

Journal of Clinical and Basic Cardiology

An Independent International Scientific Journal



Journal of Clinical and Basic Cardiology 2000; 3 (1), 23-28

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Cost Analysis of Acute Myocardial Infarction Management in DRG and PRG

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The cost of diagnostic and therapeutic procedures in patients with acute myocardial infarction (AMI) during hospitalization was determined using both the Diagnosis Related Group (DRG) and Process Related Group (PRG) systems. This cost-analysis system was planned and performed to estimate the cost of medical and non-medical staff involved in patient care and the cost of commensurables. In a 3 month period, 45 patients discharged with diagnosis of AMI, equivalent to 410 code ICD-9-CM, were enrolled in the study. Data collected were then elaborated and costs for each DRG were derived. The mean cost sustained for patient with AMI was 3062,32 ECU with a maximum of 8949,50 ECU for DRG 112 and a minimum of 1740,11 ECU for DRG 123. Our data suggest that, in patients with AMI a deep discrepancy between the DRG reimbursements and the "real" cost, for example for DRG 112 (a discrepancy equivalent to 166 %), exists. The cost difference is essentially related to different procedures involved in medical care; it follows that global cost of patients with AMI is primarily related to PRG cost and is largely independent from other components. These results prove that therapeutic strategies are very important to determine cost for each DRG and that the cost for each DRG can change in relation to PRG performed and to progress of the disease. The utilization of DRG and PRG systems appear to be an essential tool to build up a system in which not only efficiency but also quality of care are evaluated. *J Clin Basic Cardiol 2000; 3: 23-8.*

Key words: AMI, DRG, PRG, cost

Despite a reduction of about 40 % in mortality from cardiovascular disease over the last decade, acute myocardial infarction (AMI) remains one of the main causes of death in western countries; in the United States 1,500,000 people/year suffered AMI [1]. The decline in deaths from AMI is probably due to more careful prevention and to the diffusion of new therapeutic strategies, initially used in clinical trials and now available in clinical practice [2-8]. The availability of these different therapeutic approaches has induced the principal American cardiological associations to provide guidelines to standardize diagnostic procedures and early treatment for AMI patients [9-11]. Although these guidelines are designed to meet clinical judgment and individual patient need, there is considerable variability in the diagnostic and therapeutic treatment of patients during hospitalization [12, 13]. It is clear that the choice of one therapy rather than another also has great bearing on the economic, financial and social aspects involved; it seems an important goal to reach both optimal clinical management and cost containment [14-19]. The different options suggested to contain cost increases are reduction of hospital stay and limitation in the use of unnecessary "high-tech" diagnostic and therapeutic procedures [20-22]. In view of the financial constraints placed on hospital facilities, it is becoming increasingly important for diagnosis and care units to have a clear picture of the services that they provide for hospitalized patients [23]. In addition, only through an awareness of how resources are allocated can patient care be optimized [24, 25]. In January 1995 the Italian health service introduced a reimbursement system based on the Diagnosis Related Group (DRG) [26, 27]. This method, that will be fully implemented by the end of 1999, has been adopted [28, 29] to categorize patients according to their diagnoses and the economic resources employed; therefore each unit care should verify the real distribution of resources per diagnostic group, to assess the number and relative weight of the medical procedures carried out within each diagnostic group [30, 31]. The aim of the present study was to calculate the "real" cost (defined in terms of both human and material resources)

of the diagnostic and therapeutic treatments offered to AMI patients during hospitalization in a cardiology unit of a regional university hospital.

Methods

The study was carried out for three months (from March 1st to May 30th, 1996) in a cardiology unit equipped with intensive care facilities, an out-patient clinic, a catheterization and electrophysiology laboratory, and a non-invasive cardiology laboratory, all of which were accessible both to patients from other departments and to out-patients. The staff of the unit consisted of ten full-professors, twelve cardiology fellows, sixteen nurses and a radiology technician. All the different activities performed from the medical and non medical staff have been carefully evaluated and monitored for the duration of the study.

DRG and PRG: general notes

The goal of the DRG system is to combine the diagnosis of discharged patients into well defined and homogeneous medical categories by grouping patients that theoretically need identical economical resources, equal organization and medical procedures. The DRG system is the method used today to finance hospitals according to the principle of remuneration on the basis of number and type of admissions. Thus, a specific cost is determined for each case of hospital admission, regardless of the actual number of days of hospitalization.

