



Original Contribution

Creation of an intensive care unit and organizational changes in an adult emergency department: Impact on acute stroke management



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ARTICLE INFO

Article history:

Received 18 December 2016

Received in revised form 26 December 2016

Accepted 7 January 2017

Keywords:

Stroke

Thrombolysis

rt-PA

Adult emergency department

Organizational change

Managed care

ABSTRACT

Background and purpose: Following the reorganization of a University Medical Center onto a single campus, an Intensive Care Unit was created within the adult Emergency Department (ED ICU). We assessed the effects of these organizational changes on acute stroke management and the intravenous administration of recombinant tissue plasminogen activator (IV rtPA), as characterized by the thrombolysis rate, door-to-needle time (DNT) and outcome at 3 months.

Methods: Between October 2013 and September 2015, we performed a retrospective, observational, single-center, comparative study of patients admitted for ischemic stroke and treated with IV rtPA during two 321-day periods (before and after the creation of the ED ICU). All patients with ischemic stroke were included. Multivariable logistic regression models were performed. The DNT was stratified according to a threshold of 60 min. A favorable long-term outcome was defined as a modified Rankin score ≤ 2 at 3 months.

Results: A total of 1334 ischemic stroke patients were included. Among them, 101 patients received IV rtPA. The frequency of IV rtPA administration was 5.8% (39 out of 676) before the creation of the ED ICU, and 9.3% (62 out of 668) afterwards (odds ratio (OR) [95% confidence interval (CI)]: 1.67 [1.08–2.60]; $p = 0.02$). Additionally, the DNT was shorter (OR [95%CI]: 4.30 [1.17–20.90]; $p = 0.04$) and there was an improvement in the outcome (OR [95%CI] = 1.30 [1.01–2.10]; $p = 0.045$).

Conclusion: Our results highlight the benefits of a separate ED ICU within conventional ED for acute stroke management, with a higher thrombolysis rate, reduced intrahospital delays and better safety.

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1. Introduction

Ischemic stroke (IS) is a leading cause of disability, death and cognitive impairment [1]. The management of acute IS remains a major concern in routine clinical practice [1]. Thrombolysis via the intravenous administration of recombinant tissue plasminogen activator (IV rtPA) [2] is an approved treatment for acute IS, and is known to drastically reduce disability [3]. However, the level of benefit associated with this treatment is highly time-sensitive [4–6].

Given that IV rtPA administration is beneficial within a time window of just a few hours (which includes the time needed for diagnostic workup), only a small subset of IS patients actually receives effective treatment. A European survey found that only 3.3% of IS patients receive IV rtPA, and highlighted large variations from one country to another [7]. In France, no >2% to 10% of all acute stroke patients currently receive treatment, whereas 25% might be eligible [8,9]. This disparity

emphasizes the need to shorten the duration of diagnostic and therapeutic workup. It has been reported that several procedures decrease the door-to-needle time (DNT) [10,11]. In contrast, the effect of organizational and logistic changes at a hospital on the thrombolysis rate has not been studied in detail. Here, we assessed the effects of organizational and logistic changes on acute stroke management following the creation of an Intensive Care Unit (ICU) inside conventional adult Emergency Department (ED ICU) of a university medical center's. The study's primary outcome was the before/after change in the thrombolysis rate (i.e. the proportion of IS patients actually receiving IV rtPA). The secondary outcomes concerned changes in the rapidity and safety of care for IS patients receiving IV rtPA.

2. Materials and methods

2.1. Study setting

Amiens University Medical Center (Amiens, France) has a catchment area of 800,000 inhabitants for stroke and 1.9 million for thrombectomy.

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Prior to 2014, the Center's medical departments were located on two separate sites - each of which had an ED. Importantly, the main ED was located on the same site as the stroke unit and the neurology and neuroradiology departments. Since 2004, these departments have applied a dedicated protocol for the management of acute stroke patients and thrombolysis. In October 2014, all the medical departments at Amiens University Medical Center were brought together on a single site, following the construction of a new building. This enabled the consolidation of the two EDs to form a single, 19-room department, together with the creation of a new 6-room ED ICU within the consolidated ED. This unit was created to manage general critical care patients and notably stroke patients. The ED ICU is operated 24/7 by a dedicated care team, comprising emergency medicine physicians, nurses and nursing assistants with experience of life-threatening emergencies and training in stroke management. All patients admitted for suspected stroke within a timeframe compatible with IV rtPA administration were sent to the ED ICU (either directly for patients managed by paramedics or upon admission to the ED by the triage nurse), according to a specific protocol. The objective of this protocol was to accelerate the management of patients and thus increase the thrombolysis rate (i.e. the proportion of eligible patients receiving IV rtPA). To other relevant changes occurred in October 2014. Firstly, a senior duty neurologist was present 24/7; previously, he/she had been present in the ED between 8.00 am and midnight and was on call between midnight and 8.00 am. Secondly, MRI (with direct access from the ED ICU) was promoted as the first-line imaging method. All other aspects of patient management (clinical examinations, laboratory tests, indications and contraindications for thrombolysis) were similar in the two periods.

To assess the effects of these organizational changes, we performed a retrospective, observational, single-center, comparative study of the management of patients admitted for ischemic stroke during two 321-day periods: from October 15th 2013, to September 1st 2014 (i.e. before the creation of the ED ICU), and from October 15th 2014 to September 1st 2015 (i.e. after the creation of the ED ICU).

