

# Results achieved with the implementation of a Stroke Code System in a large hospital: role of emergency department and analysis of the learning curve

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None

**Objective:** To analyze the implementation of a stroke code protocol and the results obtained in an initial phase inside a hospital and in a second phase during which the stroke code was also used for attending emergencies outside the hospital.

**Methods:** Retrospective analysis of 20 months' application of the stroke code protocol. Two periods were defined for analysis. During the first period of 8 months, the code was used inside the hospital. In a second period of 12 months the code was used both inside and outside the hospital. Data collected for analysis of each period were the numbers of strokes diagnosed according to the stroke code criteria, the number of times the protocol was activated, the number of code procedures finalized, and the number of patients who received fibrinolytic therapy. The results obtained during the 2 periods were compared.

**Results:** The stroke code protocol was activated in 397 patients. More patients were identified as meeting the stroke code criteria in the second period ( $P < .001$ ); likewise, the number of times the code was activated as patients met the criteria was also higher in the second period ( $P < .001$ ). More stroke code-activated study protocols were completed in the second period than in the first ( $P < .001$ ). These results were accompanied by a larger number of patients who underwent fibrinolysis in the second period ( $P < .01$ ), although only 46 patients (21%) who completed the study protocol received fibrinolytic therapy, whereas 30 patients (40%) had received such therapy in the first period ( $P < .001$ ). The overall percentage of patients with stroke who came to the emergency department and received fibrinolytic therapy was similar in the 2 periods (5.3% in the first and 6.8% in the second). Of the 104 patients in whom the stroke protocol was activated and who did not complete the study, the main reason in the first period was that the window of opportunity had closed ( $P < .001$ ) whereas in the second period the main reason was the presence of concomitant disease ( $P < .001$ ). When fibrinolysis was not provided it was because the stroke had caused few symptoms or the event was finally considered a transient ischemic attack, which was significantly more common in the later period ( $P < .01$ ).

**Conclusions:** These results show that providing care to stroke patients within 3 hours of onset according to a protocol based on consensus between staff working inside the hospital and external emergency caregivers led to a rate of fibrinolytic therapy around 6%. The percentage was not higher in the later period than when the code was followed only inside the hospital. The study also shows that the main reasons why this percentage did not rise are the delay in reaching the emergency department and the presence of alternative diagnoses. [Emergencias 2009;21:105-113]

**Key words:** Acute stroke. Fibrinolysis. Alteplase (rtPA). Stroke code. Protocol.

## Introduction

Stroke is the main cause of disability and the second most common cause of mortality in developed countries<sup>1</sup>. In particular, stroke of is-

chemic aetiology presents in 6 million people worldwide per year. Therapeutic options for ischemic stroke were very limited until 1995 when the NINDS tPA study was published, showing that recombinant tissue-type plasminogen activa-

tor (rt-PA), a fibrinolytic agent already used in myocardial infarction and pulmonary embolism, was also effective in the treatment of acute ischemic stroke<sup>2</sup>. In that study, patients receiving early treatment with rt-PA showed a probability of at least 30% of being asymptomatic or suffering minimal disability after three months follow-up. Treatment with rt-PA was therefore accepted and widely recommended in the main guidelines on action to be taken in cases of acute stroke<sup>3,4</sup>. This finding was subsequently backed by meta-analyses of large randomized studies<sup>5</sup> and, later, by SITS- MOST (Safe Introduction of Thrombolysis in Stroke Monitoring Study)<sup>6</sup> which demonstrated better results and a lower percentage of haemorrhage than those reported in the NINDS study.

Currently, rt-PA is the only fibrinolytic agent approved by the European Agency for the Evaluation of Medicinal Products for the specific treatment of acute stroke. It must be administered within the first three hours after the onset of stroke, so the success of the treatment largely depends on the correct implementation of a system that facilitates rapid triage and diagnostic procedures. Reduced attention time in these patients is therefore fundamental in order to reduce the morbidity and mortality associated with this disease<sup>3</sup>.

