Association Between Psychomotor Activity Delirium Subtypes and Mortality Among Newly Admitted Postacute Facility Patients

Dan K. Kiely, 1 Richard N. Jones, 1,3 Margaret A. Bergmann, 2 and Edward R. Marcantonio 2,3

1 Institute for Aging Research, Hebrew SeniorLife, Boston, Massachusetts.
2 Division of General Medicine and Primary Care, Beth Israel Deaconess Medical Center, Boston, Massachusetts.
3 Harvard Medical School/Beth Israel Deaconess Interdisciplinary Center on Aging, Boston, Massachusetts.

Methods. Patients were screened for delirium on admission to PAC facilities after an acute hospitalization, and patients with “Confusion Assessment Method”-defined delirium were enrolled. Psychomotor activity was assessed using the Memorial Delirium Assessment Scale, and patients were classified as to their delirium subtype (hyperactive, hypoactive, mixed, or normal). One-year mortality data were obtained from the National Death Index. A Kaplan–Meier survival analysis and a proportional hazards analysis using indicator (dummy) variables with normal psychomotor activity as the referent were performed.

Results. The normal psychomotor activity group had the lowest 1-year mortality rate, followed by the hyperactive, mixed, then hypoactive groups in increasing order. Independent of age, gender, comorbidity, dementia, and delirium severity, hypoactive patients were 1.60 (95% confidence interval [CI], 1.09–2.35) times more likely to die during the 1-year follow-up period than were patients with normal psychomotor activity. The hyperactive (hazard ratio = 1.30; 95% CI, 0.73–2.31) and mixed (hazard ratio = 1.25; 95% CI, 0.72–2.17) psychomotor groups had nonsignificant elevated risks relative to the normal psychomotor behavior group.

Conclusions. All three psychomotor disturbance subtypes had an elevated risk of dying during the 1-year follow-up relative to the normal psychomotor group, though the hypoactive group had the highest mortality risk and was the only group with a statistically significantly elevated risk relative to the normal group.

Delirium, a clinical syndrome characterized by acute decline in attention and cognition, is common among hospitalized patients and associated with increased risk of morbidity and mortality, increased health care costs, and adverse events that lead to loss of independence (1–7). Moreover, delirious patients are frequently discharged quickly from acute care facilities despite mounting evidence indicating that delirium may persist for months (5,8–10). Many of these patients are discharged to postacute care (PAC) facilities (rehabilitation hospitals and skilled nursing facilities) due to incomplete resolution of cognitive and functional problems that prevent their immediate return home. Consequently, much of the long-term sequelae of delirium may occur in the PAC setting rather than in acute care facilities. Recently, delirium has been studied in the PAC setting. We reported that delirium affects 16% of new admissions to PAC, that 51% of these patients are still delirious 1 month later, and that persistent delirium is associated with poor functional recovery (10–13).

Abnormal psychomotor behavior observed in delirious patients has been described as varying from lethargy and somnolence to restlessness, agitation, and hyperactivity. Disturbed psychomotor activity delirium subtypes have been commonly classified as hypoactive, hyperactive, and mixed (both hypoactive and hyperactive), and used in studies (14–24). Some of these studies have examined associations between psychomotor activity delirium subtypes and mortality in the hospital setting (14–20), and results have been inconsistent. We know of no studies that examined this association in the PAC setting and beyond. Thus, the purpose of this study is to examine the association between psychomotor activity delirium subtypes and 1-year mortality among 457 newly admitted delirious postacute facility patients. A secondary purpose is to compare percentages of psychomotor disturbance delirium subtypes to percentages reported in previous studies.

