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The Prevalence and Persistence of Sliding Scale Insulin Use Among Newly Admitted Elderly Nursing Home Residents With Diabetes Mellitus

Naushira Pandya, MD, Stephen Thompson, MS, and Usha Sambamoorthi, PhD

Objective: To evaluate the initiation and persistence of sliding scale insulin (SSI) therapy in elderly nursing home (NH) residents.

Design and Participants: A longitudinal study of NH residents (N = 9804) with diabetes aged 65 years and older who were admitted between 2002 and 2003 and resided for 1 month or longer in long-term care facilities associated with a for-profit nursing home chain.

Results: Rates of SSI use were high among patients who were started on insulin during their stay in nursing homes (54%), and 22% of the total number of orders for insulin were for SSI. After insulin initiation, 83% of residents who were started on SSI remained on it by the end of the study. Of those who had not started on SSI, 33% were later switched to SSI.

Discussion: This study demonstrated that SSI regimens were highly prevalent and, once initiated, tended to be continued in the treatment of elderly patients with diabetes newly admitted to nursing homes. Multiple factors were found to be significantly associated with initiation and persistence of SSI.

Conclusion: The high prevalence and persistent use of SSI is inconsistent with the American Medical Directors Association guideline as well as current recommendations. Additional studies are needed to evaluate outcomes associated with prolonged SSI use in long-term care facilities. (*J Am Med Dir Assoc* 2008; xx: xxx)

Keywords: nursing home; diabetes; sliding scale insulin therapy

Type 2 diabetes mellitus (DM) is common among nursing home (NH) residents, with prevalence estimated at 26%.¹⁻³ Data from the National Health and Nutrition Examination Survey for 1988 to 1994 (NHANES III) show that diabetes alone was responsible for 52% of NH admissions among people with the disease.⁴ A survey of 11,527 elderly patients (aged ≥ 65 years) with DM who resided in NHs between 2002 and 2003 demonstrated that more than half were treated with insulin, alone or in combination with oral antidiabetic drugs (OADs). Among NH residents who were receiving insulin treatments, sliding scale insulin (SSI) regimens were widely used.⁵

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A typical SSI regimen comprises small doses of subcutaneous short-acting or rapid-acting insulin given 2 to 4 times daily, with doses based on preprandial and bedtime capillary blood glucose measurements.^{6,7} SSI use in the management of patients with diabetes was standard practice 75 years ago, when urine glucose was used to reflect glucose levels. Existing data on the efficiency and effectiveness of SSI are derived primarily from studies of hospitalized patients. Many hospitalized patients admitted for nonmetabolic conditions are traditionally prescribed SSI for glycemic control. However, SSI does not deliver insulin in a physiologic manner, since it attempts to correct high glucose levels on a reactive and retrospective basis rather than using a concerted effort to achieve improved overall control.⁸ The resulting fluctuation in glucose levels may lead to recurrent hypoglycemia and diabetic ketoacidosis.⁹ Several studies have shown that SSI is neither effective in meeting physiologic needs nor efficient in the inpatient setting.^{6,7,10} Results of a prospective cohort study of 171 adults with diabetes admitted to medical inpatient services showed that SSI regimens were prescribed for a majority (76%) of these patients.¹⁰ Patients on a conservative or aggressive SSI regimen were 3 times more likely to have hyperglycemic episodes compared with their counterparts who did not begin glycemic control therapy.¹⁰ In another review of consecutive adult inpatients (n = 90), only 12% of

SSI injections produced target blood glucose values (90–130 mg/dL). Glucose levels remained elevated—reflecting subtherapeutic insulin effects—after 84% of the injections.⁷ Despite the availability of easy methods (computerized and manual) for recording blood glucose levels and insulin injections, SSI regimens were never adjusted in 81% of the patients.⁷ Despite the evidence suggesting its lack of effectiveness, SSI use still persists in institutionalized patients, possibly based on advice or training received by physicians during their residency training.⁵

Although the American Medical Directors Association (AMDA) guideline on diabetes care in NH residents recommends against prolonged use of SSI,⁵ the extent to which SSI regimens are actually used in elderly NH residents with DM is not well characterized. For that reason, the primary objective of this study was to use longitudinal data to examine the initiation and persistent use of SSI regimens among elderly, newly admitted NH residents with DM and the potential predictors associated with them.

