

Chest Pain in Clinical Practice: Impact of Routine Troponin Determination on Clinical Manifestations and Care

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Introduction and objectives. To study the significance of chest pain in the clinical practice of a Spanish hospital and to evaluate the impact of routine troponin determination.

Methods. In our institution, routine serial measurements of troponins I and T were made in the evaluation of chest pain in 2000. We compared the results obtained in 1999 for all patients who visited the emergency room for chest pain and the patients who were hospitalized. We recorded the diagnosis at discharge, duration of the hospital stay, and associated costs.

Results. In 2000, 1,820 patients with chest pain visited the emergency department, which was equivalent to 1.9% of visits and 7.5 cases per 1,000 people and year: 43% of these patients were hospitalized for suspected acute coronary syndrome as compared to 49% in 1999 (–12%; $p > 0.001$). Among the patients admitted, 28% were discharged with a diagnosis of non-ischemic chest pain. Troponin determinations were associated with a lower probability of admission due to unstable angina (11.5 vs 16.0%; –28%; $p < 0.001$) and non-ischemic chest pain (12.1 vs 14.5%; –16%; $p < 0.05$), and an increase in diagnoses of non-Q wave acute myocardial infarction (3.4% vs 1.8%; +89%; $p < 0.01$). Non-ST elevation acute coronary syndrome ACS required 3,751 days of hospitalization and 1,003,420 euros of cost, and troponin determinations were associated with a reduction in hospital stays of 832 days (–18.2%) and 185,100 euros (–15.6%).

Conclusion. Chest pain had a high incidence, 7.5‰, and generates high costs in hospital admissions. The routine use of serial troponin determinations was associated with a reduction in hospital admissions due to unstable angina and non-ischemic chest pain, and costs.

Key words: *Diagnosis. Coronary disease. Unstable angina. Myocardial infarction.*

El dolor torácico en la práctica clínica hospitalaria: repercusión clínica y asistencial del uso rutinario de troponinas

Introducción y objetivos. Estudiar la importancia del dolor torácico como motivo de consulta urgente e ingreso hospitalario, así como la repercusión del uso rutinario de troponinas sobre su manejo clínico y los costes asociados.

Métodos. Durante el año 2000 nuestro protocolo de evaluación del dolor torácico incluyó la determinación seriada de troponinas I y T. Estudiamos en el año 2000, respecto a 1999, todas las consultas por dolor torácico en urgencias, los ingresos, su diagnóstico final, estancia y cuantificación económica. Los pacientes fueron agrupados en IAM con y sin onda Q, angina inestable y dolor torácico no isquémico.

Resultados. En el año 2000, el dolor torácico motivó 1.820 consultas (1,9%) y 7,5 casos por 1.000 habitantes y año. Un 43% de los pacientes con dolor torácico fue ingresado por sospecha de síndrome coronario agudo, frente al 49% en 1999 (–12%; $p < 0,001$). Un 29% de hospitalizaciones se debió a dolor torácico de origen no isquémico en el momento del alta. El uso de troponinas se asoció con una menor probabilidad de ingreso por angina inestable (11,5 frente a 16,0%; –28%; $p < 0,001$) y dolor torácico no isquémico (12,1 frente a 14,5%; –16%; $p < 0,05$), y mayor por IAM sin onda Q (3,4 frente a 1,8%; +89%; $p < 0,01$). La sospecha de síndrome coronario agudo sin ascenso del segmento ST ocasionó 3.751 días de estancia y 1.003.420 euros de coste, con una reducción, asociada al uso de troponinas, de 832 días (–18,2%) y 185.100 euros (–15,6%).

Conclusión. El dolor torácico ocasiona una elevada demanda asistencial, con un alto consumo de recursos hospitalarios. La incorporación de troponinas se asoció a una reducción significativa de las hospitalizaciones por angina inestable y dolor torácico de origen no isquémico, así como de los costes ocasionados.

Palabras clave: *Diagnóstico. Enfermedad coronaria. Angina inestable. Infarto de miocardio.*

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ABBREVIATIONS

CP: chest pain.
AMI: acute myocardial infarct.
ACS: acute coronary syndrome.
Tn: troponin.