Methods

Study Population

Patients and their caregivers were recruited between October 1, 2000 and December 31, 2003 into a randomized clinical trial of a Delirium Abatement Program (DAP) from eight greater-Boston skilled nursing facilities specializing in PAC. The facilities ranged in size from 81 to 224 beds, with 40–80 of the beds Medicare-certified. Because of the impaired cognitive status of the patients, family caregivers provided informed consent using a protocol approved by our
In addition to having delirium at PAC admission (baseline), eligible patients in this study were ≥ 65 years old, were admitted directly from an acute-care medical or surgical hospitalization, spoke English, did not have a significant hearing impairment, were communicative prior to acute illness, were not admitted for terminal care (life expectancy < 6 months), did not have end-stage dementia, were not completely activities of daily living (ADL)—dependent prior to hospitalization, and lived within 25 miles of our research site. All interviews for delirium were conducted by trained research assistants and completed preferably within 72 hours (average time to interview = 2.5 days), but not longer than 5 days after admission. A research assistant completed a standardized mental status assessment. Only baseline assessments were used in this study. Multiple assessors were used, but inter-rater reliability of the assessment team was excellent (kappa = 0.95) (26).

Delirium Assessment

The Confusion Assessment Method (CAM) is a diagnostic algorithm derived from Diagnostic and Statistical Manual of Mental Disorders, Third Revision (DSM-III-R) criteria for delirium. The CAM allows trained research assistants to perform ratings of delirium presence that agree with a psychiatrist’s diagnosis with greater than 95% sensitivity and specificity, even in populations with a high prevalence of dementia (27). The CAM diagnostic algorithm involves four criteria: 1) an acute change in mental status with a fluctuating course, 2) inattention, 3) disorganized thinking, and 4) an altered level of consciousness (27). Delirium was considered present if CAM criteria 1 and 2 were present, and either criteria 3 or 4 were present.

Delirium Symptom Interview.—The Delirium Symptom Interview (DSI) (28) is a valid and reliable structured interview for diagnosing the presence of specific critical symptoms of delirium in an objective and straightforward manner, and can be administered by lay interviewers. The DSI was used to determine the presence of specific critical symptoms of delirium including the level of psychomotor activity that interviewers used to complete the Memorial Delirium Assessment Scale (MDAS).

Psychomotor activity disturbances: Delirium subtypes.—The MDAS (29) allows trained research personnel to quantify the severity of delirium based on 10 features, scored from 0 to 3 for a maximum score of 30. The 10 MDAS features include reduced level of consciousness, disorientation, short-term memory impairment, impaired digit span, reduced ability to maintain and shift attention, disorganized thinking, perceptual disturbance, delusions, decreased or increased psychomotor activity, and sleep–wake cycle disturbance. Psychomotor variants of delirium were defined using the MDAS.

At PAC admission, the severity of psychomotor disturbance was scored using the MDAS. The assessor rated whether the patient’s behavior had increased or decreased psychomotor activity during the interview and indicated whether the patient had any of the following: (i) hypoactivity, (ii) hyperactivity, or (iii) mixed features (both hypoactivity and hyperactivity) (15). Every patient has some level of psychomotor activity, and hypoactive or hyperactive disturbances are considered “abnormal.” If neither was present the assessor scored “none” and considered the patient to have “normal” psychomotor activity.

Mortality source: National Death Index.—The National Death Index (NDI) (30) is a database of death records maintained by the National Center for Health Statistics (NCHS), which compiles mortality data submitted by state vital statistics offices. We supplied the NCHS with a file that contained the DAP participants’ name, gender, birth date, and study identifier for those who were not known by us to be dead. The NCHS provided a file of NDI matches to this information (including death status, date of death, and primary and secondary causes of death). In some cases, more than one match was supplied in order of the best match. We used additional information such as state of residence, race, and marital status to determine the best match.

Covariates

Several baseline patient characteristics were controlled for in the adjusted analysis including age, gender, comorbidity, dementia, and delirium severity. A brief interview has been validated to obtain the data necessary to complete the Charlson Comorbidity Score (CCS) from patients or caregivers (31). This interview was administered to the family caregiver (proxy) at study intake to assess current comorbidity. Dementia was defined as a positive response to the “Alzheimer’s disease” or “dementia” item on the Charlson Comorbidity questionnaire or had an International Classification of Diseases, Ninth Revision (ICD-9-CM) diagnostic code indicating the presence of dementia on medical record review. The total MDAS score, with the exclusion of the decreased or increased psychomotor activity item, was included to adjust for delirium severity.

