Impact of Activity Participation and Depression on Glycemic Control in Older Adults With Diabetes: Glycemic Control in Nursing Homes

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In the United States, 23.1% of adults ≥ 60 years of age have diabetes.[1] This population is also burdened with an increased cumulative risk of multiple complications.[2] The risk of these complications may be reduced with a reduction in A1C level.[3] However, the risks of intensive glycemic control, such as hypoglycemia, may outweigh the benefits in elderly patients with diabetes.[2]

Glycemic control in this population with diabetes is often complicated by the presence of comorbidities and a potential inability to adhere to treatment regimens.[4] According to Ciechanowski et al.,[5] "diabetes is considered to be the most psychologically and behaviorally demanding of the chronic medical illnesses." Typically, 95% of diabetes management is performed by patients. As patients age, cognitive dysfunction, functional disabilities, polypharmacy, and depression all may prevent them from adhering to treatment plans.[4]

A diagnosis of depression in the elderly may decrease adherence to exercise, diet, and medication regimens.[5] In a study by Rush et al.,[6] people with diabetes and depression were less likely to achieve their blood glucose goals. Thus, a diagnosis of depression appears to negatively affect glycemic control.[5–9]

In elderly adults with diabetes, depression can reduce quality of life, increase health care expenditures, and decrease adherence to medication and diet regimens.[4] Katon et al.[10] found there to be a significantly higher mortality among depressed patients with type 2 diabetes than among nondepressed patients. Furthermore, Rubin and Peyrot[11] have stated that "psychosocial variables [such as depression] are often stronger predictors of medical outcome such as hospitalization and mortality than are physiologic and metabolic measures [such as the presence of complications, BMI, and A1C]."

Elderly adults with diabetes have double the normal risk for depression.[4] There is evidence that, at admittance to extended care facilities, the incidence of depression increases.[12] In a pilot study by Holt et al.,[13] 52% of people with diabetes in extended care facilities also suffered from depression. This emphasizes the importance of diagnosis and treatment of depression in elderly people with diabetes, especially in light of the increased risk.

The American Diabetes Association recommends that psychosocial assessment be a routine component of the medical management of people with diabetes and that a change in the medical regimen should prompt screening for psychosocial problems such as depression.[14] Symptoms of depression in older adults can be reduced effectively with pharmacological and psychological treatments.

Antidepressant medications are the most common treatment for depression in older adults.[2] This trend is also seen in extended-care residents with diabetes. Holt et al.[13] found that 58% of residents with diabetes received pharmacological treatment for depression.

Although antidepressant medications may reduce depressive symptoms in elderly adults, it has been suggested that this may not be an ideal treatment for depressed residents.[15] The frailty of this population may make them more susceptible to the side effects of these medications.[15] Thapa et al.[16] found that nursing home residents who began therapy with tricyclic antidepressants had a rate of falls twice that of nonusers. Furthermore, residents started on selective serotonin-reuptake inhibitors had a rate of falls 80% higher than nonusers.[16] Therefore, in addition to pharmacological and psychosocial treatment, it is also important to consider the benefits of behavioral interventions in the treatment of depression.

Behavioral intervention is based on a theory that depressed individuals are unable to perceive positivity in their environment. The treatment focuses on increasing the number of positive activities. Increasing

positive events as a means of behavioral intervention has been shown to improve symptoms of depression in elderly adults.[12] Furthermore, Meeks et al.[12] found that, as nursing home residents increased their participation in activities, they experienced a clinical reduction in the symptoms of depression. However, this study is not specific to older adults with diabetes.

Many extended-care facilities recognize the impact activity participation can have on the health of their residents and offer a variety of activities. However, as Meeks et al. summarized, "general one-size-fits-all programming that is often found in nursing homes may not be an effective means of engaging the majority of residents in meaningful activities to improve their quality of life. Instead, efforts to tailor programming and especially to tailor individual interventions for depressed residents may be needed."[12]

The purpose of this study was to determine whether residents of extended-care facilities with diabetes and a concurrent diagnosis of depression have poorer glycemic control than those who are not depressed. This study also investigated the impact that activity participation has on glycemic control.

Research Design and Methods

This project was approved by the Ohio University Institutional Review Board, and a letter of agreement was obtained from each of the participating extended-care facilities.

Site recruitment

The investigators contacted extended-care facilities throughout Ohio and West Virginia. Facilities that expressed interest in participating in the study completed an agreement to be enrolled. Once completed, each facility's director of nursing was sent all of the documents used for the study. These included a nursing home diabetes care protocol, a hypoglycemia/hyperglycemia reporting form, a nutritional reporting form, and a chart face sheet. These documents were reviewed with each director of nursing to clarify any questions.