METHODS

Data

NH residents (N = 9804) with diabetes aged 65 years or older who were admitted between 2002 and 2003 and resided for 1 month or longer in skilled nursing facilities associated with a for-profit NH chain were studied. Of these residents, 5482 with diabetes had at least 1 physician order for insulin during their stay until the end of study follow-up. Two datasets were used. The Minimum Data Set (MDS) assessments were used to retrieve the residents' baseline information upon admission and track them longitudinally. The MDS is a nationally standardized 350-item summary screening and assessment tool designed to collect data on NH residents, including their physical, psychological, and psychosocial functioning, active clinical diagnoses, health conditions, treatments and services received, demographics, payer source, and advance directives.¹¹ In addition, each resident's chart was reviewed for dated physician orders data to identify the pharmacological treatment they received on and after admission.

Measures

Diagnosis of Diabetes Mellitus

A resident was considered to be diagnosed with diabetes if there was an active diabetes diagnosis in the resident's clinical record on the MDS assessment (Section I-e-a. Disease Diagnoses: Diabetes Mellitus) using the 7-day look-back period.

Pharmacological Treatment of Diabetes Mellitus

National Drug Codes and/or drug names from the physician order file were used to identify OADs and insulin administered to residents. The following antidiabetic drugs were included: metformin, sulfonylureas, thiazolidinediones, alpha-glucosidase inhibitors, meglitinides, and insulins, including aspart, glargine, Lente, lispro, neutral protamine Hagedorn (NPH), premix, regular, and Ultralente. The use of SSI was identified from the physician's medication orders.

Resident Characteristics

Residents' sociodemographic characteristics included gender, age at time of admission, race, marital status, and education, and were extracted from the admission MDS assessment.

Baseline physical and psychological comorbidities were also extracted from admission MDS assessment, including presence of any heart diseases, depression, and dementia. We used the hierarchical activities of daily living (ADL) scale to measure residents' baseline physical function,¹² and the Cognitive Performance Scale (CPS) to measure chronic cognitive impairment.^{12–14}

Facility Characteristics

Data were collected on the region, setting (urban or rural), and number of beds in each long-term care facility included in the study.

Statistical Method

Bivariate analyses on group differences in initiation and continued use of SSI use were compared using chi-square statistics. Robust multiple logistic regressions were used to predict the initiation of SSI, and the switching of SSI to non-SSI regimens and vice versa. Both bivariate and multivariate analyses controlled from the clustering of residents within facilities and were conducted using SAS-callable SUDAAN v9 software (Research Triangle Institute, Research Triangle Park, NC).¹⁵

RESULTS

Of the 9804 NH residents with diabetes aged 65 years and older (mean age 79.6 ± 7.6 , 63.1% female) admitted between 2002 and 2003, 5482 received insulin treatment during their NH stay. These residents were followed for a mean of 6.4 ± 6.1 months. Table 1 presents baseline characteristics of the residents.

Use of Insulin During the NH stay

A total of 3882 residents (71%) of the 5482 who were treated with insulin during their stay received it at the time of admission. The remainder (n = 1600) were started on insulin approximately 3.3 ± 4.3 months after admission.

SSI Use at Time of Insulin Initiation

SSI comprised 54% (n = 2956) of insulin regimens at the time of insulin initiation (Figure 2). SSI use was significantly associated with concomitant use of OADs, admission from a hospital or other NH, obesity, dependence or total dependence on the ADL scale, and residence in an urban or southern region-based facility. Of the residents on 3 or more classes of OAD, 76% were initially placed on SSI regimens. Compared with those who started insulin at admission (n = 1600), residents who started insulin later were more likely to be on SSI (n = 940, 59%). These findings remained robust after controlling for other confounding factors (Table 2).

Persistence of SSI Use After Insulin Initiation

As shown in Figure 2, the initial choice of SSI or non-SSI regimens appeared to persist. For example, after insulin initi-

Table 1. Baseline Characteristics for NH Patients Who Received Insulin During Their NH Stay

	N (%)
Total	5482 (100.0)
Gender	
Female	3460 (63.1)
Male	2022 (36.9)
Insulin initiated upon admission	
No	1600 (29.2)
Yes	3882 (70.8)
Number of concurrent OAD classes	
None	4006 (73.1)
1 Class	1165 (21.3)
2 Classes	278 (5.1)
3 Classes and Above	33 (0.6)
Admission from	
Home/board care/AL/group home	744 (13.6)
NH	405 (7.4)
Hospital	4295 (78.3)
Other	38 (0.7)
Obese (BMI ≥30 kg/m²)	1751 (31.9)
ADL scale	
Independent	293 (5.3)
Limited	1146 (20.9)
Dependent	3474 (63.4)
Totally dependent	560 (10.2)
Cognitive performance scale	
Intact	1637 (29.9)
Some impairment	3045 (55.5)
Severe impairment	539 (9.8)
Very severe impairment	253 (4.6)
Heart disease	3132 (57.1)
Depression	1720 (31.4)
Dementia	1153 (21.0)
Urban facility	3920 (71.5)

ADL, Activities of daily living; AL, Assisted living; BMI, Body mass index; NH, Nursing home; OAD, Oral antidiabetic drug.

ation, 83% of residents for whom SSI was a physician’s initial choice for insulin remained on SSI at the end of the study. Of residents who had not started on SSI (n = 2526), 33% were later converted to scheduled regimens.