INTRODUCTION

Chest pain (CP) is one of the most frequent reasons for visiting the emergency department, accounting for 5% of all emergency consults in the United States.^{1,2} Patients with an acute coronary syndrome (ACS) also present with an increased rate of complications, and benefit significantly from hospital management; thus, proper identification of this syndrome is important. In spite of the development of various methods to evaluate chest pain, the difficulty in diagnosing it leads to inappropriate hospital discharges and unnecessary hospital admissions, both of which result in increased health care costs.³⁻¹⁰ In the United States, specific units created to evaluate CP that are made up of specialized staff and specific diagnostic and risk categorization procedures, has resulted in an improvements in both medical treatment and the allocation of health care resources.⁸⁻¹² Nevertheless, in our country, we lack data on the clinical and health care significance of CP as a reason for emergency department visits.

A current addition to the evaluation of chest pain is troponins I (TnI) and T (TnT). In patients with CP without ST segment elevation, these myocyte contractile proteins are more sensitive and more specific markers for myocardial damage, with short-term and long-term prognostic value that is superior to ECG results and the use of MB isoenzyme of creatinkinase (CK-MB) values.¹³⁻¹⁷ Elevated troponin values are associated with a 3-fold to 8-fold increase in the risk of death in the short-term and enable the identification of patients who will derive benefit from more aggressive in-hospital treatment.¹³⁻¹⁹ On the other hand, normal values help identify those patients who have a low risk of complications (0.5% to 2%).¹³⁻¹⁷ As a result, serial measurement of troponins in patients with CP that is suggestive of ischemia has become a basic clinical tool and, with its use, an improvement in the clinical management of such patients can be expected; nevertheless, until the present, the true impact of the use of troponins in routine health care practice has not been evaluated.

The aim of our study is 2-fold: *a)* to determine the health care activity resulting from emergency room visits and hospital admissions triggered by chest pain in our country, and *b)* to evaluate the repercussions of the use of serial measurement of troponins on the clinical management of these patients and the resulting economic costs involved.

METHODS

Patients and evaluation protocol

The study population was the health care area under the administrative auspices of the Hospital Universitario Virgen de la Arrixaca in Murcia, which includes a total of 243 000 patients. During 1999, the protocol for evaluating CP in the emergency department included: *a)* an initial evaluation by an emergency department physician who performed anamnesis, physical exam, ECG, and elemental blood work including CK-MB; *b)* when CP was suspected to be coronary in origin, the patient was evaluated by the cardiologist on call who, after repeating the initial evaluation (including an ECG and CK-MB), made a final determination about the appropriate clinical approach. As of January 1, 2000, the evaluation process also routinely included serial measurement of TnI and TnT at the time of the patient's arrival in the emergency department, and at 6 and 12 hours after the onset of chest pain.

Laboratory tests

The markers for myocardial damage used were CK-MB measured in mass units, cardiac TnI, and cardiac TnT. The first 2 values were determined by a sandwich-type enzyme immunoanalysis with colorimetric detection on a Dimension® RxL (Dade Behring) analyzer; for measurement of TnT, a sandwich-type enzyme immunoanalysis with chemo luminescent detection on an Elecsys® (Roche) analyzer was used. The cut-off value for both types of troponin was 0.1 ng/mL and for CK-MB was 3.2 ng/mL, with any higher values considered to be abnormal.

Databases

We used an informatics application program to analyze the information collected at all the visits, and performed a review of the patients who had visited the emergency department of our hospital as a result of chest pain during the years 1999 and 2000. For the patients who were admitted, we obtained the final diagnosis at the time of discharge according to the ICD-9-CM (International Classification of Diseases, 9th revision, Clinical Modification) code,²⁰ as established by medical personnel trained in this type of work who retrospectively reviewed the clinical history at the time of admission, classified as: transmural AMI (41001, 41011, 41021, 41031, 41041, 41051, 41061, 41081, 41091), AMI without Q-wave (41071), unstable angina (4111, 4130, 4131, 4139), or nonischemic chest pain (78650, 78651). For this analysis we used the minimum basic data package (MBDP), which is an administrative and statistical informatics program, for the discharge data corresponding to each year. The

data was run with the 3M Clinical Station AP-GRD informatics program (version 4.2, 3M Health Information Systems, Wallingford, CT, USA), also determining the mean hospital stay for patients with each diagnosis. For the calculation of expenditures, we analyzed corresponding diagnosis related groups (DRG)²¹ of patients using the GECLIF22 project, a clinical-financial management tool that is the accounting standard for all hospitals in the Instituto Nacional de la Salud (National Health Institute). This application integrates all the economic and health care information, allowing calculation of expenditures by a process that starts with the costs associated with each patient.²²