Process Related Groups (PRG) [32] classify sets of procedures/services which are homogeneous in terms of cost and type. The PRG system is able to quantify the services provided for each patient, and consequently to evaluate how financial resources are used and distributed for any single health-care facility. The utilization of the PRG system permits the utilization of a system "case-management" in place of one "case-mix", permitting the personalization of the system and of the clinical-assistance by flexibility of activity.

A budget system has been adopted. The cost of a DRG should be calculated on the basis of: medical and non-medical staff, supplies, equipment, general costs and medical services from other medical units (laboratory tests etc.) and the facility overheads (a portion of the total general costs of the hospital of which the cardiology unit is part).

From an operative point of view three different phases have been identified; data acquisition, elaboration and analyses of data.

Data Acquisition

This phase has been divided into two stages:

- A) Elaboration of patients' data charts
 - B) Compilation of patients' data charts
- Elaboration of patients' data chart:* The patient's data chart was designed to pick up all necessary information; this data chart was divided into five sections:
- a) personal data: age, sex, address
 - b) type of hospitalization:
 - diagnosis on admission
 - emergency or programmed admission
 - arrival from home or other hospital department
 - c) PRG: number and types of activities provided during hospitalization
 - d) work load: time required by medical and nursing staff to perform each activity
 - e) discharge:
 - type
 - time spent in Intensive Care
 - total hospitalization time
 - main and secondary diagnosis on discharge

Compilation of patient's data chart: The data chart was completely filled out for all 318 patients discharged in the three-month period considered; the data chart was used for in- and out-patients to make a full analysis of the activity of the department considered. The data collected were then processed to work out the activity volumes, work load and cost per DRG and PRG.

DRG and PRG considered in the study: Acute myocardial infarction appears in different DRG utilizing the diagnosis code 410 of the ICD-9-CM system. Only patients with a main diagnosis of AMI (code 410) on discharge were enrolled in the study. Out of 318 patients discharged during the study period, code 410 was the main diagnosis in 47. Two patients underwent a surgical procedure and thus were dropped. It was subsequently ascertained that the remaining 45 patients were exclusively classifiable in the following DRGs:

- DRG 112 ("Percutaneous cardiovascular procedures"): 2 patients;
- DRG 121 ("Circulatory disorders with AMI and cardiovascular complications, discharged alive"): 6 patients;
- DRG 122 ("Circulatory disorders with AMI without cardiovascular complications, discharged alive"): 34 patients;
- DRG 123 ("Circulatory disorders with AMI, dead"): 3 patients

In our study, the time taken by medical and nursing personnel to perform any single procedure was directly monitored and recorded on the patient's data chart. The following PRGs, which were those "activated" during the study (physical exam; standard ECG; treadmill test; Holter test; M-B mode echocardiography; Doppler echocardiography; stress echocardiography; non invasive electrophysiology (transesophageal electrophysiological study); invasive electrophysiology (electrophysiological study); interventional electrophysiology (definitive pace-maker implantation, transcatheter ablation); diagnostic angiography and catheterization (cardiac catheteri-

zation; left and right coronary arteriography, left and right catheterization); interventional angiography (PTCA, stent implantation); nuclear cardiology; other activities in cardiology (temporary pacemaker implantation, consultations)), refer to the procedures performed. The PRGs X-ray, medication consumption, laboratory blood tests, ancillary services are derived from the patient's data chart.

Information Processing

The data collected in the previous phase of the study were then transformed into cost information per DRG. The costs were evaluated in Italian Lire and then translated into ECU at an exchange rate of 1915,10. The budget [33] is a mean of collected information pertaining to a given DRG.

This phase of research can be broken down into three stages:

- A) Determination of technical budget [34]: one for every patient type (DRG).
 - B) Construction of the economic budget.
 - C) Calculation of technical/economic budget.
- A) Determination of the technical budget:* In order to work out the technical budget, the health service's marketing and management plans must first be established. As previously mentioned, the patients considered were allocated to the various DRGs (Table 1). This table constitutes the so-called "user classification or health service marketing" plan. Once the health service marketing plan for the Cardiology Unit had been established, we focused on the centers that contribute to performing activities/services and to the related costs for patients. This operation resulted in the management plan (Figure 1). Once the management plan has been drawn up, the type and number of PRGs actually carried out can be ascertained. The activities/services (PRGs), performed for each of the four DRG types analysed in our study, as deduced from patient data charts, are inserted into the activities budget (Table 2) that reports the number of services carried out during the study period. The items "Assistance and other" by medical, nursing and technical personnel refer to activities of coordination, organization, administration and welfare services not covered by the above-mentioned PRGs. The PRGs defined as "assistance and other" by medical, nursing and technical personnel are quantified by using opportune factors to share the actual working hours among the various patients.

