



## Articles

# Nurse-Driven 4AT Delirium Screen and Outcomes in Hospitalized Older Adults

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## Delirium

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### Background

Delirium is associated with poor clinical outcomes including morbidity, mortality, prolonged length of stay (LOS), and unfavorable discharge location, yet it is under-recognized in hospital settings due to a lack of routine assessment. The 4AT is a brief validated delirium screening tool.

### Objective

This study aims to determine whether nurse-performed hospital 4AT scores are associated with LOS, discharge location, in-hospital mortality in older adults at an urban US hospital.

### Methods

As part of a quality improvement project, hospital nurses at our institution began routinely administering the 4AT every shift. We analyzed 4AT scores from 5,585 unique older adult (65+) hospital admissions occurring between 11/2022-05/2023. Maximum 4AT scores for each hospitalization were related to LOS, discharge location (home versus non-home), and in-hospital mortality using logistic regression models.

### Results

89.9% of patients received at least one 4AT score during hospitalization. Mean patient age on admission was 75.3 years (SD= 7.9). Patients in the study predominantly identified as Black (61.4%) or White (28.0%); 14.9% had maximum 4AT between 1-3, and 15.2% had maximum 4AT  $\geq 4$ . The mean LOS increased with increasing 4AT scores. The mean LOS for patients with a maximum 4AT score  $\geq 4$  was 11.6 days (SD= 11.8), compared to a mean LOS of 4.8 days (SD= 5.4) for patients with a maximum 4AT score=0. Adjusted logistic regression models revealed an OR of 0.24 (95% CI [0.20-0.30]) for discharge home when comparing patients with 4AT score  $\geq 4$  compared to patients whose 4AT score=0. 4AT scores  $\geq 4$  were also significantly associated with risk of in-hospital mortality compared to 4AT scores=0 (OR 16.6 95% CI [7.8-35.5]).

### Conclusions

Routinely administering the 4AT tool can help identify those at risk of longer LOS, unfavorable discharge locations, and in-hospital mortality, reinforcing the need for early and effective delirium treatment and implementation of delirium prevention strategies.

## BACKGROUND

Delirium is an acutely altered mental status characterized by inattention and fluctuating course. All hospitalized patients are at risk for delirium, but older adults are particularly vulnerable.<sup>1</sup> Delirium occurs in approximately 23% of hospitalized adults.<sup>2</sup> Delirium has been associated with increased morbidity and mortality, prolonged hospital admissions, increased need for rehabilitation, higher rates of

institutionalization, and greater healthcare costs.<sup>3</sup> Cost-effective, evidence-based delirium prevention interventions are well established.<sup>4</sup> Yet, in clinical practice, delirium is under-recognized in approximately 60% of hospitalized patients, although there is variation across sites and methods of delirium detection.<sup>5,6</sup> Delirium prevention strategies and early identification of delirium enhance patient safety, improve patient and family experience, and reduce hospital costs.<sup>4</sup>

The 4AT is a brief, valid, clinical screening tool.<sup>7</sup> The 4AT tool measures patients' level of alertness, orientation, attention, and acute change or fluctuation in course. The benefit of the 4AT tool is that is short (less than 2 minutes), easy to learn and administer, can be used in patients without the ability to produce a verbal response, and is usable by all health professionals. A meta-analysis found this tool has a pooled sensitivity of 88% and a pooled specificity of 88%.<sup>8</sup> The 4AT has been shown to be a good predictor of clinical outcomes including length of stay, mortality, and discharge to home outside of the US.<sup>9,10</sup>

To date, there have been limited studies of the 4AT tool as a predictor of clinical outcomes conducted within the US on hospitalized older adults, particularly in economically and racially diverse patients. In this study, we aim to examine the utility of a routine nursing-driven 4AT screen as a predictor of quality-measured clinical outcomes (length of stay, discharge location, and in-hospital mortality) in diverse hospitalized older adults.