Table 1. Abstracted Data and Classification of Activities

Category	Parameter Collected
General	Age, type of diabetes
Lab tests and general care	Number of fingersticks per day, incidence of hypoglycemia and hyperglycemia per month, percentage of target glucose levels reached per month, A1C goal reached (yes/no), lowest A1C reached in past month, number of A1C measurements per year, electrocardiogram in past year (yes/no), blood pressure recorded (yes/no), blood pressure at goal (yes/no), lipids checked annually (yes/no), lipids at goal (yes/no), microalbumin checked in past year (yes/no), weight checked monthly (yes/no)
Exams and consultations	Foot exam in past year (yes/no), podiatrist consultation (yes/no), annual eye exam (yes/no), psychologist consultation (yes/no)
Medications and vaccinations	Flu and/or pneumococcal vaccine (yes/no), ACE inhibitor/angiotensin II receptor blocker (yes/no), aspirin (yes/no), oral antidiabetic medications (yes/no), insulin (yes/no), analog insulin (yes/no), non-analog insulin (yes/no), sliding-scale insulin regimen (yes/no), all antidiabetic medications, treatment for depression
Other	Hypo- and hyperglycemic protocols, physician type, diagnosis of depression
Skills activities	Arts and crafts, cooking group, current events, educational speakers, gardening, homemaking, intellectual residents' council, music, reading/writing, sensory awareness/stimulation, word games/puzzles
Spiritual activities	Bible study, church-related spiritual activity
Social activities	1-on-1 visits, beauty shop, bingo, card games, family visits, movies, outdoors, parties, patio chats, reminiscing, smoking, snack-and-chat, socializing, talking/phone, theater group, trip/shopping, visitors
Physical activities	Exercise/sports, parachute, physical therapy, walking
Other activities	Bird watching/feeding, hand rub/lotion, therapy, helping others, nail painting, people-watching, pet therapy, spa day, special programs/TV, van ride

Patient inclusion and exclusion criteria
The facility residents had to have had diabetes for at least 1 year and to have been a resident of the facility for at least 3 months to be included in the study. Residents with type 1 or type 2 diabetes were included regardless of their treatment plans. A diagnosis of depression was based on a documented diagnosis in residents' charts.

Chart review/data abstraction
Each director of nursing provided a list of eligible residents. All eligible skilled-nursing and assisted-living residents had their charts reviewed. A key code was developed for the facilities and qualifying residents. The key code was documented on a Microsoft Excel spreadsheet and kept on a separate password-protected computer.

Activity participation was recorded as the number of activities each resident attended in a 1-month period and was then converted into hours/month. Unless otherwise specified by the facility, each activity was considered to take 30 minutes. This assigned duration was used because most of the activities at the facilities with recorded times were 20–30 minutes in length. It is possible that some activities may have taken more or less time, thus skewing the results.

At some facilities, records were only received for a period of 1 week. When this occurred, the hours/month estimate was extrapolated from residents' weekly activity participation.

Activity participation was recorded in five separate categories: spiritual, skills, physical, social, and other (Table 1). Any recorded religious activity was considered a spiritual activity. An activity was categorized as a skills activity if it required cognitive ability. A social activity was any non-skills or non-physical activity that involved interaction with other residents, family members, nurses, or staff. If an activity did not fit into any of the other four categories, it was classified as "other." Additionally, baseline information concerning care of each resident (Table 1) and demographic information, including sex, race, and age, were also obtained from eligible charts.

Statistical analysis
Statistical analysis was completed using SPSS version 17 (SPSS Inc., Chicago, Ill.). Pearson χ^2 was used to test the significance between A1C goal and diagnosis of depression. The *t* tests were used to assess whether there was a difference in the subjects' percentage of glucose control for those with or without a diagnosis of depression. The *t* tests were also run to determine if there was a statistical difference between the mean total activity of those residents who met A1C goals and those who did not and for activity subcategories. Levene's test of equality of variances and the *t* test for equality of means were also used to analyze the data. Statistical significance was determined at $P \leq 0.05$.

Study Results

Descriptive data
A total of 187 charts were reviewed, including 49 males (26%) and 138 females (74%). The majority (177) of subjects were white (94.7%). Subjects' ages ranged from 49 to 97 years, with a mean of 79.7 years. Most subjects (174) had a diagnosis of type 2 diabetes (93%), whereas only eight (4%) were diagnosed with type 1 diabetes, and five (3%) had an unspecified diabetes diagnosis. Eighty-five subjects (46%) had a diagnosis of depression, and of those, 70 residents (37%) received pharmacological treatment for depression (Table 2).

