Medical Complications in a Comprehensive Stroke Unit and an Early Supported Discharge Service

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Background and Purpose—The aims of the study were to examine the frequency and timing of predefined medical complications in unselected acute stroke patients treated in an acute comprehensive stroke unit and an early supported discharge service.

Methods—Four hundred eighty-nine acute stroke patients were included and followed up with assessments of 16 prespecified complications during the first week. Two hundred forty-four of the patients were randomly allocated to a 3-month follow-up.

Results—During the first week, 312 of 489 patients (63.8%) experienced 1 or more complications. The most common complications were pain in 117 patients (23.9%), temperature ≥38°C in 116 (23.7%), progressing stroke in 90 (18.4%), urinary tract infection in 78 (16.0%), troponin T elevation without criteria of myocardial infarction in 57 (11.7%), chest infections in 55 (11.2%), nonserious falls in 36 (7.4%), and myocardial infarction in 22 (4.5%), whereas stroke recurrence, seizure, deep venous thrombosis, pulmonary embolism, shoulder pain, serious falls, other infections, and pressure sores were each present in ≤2.5% of patients. During the 3-month follow-up, 201 of 244 patients (82.4%) experienced at least 1 complication, the most common of which was pain, which occurred in 134 patients (53.3%), followed by urinary tract infection in 68 (27.9%) and nonserious falls in 61 (25.0%). The severity of stroke on admission was the most important risk factor for developing complications.

Conclusions—This is the first study of complications in unselected acute stroke patients treated in a comprehensive stroke unit and early supported discharge service and shows that pain, progressing stroke, infections, myocardial infarction, and falls are common complications, whereas others occur infrequently. Most complications occur during the first 4 days, and stroke severity is the most important risk factor. **(*Stroke*. 2008;39:414-420.)**

Key Words: complications ■ stroke service ■ stroke unit

Although medical complications are common after stroke, can represent barriers to optimal recovery, and are potentially life-threatening, systematic investigations of both the incidence of and risk factors for medical complications have been limited. Some studies have shown that complications after stroke are common[1–8] as well as related to poor outcome.[6,7] Most of these studies have had methodologic limitations because they were retrospective series,[1–4] were restricted to patients offered only inpatient rehabilitation,[1–5] did not evaluate complications in the very acute phase,[1–5] or studied only selected groups of stroke patients.[6] Finally, most patients were not treated in stroke units (SUs).[1–6,8]

Prevention, early recognition, and management of poststroke complications are regarded as essential aspects of SU care.[9] However, only a few studies with selected groups of patients and limited recording have addressed the incidence of and risk factors for poststroke complications in SUs.[10–14] Initial SU care followed by an early supported discharge (ESD) service seems, at present, to offer the most effective management of stroke patients.[15,16] For further improvement of stroke care, more information is needed about the occurrence of complications in patients offered this evidence-based chain of stroke care.[16,17]

Our SU and ESD service have achieved good results regarding outcome in stroke patients,[15–19] and the aims of the present study were to prospectively examine the frequency and timing of predefined medical complications in unselected acute stroke patients treated in this well-defined stroke service. Secondarily, we wanted to identify the characteristics of patients with a particularly high risk of complications.

Subjects and Methods

The University Hospital of Trondheim serves as the local hospital for ≈200 000 inhabitants in central Norway. All patients consecutively admitted to our SU in the Department of Medicine with symptoms suggestive of acute stroke were screened for inclusion. Patients were included in the study if they fulfilled the following criteria: (1) a

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diagnosis of acute stroke according to the World Health Organization's definition of stroke; (2) CT scan results with no evidence of other causes that might explain the neurologic deficits (eg, tumor, trauma, infection, or vasculitis); and (3) admission to the SU within 24 hours after onset of stroke.

All patients received an initial diagnostic evaluation and treatment according to the SU care program that we have developed and evaluated in a randomized trial.[17,18] The characteristic features are a standardized protocol for acute evaluation, monitoring, and medical treatment with a focus on physiologic homeostasis, a strategy for early mobilization, a multidisciplinary team, and integration of medical care, nursing, and rehabilitation.[18] There is a strong focus on prevention of complications, including swallowing evaluation before feeding, ultrasound assessment of urine retention, and intermittent catheterization when needed.