## METHODS

### STUDY DESIGN AND SETTING

As part of a quality improvement project, nurses at our institution have routinely implemented delirium screening using the 4AT for all patients on medical or surgical floors within 24–72 hours of admission using the 4AT tool and then once a shift thereafter.<sup>11</sup> In emergency admissions aged 65 or over, delirium is often present at the time of admission, so detection at the point of admission or very soon after is important.<sup>12</sup> We analyzed hospital admissions occurring between September 2022 to May 2023. We included all admissions for patients aged ≥65 at the time of admission from all general medical/surgical hospital floor patients. Patients discharged from any ICU service, gynecology service, or without any 4AT score were excluded from the study. If a patient had multiple hospitalizations during the study period, only the first hospitalization was considered in the analysis.

This project was formally determined to be quality improvement, not human subjects research, and was therefore not overseen by the Institutional Review Board, per institutional policy.

### DELIRIUM MEASURE

Each hospitalization was categorized based on the maximum 4AT score recorded at any point during hospitalization. Categories of hospitalization included maximum 4AT score ≥4 (delirium), maximum 4AT score=1–3 (possible cognitive impairment), and maximum 4AT score=0 (no delirium).

### OUTCOMES

Length of stay was defined as time from admission to discharge and treated as a continuous measure. Discharge location was categorized as home versus non-home locations. "Home" included discharge home and discharge to home

with home health. Skilled Nursing Facilities (SNF), Long-term Acute Care Hospitals (LTACH)/Acute rehabilitation, and Hospice were considered non-home discharge locations. Mortality was defined as in-hospital mortality.

### COVARIATES

Age, gender, race (Black/African American, White, other, more than 1 race, Unknown), type of admission (Emergency, Elective, Trauma, Urgent), first Activity Measure-Post Acute Care Inpatient Mobility Short Form (AM-PAC) score, ever being in the ICU, discharge service (Medicine, Hematology/Oncology, Neurology, Surgery), and primary diagnosis (Cardiac, Gastro, Hematology/Oncology, Pulmonary, Musculoskeletal, Other) were extracted from the medical records. These covariates were chosen based on clinical importance and known associations with the outcomes.

### DATA ANALYSIS

Each hospitalization was categorized based on the maximum 4AT score recorded at any point during hospitalization. The demographic and health characteristics of the sample overall and stratified by in-hospital 4AT categories were summarized using mean and standard deviation for continuous variables and frequency counts and percentages for categorical variables. Groups were compared using chi-squared tests and t-tests.

Univariate and multivariate linear regression models were fit for length of stay among survivors. Univariate and subsequent multivariate logistic regression models were fit for discharge location (home vs. not home) and LOS among survivors, as well as in-hospital mortality. All covariates were included in multivariate models. Analyses were performed using Stata 18 (StataCorp. LLC, College Station, TX).

## RESULTS

### SAMPLE CHARACTERISTICS

We analyzed data from 5,585 unique hospitalizations over the study period, 15.2% of which were categorized as having delirium (maximum 4AT score ≥4). In total, 628 hospitalizations were excluded from the study because there was no 4AT score recorded, for a completion rate of 89.9% of at least one 4AT assessment. The mean patient age on admission was 75.3 years (SD= 7.9). Patients in the study predominantly identified as Black (61.4%) or White (28.0%). The majority of hospitalizations (69.8%) were classified as having no delirium (maximum 4AT score=0) and 14.9% were categorized as having possible cognitive impairment (maximum 4AT score=1–3). The patient characteristics are shown in [Table 1](#). There was a statistically significant difference in maximum 4AT scores between admission types, patient-identified races, hospital services, primary diagnosis groups, age on admission, and whether or not the patient ever spent time in the ICU (all p-values <0.001). There was

