Depressive Symptoms and Adherence to Asthma Therapy After Hospital Discharge*

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**Study objectives:** To evaluate the effect of depressive symptoms on adherence to therapy after discharge in patients hospitalized for asthma exacerbations.

**Design:** Prospective cohort study in which depressive symptoms were assessed during hospitalization and use of asthma medications was electronically monitored for 2 weeks after discharge.

**Setting:** Inner-city academic hospital in Baltimore, MD.

**Patients:** Patients were 59 adults with a mean age of 43.2 ± 10.9 years (± SD), who were mostly female (64%), African American (80%), and were hospitalized for an asthma exacerbation.

**Measurement and results:** Depressive symptoms were assessed with the Center for Epidemiological Studies-Depression scale. Electronic monitors were used to evaluate inhaled corticosteroid and oral corticosteroid use for up to 2 weeks after discharge. Forty-one percent of patients had high levels of depressive symptoms. Mean adherence to therapy was significantly lower in patients with (vs without) high levels of depressive symptoms (60 ± 26% vs 74 ± 21%, p = 0.02). Even after controlling for age, gender, and education, depressive symptoms were a significant and independent predictor of poorer adherence. High levels of depressive symptoms were associated with a 11.4-fold increase (95% confidence interval, 2.2 to 58.2) in the odds of poor adherence to therapy after adjustment for potential confounders.

**Conclusions:** Depressive symptoms are common in inner-city adults hospitalized for asthma exacerbations and identify a subset of patients at high risk for poor adherence to asthma therapy after discharge. Further research is needed to determine if screening for and treating depression improves adherence and asthma outcomes in this population.

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**Key words:** adherence; asthma; depression; inner city

**Abbreviations:** CES-D = Center for Epidemiological Studies-Depression; ICS = inhaled corticosteroid therapy; MDI = metered-dose inhaler; OCS = oral corticosteroid therapy

Despite the availability of effective therapies for asthma, hospitalization for severe asthma exacerbations are common, particularly among inner-city and minority populations.1 There is substantial evidence to indicate that poor adherence to asthma therapy contributes to severe asthma exacerbations and occurs even in the absence of barriers related to cost and inadequate knowledge.2–5 Emerging evidence from research in several chronic health conditions, including diabetes, HIV, and heart disease,6,7 suggests that psychosocial factors such as depression may contribute to poor adherence to therapy.8–12

Surprisingly, while depression is common among
adults with asthma, there are no published data evaluating the relationship between depression and adherence to therapy in patients hospitalized for asthma exacerbations, a subgroup at high risk for near-fatal and fatal exacerbations after discharge home. Moreover, most studies to date in asthma and other chronic health conditions have relied on self-reported adherence or pill counts to assess adherence; these measures are known to have variable reliability and validity.

Thus, the primary objective of this study was to explore the relationship between depressive symptoms and electronically monitored adherence to asthma therapy after discharge home in inner-city adults hospitalized for severe asthma exacerbations. We hypothesized that high levels of depressive symptoms would be associated with lower rates of adherence after discharge from the hospital.

Materials and Methods

This study was approved by the Johns Hopkins Internal Review Board. Data were collected as part of a prospective cohort study conducted from April 2001 through October 2002, which has been previously described. Participants were men and women ≥18 years old who had been admitted to an inner-city hospital with a physician diagnosis of asthma exacerbation. Participants did not have other respiratory disorders or contraindications to inhaled corticosteroids (ICS) and/or oral corticosteroids (OCS).

During hospitalization, patients met with a research assistant, who obtained written informed consent to participate. Sociodemographic information and asthma-related health-care use was queried by the research assistant. An abbreviated version of the Center for Epidemiologic Studies-Depression (CES-D) scale was used to assess depressive symptoms. The CES-D scale is the most widely used measure of depressive symptoms and has been shown to be reliable and valid in inner-city populations. We used the 11-item version of the scale (ie, IA Form), which has been shown to have adequate psychometric properties and correlates well with the original 20-item CES-D (ie, Cronbach α = 0.81). Based on published recommendations, a CES-D score ≥10 was used to define high levels of depressive symptoms.