Glucose control
Blood glucose was monitored for 167 subjects (89%). The number of fingersticks per day ranged from 0 to 6. Nineteen subjects (10%) received one fingerstick daily, 109 subjects (58%) received two to four fingersticks daily, and two subjects (1%) received six fingersticks daily. Thirty-five subjects (19%) received less than one fingerstick daily.

For those who had their glucose monitored, 45 subjects (27%) had a total of 192 hypoglycemic episodes, 163 of which were considered mild (blood glucose 50–69 mg/dl) and 29 of which were severe (blood glucose < 50 mg/dl). The range of these events was 14–68 mg/dl. Twelve residents had severe hypoglycemic reports, and 33 reported mild hypoglycemic events.

Forty-one of the residents who experienced a hypoglycemic episode were on insulin (91%), whereas the other four residents (9%) were not on insulin. Furthermore, 26 of the residents who experienced a hypoglycemic episode did not have a diagnosis of depression, whereas 19 were depressed. The mean lowest A1C for those who experienced a hypoglycemic event was 6.6%, whereas for those who did not experience a hypoglycemic event, it was 6.8%. Only 59 subjects (32%) had a written hypoglycemic protocol in their orders. However, 117 subjects (63%) had a hyperglycemic protocol (Table 2). Ninety-one subjects (49%) had recorded hyperglycemic incidences.

For this study, we used a liberalized blood glucose goal of 70–250 mg/dl. Most of the glucose readings (88%) were at this goal, with a range of 20–100% for a 1-month period. One hundred and thirty-nine subjects (74%) met the liberalized extended-care A1C goal of < 8.0%, with a lowest A1C mean of 6.75% for residents without depression and 6.73% for those with depression. There was no significant difference between the mean percentage of glu-

Table 2. Participant and Hypoglycemic/Hyperglycemic Event Data		
	Frequency	Percentage (%)
Total charts	187	
Male	49	26
Female	138	74
Caucasian	177	94.7
Other race	10	5.3
Type 2 diabetes	174	93
Type 1 diabetes	8	4
Unspecified diabetes type	5	3
Diagnosis of depression	85	46
Pharmacological depression treatment	70	37
Residents with at least one blood glucose reading < 70 mg/dl	45	27*
Residents with mild hypoglycemia (blood glucose 50–69 mg/dl)	33	20*
Residents with severe hypoglycemia (blood glucose < 50 mg/dl)	12	7*
Total number of hypoglycemic events/ month	192	—
Total number of mild hypoglycemic events/ month	163	—
Total number of severe hypoglycemic events/month	29	—
Residents with hypoglycemia protocols	59	32*
Residents with at least one blood glucose level > 250 mg/dl	91	49*
Residents with hyperglycemia protocol	117	63*
Residents with an A1C < 8%	139	74*
**Percentage of subjects who had their blood glucose monitored.*		

cose control by *1*) fingerstick glucose readings ($t_{df = 164} = -1.500$, $P = 0.138$, 95% CI –9.06 to 1.239) or *2*) A1C goal achievement ($\chi^2_{df = 1} = 0.266$, $P = 0.606$, odds ratio = 0.799, 95% CI 0.340–1.876) in those with or without depression.

Activity participation

Total activity participation ranged from 0 to 235 hours/month. Subjects participated in a mean of 64 hours of activity in 1 month. Subjects participated in more social activities than any other activity subcategory, with an average of 28.7 hours/month. Skill activities had the second-highest participation at an average of 15.8 hours/month (range 0–149 hours). Subjects participated in physical activities on average 6.1 hours/month and in spiritual activities 2.1 hours/month. The mean time spent in the "other" subcategory was 15.3 hours/month (Table 3).

Subjects who participated in more total activity hours were significantly more likely to achieve A1C goals ($t_{df = 23.52} = -2.995$, $P < 0.01$, 95% CI –30.465 to –5.391). However, no individual activity subcategory was significantly related to A1C level. Furthermore, there was no significant correlation between total activity participation ($r = 0$, $n = 187$, $P = 0.994$), or any of the subcategory activities and percentage of blood glucose at goal. Finally, there was no significant relationship between the total number of activity hours or any of the activity subcategories and hypoglycemic events.

