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Abstract

Background: To determine the adaptation capacitating of categories case-mix adjustment (Adjusted Clinical Groups [ACG]) in Primary healthcare (PHC) in function of the cost of care in routine clinical practice.

Methods/design: Retrospective study based on computerized medical records. All patients attended by 14 PHC teams in 2009 are included. The principle measurements were: demographic variables (age and sex), dependent variables (costs of care) and case-mix or morbidity (Johns Hopkins University Adjusted Clinical Groups Case-Mix System) variables. Episodes occurring in the study population will be accounted for by the date of registration in the clinical history for each episode/reason for consultation, whether acute or chronic, regardless of the date of initiation of the diagnostic process. ICPC-2 will be converted (mapped) to ICD-9-MC. The costs model for each patient will be established by differentiating the fix costs from the variable costs. Fix-costs: staff (wages and salaries), consumer goods, external services (structure and management); and variable-costs (laboratory, conventional-radiology, diagnostic tests, referrals and prescriptions). In the analysis, the ANOVA, chi-squared, Pearson’s lineal correlation and Mann-Whitney-Wilcoxon tests will be used. The adaptation capacitating of each category was obtained: a) outliers (atypical observations), and b) variation of Pearson coefficient. Predictive model of cost: coefficient of determination (R2) will be measured.

Discussion: The proliferation of similar studies, with homogenous definition criteria between variables, would favor the possibility of benchmarking between centres and professionals from different organizations.

Key words: Resource use, Primary care, Case-mix, Health care costs, Retrospective study, Morbidity, Management.

Background

The main factor determining the use of health services is the pattern of disease of the population, as shown by many studies in different geographic settings, care levels and health organization models. Primary healthcare (PHC) is an integral part of the national health system and is a key link in the continuity of care [1-3]. In the field of management, experiments in the separation of financing, purchasing and provision of services require more precise assessment and measurement instruments for healthcare activity. In recent years, various experiments in per capita funding have been developed as a mechanism for the allocation of healthcare resources. Health systems that are characterized by competition among insurers (United States, Germany) are grounded in the prevention of risk selection, while other national health systems (United Kingdom, Sweden) are grounded in the redistribution of resources on an equitable basis. In Catalonia (Spain), a capitation payment system is being used, although case-mix adjusted information systems (population risks) are not available [3-8]. Risk adjustment models are usually adopted for payment adjustment, models using diagnosis and/or pharmacy
data are preferred as prior use models could offer inappropriate incentives to increase services in order to receive higher payments. Diagnosis and/or pharmacy-based risk adjustment models have been adopted in Canada the USA and Europe [5,7]. The Adjusted Clinical Groups (ACG) is a risk adjustment system (case-mix) that classifies individuals according to the diseases that they present during a period of time. Its main objective is to measure the degree of disease in patient populations, based on levels of co-morbidity [9,10]. The ADG is one of the possible risk adjustment methodologies, together with the Hierarchical Coexisting Conditions (HCC), the Clinical Risk Groups (CRG), the Diagnostic Cost Groups (DCG) and the Payment Amount for Capitated Systems (PACS), which can be used to assess, in a more precise and equitable manner, the financing of an administration’s health plans (capitation payment for groups of providers), the efficient use of services and the improvement of health results [11-16]. These classification systems link the burden of morbidity, the consumption of resources and the real costs of care. Our group works in the adaptation of these systems [17-19]. The objective of the study will be to determine the adaptation capacitating of categories (inadequate categories) case-mix adjustment (ACG) in PHC in function of the cost of care in routine clinical practice in Catalonia (Spain).

## Design and Methods

### Design and study setting

Retrospective multicentre study based, will be realized on the computerized medical records of primary care patients followed from January 1, 2009 until December 31, 2009. The studied population consisted of individuals of both sexes that were assigned to 14 PHC centres in Catalonia administered by four providers from Barcelona and the metropolitan area. These PHC centres have 313,500 inhabitants in their catchment area, of which 16.1% are over 64 years of age. The population was mainly urban, with a medium-low socioeconomic status and predominately engaged in industry. The management of the centres was public and service provision was private (concerted with the Catalan Health Service). All patients that demanded care during 2009 and that were assigned to these centres were included. Patients transferring out to other centres, patients from other regions and patients attended by specialists during the study period will be excluded.

