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Impact of Delirium on Decision-Making Capacity After Hematopoietic Stem-Cell Transplantation

Thomas Zaubler, M.D., M.P.H., **Jesse R. Fann, M.D., M.P.H.**, **Sari Roth-Roemer, Ph.D.**, **Wayne J. Katon, M.D.**, **Rami Bustami, Ph.D.**, and **Karen L. Syrjala, Ph.D.**

Dept. of Psychiatry and Behavioral Health, Morristown Memorial Hospital, Atlantic Health, Morristown, NJ; the Dept. of Biobehavioral Sciences, Fred Hutchinson Cancer Research Center, Seattle, WA; the Dept. of Psychiatry and Behavioral Sciences, University of Washington, Seattle, WA; Arizona Medical Psychology, Scottsdale, AZ; and the Office of Grants and Research, Atlantic Health, Morristown, NJ.

Abstract

Background: Delirium is a common complication of myeloablative hematopoietic stem-cell transplantation (HSCT), yet no studies have explored the later effects of an episode of delirium in this setting on patients' decision-making capacity after the acute symptoms of delirium have resolved.

Objective: The authors assessed the impact of delirium during the acute phase of myeloablative HSCT on later decision-making capacity.

Method: Decision-making capacity was assessed with the MacArthur Competence Assessment Tool in 19 patients before they received their first HSCT and at 30 and 80 days post-transplantation. Delirium was assessed 3 times per week with the Delirium Rating Scale and the Memorial Delirium Assessment Scale from 7 days pre-transplantation through 30 days post-transplantation.

Results: Although there was little variance in the pre-treatment scores, with most patients showing very high or perfect scores on decision-making abilities, a multivariate regression model showed that delirium was predictive of a lower reasoning score at Day 30 post-transplantation.

Conclusion: Patients who experienced a delirium episode during the acute phase of HSCT were not likely to develop clinically meaningful impairments in decision-making capacity post-transplantation, although they evidenced minor impairment in their reasoning ability.

Although the doctrine of informed consent has been emphasized as an integral and essential component of the relationship between physician and patient, there has been very little research investigating how the process of obtaining informed consent can be operationalized in the clinical setting. In order for a patient to provide informed consent, several critical requirements must be met: the patient must be able to make a voluntary decision without

Send correspondence and reprint requests to Thomas Zaubler, M.D., M.P.H., Morristown Memorial Hospital, 100 Madison Ave., Morristown, NJ 07962. thomas.zaubler@atlantichealth.org.

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coercion or undue influence; a disclosure of information about the patient's medical illness and risks and benefits of treatment options must be made; the patient must have the capacity to make a decision that reflects a clear understanding and appreciation of the nature of his or her medical illness and treatment options and must have an ability to think reasonably about the risks and benefits of various treatment options.[1] There has been a growing but still small body of research providing empirical evidence of clinical factors that may impair decision-making capacity.

Although some preliminary investigations have found that certain medical illnesses may lead to impaired decision-making capacity,[2] there has been almost no empirical exploration of risk factors for impaired decision-making capacity in the cancer setting. To our knowledge, there have been no studies investigating this among some of the most acutely ill cancer patients, who are undergoing hematopoietic stem cell transplantation (HSCT). Although myeloablative HSCT can be a life-saving treatment that may be the sole option for long-term survival for many patients with cancer, it entails a neurotoxic conditioning regimen that often leads to multiple short-term and long-term complications, including cognitive impairment.[3–6]

Providing informed consent among patients undergoing HSCT is an arduous and challenging process, both because of the extensive amount of information that needs to be conveyed to the patient and because the toxicity of the treatment may lead to slowed information-processing[6] and potentially, impaired decision-making capacity. Myeloablative HSCT entails a conditioning treatment with high-dose chemotherapy, often with total body irradiation, followed by hematopoietic stem-cell transplantation. Patients may experience direct effects of the chemotherapeutic agents as well as subsequent immunologically-mediated complications from the stem-cell transplantation, such as graft-versus-host disease or the medications used to treat graft-versus-host disease.[7–9] Delirium is a common neuropsychiatric complication occurring in patients undergoing HSCT.

