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Leukocytosis in Patients with Neurologic Deterioration after Acute Ischemic Stroke is Associated with Poor Outcomes

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Abstract

Background—Neurologic deterioration (ND) after acute ischemic stroke (AIS) has been shown to result in poor outcomes. ND is thought to arise from penumbral excitotoxic cell death caused in part by leukocytic infiltration. Elevated admission peripheral leukocyte levels are associated with poor outcomes in stroke patients who suffer ND, but little is known about the dynamic changes that occur in leukocyte counts around the time of ND. We sought to determine if peripheral leukocyte levels in the days surrounding ND are correlated with poor outcomes.

Methods—Patients with AIS who presented to our center within 48 hours of symptom onset between July 2008 and June 2010 were retrospectively identified by chart review and screened for ND (defined as an increase in National Institutes of Health Stroke Scale score ≥2 within a 24-hour period). Patients were excluded for steroid use during hospitalization or in the month before admission and infection within the 48 hours before or after ND. Demographics, daily leukocyte counts, and poor functional outcome (modified Rankin Scale score 3–6) were investigated.

Results—Ninety-six of the 292 (33%) patients screened had ND. The mean age was 69.5 years; 62.5% were male and 65.6% were black. Patients with a poor functional outcome had significantly higher leukocyte and neutrophil levels 1 day before ND (P=.048 and P=.026, respectively), and on the day of ND (P=.013 and P=.007, respectively), compared to patients with good functional outcome.

Conclusions—Leukocytosis at the time of ND correlates with poor functional outcomes and may represent a marker of greater cerebral damage through increased parenchymal inflammation.

Keywords

Deterioration; leukocytosis; National Institutes of Health Stroke Scale; outcome; prognosis; stroke

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Neurologic deterioration (ND), the acute worsening of stroke severity,[1] is common in the stroke unit or neurologic intensive care unit. Approximately one-third of patients experience ND after acute ischemic stroke (AIS).[2,3] More than half of ND episodes occur within the first 24 hours of stroke onset.[3,4] Patients who experience ND are more likely to experience poor functional outcomes[5,6] and in-hospital mortality.[7]

ND is thought to be the result of penumbral excitotoxic cell death caused by a combination of factors, including failure of collateral perfusion, reocclusion after recanalization therapy, and inflammation of the ischemic parenchyma.[1,8,9] Cerebral ischemia results in leukocyte infiltration and proinflammatory cytokine release after a disruption of the blood–brain barrier.[10–12] Earlier studies have shown that peripheral leukocyte levels will rise following a cerebrovascular insult.[13,14] The extent of initial leukocytosis during a stroke can predict greater initial stroke severity, discharge disability, and, more tangibly, larger final infarct volume.[15,16] Recently, it has been shown that admission leukocyte levels can predict not only the likelihood of ischemic stroke,[17,18] but they are also an independent predictor of ND.[2,19]

While the predictive and prognostic relationship between admission leukocyte levels and ND in the face of AIS is becoming more clear, little is known about the dynamics of leukocyte levels before, during, or after ND, and what prognostic implications, if any, exist as a result of these fluctuations. The objective of this study was to investigate the association between leukocyte levels and ND and to determine if leukocyte levels were associated with poor patient outcomes.

Methods

Study Population and Variable Definition

Patients with AIS who presented to Tulane University Hospital between July 2008 and June 2010 were retrospectively identified through a previously collected stroke registry. Only patients who experienced ND were included in this study. ND was defined as a ≥2-point increase in a patient's National Institute of Health Stroke Scale (NIHSS) score within a 24-hour period. This definition was selected because it has been shown to be a sensitive predictor of patient outcomes in our population.[20] NIHSS examinations were performed during the initial evaluation and every subsequent morning by a neurology attending that was certified in the NIHSS examination.[21] Patients who received tissue plasminogen activator (tPA) were included in this study.