A variable was created indicating whether a patient was in a usual care or intervention facility. This variable was included in an additional adjusted analysis to control for the potential influence of the DAP on association between psychomotor type and 1-year mortality.

Data Analyses

Descriptive statistics were provided to characterize the entire sample, and each psychomotor activity delirium subtype. A Kaplan–Meier survival analysis (32) was performed, and the log-rank test and corresponding p value were used to determine if survival differed by psychomotor activity group. A corresponding plot was created to graphically display the survival trajectories over time for the psychomotor activity delirium subtypes. Unadjusted and
adjusted Cox proportional hazards analyses (32) were performed using indicator (dummy) variables with the normal psychomotor activity group as the referent. An alpha level of .05 was used in all analyses to determine statistical significance. SAS (33) was used in data manipulation and statistical analyses.

**RESULTS**

Among 7794 patient admissions, 6352 (81%) were eligible. A total of 4744 (75%) were screened, and 667 (14%) were classified as delirious. Of the 667, 138 had proxies who refused, 56 proxies did not respond within the enrollment period (despite repeated efforts), 14 patients died before the proxies were reached, and two proxies could not provide consent. Thus, 457 patients were enrolled in the study.

Table 1 shows that the average age of patients in this study was 84.0 years (standard deviation = 7.3), and the average comorbidity score was 2.6 (2.4). The average delirium severity score was 11.5 (3.7). Women represented 64.5% of the sample, and 37.6% had dementia. The 1-year mortality rate was 41.6%, which is consistent with other studies of hospitalized delirious elders (7). Table 1 also displays these patient characteristics stratified by psychomotor activity delirium subtype. Nearly half the patients had hypoactive psychomotor activity at baseline, and almost one third did not have disturbed psychomotor activity (normal). The remaining proportion almost equally comprised hyperactive and mixed subtypes.

Figure 1 presents the Kaplan–Meier survival curves for the three psychomotor disturbance subtypes and the normal psychomotor activity group. The normal group had the lowest 1-year mortality rate, followed by the hyperactive group, then the mixed group, in increasing order. The hypoactive group had the highest mortality rate. Differences in the survival trajectory of the delirium subtypes were statistically significant (log-rank = 10.9; p = .01).

We found no evidence that the proportional hazards assumption was violated. The unadjusted Cox proportional hazards analysis revealed that the hypoactive psychomotor group was 1.73 (95% confidence interval [CI], 1.22–2.45) times more likely to die during the 1-year follow-up relative to the normal psychomotor activity group (Table 2).

A similar relationship was found in the adjusted analysis (Table 3). Independent of age, gender, comorbidity, dementia, and delirium severity, hypoactive patients were 1.62 (95% CI, 1.11–2.37) times more likely to die over the 1-year follow-up period than were patients with normal psychomotor activity. The hyperactive (hazard ratio = 1.23; 95% CI, 0.70–2.18) and mixed (hazard ratio = 1.26; 95% CI, 0.73–2.14) psychomotor groups had less elevated risks relative to the normal psychomotor behavior group, and these risk estimates were not statistically significant. Twenty patients (4%) were excluded from the adjusted model due to missing values of covariates (n = 437).

The Cox proportional hazards adjusted model mentioned above was rerun with the inclusion of a variable indicating whether the patient received intervention or usual care. The results indicated that there was no intervention effect (p = .55) and the effect estimates were virtually identical to the estimates from the model without the intervention variable included (data not shown).

**DISCUSSION**

The results of this prospective study of 457 PAC patients indicate that delirious patients who entered the PAC with hypoactive psychomotor behavior had the highest risk of dying during the 1-year follow-up compared to the mixed, hyperactive, and normal psychomotor activity groups. Furthermore, unlike the mixed and hyperactive groups, the hypoactive group remained significantly more likely to die during the 1-year follow-up than was the normal psychomotor behavior group after adjusting for age, gender, comorbidity, dementia, and delirium severity.