Delirium occurs in 25% to 40% of patients with cancer,[10–12] 45% to 85% of those with advanced cancer,[13–16] and up to 50% of patients during the 4 weeks after myeloablative HSCT.[17] Delirium is often accompanied by increased distress, fatigue, and pain.[17,18] Delirium in patients with cancer, in general, has been associated with adverse outcomes, including decreased performance status;[19] increased pain and use of breakthrough analgesia;[20,21] longer length of hospital stay;[22,23] increased distress for the patient and his/her spouse, caregivers, and nurses;[24,25] and decreased survival.[16,19] Patients who experience delirium after myeloablative HSCT have been found to have worse distress 30 days later and impaired neurocognitive abilities, persistent distress, and decreased quality of life at 80 days than those without delirium.[26] Similar affective and neuropsychological deficits as those found subsequent to a delirium episode have, in both medical and psychiatric settings, been shown to be associated with impaired decision-making capacity.[27–29] The evidence, therefore, suggests that although the overt symptoms of delirium may be short-lived, there may be a lasting impact of delirium on affective functioning and cognition, thereby affecting decision-making capacity. Although it has been well established that the neurocognitive deficits associated with an acute episode of delirium are likely to lead to impairments in decision-making capacity,[30–32] no studies have investigated the "downstream" effect on

decision-making capacity of an index episode of delirium once the acute symptoms have resolved.

This prospective study investigated the impact of delirium during the acute phase of myeloablative HSCT on 30- and 80-day decision-making capacity. Although the manifest symptoms associated with an index episode of delirium will most likely resolve by 30 and 80 days post-transplantation, subclinical problems with cognition and affective functioning may persist for many weeks, leading to impaired decision-making capacity. Consistent with research in general-hospital samples, we hypothesized that patients who experienced a delirium episode after HSCT would demonstrate some degree of impairment in decision-making capacity at 30 and 80 days, as compared with patients who did not experience a delirium episode.

METHOD

Subjects

Nineteen patients, ages 25–58 years, treated at the Fred Hutchinson Cancer Research Center, were recruited before their first myeloablative allogenic or autologous marrow or peripheral blood HSCT. A broad range of cancer diagnoses was represented (Table 1).

Procedures

Study procedures from this cohort are detailed in a previous publication.[17] All procedures were approved by the Institutional Review Board, and study patients signed written informed consent statements to participate before beginning transplantation conditioning. Before conditioning, patients completed a comprehensive battery assessing health-related quality of life (HRQoL), distress, and neuropsychological functioning. They also completed the MacArthur Competence Assessment Tool for Treatment (MacCAT–T), an assessment designed to evaluate decision-making capacity. A subset of assessments, including the MacCAT–T, was given at 30 days post-transplantation, and the full battery was repeated at 80 days post-transplantation. At 7 days pre-transplantation, during conditioning, and through Day 30 post-transplantation, trained research nurses or investigators assessed patients with a brief delirium- (diagnosis, severity), distress-, and pain-assessment battery 3 times per week targeted to the same time each day (Monday, Wednesday, and Friday).[17] Pa tients with delirium were able to provide outcome data, except in the most severe cases.

Measures

Independent variables were the following; for delirium:

The Delirium Rating Scale (DRS)[33]—This 10-item, clinician-rated scale for diagnosing delirium assesses symptoms over a 24-hour period, using information from the patient interview, mental status examination, medical history and pathology test results, nursing observations, and family reports (range: 0–32). We defined a delirium episode as a DRS score >12[33,34] for at least two of three consecutive assessments.[17] The resolution of the delirium episode was defined by at least two consecutive assessments with a DRS score ≤12.

The Memorial Delirium Assessment Scale (MDAS)[35]—This 10-item, clinician-rated scale assesses delirium severity (range: 0–30) and has been validated in cancer populations.[36,37] Delirium severity for each patient was measured as the mean of the patient's peak post-transplantation MDAS score and the score for the assessments before and after the peak MDAS score.

Distress, depression and anxiety scales (given at baseline, and 30 and 80 days post-transplantation):

The Symptoms Checklist-90-Revised (SCL-90–R)[38]—This is a reliable and valid inventory of self-reported symptoms, with each item rated on a 5-point scale, from 0 (no symptoms) to 4 (extreme symptoms). We report on the Depression and Anxiety subscales.