Statistical analysis

We performed a descriptive analysis of the data obtained for each year. We used the χ^2 test to compare the probability of admission during both years. A *P* value of $<.05$ was considered statistically significant.

RESULTS

During 1999, a total of 1703 patients visited the emergency department with chest pain (CP), which was 1.88% of all medical and surgical visits for the hospital. In 2000, this number increased to 1820 patients (an additional 117 patients), which was 1.9% of all visits. The daily mean number of visits due to CP was 4.7 during 1999 and 5.0 during 2000. Taking into account the area of the population assigned to the emergency room, CP as a reason for emergency room visit caused a health care load of 7.0 inhabitants per 1000 inhabitants in 1999 and 7.5 inhabitants per 1000 inhabitants during 2000.

Of the total number of visits documented, 49% of patients were admitted in 1999, vs 43% of patients in 2000 ($P<.001$), resulting in a relative reduction of 12% in the probability of admission (Figure 1).

In Table 1, we show the patients admitted according to final diagnosis at the time of discharge. With the exception of transmural AMI, which showed similar percentages of the total number of visits for the years 1999 and 2000 (16.3% of patients in 1999 and 15.7% of patients, 2000; $P=NS$), the remaining diagnoses showed variations with the incorporation of serial troponin tests. In the year 2000, the probability of admission with a final diagnosis of CP of nonischemic origin underwent a relative reduction of 16% as compared with the year 1999 ($P<.05$), and the probability of admission due to unstable angina decreased by 28% ($P<.001$). On the contrary, the diagnosis of AMI without Q-waves accounted for 3.4% of visits, showing an increase of 89% ($P<.01$). When we combined and analyzed unstable angina and AMI without Q-wave and ACS without ST segment elevation, these

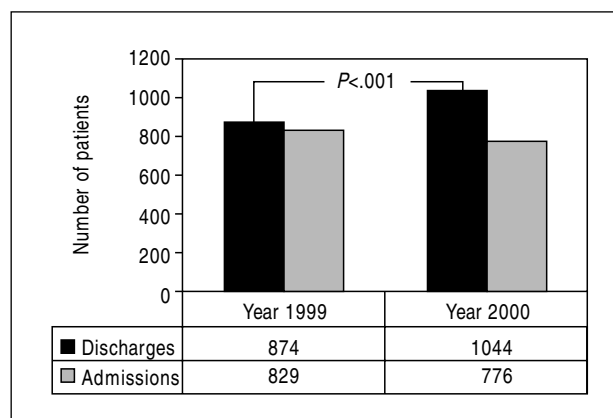


Fig. 1. Patients who went to the emergency department with CP, classified according to whether they were admitted or discharged, for the years 1999 and 2000.

diagnoses made up 17.8% of total visits in 1999 and 14.9% of visits in 2000, with a relative reduction of 16% in the probability of admission with these diagnoses ($P<.05$). The number of hospital readmissions during the 3 months after discharge decreased without reaching statistical significance during the year 2000 (37 vs 58; $P=NS$).

Consequently, as can be seen in Figure 2, the profile of patients hospitalized also changed when the number of patients with myocardial necrosis increased significantly; thus, the proportion of patients with a diagnosis of AMI (with and without Q-wave) increased from 37.4% of the total number of patients admitted in the year 1999 to 44.8% of the total number of patients admitted in the year 2000 ($P<.01$).

