Focusing on cost centres implies that the information systems are not able to obtain information about activities carried out in a specific centre. The centre is viewed as a black box in which resources are consumed and services are produced. The lack of an integrated information system has hindered the collection of some accounting data and, consequently, the cost of activities inferred from the pre-existent accounting system is not sufficiently detailed.

Possible barriers related to the lack of collaboration between organizational units (bottlenecks, increasing lead times, etc.) do not occur in the analyzed case study for the following reasons:

- the presence of the imaging unit within the orthopaedic unit significantly decreases the waiting time for the radiographic tests;
- the presence of a cardiologist and of an anaesthesiologist in the staff of the orthopaedic unit reduces the coordination with other organizational units;
- the presence of a clinical laboratory department in the hospital reduces the lead time of the laboratory tests;
- the presence of a surgery room in the orthopaedic unit allows to perform surgeries every day; and
- the presence of an efficient pharmacy unit in the hospital timely provides medical devices.

The availability of imaging devices and of the surgery room allows to carry out some important activities (radiographic tests and surgery) into the orthopaedic unit. As a consequence, waiting times are reduced and there are few conflicts of interaction among organizational units. These features of the orthopaedic unit allow to perform most of the analyzed DTP within the unit, facilitating not only the DTP mapping phase but also the DTP cost assessment phase. The ABC can be applied only to those activities that are carried out in the orthopaedic unit, and the cost of the activities performed outside can be obtained by using the pre-existent accounting system. In the case of a DTP involving more organizational units (consider the case of elderly patients), the analysis could be much more complex.

From a managerial accounting perspective, we can make the following considerations based on the pilot case study:

- the ABC framework is pivotal in health organizations funded through the DRG system. The comparison between the DRG tariff and the minimum DTP cost
allows managers to focus only on the most cost-consuming activities and resources. In this sense, a cost accounting technique allows managers to obtain information for organizational redesign. The accounting issue is strictly interconnected to organizational tools for the analysis and redesign of workflow.

- The implementation of ABC is not time consuming for DTPs carried out in only one organizational unit. In this case, the pre-existing cost-centre accounting system can reassemble easily and promptly the cost information with reference to the activities. Instead, when the DTP involves more organizational units, an accurate cost measurement based on ABC becomes a challenge. In this latter case, the barrier is mainly technical: the information system should be able to reassemble the costs of resources both with respect to organizational units and to activities. A preliminary in depth mapping of organizational and production processes is strictly required.

We argue that our contribution is not in the use of advanced cost accounting techniques, such as ABC, but in showing the potential that ABC may offer in making managers more aware of the real costs of production processes they supervise. The knowledge about the economic margin of each DTP, along with the knowledge of the processes linked to DTPs, can help managers in redesigning the workflows to make them more efficient and effective, and to reduce unnecessary costs.

6. Conclusions
The aim of this paper is to present a methodological framework to apply the ABC technique in healthcare organizations provided with a pre-existent accounting system based on cost centres. The proposed ABC methodology allows computing the minimum cost of a DTP.

The case study analyzed in the paper highlights how the information on costs obtained by ABC can guide managers in detecting opportunities to improve the efficiency of the care processes. Furthermore, it points out the advantages and barriers of the implementation phase of ABC in a context characterized by a cost centre accounting system, although the barriers cannot be generalized based on a single case study.

The results obtained by the application of ABC and the dashboard for detecting inefficient areas strengthen some key concepts proposed by accounting management scholars. First, Ittner and Larcher (2002) argue: “accounting is fundamentally an applied research area that should ultimately provide new insights for practice”. Our case study shows how accounting information, in particular cost information on activities and resources, is an organizational aspect to be taken into account for re-organizational actions. Furthermore, this case study outlines the strong integration that occurs between BPM and accounting. The accounting methodology, in this specific case the ABC, detects the critical areas on which the business process managers can intervene, linking the costs to processes. Of course, the cost information has to be merged with key performance indicators of the process to understand what are the most adequate reengineering interventions.

Second, Lega et al. outline the need to better manage the “black box” of healthcare processes for the creation of value. The proposed dashboard can be applied to evaluate the DRG associated to all performed DTPs for their strategic management.
We can conclude that the main contribution of this paper is to give evidence to the need of the translation of cost accounting theory in useful models for better manage productive processes. More in depth, our contribution has been to illustrate which kind of information is possible to infer by the application of ABC and how this information can be of great interest of practitioners in BPM. First, ABC supports a cost containment process as it allows highlighting the most cost-consuming activities and resources. Second, the ABC allows to identify the typology of reengineering interventions, distinguishing between incremental and radical ones through the comparison between the cost of a health service and the corresponding DRG tariff. Third, the ABC allows to calculate the cost absorbed by each activity of a DTP. The comparison of these costs among different organizations could make possible to evaluate the cost variability of the activities of the same DTP and to what extent the cost can be standardized. Of course the standardization process is very complex. In healthcare organizations difficulties are due primarily to two factors: first, customer involvement in producing and delivering the service (the customer interacts with frontline staff, physical facilities, and other customers involved in the process, thereby contributing to determine the conditions in which the service delivery takes place); second, the strong need for personalized service (the response of patients to healthcare can be very different and not always predictable).

The limitation of the study concerns above all the application of ABC to a single case (a single DTP). The proposed case is a pilot case study conceived as a base for further exploratory research based on multiple case studies. Further research is addressed towards two directions: to explore more in depth the use of proposed dashboard based on ABC in driving reengineering interventions; and the application of ABC to compute standard costs of DTPs. Propositions to be tested in the next research phases are related to these two aspects and are the followings:

(1) Applying the ABC to multiple DTPs in the same organization will affect positively the efficiency and the effectiveness of decisional processes on reengineering interventions on clinical pathways.