The Profile of Mood States Fatigue Subscale (POMS–Short Form)[39,40]—This is one subscale of the 30-item POMS, which is a widely-used, valid, and reliable measure of affective distress and mood disturbance (higher scores: greater fatigue).

Neurocognitive testing (given at baseline and at 80 days post-transplantation, unless otherwise noted). Executive/frontal function refers to higher-level processing skills that allow for organization, planning, problem-solving, and purposeful behavior.[41]

The Behavioral Dyscontrol Scale (BDS)[42]—This is a 9-item, performance-based, objective measure assessing neurobehavioral functioning linked to frontal lobe-mediated behaviors (range: 0–19; higher scores: less impairment), administered at baseline, 30, and 80 days by study nurses and investigators who were blind to patients' previous delirium status.

Trailmaking B[43]—This test measures cognitive flexibility (higher scores: more impairment).

The Digit Symbol Substitution Test of the Wechsler Adult Intelligence Scale–Revised (WAIS–R)[44]—This is a highly sensitive measure of visuomotor coordination skill, visual scanning, sustained attention, and response speed.

The Hopkins Verbal Learning Test–Revised (HVLT–R)[45]—This memory test measures immediate verbal learning (total words recalled over three consecutive trials) and delayed verbal recall (total words recalled after a 20-minute delay).

The Mini-Mental State Exam (MMSE)[46]—This is a brief measure of cognitive impairment extensively used in medical populations; it was given at baseline and at 30 and 80 days post-transplantation.

The dependent variable was decisional capacity, measured with the following:

The MacCAT–T was given at baseline and at 30 and 80 days post-transplantation. It is a standardized, semi-structured interview that minimizes the high variability inherent in clinical assessments of decision-making capacity.[47] Unlike other tools used to assess decision-making capacity that use hypothetical treatment scenarios, the MacCAT–T assesses

decision-making capacity specifically within the context of a relevant, personal, and immediate treatment decision that a patient is facing. The MacCAT–T entails a preliminary disclosure of information about a patient's medical illness and treatment and then an assessment of the patient's decision-making ability based on this disclosure. In order to standardize assessments with the MacCAT–T, a script was drafted for our researchers providing specific information about HSCT that was read to patients in the study. This scripted disclosure, which allowed for researchers to tailor information to the patient's specific type of cancer, served as the basis for assessing decision-making ability. The Mac-CAT–T operationalizes four standards typically used either individually or in combination by courts and clinicians to assess decision-making capacity:[48] 1) Patients must express a choice either to accept or refuse treatment; 2) Patients must understand the nature, purpose, risks, and benefits of treatment, as well as alternatives to the proposed treatment; 3) Patients must be able to use the information provided by their clinicians rationally and draw conclusions about treatment that follow logically from starting premises; and 4) Patients must appreciate how refusing or accepting treatment will affect their lives. Scores for each of the four standards assessed in the Mac-CAT–T range from 0–2 for expressing a choice, 0–6 for understanding, 0–8 for rational reasoning ability, and 0–4 for appreciation (lower scores: greater impairment for all scores). There is no overall score computed for the Mac-CAT–T because impaired decision-making capacity may be associated with deficits in any one or combination of these four standards. The MacCAT–T has been well validated and shown to have high levels of interrater reliability both in psychiatric and medical settings.[47,49,50]

Statistical Analysis

Decision-making capacity for 19 patients was assessed at baseline, at Day 30, and at Day 80 post-transplantation on the basis of the four scores of the Mac-CAT–T. The study staff was thoroughly trained to assess decision-making capacity with the MacCAT–T. Interrater reliability examining correlation between assessments from different raters was planned for the first 5 patients in the study.

In order to examine differences between patients who had a delirium episode and those who did not, the two groups were statistically compared by chi-square test or Fisher's exact test in terms of demographic and clinical factors. Several demographic and clinical factors, including age-group, gender, race, diagnosis, cell type, and donor type were considered in the comparisons.

The four MacCAT–T scores measured at the three time-points were then examined by delirium status with the nonparametric Mann-Whitney U test. The use of a nonparametric test was dictated by the non-normal distribution of the summary MacCAT–T scores. Further analyses were performed to examine the relationship between the summary MacCAT–T scores and several neuropsycho-logical test scores: BDS, Trailmaking B, Digit Symbol, MMSE, and HVLT–R, as well as with the MDAS, SCL-90–R Depression and Anxiety subscales, and the POMS Fatigue Subscale.