After hospital admission, the mean length of hospital stay for unstable angina was similar in both 1999 and 2000 (7.9 days vs 8.0 days), while length of hospital stay for AMI without Q-wave (13.2 days vs 11.0 days) and CP (7.2 days vs 6.4 days) decreased. In table 2 we show total length of hospital stay for each diagnosis in the year 1999, those predicted for the year

TABLE 1. Chest pain: visits, discharges, and admissions with final diagnosis

Year	1999	2000	P
Emergency room consults	1703	1820	
Discharge from emergency department	874 (51%)	1044 (57%)	<.001
Admissions			
AMI with Q-wave Q	279 (16.3%)	286 (15.7%)	NS
AMI without Q-wave	31 (1.8%)	61 (3.4%)	<.01
Unstable angina	273 (16.0%)	209 (11.5%)	<.001
Nonischemic	246 (14.5%)	220 (12.1%)	<.05

Data is expressed in numbers and percentages. AMI indicates acute myocardial infarct.

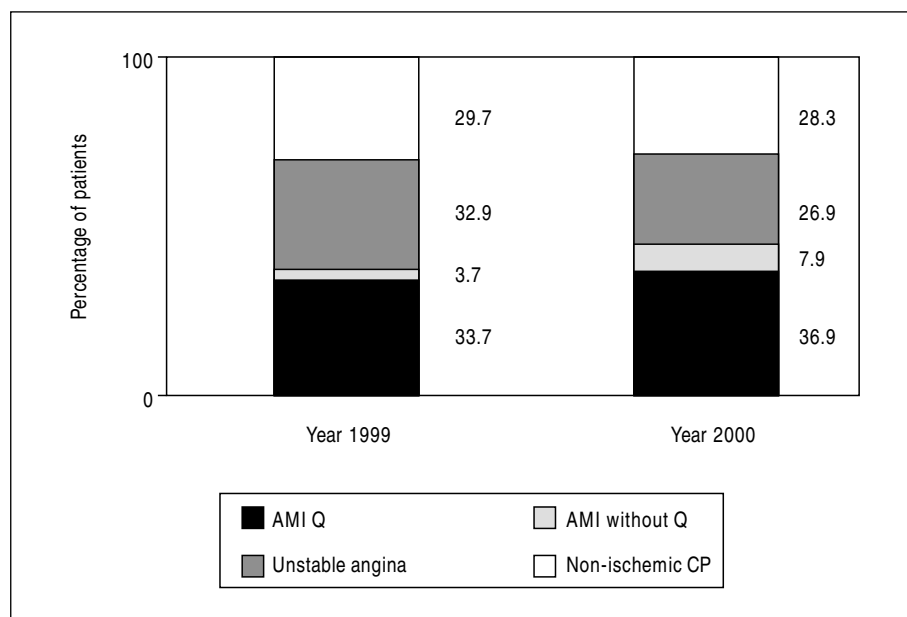


Fig. 2. Patients admitted with suspected ACS from the emergency department, classified by final diagnosis upon discharge and expressed as a percentage of the total number of patients admitted for the years 1999 and 2000.

2000, and those actually obtained in the year 2000. In the year 2000, the number of admissions for suspected ACS without ST segment elevation resulted in 3751 days of hospital stay, with an associated cost of 1 003 420 euros, with the use of troponin resulting in a 832 day reduction in length of hospital stay (–18.2%) and a 185 100 euros (–15.6%) reduction in cost. If we take into account that the increase in laboratory costs resulting from the use of serial troponins was 12 045 euros, the final balance is a decrease in expenditures of 173 055 euros (–14.6%) for the year 2000.

DISCUSSION

In our health care area, CP as the impetus for emergency department visits resulted in a health care need for 7.5% of inhabitants during the year 2000, a 0.5% increase over the previous year. Of the patients who went to the emergency department 43% were admitted to the hospital with suspected ACS, but nearly 30% of these hospitalizations did not result in a final diagnosis of heart disease. The use of troponins was associated with a lower probability of admission for patients who had no myocardial necrosis and who had no final diag-

nosis of heart disease, and was associated with a shorter length of hospital stay; consequently, the health care costs incurred were lower. In spite of the fact that CP is a growing health issue, until the present time there was no data available about the significance of CP as a reason for emergency room visits in our hospital environment. The data obtained in our study shows significant differences with respect to those published in the United States, where 5% of emergency room visits were due to CP, which is approximately 6 000 000 annual visits and 20 visits per 1000 inhabitants per year.¹ In our country, these numbers were lower, similar to those reported in the United Kingdom where CP represents 2% of emergency room visits,²³ possibly due to epidemiological and health differences associated with a greater prevalence of ischemic heart disease.