On the day of hospital discharge, participants were provided OCS (prednisone, 20 mg; two tablets per day for 7 days) and ICS (fluticasone metered-dose inhaler [MDI], 220 µg/puff; two puffs twice per day). Patients received training to optimize MDI technique as well as written and verbal instructions about their asthma regimen after hospital discharge. Trainers were blinded to depressive symptom status. Education was repeated until participants could correctly explain their medication regimen and demonstrate appropriate MDI technique. Electronic medication monitors, which provide the daily use of MDI and OCS, were utilized to assess use of ICS (DOSE CT; Meditrac Inc; Hudson, MA) and OCS (MEMS TrackCaps IV; AARDLEX Ltd; Union City, CA) after hospital discharge. Participants were informed that medication use was evaluated but were not told about the precise monitoring abilities of the devices. Participants were asked to return to a follow-up visit 2 weeks after discharge with all unused study medications.

Statistical Analysis

Electronic data were truncated at 100% each day to prevent excess use on some days (eg, test puffs or deliberate emptying of canister) from masking underuse on other days. Mean daily adherence was calculated as the actual use/prescribed use × 100%. Mean adherence for ICS was calculated during the first 14 days after discharge. Because OCS were prescribed for only the first 7 days after hospital discharge, adherence to OCS was defined as mean daily adherence during this 7-day period. Adherence to treatment was calculated as the mean of ICS and OCS adherence. As in other asthma studies, we defined poor adherence to asthma therapy as defined as <50%. Descriptive statistics were calculated using means and SDs for continuous variables and proportions for categorical variables. Student t test, Wilcoxon rank-sum tests, and χ² tests were used to analyze differences between groups. Multivariable linear and logistic regression models were used to identify the independent effect of depression on adherence to asthma therapy. Variables selected for inclusion in the regression models were age, gender, and education, since sociodemographic factors have been previously shown to be associated with depressive symptoms. Statistical significance was defined as a two-tailed p value of < 0.05. Analyses were performed using STATA Version 9.0 (StataCorp; College Station, TX).

Results

Participants

Of 111 eligible patients, 82 patients (74%) agreed to participate in the study. Fifty-nine patients (72%) completed the 2-week follow-up visit and had complete data on adherence to ICS and OCS (hereby referred to as “participants”). As compared with participants, patients without adherence data were younger (43.2 ± 10.9 years vs 35.8 ± 9.3 years, p = 0.005), but they did not differ on the other measured sociodemographic or asthma-related characteristics. Participants were most often unmarried African-American women who were high school graduates and currently unemployed (Table 1). Asthma morbidity was high. More than half (59%) had at least one hospitalization for asthma in the past year, and 83% reported having visited the emergency department for asthma in the past year. High levels of depressive symptoms were reported by 41% of the sample. Individuals with high levels of depressive symptoms did not differ on any demographic or asthma-related characteristics assessed.

Average Daily Adherence

Among all participants, adherence to therapy after discharge averaged 68% (95% confidence interval, 62 to 74%; range, 13 to 100%). Nearly one quarter (24%) used less than half of their prescribed asthma medications. No significant difference was observed between adherence to ICS and OCS.
Adherence and Depressive Symptoms

The mean (± SD) daily adherence to therapy was significantly lower in patients with (vs without) high levels of depressive symptoms (60 ± 26% vs 74 ± 21%, p = 0.02). Patients with high levels of depressive symptoms were significantly more likely to have poor adherence to asthma therapy (odds ratio, 5.5; 95% confidence interval, 1.5 to 20.7).

In a multivariable linear regression model that controlled for patients’ age, gender, and education, higher levels of depressive symptoms (ie, higher CES-D scores) were an independent predictor of poor adherence (Table 2). Similarly, in a multivariable logistic regression model that controlled for age, gender, and education, clinically significant levels of depressive symptoms were associated with an 11-fold increase in the odds of poor adherence to asthma therapy (ie, < 50% of prescribed medications), as shown in Table 3.