Thus, given the need for rapid treatment, different out-of-hospital and in-hospital emergency services play a critical role in the detection, transfer and emergency attention of stroke patients. For this reason, a common protocol of action called Stroke Code (SC) has been implemented in recent years. SC is a procedure of action based on early recognition of the signs and symptoms of stroke, which gives priority to the care and transfer of these patients to a hospital or medical centre able to offer reperfusion therapy with rt-PA.

In our hospital, SC was established in 2004. Initially, it started as an in-hospital protocol of action; subsequently, it was implemented as a common protocol of action for both intra and out-of-hospital services.

The objective of this work was to analyze the development of the SC protocol implemented in our Hospital Emergency Department (ED) and compare the percentage of stroke patients treated with intravenous thrombolysis before and after implementation of the CS established by consensus between intra- and out-of-hospital emergency services. In addition, we compared data from two different periods to evaluate evolution of the learning curve.

## Method

The SC was first implemented at our centre in January 2004. In operation 24 hours a day every day, its objective is to facilitate rapid admission, physical examination and computerized tomography (CT) scan of suspected acute stroke patients. It thus serves to select from such patients those who are candidates for fibrinolysis. Although initially only an in-hospital service, the SC was also implemented as an out-of-hospital service as from July 2005. Coordinated by the health authority Corporación Sanitaria de Barcelona, cooperation was established between the different out-of-hospital emergency services (Servei d'Emergències Mèdiques, SEM) and the four large hospitals of Barcelona, including the Hospital Clinic, all situated in urban areas. The basic objective of SC activation is to reduce the time from symptom onset to intervention, with the best possible out-of-hospital attention, transfer and early attention at the receiving centre ED, to preserve the 3-hour therapeutic window for fibrinolytic treatment.

Prehospital SC activation is based on factors including focal neurological signs (Cincinnati pre-hospital stroke scale) and evolution time in hours. SEM has established 3 groups of patients according to the perceived level of priority, where Priority 1 is as follows:

Suspected stroke of < 4 h evolution, without significant comorbidity (very old and/or disabled patients) or Rankin score < 3, are transported in an advanced life support (ALS) ambulance, staffed by a team comprising a physician, a nurse and a health transport specialist. Patients with coma of suspected vascular origin are also included as cases with priority 1.

The ALS team evaluating the patient solicits an emergency admission via the Central Communication Centre and reports on the clinical characteristics of the patient. After confirmation, the patient is transported to the nearest hospital ED. Once admitted to the ED, the patient receives immediate attention, which initiates the in-hospital phase. This includes physical examination and tests of blood pressure, heart rate, oxygen saturation, capillary glycaemia and electrocardiogram. The ED physician performs a basic neurological examination. Then a neurologist quantifies the neurological deficit using the National Institute of Health Stroke Scale (NIHSS) scale<sup>7</sup>. When the NIHSS score is > 4 and < 25, cranial CT scan is performed immediately. Radiological evaluation of the cerebral parenchyma is performed by a neurologist and a radiologist, using the Alberta Stroke

Programme Early CT Score (ASPECTS)<sup>8</sup>. In accordance with the latest guidelines on acute stroke management, if the patient meets the clinical and radiological criteria for fibrinolytic treatment, rt-PA is administered in the same ED or in the Stroke Unit<sup>9</sup>.

For the retrospective analysis of the data collected, two periods of study were defined: Period A, from 1 October 2004 to 31 May 2005 (8 months), during which only in-hospital SC was implemented, and Period B comprising both pre-hospital and in-hospital SC use from January 1st 2006 to December 31st 2006 (12 months).

During these periods data were collected, including the number of SC-assisted patients, stroke diagnoses, stroke diagnoses meeting SC criteria, SC procedures activated, SC procedures completed and the number of SC patients who finally received fibrinolytic therapy. Reasons for incompleteness of the SC procedures and for non-administration of fibrinolytic treatment in cases with completed procedures were recorded. Regarding patients who received fibrinolytic treatment, the following data were also recorded: demographics (age and gender), medical history including alcohol consumption, smoking status, diabetes mellitus, dyslipemia, arterial hypertension, previous stroke events, previous antiaggregant therapy, and present disease parameters (blood pressure, glycaemia, pre-treatment Rankin < 2 and NIHSS score, need for antihypertensive treatment and ED-administered fibrinolysis, as well as follow-up data including in-hospital mortality, Rankin < 2 and Barthel scores. Follow-up data were obtained at 1 hour, 24 hours, at discharge and at 90 days after receiving fibrinolytic treatment.