When the unadjusted analysis from the Mann-Whitney U test showed a significant difference by delirium status in any of the four MacCAT–T scores at any time-point, a

multivariate linear-regression model was used to examine the effect of delirium episode on the natural logarithm of the MacCAT–T score. Logarithmic transformation was used to normalize the data for the MacCAT–T score used in the regression analyses. Because of the small sample size, adjustments were made only for age, gender, and MacCAT–T scores pre-transplantation. Factors yielding a p value <0.05 were considered significant.

RESULTS

Among patients recruited for the study, all 19 agreed to participate, and none were excluded. Results from the interrater reliability analysis for the MacCAT–T assessment for the first 5 patients in the study (26%) showed a 92% correlation. Characteristics of patients with the Mac-CAT–T assessment by delirium status are shown in Table 1. Seven in the cohort (36.8%) had a delirium episode. None of the tested variables were statistically different between the two groups. Among patients experiencing a delirium episode in this study, the mean duration of the delirium episode was 7 days, with an average peak MDAS score during the delirium episode of 15.1. This peak MDAS occurred, on average, at Day 7 post-transplant. There were a total of seven delirium episodes, with the episodes starting as early as Day 1 post-transplantation and ending, at the latest, on Day 27 post-transplantation. Most of the delirium episodes started between Day 7 and Day 16 post-transplantation (mean post-transplantation day for the total sample was 10; standard deviation [SD]: 6.4) and ended between Day 14 and Day 19 post-transplantation (mean=18; SD: 5), well before the MacCAT–T assessments on Day 30 and Day 80 post-transplantation.

The four MacCAT–T scores were then compared by delirium status (Table 2). No variations were observed at any time-point in the scores reflecting appreciation and expressing choice, showing for all patients identical scores of 4 and 2, respectively. Therefore, these scores are not described in the table or further tested. The high average and median for the Understanding and Reasoning scores indicate a high level of decision-making capacity, with little or no impairment, for most patients. However, a statistically significant difference was observed between patients in the no-delirium group and those in the delirium group in terms of the MacCAT–T score for Reasoning at baseline and at 30 days post-transplantation (median Mac-CAT–T score for Reasoning in the no-delirium versus delirium group were 8.00 versus 7.00 at pre-transplantation (p=0.016) and 8.00 versus 7.00 at 30 days (p = 0.030).

There were no statistically significant differences between patients in the two groups in MacCAT–T scores assessed at 80 days post-transplantation (p >0.05).

Table 3 shows the nonparametric Spearman’s rank correlation coefficient examining the relationship between several neuropsychological test scores and the Mac-CAT–T scores for Reasoning and Understanding. Although little variation was observed in these two Mac-CAT–T scores, the results showed significant positive correlation between Trailmaking B and Understanding at baseline, MMSE and Understanding at Day 30, and HVLT–R and Understanding at Day 80. Significantly negative correlations were observed between MDAS, SCL-90–R Depression, POMS Fatigue, and Understanding at Day 80.

Since the unadjusted analysis using the Mann-Whitney *U* test showed a significant difference by delirium status in the MacCAT–T Reasoning score at Day 30 post-transplantation, multivariate linear regression was used to examine the independent effect of delirium status on this MacCAT–T score. Results from fitting the multivariate linear-regression model predicting the natural logarithm of the MacCAT–T Reasoning score showed that patients who experienced a delirium episode had a significantly lower predicted MacCAT–T Reasoning score at Day 30 post-transplantation (p=0.003; see Table 4), after controlling for age, gender, and MacCAT–T Reasoning score at pretransplantation.

DISCUSSION

In patients undergoing myeloablative HSCT, there is minimal variability in MacCAT–T scores between baseline and assessments at Day 30 and Day 80. Moreover, most patients had nearly perfect scores on all four measures of the Mac-CAT–T over time, suggesting that these patients have minimal, if any, impairments in decision-making. Impairments were limited exclusively to the Reasoning and Understanding scales of the MacCAT–T and are not likely consistent with the clinically meaningful level of impairment typically associated with impaired decision-making capacity that would invalidate the informed-consent process.