Discussion and Conclusions

In this study, a diagnosis of depression did not appear to result in poorer glucose control for adults with diabetes in extended-care facilities. Previous research has shown that a diagnosis of depression is associated with poorer glucose control.[5–7,9] However, these studies did not explain the mechanisms through which depression caused an increase in A1C.

Depression is associated with decreased compliance with medications, decreased physical activity, and increased inflammatory cytokines, which interfere with insulin action and result in hyperglycemia. Medication compliance was not an issue in these elderly adults, who depended on the care of nurses and staff at the facilities.

Although a diagnosis of depression did not affect A1C levels, residents who participated in more hours of activity were more likely to be at A1C target levels. If it is assumed that the hours of activity participation recorded is representative of patients' activity participation in previous months, it can be concluded that subjects who participated in more hours of activity were more likely to obtain an A1C level at goal. Recognizing that A1C

Table 3. Activity Participation

Activity	Frequency	Maximum Participation (hours)	Average Participation (hours)
Total	187*	235	64.24
Social	174	112	28.73
Skills	173	149	15.82
Other	174	50	15.27
Physical	174	26	6.13
Spiritual	174	17	2.12

**Type of activity was not reported for 13 residents.*

is an estimated average, people who experience hypoglycemic or hyperglycemic episodes may have an acceptable A1C, but still be in poor glycemic control.

None of the subcategories of activity had a significant relationship with subjects' A1C or percentage of blood glucose readings at goal. Recently it was reported that a combination behavioral approach for depression in adults with type 2 diabetes not only was effective in treating depression, but also significantly reduced A1C levels and fasting glucose levels from baseline to post-treatment and from baseline to the 3-month follow-up.[8] Participants in that study engaged in 150 minutes of aerobic activity each week along with cognitive behavioral therapy.[8]

Although it appears from the study mentioned above on combination therapy that physical activity does have an effect on glucose control, our study suggests there may be a more complex relationship. Because none of the subcategories had any significant relationship with A1C levels at goal, this may imply that participation in any activity, not only physical activity, has positive effects.

Our study showed that the quantity of activity participation may be more important than the type of activity. The application of this information may be helpful when nurses and family members encourage residents to participate in facility activities. Because it does not appear to matter what type of activity is involved but rather the quantity of activity in which patients participate, it may be advantageous to encourage residents to participate in activities they enjoy rather than focusing on one specific type of activity.

One of the most significant findings in our study was the number of subjects in these facilities with hypoglycemic events (blood glucose < 70 mg/dl). Twenty-seven percent of subjects in this study had at least one hypoglycemic event in a 1-month period, and 7% had at least one severe hypoglycemic event. Despite the high incidence and danger of hypoglycemic events, only 33% of subjects had a hypoglycemic protocol ordered.

The results found in this study suggest that hypoglycemic events were not related to the amount or type of activity in which patients participated. However, they suggest that all residents with diabetes in extended-care facilities who are on medications that can cause hypoglycemia should have specific hypoglycemia management protocols to prevent significant cognitive injury, falls, and rebound hyperglycemia from inappropriate correction of hypoglycemia.

The results of this study are limited by several factors. Primarily, the number and heterogeneity of subjects may not be representative of all extended-care facility residents with diabetes. A larger poll of data may have yielded different relationships among depression, amount of activity participation, and glucose control. Most of the facilities had standard activity sheets used to record residents' activity participation. In the facilities that did not use these sheets, it appeared that either fewer activities were offered or the activities were not recorded. However, even in facilities that used standardized sheets, the recording of activities varied greatly. Some facilities had detailed descriptions of each activity, whereas others simply had a checklist.

Furthermore, many activities could have fallen into more than one category. For example, gardening was considered to be a skills activity. However, if done in a group environment, it could have also been considered a social activity. To address this, the authors developed pre-specified categories for this study (Table 1).

Despite these limitations, this study yielded important results that may be used in the future to improve the care of extended-care residents with diabetes. First, the amount of activity in which residents participate may have more impact on their health than the type of activity. Second, a diagnosis of depression was not related to glycemic control in this select population. Finally, this study showed an unacceptable high incidence of hypoglycemic events in this population, and national requirements for standard hypogly-

cemic protocols for all residents with diabetes should be adopted.

ACKNOWLEDGMENTS

The authors would like to acknowledge the Ohio University Heritage College of Osteopathic Medicine (OUCOM) Research and Scholarly Advancement Fellowship and the Centers for Osteopathic Research and Education research office for funding and specifically Godwin Dogbey, PhD, at OUCOM for statistical support.

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