We defined two major attention times. The first was pre-hospital (from stroke symptom onset to arrival at ED), which in turn was divided into two parts: from symptom onset to SEM arrival, and from SEM arrival to hospital. The second was door-to-needle time (the interval between arriving at the hospital and starting thrombolytic infusion), which in turn was divided into three partial times: time from hospital arrival to ED hospital-box, from ED box to imaging test, and from imaging test to fibrinolysis. These times were recorded for all patients who received fibrinolysis.

The results for the full study period of 20 months were retrospectively analyzed, then the data corresponding to the two previously defined periods were compared. Quantitative variables are expressed as means  $\pm$  standard deviation and qualitative variables as percentages. Student t test

was used for the comparison of quantitative variables, and chi square test (or Fischer exact test when calculated events were < 5) for qualitative variables. The ANOVA test for repeated measures was used. In all cases, differences between time periods with a p value < 0.05 were considered statistically significant.

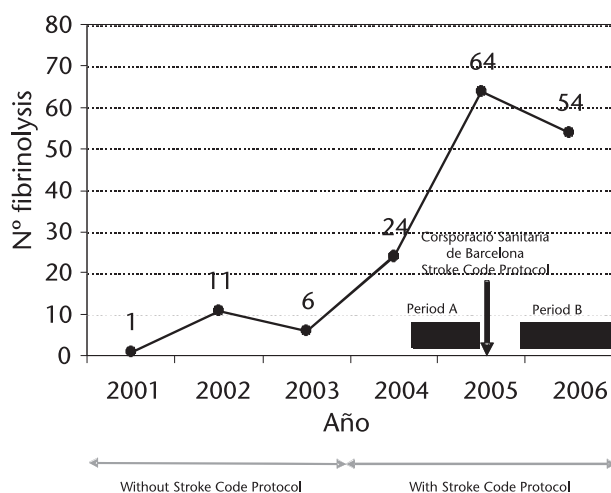
## Results

Figure 1 shows the evolution over time of fibrinolytic treatment activity at our hospital according to the different time periods defined in this study. A breakdown of overall ED activity during the 20-month study period is shown in Figure 2.

Stroke was found in 1.9% of patients visiting our ED; which means 1,212 patients over the 20 months, an average of 60 per month. Of these, 404 (33.3%), i.e. 20.2 patients per month, met the SC criteria and 394 (97.5%) finally received fibrinolytic treatment. On comparing ED activity according to time periods (Table 1), we observed that: of patients diagnosed with cerebrovascular accident (CVA) in Period A, 121 (23%) met SC criteria versus 283 (42%) in Period B ( $p < 0.001$ ). Similarly, of those patients meeting SC criteria, SC was activated more often in Period B (280, 99%) than in Period A (114 patients, 94%) ( $p < 0.01$ ). For activated SC, the protocol was completed significantly more often in Period B (222 patients, 79%) than in Period A (68 patients, 60%) ( $p < 0.001$ ). Finally, for completed SC protocol, only 46 patients (21%) received fibrinolytic treatment in Period B versus 30 patients (44%) in Period A ( $p < 0.001$ ) (Table 1). However, the percentage of all stroke patients visiting ED that finally received fibrinolytic treatment did not vary between Period A (5.6%) and B (6.8%) ( $p = 0.50$ ), as shown in Figure 3.

During the 20-month study period, 104 cases where SC was activated did not complete the study (Table 2). Comparing the reasons for non-completion by study periods, the 3-h stroke evolution period was exceeded more often in Period A (19 patients, 41%) than in B (5 patients, 9%) ( $p < 0.001$ ), whereas comorbidity was more frequent in Period B (50 patients, 86%) than in A (17 patients, 37%) ( $p < 0.001$ ).

