Monitoring After the Acute Stage of Stroke
A Prospective Study

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Background and Purposes—In the early stage of stroke, the occurrence of neurologic and medical complications is associated with clinical deterioration. Previous studies were focused on the first week after stroke onset. The aim of this study was to evaluate the impact of complications on clinical outcome in patients with stroke in the early subacute stage.

Methods—We prospectively evaluated the influence on the outcome of complications feasible (MC) and not feasible for monitoring (NMC) in all patients with stroke admitted consecutively in our subacute stroke unit. Patients were divided into three classes according to stroke severity evaluated by the National Institutes of Health Stroke Scale score. A change in the National Institutes of Health Stroke Scale score group from admission to discharge was considered clinically significant.

Results—We included 261 patients. Sixty percent of patients had complications (105 MC, 118 NMC). Hyperthermia (OR = 14.12; 95% CI: 6.01 to 33.20), urinary infections (OR = 4.92; 95% CI: 2.19 to 11.04), hypertension (OR = 2.86; 95% CI: 1.21 to 6.76), hypoxia (OR = 15.75; 95% CI: 6.73 to 36.84), and neuroradiologic damage progression (OR = 58.31; 95% CI, 19.48 to 174.55) were associated with a change to a more severe class at discharge and with a higher risk of mortality.

Conclusions—A high percentage of patients can develop both MC and NMC during this subacute stage of stroke. The occurrence of complications influences outcome and raises the question about the need for a prolonged stay in a dedicated ward for patients with stroke. (Stroke. 2007;38:1225-1228.)

Key Words: complications ■ monitoring ■ stroke units ■ subacute stroke

Treating patients with stroke in a stroke unit (SU) is associated with a better outcome.1–4 This is related to early treatment,5 mobilization,6 and careful monitoring of clinical parameters.7–9 At the “acute” stage, the following neurologic and medical complications have been recorded: stroke progression5,10; seizures6; increased intracranial pressure10; fever8,10; urinary and chest infections8,10–12; severe hypertension10; congestive heart failure11; falls8,12; and deep vein thrombosis and pulmonary embolism.8 The presence of these complications is associated with deterioration and higher mortality.11 Previous studies focused on the first week after stroke10 or did not mention the time of onset of these complications.7,8,11,12 This is an important issue, because it may influence the duration of acute stroke monitoring and clarify the best time to begin rehabilitation. Evidence exists to show that the earlier a patient starts rehabilitation, the better the outcome and the higher the probability of being discharged home.13 On the other hand, the role of monitoring after stroke is becoming more important.7,9 To date, it is still not clear how long after a stroke patients remain unstable and should be treated and monitored in a SU to achieve a better outcome.

The aim of this study was to determine which complications are the most frequent in the subacute stage of stroke, how many are detectable by monitoring, and whether these complications influence patients’ outcome.

Subjects and Methods
All patients with acute stroke consecutively admitted to a six-bed subacute SU of our university hospital in a 30-month period were included in this study. Patients were first admitted to an “acute SU” located in the emergency room where eventually thrombolysis was performed. After the acute stage, lasting from 1 to 7 days, they were transferred to our “subacute SU.”

Stroke severity was evaluated on admission with the National Institutes of Health Stroke Scale (NIHSS).14 Patients were classified according to the NIHSS score: mild if the NIHSS score was <5; moderate if the NIHSS score was between 5 and 13; and severe if the score was >13.15 The following demographic and clinical data were collected: age and sex; previous stroke and transient ischemic attack; vascular risk factors: hypertension, diabetes, dyslipidemia, and atrial fibrillation; smoking; alcohol consumption; and previous acute myocardial infarction.