This procedure is carried out in the following way:

1. Total time devoted to PRGs contained in the patient's chart;
2. Difference between total hours actually worked and total time devoted to PRGs recorded in the patient's chart;
3. Distribution of the above differences (point 2) among hospitalized patients considering days spent in Coronary Care Unit and in the ward, and the degree of the patient's disease. For purposes of clarity, we have reported in the budget the aggregate data for each PRG in terms of the number of services (number of laboratory analyses, radiological analyses, consultations and use of ancillary services for hospitalized patients).

The activity budget relating to an average hospitalized patient in a given DRG is called the unitary budget and is schematically shown in Table 3. This budget illustrates the "organizational/management protocol" of the activities carried out in the study period for an average patient in a given DRG.

Finally, by analysing the patient's charts, we can calculate the time devoted to each activity by doctors and nurses (work load), as well as the number of PRGs for each patient. Therefore, the total work load (for all patients of a given DRG) and

Table 1. Health (Service) marketing plan for patients hospitalized with AMI

INDICATORS	DRG	DRG	DRG	DRG	Total
	112	121	122	123	
Patients discharged with AMI	2	6	34	3	45
Duration of hospitalization (days)	43	80	264	10	397
Total hospitalization in ward (days)	27	28	148	0	204
Total hospitalization in CCU (days)	15	52	116	10	193
Average duration of hospitalization (days)	21.5	13.3	7.8	3.3	8.8
Average hospitalization in ward (days)	13.5	4.7	4.4	0.0	4.5
Average hospitalization in CCU (days)	7.5	8.7	3.4	3.3	4.3
Average age of discharged patients (years)	64	66	64	76	65

Table 2. Activity Budget for patients hospitalized with AMI (* = expressed in hours and minutes)

PRG (N8 services)	DRG	DRG	DRG	DRG	Total
	112	121	122	123	
Medical examination	80	184	511	42	817
Other services	58	161	326	27	572
Assistance/other services by medical personnel*	7:04	30:38	104:03	6:01	148:46
Assistance/other services by nursing personnel*	96:47	503:41	739:16	11:33	1352:18
Assistance/other services by technical personnel*	5:14	9:44	32:08	1:13	48:20
Laboratory analysis	17	66	1.326	21	1.430
Radiology, Nuclear Med., Consultation	0	5	79	3	87
Meals for hospitalized patients	54	136	449	7	646

Table 3. Unitary budget for patients hospitalized with AMI (* = expressed in hours and minutes)

PRG (N8 services)	DRG	DRG	DRG	DRG	Average
	112	121	122	123	
Medical examination	40	30.7	15	14	18.2
Diagnostic haemodynamics	1.5	0	0.6	0	0.5
Interventional haemodynamics	1	0	0	0	0.04
Other services	26.5	26.5	9.96	9	12.12
Assistance/other medical personnel *	3:32	10:13	3:04	2:00	3:17
Assistance/other nursing personnel*	48:34	83:57	21:45	3:51	30:02
Assistance/other technical personnel	2:37	1:37	0:57	0:24	1:04
Laboratory analysis	8.5	11	39	7	31.8
Radiology, Nuclear Med., Consultations	0	0.8	2.3	1	1.6
Meals for hospitalized patients	26.9	22.7	13.2	2.3	14.3

the average unit (average of work load for a given patient) for each PRG, can be worked out.

B) Construction of the economic budget: The economic budget enables us to work out the cost of each PRG used by each of the four myocardial infarction DRGs. In order to calculate the average cost of each procedure, the data regarding work loads are suitably integrated with the data regarding the depreciation of equipment, the cost of maintenance and materials, and sundry cost.

