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Improving treatment times for patients with in-hospital stroke using a standardized protocol

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ABSTRACT

Background: Previous reports have shown significant delays in treatment of in-hospital stroke (IHS). We developed and implemented our IHS alert protocol in April 2014. We aimed to determine the influence of implementation of our IHS alert protocol.

Methods: Our implementation processes comprise the following four main steps: IHS protocol development, workshops for hospital staff to learn about the protocol, preparation of standardized IHS treatment kits, and obtaining feedback in a monthly hospital staff conference. We retrospectively compared protocol metrics and clinical outcomes of patients with IHS treated with intravenous thrombolysis and/or endovascular therapy between before (January 2008–March 2014) and after implementation (April 2014–December 2016).

Results: Fifty-five patients were included (pre, 25; post, 30). After the implementation, significant reductions occurred in the median time from stroke recognition to evaluation by a neurologist (30 vs. 13.5 min, $p < 0.01$) and to first neuroimaging (50 vs. 26.5 min, $p < 0.01$) and in the median time from first neuroimaging to intravenous thrombolysis (45 vs. 16 min, $p = 0.02$). The median time from first neuroimaging to endovascular therapy had a tendency to decrease (75 vs. 53 min, $p = 0.08$). There were no differences in the favorable outcomes (modified Rankin scale score of 0–2) at discharge or the incidence of symptomatic intracranial hemorrhage between the two periods.

Conclusion: Our IHS alert protocol implementation saved time in treating patients with IHS without compromising safety.

1. Introduction

Approximately 4.0% to 13.7% of all patients with stroke develop stroke during hospitalization [1–3]. Patients with in-hospital stroke (IHS) experience more severe stroke, and thrombolysis is restricted in such patients because of recent surgery, antithrombotic therapy, and/or comorbidities [4–6]. Compared with patients with community-onset stroke, those with IHS have the potential for rapid diagnosis and treatment. However, previous studies have shown that patients with IHS experience delays in neurological evaluation and treatment [3,5,6]. In particular, these studies have suggested a greater delay in consultation with the neurologist, and the median time from stroke recognition to neuroimaging is estimated to be 4.5 h [6]. In the statewide Michigan Stroke Registry, only 3.1% of patients with IHS underwent brain imaging within 25 min from symptom recognition by hospital staff [3].

The efficacy of intravenous (IV) thrombolysis and endovascular therapy (EVT) for acute ischemic stroke decreases as the time elapsed from onset increases [7]. Thus, the importance of workflow improvement has been emphasized in previous reports, and some standardized protocols in stroke centers have achieved reduced reperfusion times [8–11]. However, few reports have described protocols for patients

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with IHS [12]. We developed an IHS alert protocol that has been implemented in our hospital since April 2014. In the present study, we evaluated the efficacy and safety of our standardized protocol for IHS.

2. Material and methods

2.1. Patient population and study design

Our institute belongs to an urban tertiary-level emergency hospital with about 650 beds and a high-volume cardiovascular disease center (2000 procedures per year). Among consecutive patients with acute ischemic stroke treated with IV thrombolysis or EVT at our institute from January 2008 to December 2016, we retrospectively enrolled patients whose ischemic stroke occurred newly in-hospital. We did not include patients who were admitted for minor stroke and deteriorated in the hospital. The patient cohort was divided into two periods: before implementation of the standardized protocol for IHS (January 2008–March 2014) and after its implementation (April 2014–December 2016). Our institutional ethics committee approved this retrospective analysis.

2.2. Patient characteristics

Patient characteristics included age, sex, the National Institutes of Health Stroke Scale (NIHSS) score at stroke onset, diagnosis on admission, the purpose of hospitalization, and medical or surgical contraindications to IV thrombolysis. Combined illnesses included atrial fibrillation, chronic heart failure, hypertension, and diabetes mellitus. Medications used before admission included antithrombotic agents. Time points included stroke symptom onset (last known time point at which the patient was well if the stroke onset was not witnessed), clinical assessment by a neurologist, neuroimaging, thrombolysis (time at which IV tissue plasminogen activator was administered), and puncture (puncturing of the femoral artery). The time points of neuroimaging were obtained from an electronic time stamp found on the first sequence acquired. When the hospital staff members witnessed the onset of stroke, we calculated the time from onset to stroke recognition as 0 min. Medical contraindications for IV thrombolysis were recent ischemic stroke, a history of intracranial hemorrhage, recent gastrointestinal or urinary tract bleeding, severe liver dysfunction, diffuse ischemic change, and anticoagulation therapy. The surgical contraindication for IV thrombolysis was the performance of recent surgical interventions.