**Discussion**

The main findings of this study are as follows: (1) high levels of depressive symptoms are common (ie, 41%) in inner-city patients hospitalized with asthma exacerbations, and (2) the presence of a high level of depressive symptoms is associated with an increased risk of poor adherence to asthma therapy after discharge home. Compared to patients with low levels of depressive symptoms, those with high levels of depressive symptoms had more than five times the odds of using less than half of their prescribed inhaled and oral asthma medications after discharge. The relationship between depressive symptoms and lower adherence remained significant even after controlling for age, gender, and education.

Depression is common in adults with chronic illnesses (up to 50%),32–34 and has been noted in up to 45% of persons hospitalized with myocardial infarction.35,36 In this study, we found a similarly high prevalence of depressive symptoms in patients hospitalized for asthma exacerbations. Though highly treatable, depression is often underdiagnosed and undertreated, resulting in increased medical morbidity, mortality, suicide risk, and health-care utilization.37 Our findings are consistent with previous reports38 of asthma patients seen in outpatient settings that have also observed that adherence is lower in patients who are depressed.

Several features of depression may influence adherence to a medication regimen including poor motivation (apathy), pessimism over effectiveness of treatment, acute deficits in attention, memory, and cognition, self-neglect, and intentional self-harm.39 Moreover, depression has been associated with increased sensitivity to unpleasant side effects of medication.40 Depression, through its influence on cognitions and attitude, also may lead patients to feel

### Table 1—Baseline Characteristics of Inner-city Participants Hospitalized With Severe Asthma (n = 59)*

<table>
<thead>
<tr>
<th>Variables</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sociodemographics</td>
<td></td>
</tr>
<tr>
<td>Age, yr</td>
<td>43.2 ± 10.9</td>
</tr>
<tr>
<td>Female gender</td>
<td>38 (64)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>47 (80)</td>
</tr>
<tr>
<td>White</td>
<td>10 (17)</td>
</tr>
<tr>
<td>Other</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
</tr>
<tr>
<td>Less than high school</td>
<td>22 (37)</td>
</tr>
<tr>
<td>High school and beyond</td>
<td>37 (62)</td>
</tr>
<tr>
<td>Employment</td>
<td></td>
</tr>
<tr>
<td>Full/part time</td>
<td>18 (31)</td>
</tr>
<tr>
<td>Unemployed</td>
<td>23 (39)</td>
</tr>
<tr>
<td>Disabled</td>
<td>11 (19)</td>
</tr>
<tr>
<td>Other</td>
<td>7 (12)</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>33 (56)</td>
</tr>
<tr>
<td>Married</td>
<td>8 (14)</td>
</tr>
<tr>
<td>Divorced, separated, or widowed</td>
<td>18 (31)</td>
</tr>
<tr>
<td>Asthma-related health-care use</td>
<td></td>
</tr>
<tr>
<td>Hospital visit in past year</td>
<td>35 (59)</td>
</tr>
<tr>
<td>ED visit in past year (n = 58)</td>
<td>48 (83)</td>
</tr>
<tr>
<td>CES-D score &gt; 10</td>
<td>24 (41)</td>
</tr>
</tbody>
</table>

*Data are presented as mean ± SD or No. (%).

### Table 2—Factors Associated With Mean Adherence to Asthma Therapy After Hospital Discharge in Inner-city Adults With Asthma Using Multiple Linear Regression (n = 59)

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Coefficient</th>
<th>SE</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.006</td>
<td>0.003</td>
<td>0.022</td>
</tr>
<tr>
<td>Gender</td>
<td>-0.172</td>
<td>0.063</td>
<td>0.009</td>
</tr>
<tr>
<td>Education</td>
<td>-0.008</td>
<td>0.061</td>
<td>0.896</td>
</tr>
<tr>
<td>CES-D (Iowa version)</td>
<td>-0.016</td>
<td>0.007</td>
<td>0.025</td>
</tr>
</tbody>
</table>