Of the 290 patients who completed the SC protocol study, fibrinolytic treatment was not administered in 214 (73.8%) for different reasons (Table 3). The presence of slight stroke or transitory ischemic attack (TIA) not warranting fibrinolytic treatment was significantly more frequent



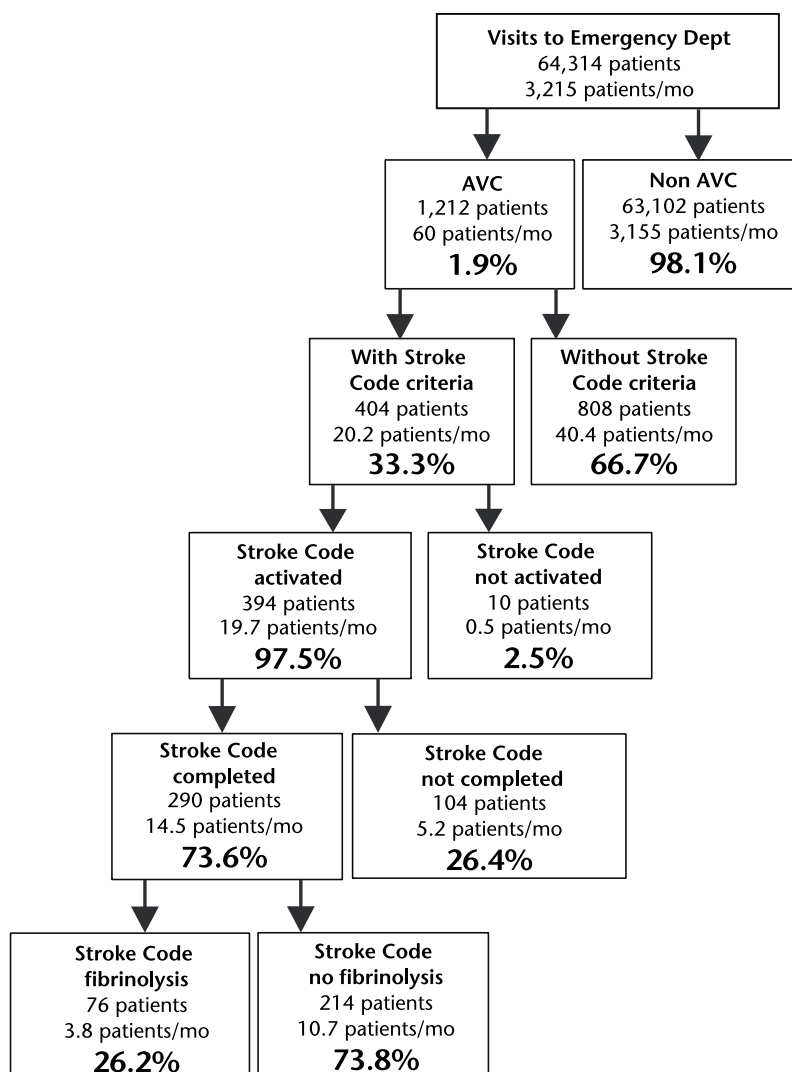
**Figure 1.** Number of fibrinolytic treatments administered at Barcelona Hospital Clinic, in patients with cerebrovascular accident referred from Emergency Department.

in Period B (49 patients, 28%) than in A (3 patients, 8%) ( $p < 0.01$ ).

Table 4 shows the characteristics of those patients who received fibrinolytic treatment.

In-hospital mortality of 7% remained stable in both study periods. In surviving patients, we observed progressive improvement in neurological symptoms until discharge, which was significant on measurement using the NIHSS scale (Figure 4).

Finally, Figure 5 shows the evolution of attention times in the SC protocol for patients who received fibrinolysis, both globally and by study periods. No significant differences were found between Period A and B regarding: prehospital time (67 and 66 minutes, respectively), door-to-needle time (65 and 73 minutes, respectively) or partial times for each period.