2.2. Population and outcome parameters

During both study periods, we included all patients with a diagnosis of cerebral infarction on discharge from the medical center (I63.0, I63.1, I63.2, I63.3, I63.4, I63.5, I63.6, I63.7, and I63.8).

The following data were extracted from the patients' medical records: age, gender, initial National Institutes of Health Stroke Scale (NIHSS score), type of brain imaging (non-contrast computed tomography or MRI), the use of IV rtPA, the time interval between symptom onset and IV rtPA, and the DNT. "Minor stroke" was defined as an NIHSS score ≤ 4 on admission [12]. Symptomatic intracranial hemorrhage (ICH) was defined by a visible parenchymal hemorrhage on imaging 22–36 h post-treatment, combined with neurological deterioration (by ≥ 4 points on the NIHSS) and/or a vigilance disorder [3]. The clinical outcome was assessed in terms of the modified Rankin score at 3 months post-treatment [13]. A favorable outcome was defined as modified Rankin score ≤ 2 at 3 months.

2.3. Statistical analysis

Data were respectively expressed as the mean \pm SD, the median [IQR] and the percentage for continuous, ordinal and categorical variables. Continuous variables were compared using a *t*-test, and ordinal variables were compared using a Mann-Whitney *U* test. Differences between proportions were tested using Fisher's test or a chi-squared test.

To determine whether the effect of the ED ICU was constant over time, we plotted the cumulative number of IV rtPA administrations before and after the unit's creation.

In order to assess the secondary endpoints (the rapidity and safety of care), we performed two logistic regression analyses. The dependent variables were the intrahospital delay (i.e. the DNT ≤ 60 min versus

>60 min) and a favorable clinical outcome (modified Rankin score at 3 months ≤ 2 versus >2). The independent variables were the creation of the ED ICU, age, gender, initial severity (initial NIHSS score), type of imaging (MRI vs. CT), and treatment delays (the time between symptom onset and hospital admission in the first regression analysis, and the time interval between symptom onset and IV rtPA administration in the second one).

All statistical analyses were performed using R software (<http://www.r-project.org/>). The threshold for statistical significance was set to $p \leq 0.05$. The study was approved by the local investigational review board.

3. Results

A total of 96,788 patients attended the ED during the study period as a whole (46,201 before the creation of the ED ICU, and 50,587 afterwards). 1334 patients had experienced ischemic stroke and were included in the study: 676 (1.5% of total admissions) before the creation of the ED ICU and 668 (1.3%) afterwards ($p = 0.06$). The thrombolysis rate increased from 5.8% ($n = 39$) before the creation of the ED ICU to 9.3% ($n = 62$) afterwards (odds ratio (OR) [95% confidence interval (CI)]: 1.67 [1.08–2.60], $p = 0.02$). The before/after plots of the cumulative number of IV rtPA administrations diverged over time - reflecting the increase in the thrombolysis rate after the creation of the ED ICU (Fig. 1). The two periods did not differ in terms of the demographic and clinical characteristics of the thrombolysed patients (Table 1). Likewise, the two periods did not differ with regard to the number of strokes of unknown onset and strokes occurring after midnight ($n = 4$ (10.3%) before the ED ICU's creation; $n = 5$ (8.1%) after the ED ICU's creation; *ns*). The proportion of minor strokes treated with thrombolysis was higher after the creation of the ED ICU ($n = 11$, 18.3%) than before ($n = 1$, 2.6%); $p = 0.046$. The proportion of DNTs ≤ 60 min was greater after the creation of the ED ICU (OR [95%CI]: 4.30 [1.17–20.90] in an adjusted model; $p = 0.04$). This was still the case after we excluded patients having undergone brain imaging performed in a local hospital prior to referral to our center (before creation of the ED ICU: $n = 0$; afterwards: $n = 2$, *ns*).

After creation of the ED ICU, MRI was performed more frequently before thrombolysis - thanks to the direct access to the imaging unit from the ED ICU.

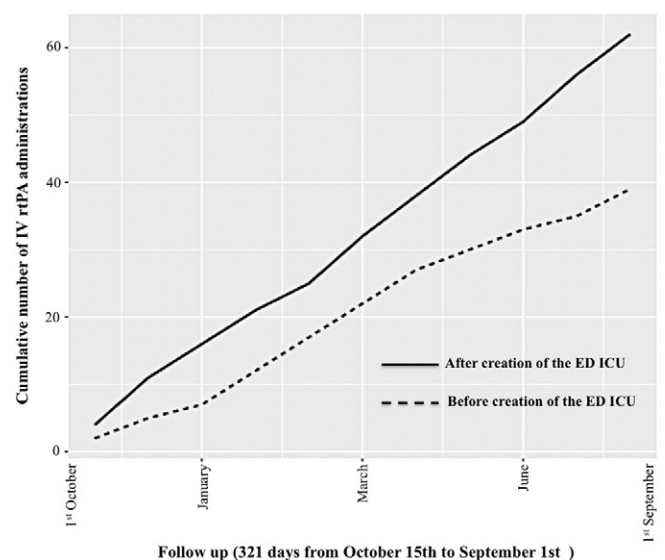


Fig. 1. Comparison of the cumulative numbers of IV rtPA administrations before and after the creation of the ED ICU (321 days of follow-up for each period). The dotted line and the solid-line represent the cumulative number of IV rtPA administrations before and after the creation of the ED ICU, respectively. The distance between the two lines continued to grow over time, regardless of the time since the ED ICU's creation.

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