Patients were excluded if they were admitted >48 hours after last seen normal (LSN), had an unknown LSN time, experienced an in-hospital stroke, had a documented infection 72 hours before or after admission, or had an infection 48 hours before or after the detection of ND. Infection was defined as any positive culture (excluding contaminants) plus any other suggestive clinical criteria (such as fever and tachycardia). Patients who received systemic corticosteroids 1 month before or during their hospital stay were also excluded. Patient demographics, daily leukocyte counts (measured in 10^9 cells/L) from routine complete blood cell counts (CBCs) with differential, admission and daily NIHSS scores, and outcome measures were recorded. Stroke etiology was categorized according to previously

standardized definitions set forth in the Trial of Org 10172 in Acute Stroke Treatment.[22] CBCs were examined in a 2-day window surrounding ND. For simplicity, 2 days before ND is written as ND–2; 1 day before ND, ND–1; day of ND, ND–0; 1 day after ND, ND+1; and 2 days after ND, ND+2. Outcome measures included return to pre-ND NIHSS score (baseline), length of stay (LOS), NIHSS score at discharge, modified Rankin Scale (mRS) at discharge (with poor functional outcome defined as a discharge mRS score >2), favorable discharge disposition (home or inpatient rehabilitation), unfavorable disposition (skilled nursing, long-term acute care, hospice, or death), and in-hospital mortality. A neurology attending, certified in the mRS,[23,24] documented the mRS score for each patient upon discharge as part of our registry.

Statistical Analysis

Categorical variables were assessed using the Chi-square or Fisher exact tests where appropriate. Leukocyte, neutrophil, and lymphocyte counts were assessed using Student *t* test, Wilcoxon rank sum test, and analysis of variance to assess differences between groups. The Spearman correlation was used to assess the correlation between leukocyte, neutrophil, and lymphocyte counts and variables of interest. A random effects mixed model was used to assess the changes in total leukocyte, neutrophil, and lymphocyte counts over time adjusting for baseline NIHSS score and race.

Results

Outcome Measures

Four hundred thirty-eight consecutive patients admitted to our center with AIS between July 2008 and June 2010 were screened. After excluding patients based on our methods, 292 patients met the inclusion criteria. Of these, 96 target subjects (32.9%) experienced ND; Table 1 shows their demographic data and characteristics. Tables 2–4 show their outcome measures with this study in relation to total leukocyte (Table 2), neutrophil (Table 3), and lymphocyte (Table 4) levels surrounding ND.

Patients who failed to return to their pre-ND NIHSS score had significantly greater total leukocyte levels on ND+2 compared to patients who returned to their baseline (P =.038). Otherwise, total leukocyte, neutrophil, or lymphocyte levels in the 2 days surrounding ND were not significantly different in patients who returned to their pre-ND NIHSS score compared to those who did not.

Patients with a longer LOS had significant differences in total leukocyte, neutrophil, and lymphocyte levels, although these disparities occurred at different times in relation to ND. Mean total leukocyte levels were significantly higher on ND+1 in those with a longer LOS (P < .001), while mean neutrophil levels were elevated on ND–0 and ND+1 (P =.037 and P <.001, respectively). Lymphocyte levels were significantly lower in those with a longer LOS on ND–2, ND–1, and ND–0 (P = .048, P =.026, and P <.001, respectively).

Patients with a higher NIHSS score on discharge had higher total leukocyte levels on ND–1, ND–0, ND+1, and ND+2 (P = .047, P = .005, P = .001, and P < .001, respectively). Neutrophil levels were significantly higher on ND–2, ND–0, ND+1, and ND+2 (P = .022, P

= .004, P = .009, and P < .001, respectively). Lymphocyte levels were significantly lower on ND+2 in those with a higher discharge NIHSS score (P =.001).

Patients with a poor functional outcome (discharge mRS score >2) had similar differences in their leukocyte levels. Mean total leukocyte levels on ND–1 and ND–0 were higher in those with a poor functional outcome compared to patients with good functional outcome (P =.048 and P =.013, respectively), as were mean neutrophil levels on ND–1 and ND–0 (P =.026 and P =.007, respectively).

Patients with an unfavorable discharge disposition had significantly higher mean neutrophil levels on ND–0 (P = .019). Lymphocyte levels were significantly lower on ND–1, ND–0, ND+1, and ND+2 (P = .046, P = .002, P =.002, and P <.001, respectively) in those with an unfavorable discharge disposition.

Leukocyte Level Changes Around ND

Only lymphocyte levels were found to be significantly increased 1 day before the ND event (P =.001). No other cell type underwent significant changes in the days before or after ND. In terms of correlating leukocyte levels and the ND event, total leukocyte levels on ND–2 and ND–0 positively correlated with the patients' NIHSS scores on the day of the event (r = 0.367 [P = .042] and r = 0.324 [P = .011], respectively). Neutrophils on ND–0 were also found to positively correlate with the NIHSS score on the day of ND (r = 0.294; P =.021). Lymphocyte levels were not correlated with the NIHSS score during ND at any time proceeding, during, or after ND (Table 5).