After care in the SU, patients were followed up by an ESD service, which also has been evaluated in a randomized, controlled trial.[19] As part of this service, all patients receive an outpatient evaluation 4 weeks after discharge, with a focus on prevention and/or treatment of complications and on establishing optimal and individualized secondary stroke prevention.[19]

Assessment of Complications

During the first week after admission, 16 prespecified complications were recorded for all patients after daily examinations, performed by specially trained physicians, nurses, and physiotherapists. Fifty percent of the patients were randomly allocated to a follow-up study for 3 months after stroke, with assessment of 13 of the 16 predefined complications every week performed by a phone call to the patient and/or caregivers and after 3 months, by a visit performed by the same staff. The definitions of complications were almost similar to those in previous studies[1,8] (Table 1). The follow-up questions were also similar to previously used questionnaires.[8] All complications were symptomatic except for troponin T elevation (Table 1).

Data Analyses

If a complication occurred more frequently than in 2.5% of the patients during the first week, it was classified as a frequent acute complication. Occurrence of a complication in >5% of the patients during the 3-month follow-up was classified as a frequent long-term complication.

Logistic-regression analyses were performed with complication as the dependent variable and demographic and stroke characteristics as independent variables. Stroke assessed by the Scandinavian Stroke Scale (SSS) was divided into 5 categories of severity. Backward logistic-regression elimination with a P to enter of 0.05 and a P to remove of 0.10 was used in multivariate analysis. Trends were analyzed by the Cochran-Armitage test for trend. Probability values were 2-sided. This study was part of a larger investigation on recovery after stroke and was approved by the regional ethics committee at our university.

Results

Six hundred sixty-four patients with suspected stroke admitted to our SU between January 1, 2002 and May15, 2003 were screened for inclusion. One hundred sixty-four patients were excluded because of a diagnosis other than stroke (110 patients) or arrival after 24 hours from stroke onset (54 patients). Hence, 500 consecutive patients with the diagnosis of acute stroke admitted within 24 hours were initially included. Eleven patients did not wish to participate during follow-up, and therefore, only 489 patients were finally included in the analyses of complications during the first week. Two hundred forty-four patients were randomized to follow-up and included in the 3-month analyses.

Table 2 shows the baseline characteristics, with a mean age of 77.2 years, the proportion of females at 52.4%, and risk

Table 1. Definitions of Complications

Neurologic Complications	
Stroke progression	Decrease of >2 points on the sum score for the following items: consciousness; gaze paresis; arm, hand, or leg strength on the SSS during the first 72 hours
Stroke recurrence	New onset of focal or neurologic deficits that cannot be attributed to the presenting lesion and are consistent with World Health Organization definitions of stroke
Seizures	Clinical diagnosis of focal and/or generalized seizure in a previously nonepileptic patient
Infections	
UTIs	Clinical symptoms of UTI combined with a positive urine dipstick examination for nitrite and/or pyuria
Chest infections	Auscultatory respiratory crackles combined with at least 1 of the following: temperature >38°C, new purulent sputum, or positive chest radiograph
Other infections	Clinical symptoms, signs, or both associated with specific systems and positive microbiological cultures or radiographic or other imaging investigation indicating an infection other than in the chest or urinary tract
Fever	Temperature ≥38.0°C at any time during the first week
Fall complications	
Nonserious falls	Any documented fall regardless of cause but without any serious damage (see serious falls)
Serious falls	Falls that result in fracture or suturing of wounds or prolonged hospitalizations
Pressure sores/skin breaks	Any skin break or necrosis resulting from pressure or trivial injury (excluding those related to falls
Thromboembolism	
Deep vein thrombosis	Clinical diagnosis of deep vein thrombosis supported by ultrasound or venography
Pulmonary embolism	Clinical diagnosis supported by computed tomography scan or ventilation/perfusion scan
Cardiac events	
Acute MI	Signs and symptoms fulfilling the diagnostic criteria of acute MI; ECG performed on admission and days 2, 3, and 7 and if chest pain was present
Other myocardial damage	Elevated troponin T levels (>0.06 mmol/L) but without other criteria necessary for the diagnosis of acute MI. The tests were performed on admission and on days 2, 3, and 7 and if chest pain was present
Pain	
Shoulder pain	Pain in the shoulder area requiring analgesia for >2 consecutive days
Other pain	Any other source of pain requiring regular or frequent analgesia