Also, the approach to managing CP is quite different. In the United States, the majority of patients (60%) were admitted after an emergency department visit during the year 2000, vs 43% in our country, a number that is closer to the 30% to 40% reported in the United Kingdom.²³⁻²⁵ This difference may be explained by the more defensive approach that exists in

TABLE 2. Length of hospital stay and health care costs

	1999		Predicted 2000		2000		Balance	
	No.	Length of stay	No.	Length of stay	No.	Length of stay	Length of Stay	Cost
AMI without Q-wave	31	409	33	435	61	668	+233	+81 411
Unstable angina	273	2163	291	2306	209	1672	–634	–161 005
Nonischemic	246	1777	255	1842	220	1411	–431	–105 508

N indicates number of patients; Length of stay, total number of days of hospital admission for each diagnosis. Expenditures in euros.

hospitals in the United States, where CP of an ischemic origin with inappropriate discharge is the principal cause of legal malpractice suits, comprising 20% of the total cost of compensation.^{8,26-28} In fact, in the United States, more than half of the diagnoses of ACS made in the emergency room (up to 70% in some studies) turn out to be incorrect on follow-up in-hospital evaluation;^{26,27,29,30} this contrasts with Spain, where CP without a final diagnosis of ischemia accounted for 28% of admissions during the year 2000. Even in a series of 467 consecutive patients admitted for suspected ACD in a tertiary hospital in Catalonia, the number of diagnoses of nonspecific thoracic pain was only 19%.³¹ We were unable to determine whether this trend of being more apt to discharge patients in our country is appropriate or inappropriate, given the absence of followup of patients' clinical course after discharge from the emergency department. The fact that, with respect to all visits, the rate of AMI diagnosed was similar in our country and the United States (16% vs 15%), while the percentage of unstable angina is much lower in our country (11%-16% vs 30%-35%), leads us to believe that unstable angina is a subgroup of ACS that results in the majority of patient discharges in our country.⁸

Our study showed that the use of serial troponin evaluation in the evaluation of CP affects the clinical progression of patients admitted for suspected ACS. The diagnosis of AMI with Q-wave was not affected, but there were changes in the progression of patients with ACS without ST segment elevation, with a lower probability of admission due to unstable angina. This may be due in part to the greater sensitivity for the detection of myocardial necrosis, causing a change in diagnosis from unstable angina to AMI without Q-wave, an effect that was nearly duplicated in the United States in light of the new definition of AMI from certain scientific societies.³² On the other hand, use of the new definition may bring with it better assessment of risk and, as a result, a greater number of discharges of patients with low-risk unstable angina, which would confirm the decrease in the probability of admission due to nonischemic CP, representing a subgroup of unnecessary admissions that in our country was only 28.3% of the total.

In addition, principally as a result of the decrease in the probability of admission and, to a lesser degree, to the reduction in length of stay and readmissions, hospital expenditures decreased during the year 2000. There are no studies that have exclusively evaluated the health care repercussions of using troponins, although there has been cost-benefit analysis within CP units in the United States that show important reductions in expenditures for the evaluation and treatment of chest pain.^{11,33-35} Nevertheless, given that the 2 countries are not comparable, as we noted previously, in the face of this growing health problem, researchers

need to define the importance and possible benefit of the use of troponins and the existence of chest pain units.

Limitations

First, this is a retrospective study and there was no data available concerning the patients' course after discharge. Second, it was not possible to establish definitive conclusions with respect to the influence of the use of troponins, given that the changes may have been influenced by other noncontrolled variables that could have caused artifacts.

CONCLUSIONS

CP is a growing problem, causing rising health care demands and affecting 7.5% of our inhabitants and 1.9% of emergency department visits in Spanish hospitals, as well as being responsible for an increase in the use of health care resources. The use of serial measurement of troponins in the evaluation of CP is associated with a significant reduction in hospitalizations due to unstable angina or nonischemic CP, as well as a decrease in economic costs incurred.

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