Patients who did experience an episode of delirium during the acute treatment period were significantly more likely than patients who did not experience delirium to have a lower Reasoning score on the MacCAT–T at 30 days post-transplantation. Moreover, in a multivariate-regression model, a delirium episode during the acute treatment period was significantly associated with a lower Reasoning score at Day 30 post-transplantation, after controlling for age, gender, and MacCAT–T Reasoning score at pre-transplantation. Although statistically signifi-cant, the small difference in the Reasoning scores is not likely to translate into a clinically meaningful level of impairment in decision-making capacity. Furthermore, those patients with impaired reasoning at 30 days recovered by 80 days post-transplantation on MacCAT–T scores. No statistically or clinically meaningful associations were noted at Day 80 in patients who had experienced a delirium episode versus those who did not.

Interestingly, patients who went on to develop a delirium episode were significantly more likely to have a lower Reasoning score at pre-transplantation. Once again, the lower Reasoning score was still very high and was not likely to translate into a meaningful impairment in decision-making capacity. It is possible that a subtle underlying neurocognitive deficit at baseline may predispose patients to develop delirium and subsequent deficits in reasoning 30 days post-transplantation. This is consistent with the finding that pre-transplantation executive functioning in patients undergoing HSCT has been found to be associated with incident delirium.[17]

Although there was very little variance in the Mac-CAT–T scores, raising questions about the clinical significance of the findings, we did find significant correlations between Trailmaking B and Understanding at baseline, MMSE and Understanding at Day 30 post-transplantation, and HVLT–R and Understanding at Day 80 post-transplantation. These findings suggest that these measures of neuropsychological functioning may be useful as

screening tools that might trigger a more formal assessment of decision-making capacity. Our finding that deficits in neuropsychological functioning may be associated with impaired decision-making capacity is consistent with findings in other studies, as well.[49,51,52] These findings also reveal significant correlations in directions that make clinical sense between neuropsychological domains that are known to affect decision-making capacity and the MacCAT–T scores, which provides additional support for the validity of the MacCAT–T in the patient population we studied.

The significant negative correlations between the 80-day post-transplantation MacCAT–T Understanding score and the MDAS, SCL-90–R Depression, and POMS Fatigue scores is not surprising and provides further support for the validity of the MacCAT–T in this patient population. Patients who experienced more severe delirium as measured by the MDAS are more likely to have ongoing neuropsychological deficits,[26] which may lead to an impaired ability to understand. Similarly, affective dysregulation is associated with impaired understanding. Although most studies have focused on the association between cognitive deficits and impaired decision-making capacity, intense emotional states and disordered affective states may also lead to impaired decision-making abilities.[29] Patients undergoing HSCT who experience a delirium episode are also at risk for more severe affective dysregulation post-transplantation.[26]

It is especially encouraging that patients with cancer undergoing a very toxic chemotherapeutic regimen leading to many side effects and complications did not experience significant deficits in decision-making capacity. This underscores the importance of not conflating symptom severity or diagnosis with incapacity. This finding is consistent with a similar finding in one of the only other studies examining decision-making capacity in patients with cancer.[53] In that study of ambulatory patients, no relationship was found between cancer symptom severity and any of the four standards used to assess decision-making capacity.

All too often, clinicians may assume that an extremely debilitated and disabled patient may not have sufficient decision-making capacity to participate meaningfully in an informed-consent process and, therefore, defer decision-making authority to a proxy. It is critical that clinicians respect patients' autonomy and the right to make a decision about their own treatment. Moreover, there is evidence that participating in an informed-consent process may have a direct salutary effect among patients undergoing cancer treatment.[54] Providing critical information about treatment in a supportive manner may lead to an increased sense of personal control and a neutralization of negative emotions that patients may experience as they anticipate going through such an arduous treatment as myeloablative HSCT. Studies have also found that patients who actively participate in an informed-consent process are more likely to have better medical outcomes and greater compliance with treatment.[55]

Assessments of decision-making capacity with the MacCAT–T do not readily translate into a binary judgment as to whether or not a patient has legal competence to consent to a treatment.[47] The scales provide a level of deficiency or proficiency in each of the four abilities tested by the MacCAT–T. This information must be combined with clinical and historical information about the patient to make a binary determination about competence.