Discussion

Among patients with ND after AIS, we found that higher serum leukocyte and neutrophil levels were associated with a variety of poor outcomes. In addition, those individuals with worse outcomes had decreased lymphocyte counts. Overall, the differences in total leukocyte, neutrophil, or lymphocyte levels generally occurred in the 24-hour window before and after ND, with a majority of differences occurring on ND–0.

Leukocytic infiltration of the penumbra that leads to excitotoxic neuronal death is thought to contribute to ND.[25,26] It has been shown that elevated leukocyte levels on admission predict ND[7] and are associated with poor outcomes.[15] Our results suggest that elevated leukocyte levels beyond admission are also associated with poor outcomes. The inverse relationship we observed between lymphocyte levels and poor outcomes deserves special consideration. The role of lymphocytes in ND is still unclear, but it has been suggested that specific subtypes of lymphocytes (namely, T-regulatory cells) play a crucial role in curtailing the inflammatory response seen in stroke.[27,28] The poor outcomes we observed in patients with lower lymphocyte counts could have been the result of fewer T-regulatory cells that were available to modulate an immune response, thereby leading to greater cerebral damage. Additional investigations are needed to elucidate the complex immunomodulatory interactions that occur after stroke.

Unlike previous findings, we did not observe significant changes in total leukocyte or neutrophil levels after stroke. However, our population consisted solely of ND patients as opposed to other studies that were not as specific.[12,13] In terms of the predictive value of leukocyte changes before and during ND, we did find that lymphocyte levels significantly increased on ND–1, and that total leukocyte and neutrophil counts on ND+0 correlated well with the NIHSS score during ND. Together, these changes may serve as potential surrogate markers of ND, but more investigations are needed to elucidate the predictive role of leukocytes for ND.

Patients with stroke are more likely to acquire an infection,[29] which is associated with a worse outcome.[30] In addition, leukocyte levels will rise after stroke regardless of infection.[31] We sought to limit these potentially confounding factors by excluding patients with documented infection. Therefore, the results of this study should be tempered with the fact that other investigations may not have had these exclusions; the generalizability of this study may therefore be limited. However, our observations of elevated leukocyte counts with poor outcomes may offer a partial explanation as to why stroke patients with infection may have worse outcomes.

Our findings may not be applicable to all patient populations because our study was conducted at a single center and our sample size was limited. It is difficult to compare findings on ND given that there are no standardized ND definitions currently accepted in the literature.[32] We therefore elected to use a more sensitive definition of ND (≥2-point increase in NIHSS score in a 24-hour period). We were also limited by the retrospective nature of our study. Daily CBCs were not received for all patients due to physician preference at the time of hospitalization, resulting in selection bias. Because more than half of ND episodes occur within 24 hours of stroke, not all patient leukocyte counts were available for the 24 to 48 hours preceding ND. Our results are also limited by the fact that our analyses were confined to patients who experienced a first-time ND. However, we observed that patients may have >1 episode of ND during their hospital stay (data not shown).

In conclusion, we found that patients with ND and poor outcomes had significant differences in the leukocyte levels in the immediate days surrounding ND. Additional elucidation of the dynamic changes in white blood cell differentials could prove useful in terms of predicting ND. With the help of a common definition of ND, it is possible that close laboratory monitoring could serve to identify patients that are likely to experience ND. The rapid and accurate identification of these patients could provide a potential target group for testing future therapies to prevent, or at least mitigate, this potentially disastrous consequence of stroke.

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Table 1

Patient demographics

Variable	ND patient demographics (N = 96)
Median age, y (IQR)	69.5 (61–79)
Male, n (%)	60/96 (62.5)
White, n (%)	30/96 (31.3)
African American, n (%)	63/96 (65.6)
Admission NIHSS, median (IQR)	10 (4–17)
Discharge NIHSS, median (IQR)	9 (4–19)
Length of stay, median (IQR)	8.5 (5–16)
mRS score at discharge, median (IQR)	4 (3–5)
Favorable discharge disposition, n (%)	58/85 (68.2)
Mortality, n (%)	19/96 (20)
tPA given, n (%)	31/96 (32.3)
TOAST, n (%)	
Cardioembolic	21/77 (27.3)
Large vessel occlusion	22/77 (28.6)
Small vessel occlusion	16/77 (20.8)
Cryptogenic, >1 cause	10/77 (13.0)
Cryptogenic, unknown cause	2/77 (2.6)
Other	6/77 (7.8)

Abbreviations: IQR, interquartile range; mRS, modified Rankin Scale; ND, neurologic deterioration; NIHSS, National Institutes of Health Stroke Scale; TOAST, Trial of Org 10172 in Acute Stroke Treatment; tPA, tissue plasminogen activator.