Table 4 shows how the cost of the above-mentioned PRGs is calculated, taking as an example coronary angioplasty for DRG 112. The "cost" column shows the cost per minute of medical and nursing personnel: this value is derived from the total cost sustained for personnel in the study period divided by the total time (in minutes) actually worked by this personnel in the same period. The "quantity" column reports the volume of resources used: for personnel this volume is given by the unit work load expressed in minutes.

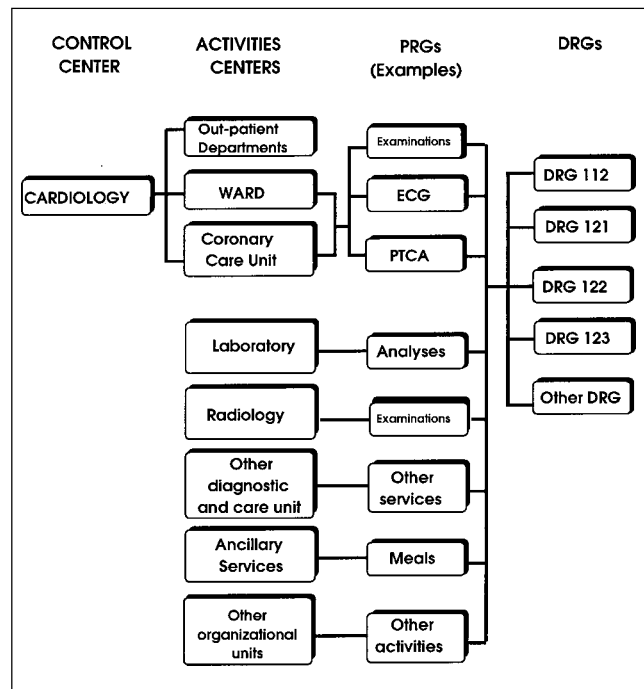


Figure 1. Management control planning

Table 4. Calculation of unit cost of coronary angioplasty for patients hospitalized with AMI (* expressed in ECU; ' expressed in hours and minutes)

COST ITEM	COST*	QUANTITY	UNIT COST
Medical personnel	529	3:08'	51,77
Nursing personnel	398	3:20'	41,54
Depreciation of equipment		1	125,07
Costs of maintenance		1	68,79
Materials used		1	3265,79
Sundry costs and expenses		1	142,11
TOTAL		1	3695,10

The cost for personnel, as seen in the "unit cost" column, is calculated by multiplying the cost index by the quantity: this represents the cost sustained for one coronary angioplasty procedure. For what concerns the determination of unit costs for depreciation, maintenance, materials and sundries, these are calculated by dividing the pertinent annual cost by the number of procedures forecast for the current year.

The "total" expresses the sum of all costs (resources used). Therefore the amount of 3695,10 ECU represents the total unit cost of coronary angioplasty for DRG 112. This cost constitutes the direct cost (that is, excluding the costs of coordination, organization, etc.) of medical and nursing personnel and of the share of the facility's running costs; these two categories of cost are subsequently included in the budget for each DRG.

As for the unit cost of PRGs "Assistance and various" on the part of medical and nursing personnel, this is given by the relationship between total expenditure for personnel in the study period and the total time actually worked by this personnel in the same period.

The unit cost of laboratory and radiological examinations, consultations, and meals is obtained by averaging the costs of every examination, consultation, and meal actually provided for each DRG. Finally, the cost of drugs represents the average cost of the total drug protocol used for patients in a given DRG.

Table 5. Technical/economic budget for DRG unitary (average cost per patient discharged expressed in ECU; DEPTS = departments)