Table 2. Characteristics of All Patients and of Patients With and Without Complications*

	All Patients	Patients With Complications*	Patients Without Complications*	*P* Value
Female, n (%)	256 (52.4)	176 (56.4)	80 (45.2)	0.019
Age, mean (SD), y	77.2 (10.2)	78.4 (8.6)	74.9 (9.2)	0.0001
Risk factors, n (%)				
Hypertension	190 (38.9)	117 (37.5)	73 (41.2)	0.47
Previous stroke	108 (22.1)	66 (21.2)	42 (23.7)	0.51
Atrial fibrillation	102 (20.9)	71 (22.8)	31 (17.5)	0.17
Diabetes	72 (14.7)	44 (14.1)	28 (15.8)	0.60
MI	71 (14.5)	46 (14.7)	25 (14.1)	0.85
Transient ischemic attack	57 (11.7)	40 (12.8)	17 (9.6)	0.29
Diagnosis				
Ischemic stroke, n (%)	443 (90.6)	278 (89.6)	165 (93.2)	0.14
Hemorrhagic stroke, n %)	46 (9.4)	34 (10.9)	12 (6.8)	0.14
Stroke severity				
Reduced consciousness on admission, n (%)	104 (21.3)	98 (28.8)	14 (7.9)	0.0001
SSS score, mean (SD)	39.4 (16.8)	34.9 (16.9)	47.4 (13.3)	0.0001

*One or more complications during the first week after stroke onset.

factors for and distribution of stroke diagnoses, which were similar to those of other unselected stroke populations. Two hundred one patients (41.1%) were admitted within 6 hours of symptom onset. Forty-two patients (17.2%) died during the 3-month period, and the average stay in the SU was 12 days.

Three hundred twelve patients (63.8%) experienced 1 or more complications during the first week. Female sex ($P=0.019$), age ($P<0.0001$), and severity of stroke as assessed by reduced consciousness on the SSS at admission ($P<0.0001$) were significantly associated with an increased risk for complications (Table 2). No significant association was found between the risk factors for stroke or diagnosis (hemorrhagic or ischemic stroke) and the occurrence of complications (Table 2). In multivariate analyses, only the severity of stroke was significantly associated with an increased risk for complications. Table 3 shows the increased odds for complications in patients with severe stroke assessed by the SSS.

During the first week, 8 complications were common (frequency >2.5%; Table 4). Other pain was present in 23.9% of patients, temperature >38°C in 23.7%, progressing stroke in 18.4%, urinary tract infection (UTI) in 16.0%, troponin T elevation without criteria for myocardial infarction (MI) in 11.7%, chest infection in 11.2%, nonserious falls in 7.4%, and MI in 4.5%. The other complications were each present in ≤2.5% of patients (Table 4).

The timing of the common complications, presented as the cumulative proportion of patients who experienced 1 or more of these complications during the first week, shows that in most cases, the complications had their onset within the first 24 hours and rarely after 4 days from admission (Figure 1). The timing of the less frequent complications showed the same trend. Table 5 shows that 5 of the 8 most common complications (fever, chest infections, MI, progression of stroke, and UTI) occurred significantly more frequently in patients with severe stroke compared with milder ones (*P* for trend ≤0.001). Troponin T elevation was almost significant ($P=0.079$), whereas falls and pain seemed to be most frequent in patients with a moderately severe stroke (Table 5).

Table 3. Frequency of and OR for the Development of Complications During the First Week After Stroke Onset According to Stroke Severity on Admission, as Assessed by the SSS

			Frequency of Complications			
Stroke Severity		No. of Patients	n	%	OR	95% CI
Very severe	SSS=0–14	61	52	85.2	10.8	4.9–23.9
Severe	SSS=15–29	58	49	84.5	10.1	4.6–22.6
Moderate	SSS=30–44	111	91	82.0	8.5	4.7–15.5
Mild	SSS=45–51	124	73	58.5	2.7	1.6–4.4
Very mild	SSS=52–59	135	47	34.8	1.0	...