### Main measures

The dependent variables will be included: mean number of visits, care episodes and total direct costs in PHC. Additional variables will be studied: a) general: age, sex, centre or team, clinical service (family medicine [patients over the age of 14] or pediatrics [between 0 and 14 years of age]), basic activity unit, and number of visits carried out; b) case-mix or co-morbidity; c) total direct costs. A visit was defined as any contact between PHC teams and a patient in a PHC centre or at home due to a demand for care or a health problem. Annual coverage (intensity of use) was defined as the ratio: patients attended/assigned population. An episode or reason for visit was considered as a process of care for a disease or an explicit patient demand (contact with health services) and was quantified according to the International Classification of Primary Health (ICPC-2) [20]. ICPC-2 was converted (mapped) to International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-MC) [21] by a five-strong working group (one information retrieval officer, two clinical physicians and two consulting technicians). The criteria followed differed according to whether the relationship between the codes was null (one to none), univocal (one to one) or multiple (one to several).

### The ACG Risk Adjustment System

The following measures will be used to calculate the general co-morbidity of the patients: a) the Charlson index [22] as an approximation of the severity of the patient; b) the individual case-mix index, obtained by the ACG. The ACG Grouper version 8 functional algorithm is composed of a series of consecutive steps which result in 106 ACG, which are mutually exclusive for each patient attended. The construction of an ACG requires the age, sex and the reasons for consultation or diagnoses codified according to the ICD-9-MC. The process of converting ICD-9-MC to ACG consists of 4 stages: the first two group a series of conditions according to similarity of resource consumption and the second two combine the most-common groupings: a) ICD-9-MC diagnoses are grouped into 32 Ambulatory Diagnostic Groups (ADG), of which a patient may have one or more; b) ADG are transformed into 12 Collapsed Ambulatory Diagnostic Groups (CADG); d) CADG are transformed into 25 Major Ambulatory Categories (MAC); and e) MAC are transformed into ACG. This assigns each patient to a resource iso-consumption group. This method provides the United States of each group with respect to the mean total cost, providing the resource utilization bands (RUB), which group each patient into one of five mutually-exclusive categories (1: healthy users, 2: low morbidity, 3: moderate morbidity, 4: high morbidity, and 5: very-high morbidity) according to
morbidity, and the Expanded Diagnosis Clusters (EDC), which select patients by specific condition.

**Models of cost, use of resources and adaptation capacitating calculation**

The design of the system of partial costs was defined taking into consideration the information requirements and the degree of development of the information systems available. The cost per patient attended during in 2009 was taken as the unit that served as a basis for the final calculation. The model developed for each patient in PHC was established by differentiating fixed costs (operations) and variable costs (depending on the activity carried out for each patient). The main accounting items in the first group were: personal (wages and salaries, indemnisation, social security); purchases (medications, medical equipment); expenses related to the purchase of other supplies (clothing, cleaning supplies or office supplies); external services (repairing and conserving building, external professional services, insurance, etc.); and a group of costs belonging to the structure and management of the centre that are in agreement with General Accounting Plan for Healthcare Centres. The distribution of fixed expenses to each patient was based on a criteria distribution per visit (average/unit: fixed expenses/number of total visits). The variable costs/patient was calculated according to diagnostic tests ordered (therapeutic requests (prescription drugs) and referrals. The study concepts included will be: laboratory (hematology, biochemistry, serology or microbiology tests requested; mean cost per request), conventional radiology (simple radiology, contrast radiology, ultrasound scans, mammograms and orthopantomography; tariff per test requested), medical transport (transfers by ambulance; mean cost per request), diagnostic tests (digestive endoscopy, electromyography, spirometry, teleradiography, computed tomography, audiometry, densitometry, ambulatory blood pressure, campimetry, stress tests, heart ultrasound, and others; tariff per test requested), referrals (urgent or regular referrals to reference specialists or hospitals; adapted tariff per reference), prescriptions (acute, chronic or on-demand; CatSalut: retail price per package). The tariffs used came from the analytical accounting carried out by PHC centres, invoices of intermediate products issued by the different providers and the prices established by CatSalut. The mean cost per visit was calculated and a final direct distribution for each patient was made. Therefore, the cost per patient (Cp), according to the final service assigned was: 