Table 2

Total leukocyte count and outcome in patients with neurologic deterioration

	ND–2, mean (SD)	ND–1, mean (SD)	ND–0, mean (SD)	ND+1, mean (SD)	ND+2, mean (SD)
Returned to baseline NIHSS	10.0 (4.4) n = 15	9.6 (3.7) n = 30	10.3 (3.6) n = 29	10.9 (3.9) n = 29	10.9 (3.9) n = 26
Did not return to baseline NIHSS	8.5 (4) n = 22	8.9 (5.4) n = 40	9.8 (4.3) n = 41	9.1 (3.6) n = 35	8.8 (2.7) n = 29
P value	.199	.199	.359	.074	.038 *
Length of stay (days)					
<5	9.6 (5.7) n = 6	7.9 (2.2) n = 18	8.5 (3.3) n = 17	6.9 (2) n = 16	8.4 (1.9) n = 8
5–8	10.4 (2.9) n = 10	8.9 (3.0) n = 13	10.7 (5.2) n = 12	9.7 (4.0) n = 9	7.8 (2.8) n = 8
>8	8.3 (4.2) n = 21	9.9 (5.9) n = 39	10.5 (3.8) n = 41	11.2 (3.8) n = 39	10.5 (3.6) n = 39
P value	.414	.361	.19	<.001 †	.058
NIHSS score at discharge					
1–7	7.5 (2.5) n = 16	7.6 (2.3) n = 30	8.2 (2.6) n = 29	8.1 (2.4) n = 29	7.7 (2.2) n = 21
8–14	8.8 (2.7) n = 8	10.8 (8.1) n = 15	11.1 (4.3) n = 15	12.7 (3.3) n = 11	12.5 (3.3) n = 12
>14	11.4 (5.8) n = 12	9.6 (3.6) n = 21	11.6 (4.7) n = 21	10.5 (4.9) n = 19	10.5 (3.7) n = 17
P value	.047 *	.078	.005 *	.001 *	<.001 †
mRS score					
0–2	6.2 (0.7) n = 3	6.4 (4.9) n = 10	7.1 (2.4) n = 10	8.0 (3.0) n = 11	7.5 (2.0) n = 6
3–6	9.4 (4.3) n = 34	9.5 (4.7) n = 59	10.4 (4.0) n = 59	10.2 (3.9) n = 52	10.0 (3.5) n = 48
P value	.212	.048 *	.013 *	.082	.089
Disposition					
Favorable	8.5 (2.9) n = 23	9.2 (5.3) n = 46	9.3 (3.6) n = 45	9.5 (3.1) n = 42	9.5 (3.3) n = 36
Unfavorable	11.0 (6.1) n = 10	9.5 (4.3) n = 16	11.9 (5.3) n = 17	10.9 (5.4) n = 16	10.0 (3.9) n = 14
P value	.117	.844	.028 *	.19	.596

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	ND–2, mean (SD)	ND–1, mean (SD)	ND–0, mean (SD)	ND+1, mean (SD)	ND+2, mean (SD)
Mortality					
Yes	10.2 (5.6) n = 6	8.8 (2.4) n = 13	10.4 (3.6) n = 12	9.2 (4.8) n = 10	9.4 (1.4) n = 8
No	8.9 (3.9) n = 31	9.3 (5.2) n = 57	9.9 (4.1) n = 58	10.0 (3.7) n = 54	9.9 (3.7) n = 47
P value	.498	.752	.697	.520	.738

Abbreviations: ND, neurologic deterioration; ND–2, 2 days before ND; ND–1, 1 day before ND; ND–0, day of ND; ND+1, 1 day after ND; ND+2, 2 days after ND; SD, standard deviation; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale.

Leukocyte levels measured in 10^9 cells/L.