In a recent review article of psychomotor activity delirium subtype studies, De Rooij and colleagues (24) emphasized the importance of understanding the different methods used to define and assess psychomotor activity. All studies included in their review used a different method for subtype classification, thus illustrating that there is no consensus concerning the optimal classification system for delirium subtypes.

Table 4 displays the percentages of the psychomotor activity delirium subtypes for our study and 10 other studies, and highlights three important points. First, the percentages...
of the psychomotor activity delirium subtypes vary dramatically across different studies. Second, many of these studies did not include a normal (no psychomotor disturbances) category or a mixed category (both hypoactivity and hyperactivity). Finally, differences in methods used to define psychomotor activity and the inclusion of patients from different settings (i.e., surgical, general medical, intensive care unit, neuropsychiatry clinic, case series) may partially explain the differences in percentages of delirium subtypes, and make it difficult to compare and generalize findings across these studies.

Liptzin and Levkoff (15) studied 325 patients admitted for medical or surgical care and reported that, among the 125 patients with DSM-III-defined delirium, the hyperactive patients had the lowest mortality rate in the hospital and at

Figure 1. Kaplan–Meier survival curves for the three psychomotor disturbance subtypes (hypoactive, hyperactive, mixed) and the normal (no psychomotor disturbances) psychomotor activity group. Differences in the survival trajectory of the delirium subtypes were statistically significant (log-rank = 10.9; \( p = .01 \)). Normal; M = mixed; H = hypoactive; R = hyperactive.

Table 2. Unadjusted Hazard Ratios and 95% Confidence Intervals (CI) Estimating the Risk of Dying During the 1-Year Follow-Up Period for Patients With Abnormal Psychomotor Activity (Hyperactive, Mixed, Hypoactive) Relative to Normal Psychomotor Activity (Reference Group) \((N = 457)\)

<table>
<thead>
<tr>
<th>Psychomotor Activity</th>
<th>Hazard Ratio</th>
<th>95% CI</th>
<th>( p ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>1.00</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Hyperactive</td>
<td>1.12</td>
<td>0.64, 1.95</td>
<td>.70</td>
</tr>
<tr>
<td>Mixed</td>
<td>1.42</td>
<td>0.86, 2.34</td>
<td>.17</td>
</tr>
<tr>
<td>Hypoactive</td>
<td>1.73</td>
<td>1.22, 2.45</td>
<td>.002</td>
</tr>
</tbody>
</table>

Notes: *Memorial Delirium Assessment Scale (excluding the “decreased or increased psychomotor activity” item). This is a measure of delirium severity.

\( CI = \) Confidence interval; \( CCS = \) Charlson Comorbidity Score; \( Dementia = \) either International Classification of Diseases, Ninth Revision (ICD-9) code for dementia or CCS dementia item positive.
nursing facility patients may not generalize to individuals
locations. Results of our study involving PAC skilled
Concerning limitations, our data were collected from a single
assessors was excellent. NDI data were successfully linked
validated diagnostic algorithm (CAM), performed assess-
Trained research personnel, using an established and
admitted to PAC skilled nursing facilities for up to 1 year
literature by following a large cohort of delirious patients
and that patients with persistent delirium were more likely to
die in the hospital compared with patients who resolved
etologic and outcome profiles in a case series of 183 elderly
patients and found that hypoactive patients had the highest
mortality (10%) followed by hyperactive (9%) and mixed
activity died during their study period. O’Keefe and Lavan
(34) prospectively examined 94 hospital patients and
reported that a higher percentage of hypoactive (21%)
patients died compared to hyperactive (15%), mixed (16%),
and neither (0%). Camus and colleagues (18) compared the
eiologic and outcome profiles in a case series of 183 elderly
patients and found that hypoactive patients had the highest
mortality (10%) followed by hyperactive (9%) and mixed
(6%). The findings of these last two studies are consistent
with the results of our study, though, unlike our study, the
differences in both of these studies were not statistically
significant.