**Figure 2.** Distribution of patients.

**Table 1.** Distribution of patients according to the two time periods of the study

	Period A	Period B	P
Study time period (months)	8 (Oct-04/May-05)	12 (Jan-06/Dec-06)	
Emergency department activity	26,002	38,312	< 0.05
– Visits with diagnosis of CVA*	531 (2.0%)	681 (1.8%)	
– Visits without diagnosis of CVA	25,471 (98.0%)	37,631 (98.2%)	
CVA in ED**	531	681	< 0.001
– With STROKE CODE criteria	121 (23%)	283 (42%)	
– Without STROKE CODE criteria	410 (77%)	398 (58%)	
STROKE CODE	121	283	< 0.01
– Activated	114 (94%)	280 (99%)	
– Not activated	7 (6%)	3 (1%)	
ACTIVATED STROKE CODE	114	280	< 0.001
– Completed	68 (60%)	222 (79%)	
– Not completed	46 (40%)	58 (21%)	
Completed STROKE CODE protocol	68	222	< 0.001
– Fibrinolysis	30 (44%)	46 (21%)	
– No fibrinolysis	38 (56%)	176 (79%)	

\*CVA = Cerebrovascular accident. \*\*ED = Emergency Department.

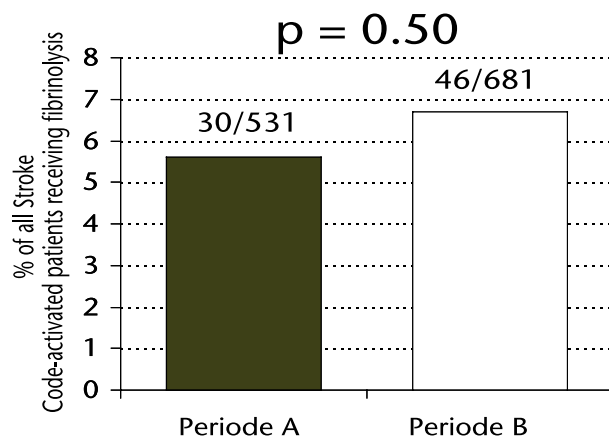
## Discussion

The present study shows the implications of implementing the SC protocol in an ED, from the perspective of an ED physician. Three main conclusions may be drawn from this study. Firstly, fully implemented SC only resulted in fibrinolytic treatment being administered to 6% of patients. Secondly, the main reasons for this relatively low rate of fibrinolysis were late arrival at ED and the presence of alternative diagnoses. Finally, regarding the impact of SC activation on the efficacy of thrombolytic treatment, the implementation of a common in-hospital protocol has not resulted in a significant increase in the number of stroke patients benefiting from rt-PA treatment.

The percentage of patients receiving fibrinolysis (6%) found in this study is similar to that reported for another large hospital in Barcelona<sup>10</sup>. That study determined the applicability of SC implementation in daily clinical practice and its impact on the efficacy of fibrinolytic treatment. On dividing the study period into three 6-month periods, the authors found a significant progressive increase in the number of patients finally treated with rt-PA, from 4.8% to 8%. However, in a recent one-year study by Belvis et al<sup>11</sup> evaluating the benefits of out-of-hospital SC, the authors reported that 19% of stroke patients received fibrinolytic treatment.

The difference in percentages between hospitals in the same city (Barcelona) may be explained by a number of differentiating factors, including structural and organizational characteristics, area served and population demographics, as well as type of prehospital emergency services involved in each urban area. These and other factors may justify why, at this time, it is difficult for our hospital centre to increase the 6% found in this study<sup>12</sup>.

In addition, the significantly greater percent-



**Figure 3.** Percentage of total stroke visits to Emergency Department where fibrinolytic treatment was administered.

**Table 2.** Main reasons for non-completion of the procedures in 104 patients for whom the Stroke Code was activated

	Total (n = 104)	Period A (n = 46)	Period B (n = 58)	p
Evolution time exceeded Stroke Code time window of 3 h	24 (23%)	19 (41%)	5 (9%)	< 0.001
Very old and/or disabled patients	67 (64%)	17 (37%)	50 (86%)	< 0.001
Not diagnosed with CVA	9 (9%)	7 (15%)	2 (3%)	0.07
Other	4 (4%)	3 (7%)	1 (2%)	0.32

CVA: Accidente vascular cerebral.