$^{*}P < .05$.

$^{\dagger}P < .001$.

Table 3

Neutrophil count and outcome in patients with neurologic deterioration

	ND–2, mean (SD)	ND–1, mean (SD)	ND–0, mean (SD)	ND+1, mean (SD)	ND+2, mean (SD)
Returned to baseline NIHSS	7.6 (4.5) n = 15	6.9 (3.6) n = 30	7.8 (3.2) n = 29	7.8 (3.9) n = 29	8.3 (3.9) n = 26
Did not return to baseline NIHSS	6.3 (3.9) n = 22	6.4 (5) n = 40	7.5 (4.4) n = 41	6.9 (3.6) n = 35	6.8 (2.7) n = 29
P value	.243	.305	.456	.243	.218
Length of stay (days)					
<5	7.0 (5.9) n = 6	4.9 (1.9) n = 18	5.5 (3.6) n = 17	4.4 (1.5) n = 16	6.3 (2.7) n = 8
5–8	7.9 (3.2) n = 10	6.4 (2.7) n = 13	8.5 (3.5) n = 12	7.3 (4.0) n = 9	5.4 (2.4) n = 8
>8	6.3 (4.1) n = 21	7.5 (5.5) n = 39	8.2 (3.4) n = 41	8.5 (3.7) n = 39	8.1 (3.5) n = 39
P value	.619	.131	.037*	<.001†	.059
NIHSS score at discharge					
1–7	5.3 (2.4) n = 16	5.1 (2.1) n = 30	5.9 (2.7) n = 29	5.6 (2.3) n = 29	5.2 (2.1) n = 21
8–14	6.1 (2.8) n = 7	7.9 (7.5) n = 15	8.9 (4.2) n = 14	8.8 (4.3) n = 11	9.9 (3.2) n = 12
>14	9.9 (5.9) n = 10	7.0 (3.8) n = 21	8.6 (3.7) n = 20	8.3 (4.4) n = 19	8.6 (3.6) n = 17
P value	.022*	.102	.004*	.009*	<.001†
mRS score					
0–2	3.9 (0.64) n = 3	3.6 (1.2) n = 10	4.5 (2.6) n = 10	5.3 (2.7) n = 11	5.2 (1.6) n = 6
3–6	7.1 (4.2) n = 34	7.0 (4.6) n = 59	8.1 (3.9) n = 59	7.7 (3.8) n = 52	7.8 (3.5) n = 48
P value	.199	.026*	.007*	.055	.08
Disposition					
Favorable	6.1 (2.8) n = 23	6.5 (4.9) n = 46	6.9 (3.6) n = 45	6.9 (3.1) n = 42	6.9 (3.2) n = 36
Unfavorable	9.2 (5.9) n = 10	7.4 (4.3) n = 16	9.8 (4.8) n = 17	8.1 (5.2) n = 16	8.1 (3.7) n = 14
P value	.217	.334	.019*	.566	.289

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	ND–2, mean (SD)	ND–1, mean (SD)	ND–0, mean (SD)	ND+1, mean (SD)	ND+2, mean (SD)
Mortality					
Yes	8.1 (5.6) n = 6	6.1 (2.4) n = 13	8.0 (3.9) n = 12	7.0 (4.2) n = 10	7.6 (1.7) n = 8
No	6.6 (3.9) n = 31	6.7 (4.8) n = 57	7.5 (4.0) n = 58	7.4 (3.7) n = 54	7.5 (3.6) n = 47
P value	.443	.642	.744	.803	.890

Abbreviations: ND, neurologic deterioration; ND–2, 2 days before ND; ND–1, 1 day before ND; ND–0, day of ND; ND+1, 1 day after ND; ND+2, 2 days after ND; SD, standard deviation; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale.

Neutrophil levels measured in 10^9 cells/L.

$^{*}P < .05$.

$^{\dagger}P < .001$.