2.3. Quality improvement processes

Our implementation processes for patients with IHS comprised the following four main steps: development of an IHS alert protocol, workshop for IHS, preparation of a standardized IHS treatment kit, and real-time feedback by a monthly hospital staff conference.

2.3.1. Step 1: development of IHS alert protocol

In the pre-implementation period, when the hospital staff members identified patients with suspected stroke, they first contacted the doctor in charge. The doctor then consulted the neurologists immediately or after neuroimaging or observed the patient without consultation at his or her own discretion. If the doctor consulted a neurologist, the neurologist added the necessary neuroimaging or blood tests to determine the indication for IV thrombolysis and/or EVT.

We developed an alert step to quickly identify patients with IHS (Fig. 1). The protocol was activated when hospital staff members identified patients who had developed arm drift, facial droop, or speech disorder (symptoms taken from the three-item Cincinnati Prehospital Stroke Scale [13]) within 4.5 h of the time the patients were last seen to be well or with unknown onset. The hospital staff members who recognized these symptoms called the following staff in parallel: the

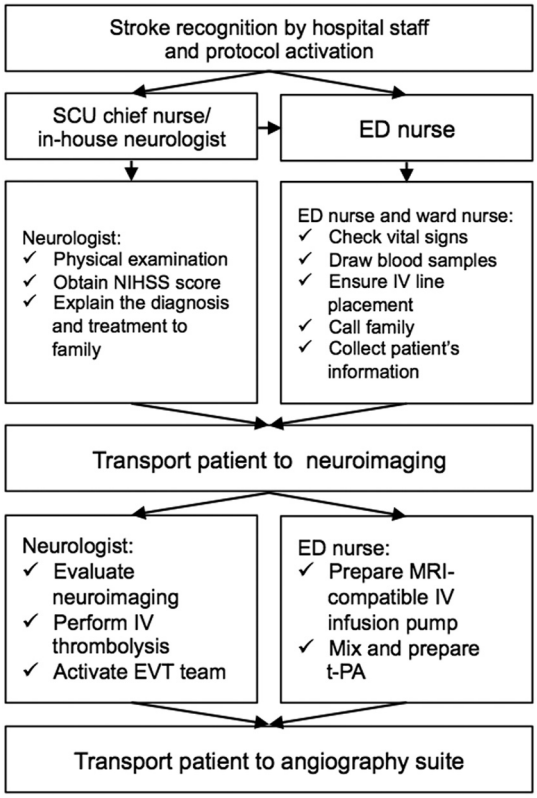

Fig. 1. Flow chart of the in-hospital stroke protocol. Neurologists and the emergency department nurse act in parallel. SCU, stroke care unit; ED, emergency department; NIHSS, National Institutes of Health Stroke Scale; IV, intravenous; CT, computed tomography; MRI, magnetic resonance imaging; EVT, endovascular therapy.

stroke care unit chief nurse during working hours or an in-house neurologist during off-hours, the emergency department (ED) nurse, and a doctor in charge of the patient during working hours or an on-call doctor of the department in charge of the patient during off-hours. The stroke care unit chief nurse activated the mobile stroke team, which comprised at least two neurologists and the ED nurse. The ED nurse or the ward nurse placed at least one IV line and drew blood samples for laboratory testing. The blood tests included a complete blood count, biochemistry panel, coagulation parameters, and glucose concentration as listed on the laminated card. The card had been distributed to each ward and posted beforehand. The ward nurse sent a blood sample to the ED for coagulation testing. Point-of-care testing of the international normalized ratio was performed in the ED with a simple blood coagulation analyzer (CG02N; A & T Corporation, Kanagawa, Japan) to avoid delay in laboratory processing.

The ward nurse called the patient's family, and the neurologist explained the diagnosis and treatment. The ward nurse or ED nurse investigated the diagnosis on admission, the last known well time, and the day of the operation and antithrombotic therapy and completed the checklist on the card (Fig. 2). The neurologist assessed the severity of the patient's neurological deficits using the NIHSS and checked the inclusion and exclusion criteria for IV thrombolysis.

After rapid evaluation, the neurologist and ED nurse transferred the patient to the computed tomography (CT) scan room. The neurologist immediately initiated IV thrombolysis on the CT table using a magnetic resonance imaging (MRI)-compatible IV infusion pump (MRidium™ 3860 +; IRadimed, Winter Springs, FL, USA) if the patient had no contraindications to IV thrombolysis. The patient was then rapidly transferred to the MRI room for optimal determination of the core infarct volume and large vessel occlusion. The neurologist activated the EVT team when the MRI showed a favorable diffusion-weighted imaging Alberta Stroke Program Early CT score of > 5 points and magnetic