OR indicates odds ratio.
*$P<0.0001$ for trend.

Table 4. Frequency of Complications During the First Week After Stroke Onset

	Frequency	
	n	%
Common acute complications, >2.5%		
Diffuse pain	117	23.9
Fever	116	23.7
Progressing stroke	90	18.4
UTI	78	16.0
Troponin T elevation without MI	57	11.7
Chest infections	55	11.2
Nonserious falls	36	7.4
Acute MI	22	4.5
Infrequent acute complications, ≤2.5%		
Other infections	12	2.5
Seizures	10	2.0
Shoulder pain	10	2.0
Stroke recurrence	5	1.0
Serious falls	5	1.0
Deep vein thrombosis	3	0.6
Pulmonary embolism	3	0.6
Pressure sore	3	0.6

For the 244 patients followed up for 12 weeks, all complications were recorded every week except troponin T elevation, progressing stroke, and fever, which were recorded only during the first week. Two hundred one patients (82.4%) experienced 1 or more complications from 0 to 12 weeks. Pain was still the most frequent complication (53.3% of patients), followed by UTI (27.9%), nonserious falls (25.0%), chest infections (17.2%), other infections (12.7%), shoulder pain (10.7%), MI (7.0%), and recurrent stroke (5.3%; Table 6). Other complications occurred infrequently. The cumulative proportions of patients who experienced a complication during the 12-week period are summarized in Figure 2. Most of the complications had their onset during the first week, except for pain, UTI, and falls, which also had their onset later in the follow-up period. There were no significant differences in baseline characteristics and the frequency and type of complications during the first week between the group followed up for only 1 week and the group followed up for 12 weeks. The 54 patients excluded owing to late admission had milder strokes (SSS mean score 44.2; SD, 13.4; $P=0.036$) than did patients included in the study.

Discussion

To the best of our knowledge, this is the first prospective study of the timing and frequency of complications in an unselected group of acute stroke patients treated in an evidence-based chain of care consisting of comprehensive acute SU care followed by an ESD service. Despite treatment in a chain of care of probably high quality, acute complications were still common, as ≈2 of 3 stroke patients experienced 1 or more of the predefined complications during the first week after stroke and 4 of 5 during 3 months of follow-up.

The most common complications during the first week were other pain, followed by fever, progressing stroke, and UTI, whereas complications like pressure sores and clinical signs of deep venous thrombosis and pulmonary embolism, which might be regarded as immobilization-related compli-