During hospitalization in our SU, patients received continuous monitoring of electrocardiogram, oxygen saturation, blood pressure, respiratory and cardiac frequency. Body temperature, capillary glucose levels, and swallowing function were evaluated several times per day. We prospectively evaluated the occurrence of medical and neurologic complications. Complications were divided in two classes: feasible for monitoring (MC) or not feasible (NMC).7 The
former were cardiac complications (new onset of arrhythmias, new changes on electrocardiogram, heart failure, myocardial infarction defined according to the European Society of Cardiology/American College of Cardiology Committee),7,16 hypertension (systolic blood pressure >200 mm Hg, diastolic blood pressure >105 mm Hg),7 hypotension (systolic blood pressure <80 mm Hg),7 fever (body temperature >37.8°C),2,3 and hypoxia (SO2 <92%).2,3 NMC were: pneumonia; urinary infections; dehydration; hyperglycemia (blood glucose of 10 mmol/L or higher);4 pulmonary embolism; deep vein thrombosis; and seizures and neuroradiologic damage progression (occurrence of brain swelling, hemorrhagic transformation, mass effect, and hematoma enlargement).3,17 These complications were evaluated with clinical observation and with the support of instrumental examinations (brain computed tomography/magnetic resonance imaging scan; chest x-ray, and so on).

All patients were evaluated according to a standardized diagnostic procedure. Transcranial and neck vessel ultrasonography was performed within 24 to 48 hours of admission in all patients. Patients with nonlacunar infarctions received an echocardiography, whereas other examinations were performed according to the judgment of the treating physician.

On discharge, the severity of clinical deficit was evaluated again with the NIHSS4 dividing the patients into the same three classes (mild, moderate, and severe) and comparing the NIHSS groups at admission and discharge. A change in the NIHSS group from admission to discharge was considered clinically significant. The factors influencing these changes were analyzed. Patients who died during hospitalization were classified clinically worse even if initially classified in the severe class.

Statistical Analysis
We compared the three NIHSS groups with the χ2 test. Continuous variables were expressed as mean±SD and were compared using the Student t test. The adjusted OR and 95% CI with “change of class” as the dependent variable were estimated by means of logistic models, which included variables that statistically differed in bivariate analysis and that were further associated with the outcomes to control for potential confounding variables and to avoid possible bias. In all analyses, a probability value less than 0.05 was considered significant.

Results
Patients were admitted to our SU with a mean delay of 4 days from stroke onset of (±3.7 SD). They had a mean hospital stay of 14.78 days (±13 SD). From a total of 261 patients admitted to the SU, 186 (71.3%) had an ischemic stroke and 75 (28.7%) had a hemorrhagic stroke.

Patients’ baseline characteristics and medical histories are shown in Table 1. On admission, patients were classified into the three NIHSS groups as follows: 98 (37.5%) patients to the mild class, 94 (36%) to the moderate, and 69 (26.5%) to the severe class. On discharge, 125 (47.9%) patients were in the mild class, 79 (30.3%) in the moderate, 33 (12.6%) in the severe class, and 24 (9.2%) died during hospitalization (see Figure 1 for details).

Fifty-three patients (20%) changed their class from admission to discharge moving from a worse to a better class; 30 (11%) moved into a more severe class. The remaining 178 patients (69%) did not change class. One hundred fifty-seven (60.2%) patients had complications during hospitalization. Forty-seven patients had ongoing complications on admission, and their complications persisted during their hospitalization period. Among complicated patients, 105 (66.9%) had MC, and 118 (75.2%) had NMC (66 patients had both types of complications).

Data are shown in Figure 2. The mean delay of occurrence of complications was 9.08 days (±10.48 SD) after stroke onset.

<table>
<thead>
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<th>TABLE 1. Baseline Characteristics and Medical History of Patients*</th>
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*Continuous data are expressed as mean±SD. Categorical data are expressed as percentages of patients (%).

The most frequent medical and neurologic complications occurring during the hospital stay are shown in Table 2. The bivariate analysis showed that the presence of a MC or NMC was associated with clinical deterioration (P<0.001 in both cases). The following complications were associated with a change to a more severe class: hyperthermia (P=0.0018), urinary infections (P=0.00036), consciousness disturbances (P<0.0001), hypertension (P=0.002), hyperglycemia (P=0.041), hypoxia (P=0.0009), and neuroradiologic damage progression (P<0.0001). The multivariate analysis found that hyperthermia (OR=14.12; 95% CI, 6.61 to 31.20), urinary infections (OR=4.92; 95% CI, 2.19 to 11.04), hypertension (OR=2.86; 95% CI, 1.21 to 6.76), hypoxia (OR=15.75; 95% CI, 6.73 to 36.84), consciousness disturbances (OR, 15.24; 95% CI, 6.42 to 34.38), and neuroradiologic damage progression (OR=58.31; 95% CI, 19.48 to 174.55) were independently associated with a higher risk of mortality and a move to a more severe class on discharge. When we considered the NIHSS score on discharge, without classifying patients into groups, we obtained similar results, but we found that also hyperglycemia (OR=2.64; 95% CI, 1.35 to 5.14) and pulmonary infections (OR=4.08; 95% CI, 1.88 to 8.85) were associated with a more severe NIHSS score (data shown in Table 3).