With respect to this proposition, next steps of the research will concern the development of multiple case studies related to all the DTPs of the same organization that share similar resources. This way, it will be possible to place the analyzed DTPs in the quadrants of the dashboard and to identify: first, the kind of interventions requested on each DTP; second, the amount of unused resources that could be employed for other purposes. After this stage, the research will be devoted to gather qualitative and quantitative data on the impact of the dashboard on the effectiveness and on the efficiency of reengineering interventions adopted:

(2) Using ABC to calculate the costs of the same DTP in different healthcare organizations could imply a greater reliability in the standardization of DTPs’ costs.

Concerning the cost standardization process, we intend to compute the cost of the same DTP performed in different healthcare organizations to infer which factors impact on a DTP cost variability. This analysis will be conducted using multiple case studies relating to national and international healthcare organizations, in order to evaluate to what extent contextual organizational elements affects cost variability and the level of cost standardization.
References


**Further reading**


**Appendix**

Field observation and interviews have been used to map the DTP. The questions made to key actors are: “Can you describe which is the aim of your activities?”; “Which kind of resources are consumed by the activity?”; “Which are the input data of the activity”; “Which are the outputs of the activity?”; “To which activity is this activity linked?” In the following table, each component of the DTP is described according to the above questions (Table A1).
<table>
<thead>
<tr>
<th>DTP components</th>
<th>Aim of activity</th>
<th>Resource consumed</th>
<th>Input data</th>
<th>Outputs</th>
<th>Activities linked</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary Examination</td>
<td>The aim is diagnosis evaluation. Through the telephonic booking, the patient enters the outpatient clinic; if the visit confirms the request for the surgery, the patient will book the pre-surgery examination</td>
<td>Electric energy, heating, and physicians</td>
<td>Booking form</td>
<td>Diagnosis and, eventually, reservation form for surgery</td>
<td>Check in and Opened Case History</td>
</tr>
<tr>
<td>Check in and opened medical record</td>
<td>The aim is patient’s registration in database and case history. The nurse records the information in medical records</td>
<td>Electric energy, heating, nurses, administrative staff</td>
<td>Booking form</td>
<td>Case history and the list of examinations to do</td>
<td>Blood sample</td>
</tr>
<tr>
<td>Blood sample and transport</td>
<td>This activity is performed in the test laboratory. Its aim is to draw a blood sample. We include the transport of blood from outpatients to laboratory. This activity is performed also in the stay in hospital phase</td>
<td>For this activity we used the cost obtained by accounting so this question does not apply</td>
<td>List of examinations</td>
<td>Results of blood testing</td>
<td>Admission/discharge procedure</td>
</tr>
<tr>
<td>Imaging tests</td>
<td>Its aim is to perform the imaging tests needed to choose the prosthesis and to surgery. This activity is performed also in the stay in hospital phase</td>
<td>For this activity we used the cost obtained by accounting so this question does not apply</td>
<td>List of examinations</td>
<td>Results of imaging tests</td>
<td>Admission/discharge procedure</td>
</tr>
<tr>
<td>Admission</td>
<td>The aim is to check the medical record and to assign the sleeping accommodation. This activity is performed by a ward sister. As this activity is performed few times, we included it in the stay in hospital activity</td>
<td>As this activity is performed few times, we included it in the stay in hospital activity</td>
<td>Results of examinations (blood and radiographic) and medical record</td>
<td>Registration in a database for the surgery</td>
<td>Anaesthesiological visit</td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>DTP components</th>
<th>Aim of activity</th>
<th>Resource consumed</th>
<th>Input data</th>
<th>Outputs</th>
<th>Activities linked</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaesthesiological visit</td>
<td>The aim is to decide the type of anaesthesiological therapy and, eventually, other examinations</td>
<td>Electric energy, heating, physicians, and stationery</td>
<td>Medical record</td>
<td>Anaesthesiological therapy and a list of further examination</td>
<td>Surgery intervention</td>
</tr>
<tr>
<td>Request for health goods such as drugs, medical devices, haemetic materials</td>
<td>The aim is to prepare a list of drugs, medical devices and blood tests needed to surgery and therapy. This activity is performed by a nurse through informative system. The request is made before the intervention and after the intervention.</td>
<td>As this activity is performed in few time, we have not considered it in the ABC model</td>
<td>Medical record in which physicians have signed the typology of intervention and therapy</td>
<td>The request</td>
<td>Surgery and therapy of stay in hospital</td>
</tr>
<tr>
<td>Surgery (drugs and medical devices, patient transport, surgical intervention)</td>
<td>The patient is transported to surgery room by staff. The surgery consists of a preoperative phase and surgery. The nurse organizes the requested drugs and medical devices on a serving cart</td>
<td>Electric energy, water, heating, nurses, physicians, drugs, medical devices, laundry, and cleanliness</td>
<td>Medical record and health good requested</td>
<td>Intervention</td>
<td>Stay in hospital</td>
</tr>
<tr>
<td>Therapy post-surgery and stay in hospital</td>
<td>Usually the stay in hospital lasts 7 days. The patient undergoes therapy and examination to check the results of the surgery</td>
<td>Electric energy, water, heating, nurses, physicians, health staff, drugs, medical devices, laundry, cleanliness, and meal</td>
<td>Medical record</td>
<td>Results of intervention recorded in a clinic record</td>
<td>Discharge procedure</td>
</tr>
<tr>
<td>Discharge procedure</td>
<td>The physician writes the diagnosis, the therapy and the follow-up programme for the patient in the discharge record. The discharge record is sent to the planning and control unit through the informative system</td>
<td>Electric energy, heating, physicians, and stationery</td>
<td>Clinic record</td>
<td>Discharge record</td>
<td>Planning and control unit</td>
</tr>
</tbody>
</table>
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