**Table 3.** Reasons for non-administration of fibrinolysis in 214 patients who completed the STROKE CODE circuit

	Total (n = 214)	Period A (n = 38)	Period B (n = 176)	p
Hemorrhagic CVA*	75 (35%)	18 (47%)	57 (32%)	0.09
Slight CVA/ TIA**	52 (24%)	3 (8%)	49 (28%)	0.01
Treatment with acenocumarol	25 (12%)	4 (11%)	21 (12%)	1.00
Hypertensive crisis	21 (10%)	3 (8%)	18 (10%)	1.00
No CVA	11 (5%)	1 (3%)	10 (6%)	0.69
Rankin > 3	9 (4%)	0	9 (5%)	0.37
Extensive / need for ICU***	3 (1%)	0	3 (2%)	1.00
Other	25 (12%)	16 (42%)	9 (5%)	< 0.001

\*CVA = Cerebrovascular accident. \*\*TIA = Transitory Ischemic Attack. \*\*\*ICU = Intensive Care Unit.

age of patients not treated with thrombolysis due to slight stroke or TIA in Period B may also explain the low percentage.

Implementation of the extra- and in-hospital SC protocol was accompanied by a reduction in the number of patients who, after SC activation, did not complete the SC process because they exceeded the 3-hour time window. During Period B, the main reason for non-completion of the SC process was the number of very old and/or disabled patients. This finding should lead us to question what the best policy is from the management point of view, given that a SC circuit involves considerable assignment of specific resources, to the detriment of other patients visiting EDs which are usually overcrowded and

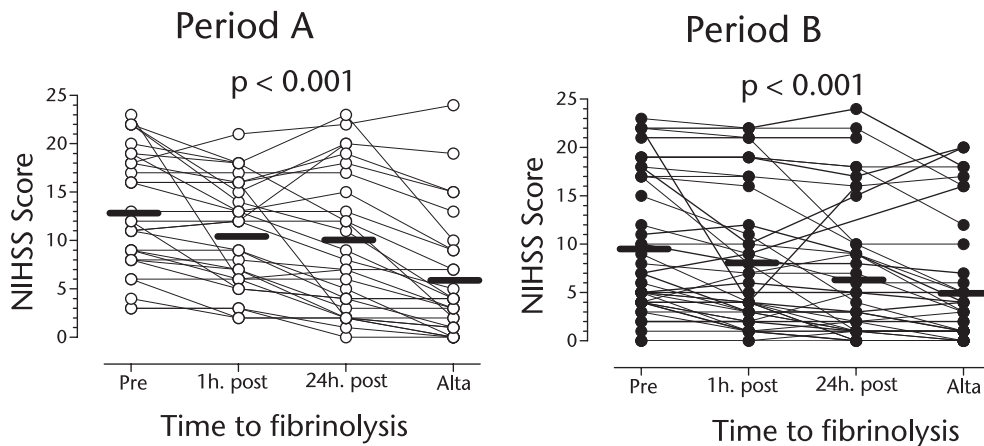
cramped for space<sup>13-16</sup>. It is important to avoid the inclusion in the circuit of patients who will not receive fibrinolytic treatment for comorbidity reasons.

Although total attention time (from patient stroke alert to fibrinolysis) did not significantly differ between the two study periods, it is important to point out that total times of 137 and 146 minutes are acceptable. Most members of general population do not identify early stroke symptoms as an emergency, which results in delayed alerts. A multicentre prospective study performed by the Cardiovascular Disease Group of the Spanish Society of Neurology in 1995 found that only 58.2% of patients with stroke consulted within the first 3 hours<sup>17</sup>. In the univariate analysis, the most serious

**Table 4.** Main epidemiological, clinical and evolution characteristics of patients who completed the STROKE CODE protocol and received fibrinolysis