Discussion
Our data show that (1) 60% of patients develop complication in the subacute stage of stroke; (2) approximately two-thirds of them have MC; (3) the most frequent complications were:
hyperthermia, cardiac complications, hyperglycemia, urinary infections, consciousness disturbances, low oxygen saturation, hypertension, and pulmonary infections; (4) 20% of patients moved from a worse to a better class and 11% moved to a more severe class with the other remaining unmodified; and (5) hyperthermia, urinary infections, hypertension, hypoxia, neuroradiologic damage progression, and consciousness disturbances are major predictors of a change to a more severe class or death on discharge.

To our knowledge, this is the first study to report on stroke complications after the very acute stage of stroke and on their influence on outcome. Patients were not recruited in this study immediately after stroke onset, but after a delay of a few days as a result of their recruitment in an acute SU located in the emergency department to shorten the delay for thrombolysis. Thus, our patients were in the subacute stage of stroke. We classified patients into groups according to previous studies.15 This method may lead to a loss of information. Nevertheless, we also performed a logistic regression analysis with crude values of the NIHSS and we obtained comparable results. The NIHSS classes that we used in this study have been shown to have a prognostic value; patients in the mild class are more likely to be discharged home, patients in the moderate class in rehabilitation centers, and patients in the severe class are more likely to be institutionalized.15 A change in the NIHSS class may actually have more prognostic implications than a simple increase in the crude values of NIHSS score. Thirty patients worsened during hospitalization. Despite the small sample of our population, complications associated with deterioration were similar to those reported by previous studies, although the delay from stroke onset was different.6–8,10–12,15

The majority (69%) of our patients stabilized; their deficit did not change. Of the remaining 31%, many patients (20%) improved. However, 11% of patients deteriorated. The deterioration is caused in the large majority by medical complications. However, consciousness disturbances and neuroradiologic damage progression were two variables significantly associated with clinical deterioration. This is not surprising, because the level of consciousness is one item of the NIHSS, and neuroradiologic damage progression, in particular brain swelling, has already been shown to be a major predictor of clinical deterioration.18 Among complications, hyperthermia, urinary infections, hypertension, and hypoxia are independently associated with clinical deterioration. Two thirds of complicated patients have MC, which can therefore be detected early and immediately corrected. The presence of MC is strongly associated with clinical deterioration (P<0.001). Previous studies already showed that monitoring in the first 2 days after stroke enhances the benefits of conventional SU.7,9,17 Our data suggest that, even after these first 2 days, patients still cannot be considered “stable” and monitoring is still crucial to improve patients’ outcome and to prevent late clinical deterioration. Although it is acknowledged that organized stroke care improves patients’ outcomes, the correct duration of intensive stroke care remains undetermined. Different countries provide different definitions of SUs, ranging from acute

Figure 1. Patients (n=261) divided into classes on (1) admission and (2) discharge.

Figure 2. Patients (n=157) who developed complications feasible for monitoring (MC) and not feasible for monitoring (NMC) during hospitalization. Values are number of patients.
SU, admitting patients acutely and continuing treatment usually less than 1 week, to comprehensive and rehabilitation SUs, admitting patients after a short delay and continuing treatment and rehabilitation until necessary. Previous studies showed effectiveness of acute SU, in particular if equipped with monitoring facilities. This advantage is even more consistent for patients with a longer stay in comprehensive and rehabilitation SUs. Our data support this observation, showing that even after the acute stage, patients develop several complications that can induce deterioration in the severity of the clinical deficit. The high prevalence of MC enhances the role of SU in the subacute stage of stroke, and the severity of the clinical deficit. The high prevalence of MC with a severe outcome on discharge.

Further studies are needed to confirm our results and clarify the benefit of a longer monitoring of patients with stroke.

**Disclosures**

None.

**References**


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