COST'S VOICE	DRG 112	DRG 121	DRG 122	DRG 123	DRG AVERAGE
Medical examination	254.16	187.87	109.77	93.81	125.53
Diagnostic haemodynamics	929.25	0.00	367.53	0.00	318.99
Interventional haemodynamics	3695.11	0.00	0.00	0.00	164.23
Other PRG (services)	222.89	247.66	110.92	132.46	135.57
TOTAL PRG	5101.40	435.52	588.22	226.28	744.32
Assist./other medical personnel	58.54	84.59	50.70	9.97	54.41
Assist./other nursing personnel	603.19	1046.39	271.02	47.99	374.30
Technical Radiology Personnel	25.89	16.05	9.35	4.01	10.62
Drugs	161.93	683.97	601.62	788.59	605.52
Other costs and expenses	41.04	90.60	46.02	43.34	51.57
TOTAL DIRECT COSTS	5991.99	2357.12	1566.94	1143.44	1840.73
Share of facility costs (30%)	2568.00	1010.20	671.55	490.04	788.89
TOTAL COSTS HOSPITALIZATION	8559.99	3367.32	2238.49	1633.48	2629.62
Laboratory analysis	45.68	59.12	209.60	37.62	170.78
Radiology, Nuclear medicine	0.00	38.73	93.46	0.04	78.39
Cooking	343.83	289.99	168.88	29.85	183.53
TOTAL SERVICES OTHER DEPTS.	389.51	387.84	471.93	106.64	432.70
TOTAL COSTS	8949.50	3755.16	2710.42	1740.12	3062.32

C) *Calculation of the economic budget:* The technical/economic budget [5, 7, 21] illustrates the total cost for all hospitalized patients in a given DRG (total budget) and the average unit cost per patient (unitary budget) in all DRGs (see Table 5). The cost of a given DRG constitutes the sum of all costs for every PRG. In addition to the items previously analysed, the technical/economic budget includes the items "Other costs and expenses" and "Share of facility costs". The former concerns expenditure not taken into account in the PRGs previously encountered and directly ascribed to cardiology (eg, leasing fees, materials etc.). The latter represents the estimated share of the general costs of the entire hospital (auxiliary costs such as cleaning services, central administration office, Health Administration data processing etc.) attributable to the cardiology department. With regard to the hospital structure under investigation, this quota is estimated as 30 % of the total net cost of the Cardiology department.

Results and Discussion

The present prospective investigation was aimed at ascertaining the real number of medical procedures carried out by our department, at evaluating the work load involved and at estimating the actual cost for every single patient. This study included both in-patients and out-patients, referred to our institution for a broad spectrum of cardiological diagnoses. The data on the patients with AMI who were discharged during the study period were selected and analysed. Such an analysis can be made for any group of patients identified by clinical diagnosis and by diagnostic group code. To date, no detailed analysis of the impact of the DRG system on clinical cardiology has been made. Moreover, those studies which are available in the literature have usually been limited to generic statistical assessment of the DRG system as a whole. The need for management studies based on "patient by patient" analysis is essential if we want to determine the true cost of patient care and to ensure that the rates applied under the hospital financing system are suitable. This is particularly true in car-

diology, in which the wide variety of procedures used gives rise to striking differences in the consumption of economical/financial resources.

From our study it emerges that the highest cost for patients with AMI (the average cost is 3062.32 ECU – Table 5, column "Average DRG") is for patients discharged with DRG 112 (Percutaneous Cardiovascular Procedures). This figure is 8949.50 ECU, while the lowest cost is 1740.12 ECU for DRG 123 (Cardiovascular disease with AMI, dead); therefore, there is a difference of 7209.38 ECU between the highest and lowest cost per DRG (Table 5).

The main reason why there is such a marked difference in the cost of AMI patients belonging to different DRGs is essentially due to PRG costs; indeed, the DRGs with highest costs for PRGs are also those with the highest total cost (Table 5). The high PRG cost of DRG 112 can be explained by the fact that this DRG involves interventional cardiology, at a cost of 3695,10 ECU (Figure 2). If we add the direct cost, the full cost of interventions rises to 5311,63 ECU which alone constitutes 74 % of the value of the general cost variation in-