	Total (n = 76)	Period A (n = 30)	Period B (n = 46)	p
<b>Epidemiological characteristics</b>				
– Age (years)	71 ± 12	71 ± 15	72 ± 11	0.85
– Male sex (%)	65%	70%	62%	0.62
<b>History</b>				
– Alcohol consumption (%)	20%	17%	22%	0.77
– Smoker (%)	15%	7%	20%	0.18
– Diabetes mellitus (%)	19%	20%	18%	1.00
– Dyslipemia (%)	35%	20%	55%	< 0.05
– Arterial hypertension (%)	32%	33%	31%	1.00
– CVA (%)	11%	7%	13%	0.46
– Ischemic cardiopathy (%)	28%	23%	31%	0.60
– Auricular fibrillation (%)	28%	32%	24%	0.44
– Cardiac insufficiency (%)	9%	13%	6%	0.43
– Antiaggregant treatment (%)	63%	73%	56%	0.15
<b>Current disease</b>				
– Systolic arterial pressure (mmHg)	156 ± 20	157 ± 21	155 ± 19	0.60
– Glycaemia (mg/dl)	132 ± 38	128 ± 42	153 ± 35	0.49
– Rankin score < 2 pre-treatment (%)	68%	60%	73%	0.31
– NIHSS score pre-treatment (points)	10.9 ± 7.0	13.0 ± 6.1	9.4 ± 7.2	< 0.05
– Need for hypertensive treatment (%)	15%	13%	16%	1.00
– Fibrinolysis en urgencias (%)	25%	27%	24%	1.00
<b>Evolution</b>				
– In-hospital mortality (%)	7%	7%	7%	1.00
– Rankin score < 2 after 90 days (%)	35%	31%	40%	0.57
– NIHSS score after 90 days (points)	4.5 ± 15.9	1.8 ± 2.0	6.7 ± 21.0	0.34
– Barthel score after 90 days (points)	83 ± 33	80 ± 32	86 ± 34	0.57

CVA: Cerebrovascular accident.

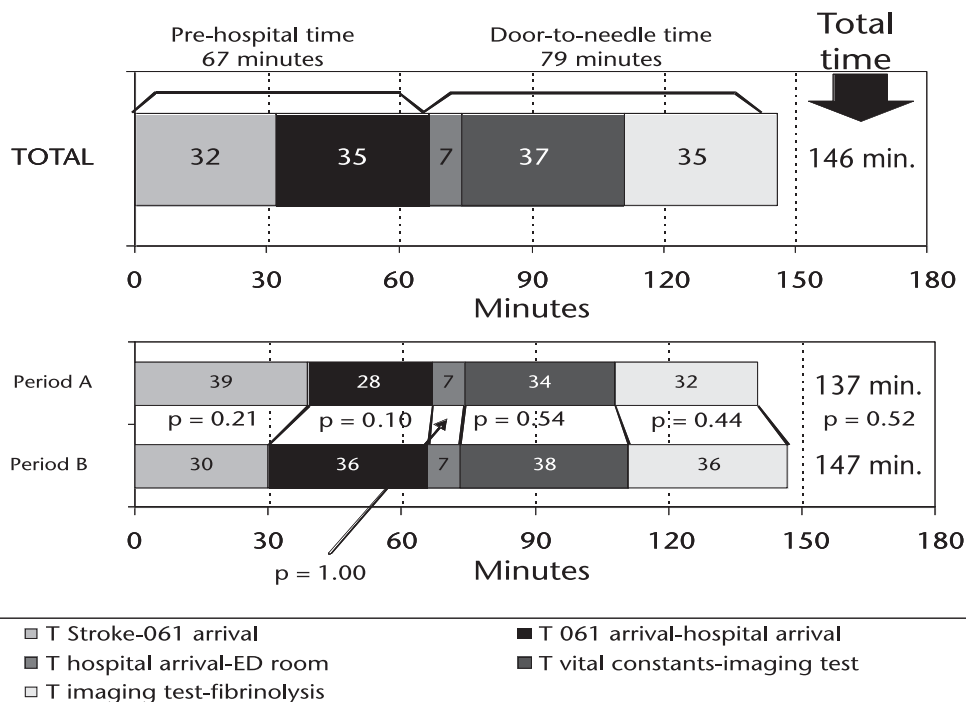


**Figure 4.** Evolution of NIHSS (score points) in STROKE CODE activated patients who received fibrinolysis.

cases, women, and patients with low socio-educational level used emergency services more rapidly. In the multivariate analysis, the most serious cases and patients who presented directly at the hospital showed the least risk of late arrival. Although these data were not collected in the present study, it is evident that continued and increased public health campaigns are required to improve early detection of this disease. Educational campaigns via the major media could be conducted,

focusing on the main symptoms and the need for rapid communication with medical emergency services<sup>18</sup>. Such campaigns directed at the general population should be given greater priority, as concluded in a recent review<sup>19</sup>.