Such binary determinations also take into account the risk/benefit ratio of the treatment that is being decided on by the patient. For example, when a patient is refusing a life-saving, low-risk treatment, a relatively stringent threshold for determining competence should be applied. Conversely, when a patient refuses an experimental, high-risk treatment, a less-stringent threshold for determining competence may be used.[56] The stringency of the threshold used is based on an assessment of a patient's ability to meet the standards assessed by the MacCAT–T: expressing a choice, understanding, appreciation, and reasoning. In this study, given the uniformly high MacCAT–T scores, it is likely that, if a determination of competence were required, all of the patients would have been deemed competent over time. However, one of the limitations of this study is that we did not have separate raters provide an assessment about competence that could then be correlated with the MacCAT–T scores.

Another limitation of this study is that decision-making capacity was assessed at pre-determined time-points and not necessarily when patients were acutely ill. Also, the study sample size was small; with a larger sample, it may have been possible to identify subsets of patients who develop delirium and have specific neuropsychiatric or medical deficits and, as a result, are at risk for more significant impairments in decision-making capacity even when the delirium has resolved.

Our hypothesis that patients who experienced an episode of delirium during the acute phase of treatment would have impaired decision-making capacity after the acute symptoms of delirium had resolved turned out to be incorrect. Although the MacCAT–T did demonstrate a significantly lower Reasoning score at Day 30 post-transplantation in patients who had experienced an episode of delirium during the acute phase of treatment, as compared with those who did not, there was, overall, minimal variability in the MacCAT–T scores, with most patients attaining nearly perfect scores, even among those patients who had experienced a delirium episode. We do not feel that this reflects a limitation of the MacCAT–T in this setting, since the MacCAT–T scores were significantly correlated in directions that make clinical sense with our findings from the battery of neuropsychological tests that the patients received. Our findings underscore the need to be respectful of patients' right to make decisions about their treatment, even when they are extremely ill and undergoing a very toxic treatment regimen. Patients undergoing HSCT who experienced a delirium episode were found to have neuropsychological deficits (in executive functioning, attention, and processing speed), heightened distress, and decreased health-related quality of life after the acute phase of their treatment,[26] yet these deficits were not severe enough to impair decision-making capacity. Future research should target assessments specifically when patients are experiencing acute symptoms, which often coincide with the need to make critical decisions about treatment that require participation in an informed-consent process. Further research is also needed to develop reference ranges for MacCAT–T scores for a range of medical conditions and how these scores correlate with binary clinical assessments regarding competence to make an informed decision about treatment. This will help to determine the relative weight to give the MacCAT–T scores so that they may be more readily translated into a final assessment about a patient's competence.

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TABLE 1.

Characteristics of Patients, With MacCAT–T Assessment by Delirium Status

	No Delirium Episode (N=12)	Delirium Episode (N=7)	Total Sample (N=19)
Age, N (%)			
22–45	9 (75)	4 (57)	13 (68)
46+	3 (25)	3 (43)	6 (32)
Gender, N (%)			
Male	7 (58)	3 (43)	10 (53)
Female	5 (42)	4 (57)	9 (47)
Race, N (%)			
White	11 (92)	7 (100)	18 (95)
Other	1 (8)	0 (0)	1 (5)
Diagnosis,[a] N (%)			
Chronic myelogenous leukemia (CML)	5 (42)	2 (29)	7 (36)
Acute leukemias	3 (25)	1 (14)	4 (21)
Myelodysplastic syndrome (MDS)	3 (25)	1 (14)	4 (21)
Breast cancer	0 (0)	2 (29)	2 (11)
Non-Hodgkin's lymphoma (NHL)	1 (8)	1 (14)	2 (11)
Cell type, N (%)			
Bone marrow	11 (92)	4 (57)	15 (79)
Stem-cell	1 (8)	3 (43)	4 (21)
Donor type, N (%)			
Allogenic	12 (100)	5 (71)	17 (89)
Autologous	0 (0)	2 (29)	2 (11)

MacCAT–T: MacArthur Competence Assessment Tool for Treatment.

All p values, based on chi-square test or Fisher's exact test, were nonsignificant..

[a]Because of the small numbers in the cells, the p value was obtained by use of collapsed categories of CML/acute leukemias/MDS versus breast cancer/NHL.