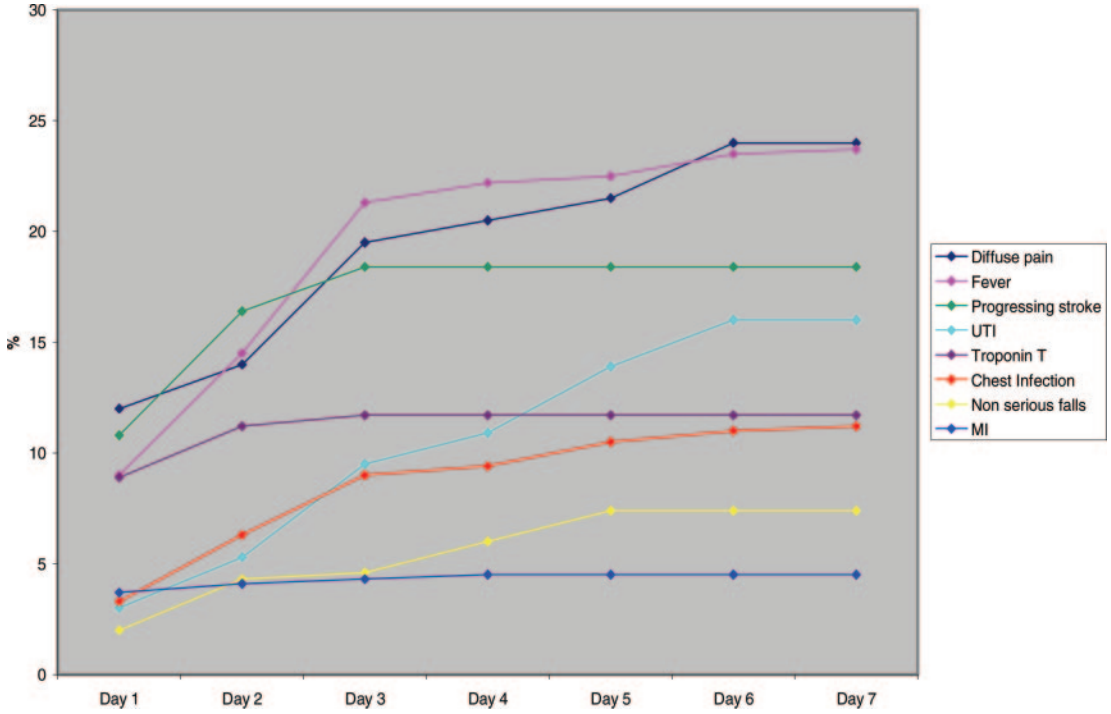

Figure 1. Timing of the most common complications (>2.5%) during the first week after stroke, expressed as the cumulative proportion (%) of patients who were noted to have 1 or more of these complication during the first week after stroke.

Table 5. Stroke Severity and Frequency of the 8 Most Common Complications During the First Week

	SSS 0–14 (n=61)		SSS 15–29 (n=58)		SSS 30–44 (n=111)		SSS 45–51 (n=124)		SSS 52–58 (n=135)		*P* Value
Complication	n	%	n	%	n	%	n	%	n	%	for Trend
Fever	34	55.7	32	55.2	23	20.7	19	15.3	8	5.9	0.0001
Chest infections	29	47.5	14	24.1	4	3.6	7	5.6	1	0.7	0.0001
Progressing stroke	18	29.5	12	20.7	41	36.9	13	10.5	6	4.4	0.0001
MI	8	13.1	8	13.8	4	3.6	1	0.8	1	0.7	0.0001
UTI	12	19.7	9	15.5	31	27.9	20	16.1	6	4.4	0.001
Troponin T	8	13.1	10	17.2	11	9.9	22	17.7	6	4.4	0.079
Falls	1	1.6	4	6.9	17	15.3	10	8.1	4	3.0	0.63
Other pain	6	9.8	17	29.3	32	28.8	36	29.0	26	19.3	0.54

cations, have almost disappeared in a modern SU. Most complications occurred during the first 4 days after admission, and stroke severity was the most important risk factor for the development of complications.

Studies of high quality on complications after stroke are difficult to perform; they require a systematic approach as well as honest reporting. The strengths of our study were the prospective design, the close observation of an unselected group of stroke patients from the first 24 hours after onset in a well-established and defined evidence-based stroke service, prespecified criteria for complications, and recording by a small number of trained health professionals. The completeness of recording of complications is a problem that seldom has been paid attention to. We specifically focused on this issue, as complication rates might be used as quality indicators for stroke care and underreporting of complications could falsely indicate a seemingly high quality of care. In our opinion, a strength of our study is that we have previously shown good outcomes for patients treated in our stroke service,[15–19] indicating service of high quality, regardless of complication rates. Hence, we encouraged the recording of all actual complications to have the possibility of further improving stroke care. Our results should therefore be close to the true complication rates in unselected acute stroke patients treated in an effective stroke service. The 54 stroke patients excluded because of late admission had milder strokes and therefore, likely a lower risk of complications. Because these patients accounted for only 11% of the study population, their impact on complication rates would have been modest.

Table 6. Frequency of Complications During the 3 Months After Stroke Onset

Frequency of Complications	n	%
Common complications, >5.0 %		
Other pain	134	53.3
UTI	68	27.9
Nonserious falls	61	25.0
Chest infections	42	17.2
Other infections	31	12.7
Shoulder pain	26	10.7
Acute MI	17	7.0
Stroke recurrence	13	5.3
Rare complications, ≤5.0 %		
Serious falls	8	3.3
Pressure sores	7	2.9
Seizures	6	2.5
Deep vein thrombosis	6	2.5
Pulmonary embolism	3	1.2

One limitation is that we recorded only 16 complications. Other complications might have been appropriate and interesting to include. It is also a weakness that, owing to limited resources, only half of the patients could be followed up for 3 months, although they seem representative of the whole group.