**Table 1. Patient Characteristics**

| Maximum 4AT Score                   | 0            | 1-3        | 4+          | p-value |
|-------------------------------------|--------------|------------|-------------|---------|
|                                     | N= 3,901     | N=833      | N=851       |         |
| Gender, n (%)                       |              |            |             | 0.041†  |
| Female                              | 2,061 (52.8) | 464 (55.7) | 486 (57.1)  |         |
| Mean Age on Admission (years) ± SD  | 74.0 ± 7.0   | 78.0 ± 8.7 | 78.8 ± 9.2  | <0.001‡ |
| Patient-identified race, n (%)      |              |            |             | <0.001† |
| Black                               | 2,201 (56.4) | 625 (75.0) | 604 (71.0)  |         |
| White                               | 1,244 (31.9) | 150 (18.0) | 169 (19.9)  |         |
| Other                               | 86 (2.2)     | 12 (1.4)   | 7 (0.8)     |         |
| More than 1 race                    | 89 (2.3)     | 19 (2.3)   | 27 (3.2)    |         |
| Unknown                             | 281 (7.2)    | 27 (3.2)   | 44 (5.2)    |         |
| Hospital Admission Type, n (%)      |              |            |             | <0.001† |
| Elective                            | 1,371 (35.2) | 62 (7.4)   | 48 (5.6)    |         |
| Emergency                           | 2,072 (53.1) | 654 (78.5) | 652 (76.6)  |         |
| Trauma                              | 70 (1.8)     | 33 (4.0)   | 51 (6.0)    |         |
| Urgent                              | 387 (9.9)    | 84 (10.1)  | 100 (11.8)  |         |
| Discharging Hospital Service, n (%) |              |            |             | <0.001† |
| Medicine                            | 2,055 (52.7) | 554 (66.5) | 527 (61.9)  |         |
| Hematology/Oncology                 | 410 (10.5)   | 102 (12.2) | 77 (9.0)    |         |
| Neurology                           | 139 (3.6)    | 68 (8.2)   | 126 (14.8)  |         |
| Surgery                             | 1,297 (33.2) | 109 (13.1) | 121 (14.2)  |         |
| Primary Diagnosis Group, n (%)      |              |            |             | <0.001† |
| Cardiology                          | 946 (24.3)   | 185 (22.2) | 215 (25.3)  |         |
| Gastroenterology                    | 418 (10.7)   | 66 (7.9)   | 41 (4.8)    |         |
| Hematology/Oncology                 | 537 (13.8)   | 67 (8.0)   | 57 (6.7)    |         |
| Pulmonology                         | 255 (6.5)    | 49 (5.9)   | 44 (5.2)    |         |
| Musculoskeletal                     | 320 (8.2)    | 34 (4.1)   | 20 (2.4)    |         |
| Other                               | 1,423 (36.5) | 432 (51.9) | 473 (55.6)  |         |
| Mean First AM-PAC score ± SD        | 18.0 ± 4.9   | 14.1 ± 4.9 | 11.2 ± 5.1  | <0.001‡ |
| Ever in ICU, n (%)                  |              |            |             | <0.001† |
| Yes                                 | 264 (6.8)    | 118 (14.2) | 224 (26.3)  |         |
| Mean LOS (days) ± SD^               | 4.8 ± 5.4    | 7.9 ± 7.9  | 11.6 ± 11.8 | <0.001‡ |
| Discharge Location, n (%)^          |              |            |             | <0.001† |
| Home                                | 3419 (87.9)  | 471 (57.3) | 305 (39.1)  |         |
| LTACH/ Acute Rehabilitation         | 115 (3)      | 84 (10.2)  | 103 (13.2)  |         |
| SNF                                 | 303 (7.8)    | 237 (28.8) | 286 (36.6)  |         |
| Hospice                             | 29 (0.8)     | 27 (3.3)   | 83 (10.6)   |         |
| AMA                                 | 23 (0.5)     | 4 (0.4)    | 4 (0.5)     |         |
| In-Hospital Mortality, n (%)        |              |            |             | <0.001† |
| Yes                                 | 11 (0.28)    | 9 (1.08)   | 69 (8.11)   |         |

SD, Standard Deviation; AM-PAC, Activity Measure for Post-Acute Care; ^, Among survivors; †, P-value of Chi-squared Test; ‡, P-value of Linear Regression; Primary Diagnosis Group is based on ICD 10 code first alphabetical letter: Cardiology, I; Gastroenterology, K; Hematology/ Oncology, C, D; Pulmonology, J; Musculoskeletal, M; Other, E, F, H, L, R- Z); LTACH, Long Term Acute Care Hospital; SNF, Skilled Nursing Facility

a modest difference in delirium between women and men (p-value=0.041).