### Table 3—Factors Associated With < 50% Use of Asthma Therapy After Hospital Discharge in Inner-city Adults With Asthma Using Logistic Regression (n = 59)

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Odds Ratio</th>
<th>95% Confidence Interval</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>High depressive symptoms</td>
<td>11.4</td>
<td>2.2–58.2</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Age</td>
<td>0.9</td>
<td>0.9–1.0</td>
<td>0.06</td>
</tr>
<tr>
<td>Female gender</td>
<td>4.8</td>
<td>0.8–29.2</td>
<td>0.09</td>
</tr>
<tr>
<td>Lower education*</td>
<td>0.3</td>
<td>0.1–1.7</td>
<td>0.18</td>
</tr>
</tbody>
</table>

*Less than high school education vs high school education and beyond.
less satisfied with the effects of their medications and even their medical care in general. For example, we have previously reported that depressed inner-city mothers reported more negative beliefs about asthma therapy for their children and were more likely to misunderstand the function and use of asthma medications.10

Poor adherence to therapy increases the risk of adverse asthma-related outcomes, including emergency department visits and hospitalizations.4 Hence, our study adds to the growing body of evidence identifying depression as an important and modifiable factor related to both adherence to asthma therapy and asthma outcomes. These data suggest that routine screening of depressive symptoms (eg, CES-D41 or nine-item depression scale of the Patient Health Questionnaire42) may be indicated among patients with multiple hospitalizations for asthma; such efforts are likely to identify a large number of individuals who may benefit from therapy directed at treating depression (eg, counseling, medications) and more intensive follow-up after discharge home. Also, previous studies43–46 have shown that treatment of depression can improve adherence to therapies for comorbid conditions such as HIV and multiple sclerosis. Thus, a systematic approach of identifying and treating depression and other psychosocial risk factors in patients with multiple hospitalizations for asthma exacerbations may not only treat depression, but also improve asthma management and health-related outcomes after hospital discharge.

An important strength of this study was the use of electronic monitoring to objectively assess adherence to both ICS and OCS therapy after hospital discharge. The use of electronic monitoring in research settings is a valuable alternative to measures such as self-report, canister weights, and pill counts. In providing self-report data, participants frequently fail to document doses missed or taken at inappropriate intervals.24,47 Other objective measures of adherence (eg, canister weights and pill counts) also tend to overestimate adherence as they cannot account for the fact that participants may deliberately dump medication to appear in good compliance with the regimen.48 It is important to note that participants were provided with all study medications during this period. Thus, rates of adherence in this study likely reflect a best-case scenario when medications are free and motivation to adhere to therapy is high.

There are several limitations to this study. There was a trend for data to be missing among younger participants. It is unlikely that this would bias the results obtained, as previous studies5 have not found a consistent relationship between age and adherence. Data were available only for those individuals who agreed to participate in this study, so we were not able to determine whether depressive symptoms differed between participants and nonparticipants. Also, while we relied on a screening tool that has been validated to identify patients with clinically significant levels of depressive symptoms, use of a structured clinical interview for depression would have provided a more rigorous assessment of the presence of a mood disorder. Participants in this study represented a high-risk population with a high burden of a host of psychosocial problems. It is unclear whether similar findings would be obtained in a more affluent, nonminority population. In addition, depressive symptoms have served as a marker of other factors such as unemployment, poverty, and social isolation (indicating a lack of social support), which in turn may have contributed to hospitalization as well as nonadherence after discharge.

Conclusions

Our results suggest that depressive symptoms are common among minority adults hospitalized for asthma and serve as an important predictor of poor adherence to asthma therapy after discharge home. Our findings add to a growing body of evidence across several chronic health conditions and suggest that screening and treating depression, and providing additional forms of psychosocial support may improve the health outcomes of asthma patients, both in terms of symptom remission and of improved quality of life.

References

tions for enhancing compliance. AIDSCare 1996; 9:261–269
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