Table 4

Lymphocyte count and outcome in patients with neurologic deterioration

	ND–2, mean (SD)	ND–1, mean (SD)	ND–0, mean (SD)	ND+1, mean (SD)	ND+2, mean (SD)
Returned to baseline NIHSS	1.5 (0.57) n = 15	1.8 (0.92) n = 30	1.4 (0.86) n = 29	1.5 (0.81) n = 29	1.4 (0.5) n = 26
Did not return to baseline NIHSS	1.4 (0.75) n = 22	1.7 (1) n = 40	1.5 (0.78) n = 41	1.2 (0.52) n = 35	1.2 (0.56) n = 29
P value	.380	.569	.770	.203	.111
Length of stay (days)					
<5	1.9 (0.87) n = 6	2.2 (1.1) n = 18	2.1 (1.1) n = 17	1.7 (0.79) n = 16	1.4 (0.82) n = 8
5–8	1.5 (0.49) n = 10	1.7 (1.1) n = 13	1.3 (0.57) n = 12	1.4 (0.58) n = 9	1.5 (0.36) n = 8
>8	1.2 (0.64) n = 21	1.5 (0.84) n = 39	1.2 (0.55) n = 41	1.2 (0.62) n = 39	1.3 (0.51) n = 39
P value	.048 *	.026 *	<.001 †	.107	.505
NIHSS score at discharge					
1–7	1.5 (0.46) n = 16	1.7 (0.89) n = 30	1.6 (0.85) n = 29	1.5 (0.67) n = 29	1.6 (0.52) n = 21
8–14	1.5 (0.64) n = 8	1.8 (0.79) n = 15	1.4 (0.56) n = 15	1.5 (0.44) n = 11	1.4 (0.54) n = 12
>14	1.1 (0.82) n = 12	1.8 (1.3) n = 21	1.3 (0.96) n = 21	1.1 (0.66) n = 19	1.0 (0.39) n = 17
P value	.274	.966	.463	.085	.001 *
mRS score					
0–2	1.8 (0.27) n = 3	2.0 (1.1) n = 10	1.8 (1.1) n = 10	1.7 (0.94) n = 11	1.5 (0.54) n = 6
3–6	1.4 (0.6) n = 34	1.7 (0.96) n = 59	1.4 (0.75) n = 59	1.3 (0.58) n = 52	1.3 (0.54) n = 48
P value	.395	.281	.140	.038 *	.280
Disposition					
Favorable	1.5 (0.52) n = 23	1.8 (0.83) n = 46	1.6 (0.75) n = 45	1.5 (0.62) n = 42	1.5 (0.5) n = 36
Unfavorable	1.1 (0.73) n = 10	1.4 (1.1) n = 16	1.0 (0.45) n = 17	1.1 (0.74) n = 16	0.9 (0.40) n = 14
P value	.066	.046 *	.002 *	.002 *	<.001 †

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	ND–2, mean (SD)	ND–1, mean (SD)	ND–0, mean (SD)	ND+1, mean (SD)	ND+2, mean (SD)
Mortality					
Yes	1.3 (1.1) n = 6	2.0 (1.5) n = 13	1.5 (1.2) n = 12	1.0 (0.59) n = 10	1.0 (0.46) n = 8
No	1.4 (0.59) n = 31	1.7 (0.85) n = 57	1.4 (0.73) n = 58	1.4 (0.67) n = 54	1.4 (0.53) n = 47
P value	.737	.333	.757	.089	.034*

Abbreviations: ND, neurologic deterioration; ND–2, 2 days before ND; ND–1, 1 day before ND; ND–0, day of ND; ND+1, 1 day after ND; ND+2, 2 days after ND; SD, standard deviation; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale.

Lymphocyte levels measured in 10^9 cells/L.

*$P < .05$.

†$P < .001$.

Table 5

Correlation between cell type and National Institutes of Health Stroke Scale score during neurologic deterioration

Cell type	NIHSS during ND
Total leukocytes	
ND–2 (n = 31)	r = 0.367; $P = .042$ *
ND–1 (n = 59)	r = 0.078; $P = .555$
ND–0 (n = 61)	r = 0.324; $P = .011$ *
Neutrophils	
ND–2 (n = 31)	r = 0.328; $P = .071$
ND–1 (n = 59)	r = 0.093; $P = .485$
ND–0 (n = 61)	r = 0.294; $P = .021$ *
Lymphocytes	
ND–2 (n = 31)	r = 0.199; $P = .283$
ND–1 (n = 59)	r = −0.010; $P = .939$
ND–0 (n = 61)	r = −0.003; $P = .981$

Abbreviations: ND, neurologic deterioration; ND–2, 2 days before ND; ND–1, 1 day before ND; ND–0, day of ND; NIHSS, National Institutes of Health Stroke Scale.

* $P < .05$.