In our experience, implementation of the extra- and in-hospital SC protocol was not related with an increase in the number of patients who finally received fibrinolytic treatment. This result is to a certain extent understandable, considering



**Figure 5.** Evolution of attention times in STROKE CODE activated patients who received fibrinolysis.

that prehospital times were the same in the study periods A and B.

Lastly, the present study has three limitations. Firstly, it was performed in a single hospital centre. Every hospital centre, especially its ED, has different organizational characteristics, and SC implementation in the in-hospital phase may differ considerably from one hospital to another. This makes it difficult to generalize any conclusions drawn. Secondly, some of the differences between study periods may possibly be due to their different durations, which also involves the possibility that seasonal stroke factors may have influenced the results. Finally, there was no long-term follow up to evaluate the impact of SC on subsequent morbidity, mortality and quality of life.

In conclusion, this study shows that attention based on protocol and collaboration between extra- and in-hospital teams for stroke patients with less than three hours evolution did not result in increased percentage of patients finally receiving fibrinolytic treatment, despite increased activation of the stroke code.

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## Resultados alcanzados con la puesta en marcha del circuito "Código Ictus" en un gran hospital: papel de urgencias y análisis de la curva de aprendizaje

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**Objetivo:** Analizar el desarrollo y los resultados obtenidos con la puesta en marcha del circuito "Código Ictus" (CI), tanto en su fase de implementación intrahospitalaria, en un primer periodo, como en la fase de implementación intra y extrahospitalaria, en un segundo periodo.

**Método:** Se definieron 2 periodos: un primer periodo A de 8 meses con circuito CI intrahospitalario y un segundo periodo B de 12 meses con circuito CI intra y extrahospitalario. De cada periodo se contabilizaron el número de ictus con criterio de CI, los CI activados, los CI con estudio completado y aquéllos que acabaron recibiendo tratamiento fibrinolítico. Finalmente se compararon los 2 periodos descritos.

**Resultados:** El CI fue activado en 397 pacientes. En el periodo B hubo más pacientes con criterio de CI que en el A ( $p < 0,001$ ). El número de activaciones del CI una vez que el paciente cumplía criterio fue asimismo mayor en el periodo B respecto al A ( $p < 0,001$ ). Se completaron más estudios en los CI activados en el periodo B que en el A ( $p < 0,001$ ). Esto se acompañó de un aumento en el número total de pacientes a los que se les efectuó fibrinólisis en el periodo B ( $p < 0,01$ ), aunque en dicho periodo sólo 46 (21%) de los pacientes en los que se completó el estudio de CI se realizó tratamiento fibrinolítico, frente a 30 pacientes (40%) en el periodo A ( $p < 0,001$ ). El porcentaje global de pacientes con ictus que acudieron a urgencias y en los que se hizo fibrinólisis no se modificó en ambos periodos

(5,3% en el periodo A, 6,8% en el periodo B,  $p = NS$ ) De los 104 casos en los que se activó el CI y no se completó el estudio, en el periodo A fue a causa de sobrepasar el periodo ventana ( $p < 0,001$ ), mientras que en el periodo B la causa principal fue la existencia de comorbilidad. La no realización de fibrinólisis por tratarse de un ictus con poca traducción semiológica o por ser finalmente un accidente isquémico transitorio fue significativamente más numerosa en el periodo B ( $p < 0,01$ ).

**Conclusiones:** Estos resultados reflejan que la puesta en marcha de una atención protocolizada y consensuada entre los dispositivos extra e intrahospitalarios para los pacientes con ictus de menos de 3 horas de evolución consigue un porcentaje final de ictus fibrinolisados del 6%, lo cual no supone un incremento porcentual de tratamiento fibrinolítico respecto al periodo de protocolo exclusivamente intrahospitalario. De este estudio se extrae, además, que las principales causas por las que no se consigue aumentar este porcentaje son por una parte la tardanza en la llegada del paciente a urgencias y la presencia de diagnósticos alternativos, por otra. [Emergencias 2009;21:105-113]

**Palabras clave:** Ictus agudo. Fibrinólisis. Rt-PA. Código ictus. Protocolo.