Despite differences among studies regarding selection of patients, timing, duration of follow-up, definition of complications, and type of complications, our overall frequency of complications is largely in agreement with several other studies[4,6,8] and reviews.[20,21] SUs are believed to be an effective organization for the prevention, early identification, and management of complications.[10,15,17,18] Hence, studies on complications in patients who are not offered SU care might not be representative of modern, effective stroke care. Regarding SU studies, our complication rate was somewhat higher than in the study from Germany.[14] The younger age (mean, 66 years vs 77 years) can probably explain most of the differences. In the study from England,[10] fever and other pain were not recorded, which can account for a lower frequency of complications. Our complication rates were similar to the results of an Italian study, except for fever and chest infections, which were very low in their study.[13] The increased risk of complications in the acute phase has also previously been reported.[14,20,21] Studies on complications lacking information from the early acute phase or from follow-up after the first week cannot tell the whole story about the frequency of complications after stroke.

The selection of patients is another factor that likely impacts the frequency of complications. Davenport and coworkers[1] found that patients of advanced age, with high comorbidity, and with previous disability had the highest risk of complications. Our results indicate that SU care reduces the risk of complications due to comorbidity, but age is still important. Stroke studies in western Europe of patients with a mean age <70 years have probably excluded elderly

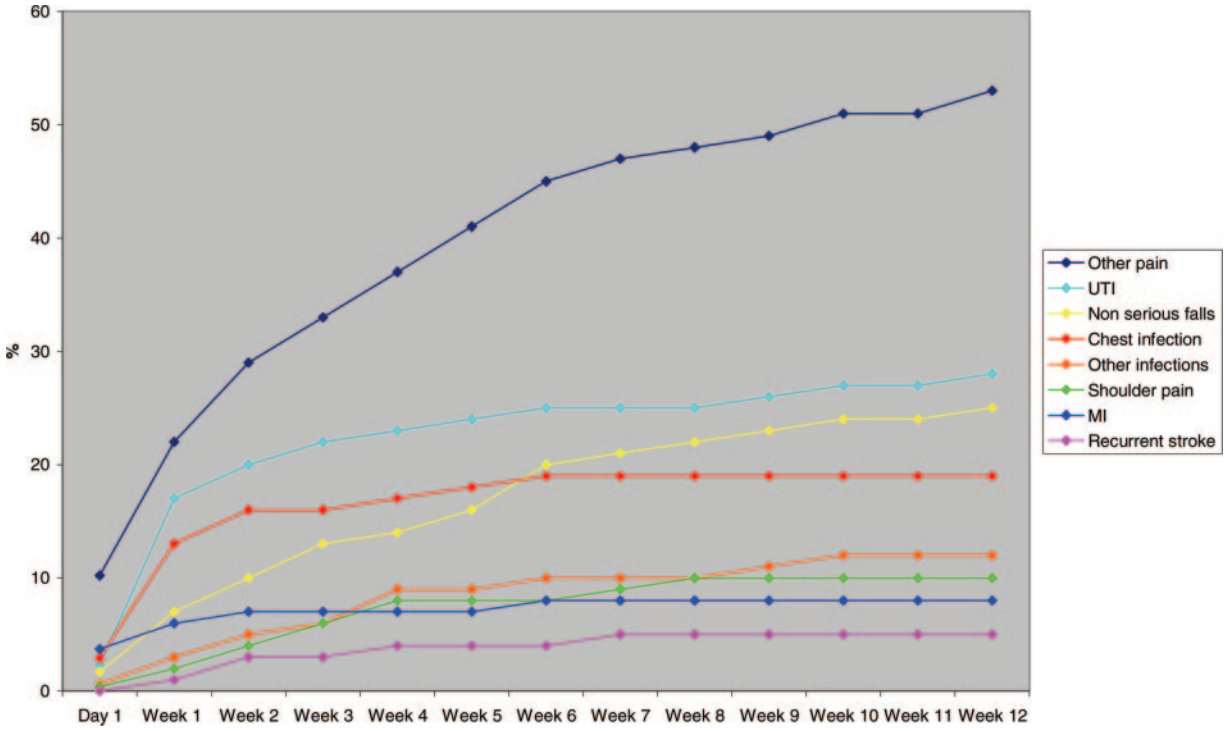

Figure 2. Timing of the most common complications (>5%) during the first 3 months after stroke, expressed as the cumulative proportion (%) of patients who were noted to have 1 or more of these complication during these 3 months.