Marcantonio and colleagues (20) prospectively studied
122 hip fracture surgery patients and found that hyperactive
patients (including mixed-type patients who were combined
with the hyperactive types) were more likely to die after hip
fracture compared to hypoactive patients, though this
difference was not statistically significant. Kelly and
colleagues (19) studied a series of nursing facility delirium
patients and reported that psychomotor activity delirium
subtype did not predict mortality during or subsequent to the
patient’s hospitalization. However, they report that hypo-
active patients were more likely to have persistent delirium
and that patients with persistent delirium were more likely to
die in the hospital compared with patients who resolved
their delirium. Our study significantly adds to the above
literature by following a large cohort of delirious patients
admitted to PAC skilled nursing facilities for up to 1 year
after the delirium episode.

This study has strengths and limitations to consider.
Trained research personnel, using an established and
validated diagnostic algorithm (CAM), performed assess-
ments. The inter-rater reliability of our study team of
assessors was excellent. NDI data were successfully linked
to our PAC data allowing for the study of 1-year mortality.
Concerning limitations, our data were collected from a single
metropolitan region and may not generalize to rural
locations. Results of our study involving PAC skilled
nursing facility patients may not generalize to individuals
receiving PAC in a rehabilitation hospital or community
setting. Although our assessments were performed within
2.5 days of PAC admission, we cannot be sure if some
patients developed delirium after admission to the PAC
facility. Some mismatching could have occurred when
linking the NDI data to our database, though we would
expect that this misclassification is nondifferential and
would likely increase the association if removed. Finally,
the relatively small sample sizes in the hyperactive ($n = 47$
and mixed ($n = 55$) subgroups may have contributed to
a lack of power in detecting statistically significant differ-
ences in the mortality analysis.

Our findings have substantial clinical significance. The
literature has documented that physicians and nurses are less
likely to detect cases of hypoactive delirium than other
psychomotor disturbance subtypes (6). These patients are
not immediately disruptive to their medical care, yet their
delirium makes them unlikely to engage in activities that
will promote recovery from acute illness. Our findings
associating this class of delirium with the highest mortality
risk emphasize the need for systematic case finding effects
to detect hypoactive delirium. These efforts will ensure that
(i) hypoactive delirium is promptly recognized, (ii) the
underlying causes of the delirium are properly addressed,
and (iii) a plan for ADL support and functional reha-
bilitation is developed. These steps are imperative to reduce
mortality risk and promote functional recovery among these
highly vulnerable patients.

Conclusion
All three psychomotor disturbance subtypes had an
elevated risk of dying during the 1-year follow-up relative
to the normal psychomotor group, though the hypoactive
group had the highest mortality risk and was the only
statistically significantly different group relative to the
normal group. This finding has additional importance
considering that the hypoactive form of delirium is common
among older persons and often goes unrecognized (7,37).

Acknowledgments
This work was supported in part by grants R01AG17649 (to E. R. M.)
and R03AG025262 (to R. N. J.) from the National Institute on Aging.
Dr. Marcantonio is a Paul Beeson Physician Faculty Scholar in Aging Research.

We thank Monique Bussell, Kerry Clark, Kathryn Johnson, Maria Kereshi, Jennifer Kettell, Melissa McKenna, Mary Michaels, and Sara Van Valkenburg for their efforts to enroll and interview patients for this study, and Judy Coulombre and Maryann Wallace for medical record review. We also acknowledge Pamela A. Heidell and Ellen Gornstein for reviewing the manuscript.

Address correspondence to Dan K. Kiely, MPH, MA, Hebrew SeniorLife, Institute for Aging Research, 1200 Centre Street, Boston, MA 02131. E-mail: kiely@hrca.harvard.edu

REFERENCES


Received June 14, 2006
Accepted August 4, 2006
Decision Editor: Darryl Wieland, PhD, MPH