TABLE 2.

MacCAT–T Scores by Delirium-Episode Status

	Group						
	No Delirium Episode (N=12; 63%)			Delirium Episode (N=7; 37%)			
MacCAT-T Standard[a]	**Mean**	**Median**	**SD**	**Mean**	**Median**	**SD**	**P**
Pre-Transplantation[b]							
Understanding	5.96	6.00	0.13	5.79	5.88	0.25	NS
Reasoning	7.94	8.00	0.17	7.33	7.00	0.52	0.016
Day 30[b]							
Understanding	5.84	5.88	0.19	5.77	6.00	0.32	NS
Reasoning	7.75	8.00	0.46	6.94	7.00	0.78	0.030
Day 80[b]							
Understanding	5.70	5.75	0.37	5.72	6.00	0.41	NS
Reasoning	7.71	8.00	0.49	8.00	8.00	0.00	NS

p values are based on the Mann-Whitney *U* test. MacCAT–T: MacArthur Competence Assessment Tool for Treatment; SD: standard deviation; NS: not significant.

[a]Appreciation and Expressing Choice scores had no variation at any time-point, with all patients scoring 4 and 2, respectively.

[b]The number of patients (N) who had baseline, 30-day, and 80-day follow–up on the MacCAT were 17, 16, and 12, respectively.

TABLE 3.

Spearman Rank-Order Correlation Coefficients Between Several Neuropsychological Test Scores and the Reasoning and Understanding Scores of the MacCAT–T

Neuropsychological Test	Correlation (Reasoning)	p (*t*-test)	Correlation (Understanding)	p (*t*-test)
Pre-Transplantation				
Behavioral Dyscontrol Scale	−0.07	NS	−0.22	NS
Trailmaking B	0.004	NS	0.50	0.041
Digit Symbol	−0.13	NS	0.17	NS
Mini-Mental State Exam	0.45	0.068	0.44	NS
Hopkins Verbal Learning Test—Revised	0.35	NS	0.12	NS
Memorial Delirium Assessment Scale	−0.43	NS	−0.28	NS
Symptom Checklist Anxiety subscale	0.18	NS	−0.08	NS
Symptom Checklist Depression subscale	0.14	NS	−0.04	NS
Profile of Mood States Fatigue subscale	0.001	NS	−0.12	NS
Day 30				
Behavioral Dyscontrol Scale	0.34	NS	0.11	NS
Mini-Mental State Exam	0.27	NS	0.61	0.009
Memorial Delirium Assessment Scale	−0.22	NS	−0.34	NS
Symptom Checklist Anxiety subscale	−0.21	NS	−0.46	0.049
Symptom Checklist Depression subscale	−0.21	NS	−0.27	NS
Profile of Mood States Fatigue subscale	−0.41	NS	−0.23	NS
Day 80				
Behavioral Dyscontrol Scale	−0.34	NS	0.14	NS
Trailmaking B	0.34	NS	0.38	NS
Digit Symbol	0.37	NS	0.55	0.052
Mini-Mental State Exam	−0.17	NS	0.28	NS
Hopkins Verbal Learning Test—Revised	0.27	NS	0.61	0.028
Memorial Delirium Assessment Scale	−0.089	NS	−0.66	0.010
Symptoms Checklist Anxiety subscale	0.03	NS	−0.34	NS
Symptoms Checklist Depression subscale	0.35	NS	−0.54	0.038
Profile of Mood States Fatigue subscale	0.43	NS	−0.60	0.023

MacCAT–T: MacArthur Competence Assessment Tool for Treatment.

TABLE 4.

Linear-Regression Model for the Natural Logarithm of Summary MacCAT–T Score for Reasoning at Post-Transplantation Day 30

Factor (N=16)	Mean or %	β	95% CI	p (Wald test)
Delirium episode present	42.1%	−0.20	(−0.30 to −0.10)	0.003
Age (per 10 years)	39.5	0.01	(−0.03 to 0.05)	0.66
Gender (male)	57.9%	−0.04	(−0.12 to 0.04)	0.36
MaeCAT-T score (Reasoning, pre-treatment)	7.7	−0.04	(−0.18 to 0.10)	0.62

MacCAT–T: MacArthur Competence Assessment Tool for Treatment; CI: confidence interval.