patients and are not representative of the general stroke population, whereas our mean age of 77 years is in agreement with epidemiologic studies.[22,23]

The severity of stroke was strongly associated with a greater risk of most complications, which corresponds to results from several other studies.[1–5,8,24] However, the occurrence of other pain and falls during the first week was not associated with the severity of stroke. These findings might be explained by the fact that patients with severe stroke very often have reduced consciousness or a reduced ability to speak and therefore will not perceive or be able to inform caregivers about pain, and due to their inability to move and walk, they will not be at high risk for falls. In the long term, the severity of stroke also seems to be important for these complications.[8]

Definition of complications is another factor that may contribute to differences in results across studies. Our definition of progressing stroke did not include speech, and therefore, the number of patients with progressing stroke might have been slightly underestimated. All of our other definitions were similar to those used in most previous complication studies.[1,8,10] The results from a recent study with a low complication rate of 27% in acute inpatients might be explained by differences in definitions, types of complications recorded, and perhaps even incomplete recording, as those investigators found an occurrence of fever in only 1.2% of patients, which is remarkably low.[25] For further systematic research on and comparison of complications, guidelines regarding operative definitions of key complications are needed. The definitions from Davenport et al[1] might be a possible framework for future complications studies, if supplemented with some important complications in the very acute phase.

In our study, we mainly included symptomatic complications and not those that could only be discovered by continuous monitoring during the acute phase, eg, low oxygen tension, periods of cardiac arrhythmias, or hypotension.[11–13] During the years when our study was ongoing, we could not offer continuous monitoring to all acute stroke patients, and for this reason, we excluded these complications. A recent study indicates that prolonged monitoring can detect complications like hypoxia and hypertension, but the importance of these findings is unknown.[26]

What can be learned from the results of our study? First, to reduce the present rate of complications, a focus on the first 4 days seems important, because most complications have an early onset. Perhaps greater use of continuous monitoring can be of value in reducing some complications in this initial phase, effected by better control of physiologic homeostasis.[11–14,27,28] However, more research is needed to find the appropriate level and length of monitoring,[26–29] as bed-related complications might increase if monitoring increases and mobilization decreases.[9,18,26,28,29] Many of the other complications like infections, pain, and falls will probably not be affected by more monitoring but depend more on the care given by specially trained staff in the SU.[9,14,26] Although most complications occur during the first 4 days, present knowledge indicates that an average length of stay of at least 1 week is necessary for the optimal effect of SU care on survival and functional recovery.[9,15] This suggests that reduction of complications is not the only important factor in effective SU care.

Because many complications are associated with the severity of stroke, treatment that can reduce the size and severity of brain injury might be the most important factor for further reduction of complications. Hence, effective acute stroke treatment, like thrombolysis and control of physiologic homeostasis[27] in the setting of an evidence-based SU,[9,15,18] might be the most important means to reduce acute complications.

During follow-up, onset of new complications was rare, suggesting that our ESD service might take care of complications and their prevention appropriately, with the exception of pain. Pain in the paretic upper extremity may still be a problem,[30] but in our study, pain in other locations was far more frequent. Others have reported similar results.[8] Whether these pain problems were present before the stroke, are an expression of underlying depression, or are a more direct consequence of the stroke or the functional problems after stroke needs to be clarified in future studies.

In summary, complications are still frequent after stroke despite treatment in a comprehensive SU and close follow-up in a well-organized ESD service. Most complications have their onset during the first 4 days and stroke severity is the most important risk factor, indicating that treatment that has the potential of reducing the size and severity of brain injury might be very important for reducing complications after stroke. Pain, progressing stroke, infections, MI, and falls are the most common complications, whereas others occur infrequently. We still have challenges, and further research is needed regarding complications, as optimal prevention, management, and effects on outcome have not been established for many complications.

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Disclosures

None.

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