\[
C_p = \text{mean cost per visit} \times \text{number of visits} \times \text{[semi-fixed costs]} + \text{[variable costs]}
\]

The adaptation capacitating calculation of each ACG category was obtained: a) by depuration (outliers) of the cost variable to establish a cut-off point (T) of the extreme cases (atypical observations) using the formula: 

\[
T = Q_3 + 1.5(Q_3 - Q_1)
\]

where Q3 and Q1 are the third and first quartiles of the distribution, and b) variation of Pearson coefficient (standard deviations/mean) of the reference population.

**Power calculation to determine sample size**

With an expected synthetic index of 50% and assuming a random error of 5% (95% confidence interval), a normal distribution (bilateral contrast) and an estimated precision of 1.5‰, the sample size to be recruited 230,000 patients. The statistical power of the model will be 80%.

**Statistical analysis**

The data will be carefully reviewed, observing its frequency distributions and searching for possible errors in registration or codification. A descriptive univariate analysis will be performed with means values, standard deviations (SD) and Pearson’s coefficient of variation; normality of the distribution will be tested using the Kolmogorov-Smirnov test. In the bivariate analysis, the Student’s t, ANOVA, chi-squared, Pearson’s lineal correlation and Mann-Whitney Wilcoxon tests will be used. In order to achieve a better adaptation of the distribution’s normality in the analysis, the following steps will be taken the transformation of the dependent cost variables, visits or episodes, using the natural logarithm. The calculation of the explanatory power of the ACG classification will be established using the coefficient of determination (R2), obtained by the quotient of the intragroup variance and the total (ANOVA). The coefficient of determination with three models of linear regression (the first with age as the independent variable; the second with age and sex; and the third with age, sex and number of episodes) will be used to analyze the variability of the costs. The homogeneity of the variances will be tested using the Cochran test. Multiple linear regression analysis (procedure: enter) and covariance (ANCOVA; procedure: Bonferroni) will be carried out according to the recommendations of Tompson and Barber for the correction of the models used. In addition, a multilevel analysis, where the variables, centre and physician, will act as components, will be made. The SPSSWIN program version 18 and STATA/SE 11.0 for Windows will be used, and the level of statistical significance was p.

**Data confidentiality**

Confidentiality will be respected at all times according to the Spanish data protection law [24], and data was decoupled for analysis.

Approval by the Committee of Ethics and Clinical Research
In accordance with Spanish recommendations, the Study Protocol was approved by the Committee of Ethics of Clinical Research of the Foundation Gol and Gurina (IDIAP).

**Study timeline**

1. **Phase 1**: Meeting to decide general planning of the study. Tasks will be assigned to investigators and informative meetings held with physicians from participating PHC centres. Posterior follow-ups will be quarterly. A bibliographical and documental search will be made and a structured summary drawn up. Time: 1 month.

2. **Phase 2**: Measure of patient variables (quantitative information). Time: 5 months. This includes: a) design and drawing up of a morbidity data base (care episodes attended by patient/year). Time: 1 month; b) design and drawing up pharmaceutical prescription data base (CatSalut). Time: 1 months; c) design and drawing up direct costs data base (laboratory, radiology, referrals and pharmaceutical prescription per patient/year). Time: 1 months; d) conversion (mapping) of CIAP to ICD-9-MC. Time: 1 month; and e) obtention of an ACG per patient/year. Time: 1 month.