#### HOSPITAL ADMISSION TYPE

Significant differences in outcomes were seen between hospital admission types. Notably, more than 75% of patients with a maximum 4AT score ≥4 were admitted from the

**Table 2. Relationship Between 4AT Score and Outcomes**

| Maximum 4AT Score | Adjusted Reg Coeff (95% CI) | Adjusted OR (95% CI) | Adjusted OR (95% CI)  |
|-------------------|-----------------------------|----------------------|-----------------------|
|                   | LOS                         | Discharge to Home    | In-Hospital Mortality |
| 4AT= 0            | Reference                   | Reference            | Reference             |
| 4AT= 1-3          | 2.3 (1.8-2.9)               | 0.35 (0.29-0.43)     | 2.3 (0.9-5.9)         |
| 4AT≥ 4            | 5.4 (4.8-6.0)               | 0.24 (0.20-0.30)     | 16.6 (7.8- 35.5)      |
| Overall p-value   | <0.001                      | <0.001               | <0.001                |

LOS, Length of Stay; Reg Coeff, Regression Coefficient; OR, Odds Ratio; CI, Confidence Interval; Regression models adjusted for age, gender, race, type of admission, first AMPAC, ever in ICU, discharge service, and primary diagnosis.

emergency admission. Moreover, only 3% of elective admissions had a maximum 4AT score ≥4, compared to 20% of non-elective admissions (including emergency, trauma, and urgent).

#### LENGTH OF STAY

The mean length of stay (LOS) among all patients surviving hospitalization was 6.3 days (SD= 7.5) and the mean length of stay significantly increased with increasing maximum 4AT scores (p-value<0.001). The mean LOS for patients with a maximum 4AT score ≥4 was 11.6 days (SD= 11.8, median=8), compared to a mean LOS of 7.9 days (SD= 7.9, median=6) for patients with a maximum 4AT score=1-3 and mean LOS of 4.8 days (SD= 5.4, median=3) for patients with a maximum 4AT score=0. Linear regression models adjusted for age, gender, race, type of admission, first AM-PAC, ever in ICU, discharge service, and primary diagnosis showed that the average LOS was 2.3 and 5.4 days longer for those with a maximum 4AT score of 1-3 or 4+, respectively, compared to those with a score of 0 (p-value <0.001) (Table 2).

#### DISCHARGE LOCATION

While 87.9% of patients with 4AT score=0 and 57.3% of patients with 4AT score=1-3 were discharged to home, only 39.1% of patients with 4AT score ≥4 were discharged home. Moreover, 36.6% of patients with 4AT score ≥4 were discharged to a skilled nursing facility, 13.2% to a long-term acute care hospital or acute rehab, and 10.6% to hospice, compared to 7.8%, 3.0%, and 0.8%, respectively, of patients with 4AT score=0. All discharge locations and frequency by maximum 4AT score are shown in Figure 1. Logistic regression models adjusted for age, gender, race, type of admission, first AM-PAC, ever in ICU, discharge service, and primary diagnosis revealed an OR of 0.24 (95% CI [0.20-0.30]) for discharge home when comparing patients with 4AT score ≥4 compared to patients whose 4AT score=0 (Table 2). Further analysis showed an OR of 0.35 (95% CI [0.29-0.43]) for discharge home when comparing patients with 4AT score=1-3 to those with 4AT score=0 (Table 2; overall p-value<0.001).