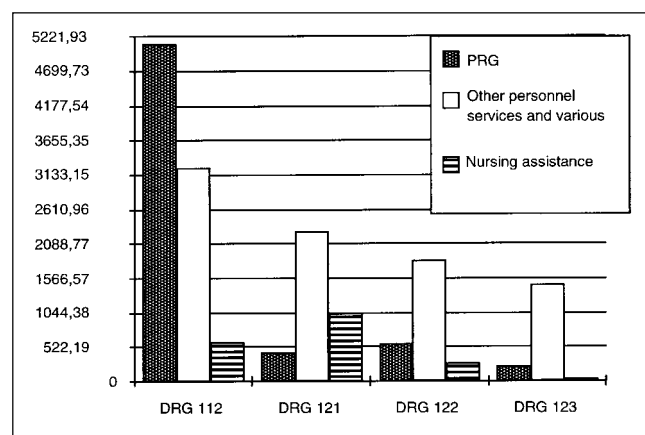


Figure 2. Comparison of DRGs subdivided into cost components

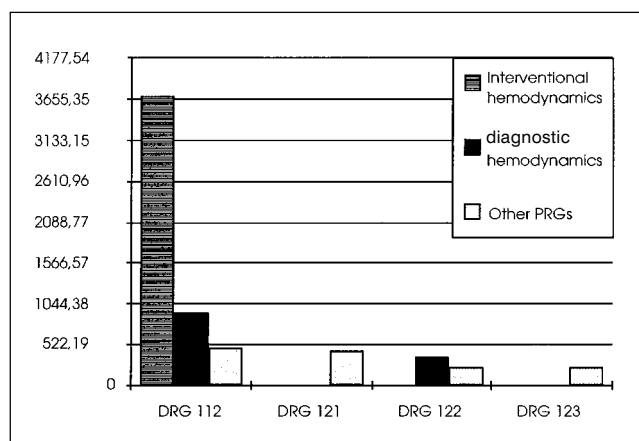


Figure 3. Comparison of costs of PRGs for each DRG

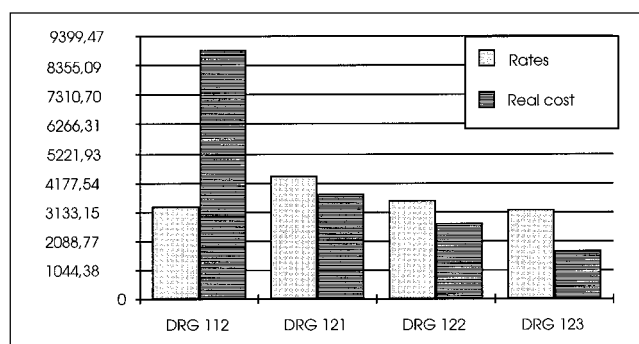


Figure 4. Comparison between real costs and government-established reimbursement rate for each DRG considered

dex (Figure 3). The remaining 26 % are essentially made of the differential costs (compared with DRG 123) of PRGs “Invasive Diagnostic Procedures”, “Examination” and “Other services”. Consequently, these data confirm that DRG cost essentially depends on the cost of the PRGs involved. These data show that the total cost for hospitalized patients with AMI is mainly related to PRG costs and not to other factors, such as assistance, drugs, radiological and laboratory tests.

Leaving aside the fact that the diagnosis of acute myocardial infarction covers some four diagnostic groups (DRG 112, 121, 122, and 123), our study underlines the large discrepancy between the DRG reimbursement rate fixed by the government and the “real” cost sustained by health care facilities for any single patient (Figure 4); in the case of DRG 112, the reimbursement rate is underestimated by 5589,19 ECU equivalent to 166 % of the total reimbursement rate). Furthermore, the full cost of the PRG Interventional cardiology alone is higher than the DRG 112 reimbursement (5311,63 ECU as against 3360,31 ECU); therefore, even if no further expenses were incurred during hospitalization, a deficit of 1951,32 ECU (equal to 58 % of the reimbursement rate) would remain.

The method applied in this study is able to evaluate the exact amount of expenditure for any single patient and thus to reach a more accurate assessment of what the government reimbursement rate should be. Unlike the DRG system, which is oriented towards a retrospective analysis of the services carried out, the PRG system enables us to examine all form of clinical procedures performed during hospitalization. Finally, by focusing attention on the services required to satisfy the patient’s needs, the PRG system may introduce the concept of “personalization” of medical assistance through the flexible standardization of health-care procedures.

The aim of this study is not to criticize the introduction of the DRG system into public health financing, but rather to discern flexible and practical ways of improving the system of reimbursements as it is currently applied. It should be borne in mind that, if reimbursement rates are not correctly defined on the basis of real costs, patients will risk being selected not so much on the basis of diseases and professional/management capacities as on the basis of economic considerations. Our experience suggests that the use of the DRG-PRG system is an essential means of creating a valid system for the efficient management of a cardiology unit. As this system enables the cost sustained and the quantity/quality of resources used to be examined simultaneously, it can be used to gather all of the information necessary in order to establish if reimbursements cover real costs, and to suggest any action which may be undertaken to reduce deficits or utilize surpluses.

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