3. **Phase 3**: Drawing up of a computer programmer for deputation of dependant variables, using MS Access and Visual Basic. Time: 1 month.

4. **Phase 4**: Design and carrying out of interviews with physicians, and adaptation of data quality. Identification the inadequate categories of classification (ACG). Time: 2 month.

5. **Phase 5**: Data analysis. Including: a) statistical analysis: descriptive, bivariate and multivariate; and b) interpretation of the results. Time: 1 month.

6. **Phase 6**: Scientific diffusion of the results. This will include the writing, translation and publication of the results obtained. Time: One year.

**Discussion**

We expect the greatest limitations of the study to be related to the degree of development of maturity of information systems, the accuracy of conversion of ICPC-2 to ICD-9-MC, the accuracy of the measurement of costs and the efficiency or possible variability and/or severity in the selection of the care episode by physicians, which might lead to contamination between groups or a lack of clinical specificity. There is literature available on the use and behaviors of ACG. However, the contributions in the calculation of adaptation categories are limited [18-19,25-30]. Our study associates the burden of morbidity with the use of health resources and the costs of care, with the aim of calculating the adaptation of each category of the ACG classification system in patients belonging to various PHC centres in Catalonia. It is worth noting that the organization of PHC in our country, which includes population assignment and computerised centres, offers an ideal framework for case-mix studies of broad geographic scope and in routine clinical practice [1,19]. Nonetheless, it should be noted that without an adequate standardization of methodologies for the definition of patient characteristics and for the number and the measure of the variables studied, the obtained results should be interpreted with prudence, forcing us to be cautious with the external validity of the results. The capitation model system aims to promote efficient behaviours for paying service providers according to the burden of disease in a given period of time. This type of model gives the present study an attractive conceptual and practical application. Therefore, a possible scenario for the debate in the model of financing PHC teams could be developed from a combination of factors including: a) the weighting of structural costs related to accessibility; b) the variable costs depending on case-mix (ACG) and the complexity of the patient; and c) quality objectives derived from the policy sought by the buyer and expected by the client.

We expect the greatest limitations of the study to be related to the degree of development of maturity of information systems, the accuracy of conversion of ICPC-2 to ICD-9-MC, the accuracy of the measurement of costs and the efficiency or possible variability and/or severity in the selection of the care episode by physicians, which might lead to contamination between groups or a lack of clinical specificity. The method of calculating the costs is an issue that should be taken into consideration when comparing the ADAPTATION of different countries. However, the greatest limitation is present in the external validity of the results; the centres studied are not necessarily representative of a general universe, given they were selected because of the quality of their information systems. The ACG have been designed as measure of health status and the health resources used in a group of individuals. Future research is necessary in population level risk adjustment and capitation payment so that the ACG system can be used in the clinical management of the centres. The proliferation of similar studies, with homogenous definition criteria between variables, would favor the possibility of benchmarking between centres and professionals from different organizations. Nonetheless, we should further study the behaviors of each ACG group in order to reduce the percentage of
variability (outliers).

List of abbreviations used

ACG    Adjusted Clinical Groups
ADG    Ambulatory Diagnostic Groups
PHC    Primary Health Care
RUB    Resource Utilization Band
CADG   Collapsed Ambulatory Diagnostic Groups
ICPC-2  International Classification of Primary Health Care
ICD-9-MC  International Classification of Diseases
EDC    Expanded Diagnostic Clusters
MAC    Major Ambulatory Categories
PCS    Patient Classification System

Authors

AS, SV, RN, CV, AP and MV drew up the study protocol and structured the bibliographical search. AS and SV will carry out data obtain. AS, SV, RN, CV, AP and MV will carry out the analysis and interpretation of the initial results. All authors will contribute ideas, interpret the findings and review rough drafts of the manuscript. All authors will approve the final versions of all manuscripts. AS is the head of the Catalan study.

References

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