#### IN-HOSPITAL MORTALITY

Table 1 shows that a total of 89 patients experienced in-hospital mortality, and of these patients, 69 (77.5%) had a 4AT score ≥4. Logistic regression models adjusted for age,

gender, race, type of admission, first AMPAC score, ever in ICU, discharge service, and primary diagnosis revealed an OR of 16.6 (95% CI [7.8-35.5]) for in-hospital mortality for patients with a 4AT score ≥4 compared to patients whose 4AT score=0 (Table 2; p-value <0.001). Additionally, adjusted OR of in-hospital mortality for patients 4AT score ≥4 compared to patients whose 4AT score=1-3 was 2.3 (95% CI [0.9-5.9]) (Table 2; p-value<0.001).

#### DISCUSSION

Routine nurse-administered 4AT scores were associated with longer length of stay and non-home discharge locations in a diverse, hospitalized U.S. sample. Similar to prior studies, patients with a 4AT score indicating delirium or possible cognitive impairment had significantly longer hospitalizations, significantly lower odds of being discharged home and significantly higher odds of in-hospital mortality than patients with no impairment.<sup>9,10</sup> Our findings demonstrate that the 4AT tool can be used to routinely and quickly screen for risk of negative clinical outcomes among hospitalized U.S. older adults in an urban, vulnerable patient setting.<sup>4,9</sup> We attribute the high rate patients receiving at least one 4AT score during hospitalization (89.9%) to the utilization of trained nurses as administrators of the tool. This aligns with literature showing high completion of 4AT by staff.<sup>6</sup> Our study demonstrates a pragmatic way to use trained nursing staff to administer delirium screening tools.

We observed an association in delirium prevalence among patients of different racial backgrounds. Specifically, patients who identified as Black exhibited a higher prevalence of 4AT scores indicative of delirium compared to patients of other racial groups. This finding aligns with prior research that has documented an increased incidence of delirium in Black and Hispanic-Latinx patients when compared to their non-Hispanic White counterparts.<sup>13</sup> These disparities in delirium rates may be attributed to neighborhood-level markers of social disadvantage, systemic inequities within the healthcare system, and higher rates of multimorbidity, which may result in the undertreatment of delirium among Black patients, relative to their White counterparts.<sup>14-16</sup>

These discoveries merit increased investment and participation in multicomponent delirium screening and prevention strategies. Well-established delirium prevention interventions such as the Hospital Elder Life Program

(HELP), have been proven to reduce the incidence of delirium in older adults, resulting in both decreased length of stay and rates of institutionalization after hospitalization but are underutilized.<sup>17</sup> Given that patients from minority groups are more likely to experience in-hospital delirium and therefore negative clinical outcomes, delirium prevention strategies may be a major target for reducing health disparities in older adults.

In addition, delirium prevention strategies must be accompanied by improved treatment of delirium. Prior studies have shown a high prevalence of delirium in the emergency room at initial presentation, varying from 7-35%.<sup>18</sup> The prevalence of delirium in the emergency room highlights the need for early detection and treatment to ameliorate the inequities associated with hospital delirium.

The strengths of the study include the large number of hospitalizations with a diverse array of primary diagnoses, discharge services and a large proportion of patients identifying as Black. It is noteworthy that research on the implementation of delirium assessment tools in routine clinical practice is scarce, and this study significantly contributes to this limited body of literature with its extensive scope. Limitations of our study include that we did not include or assess individuals who did not receive a 4AT score. Additionally, the study's generalizability is constrained due to our hospital's disproportionate representation of Black patients and underrepresentation of White, Hispanic, and Asian American patients. Furthermore, though the 4AT has strong validation data, it is a brief assessment tool and that a final diagnosis needs to be made by the clinical team.

Despite these limitations, this study supports that the 4AT tool can identify patients at risk for poor clinical outcomes in hospitalized older adults and highlights the need to implement multicomponent delirium prevention strategies to reduce the incidence of delirium and thus diminish the burden of the associated adverse outcomes.

#### AUTHOR CONTRIBUTIONS

Study Concept and Design: MS, MHS, DR, MM, LJG

Data Extraction: LH

Drafting of manuscript: MS, KW, LJG

Statistical Analysis: MS, KW, LJG

Critical Revisions and important intellectual content of manuscript: BS, MHS, DR, MM, LH, KW, LJG

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