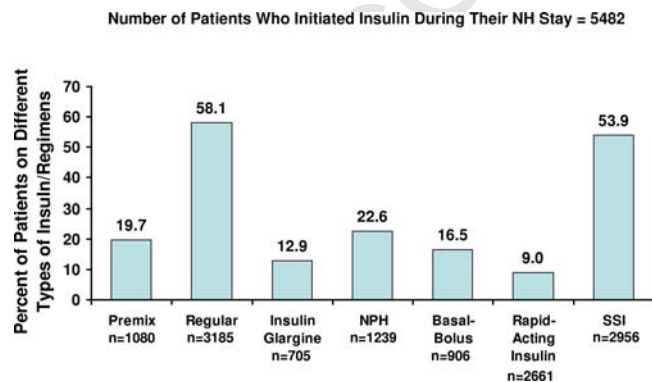


Fig. 1. Distribution of types of insulin at time of insulin initiation (percentages do not add up to 100% due to overlap of orders). NH, nursing home; NPH, neutral protamine Hagedorn; SSI, sliding scale insulin.

Patients Who Initiated Insulin During Their NH Stay
Total N=5482

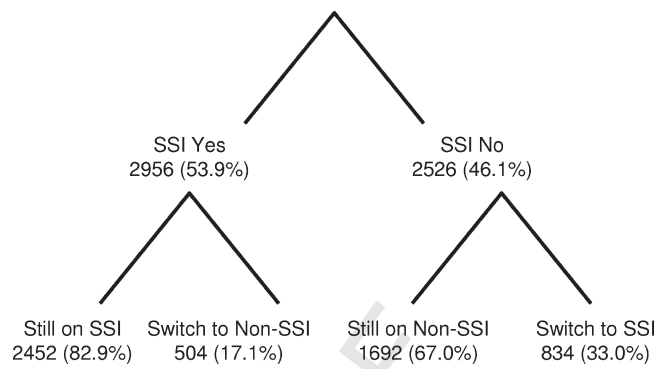


Fig. 2. Follow-up of SSI use among insulin users (mean follow-up time after insulin initiation: 5.2 months). NH, nursing home; SSI, sliding scale insulin.

Persistence of SSI use was significantly associated with insulin initiation on admission, use of 1 or more concurrent OAD classes, admission from a hospital, and aged 75 years or older (Table 3). Among patients in whom non-SSI insulin was initiated, switching to SSI was associated with obesity, black race/ethnicity, urban facilities, and months of follow-up after insulin initiation (Table 4). These findings remained robust even after controlling for other confounding factors. SSI use was not significantly associated with other factors, including education, gender, marital status, heart disease, dementia, and type of insulin.

DISCUSSION

This study demonstrated that SSI regimens were highly prevalent and, once initiated, tended to persist in the treatment of elderly patients with diabetes newly admitted to NHs. A limitation in the current study is the lack of A1C monitoring data in this database; therefore, we were unable to evaluate the impact of SSI use on overall glycemic control in these residents.

SSI regimens are reactive, using short-acting human insulin to attempt correction of hyperglycemia after it has occurred. Because there is no basal component providing insulin coverage for hepatic glucose output (known to be increased in type 2 DM) and hyperglycemia related to meals, or for diurnal variations, large fluctuations in blood glucose levels occur.¹⁶

There are no standards for SSI regimens. The American College of Endocrinology Position Statement on Inpatient Diabetes and Metabolic Control notes that, in addition to insulin requirements to cover basal and prandial needs, patients often require supplemental or correction insulin for treatment of newly recognized diabetes, when insulin requirements are unknown, or when new therapies are initiated such as external nutrition or glucocorticoid treatment.¹⁷ According to the position statement, SSI “. . . has resulted in unacceptably high rates of hyperglycemia, hypoglycemia, and iatrogenic ketoacidosis in hospitalized patients.” The American Diabetes Association (ADA) Clinical Practice Recommen-

Table 2. Residents Who Received SSI at Time of Insulin Initiation

	SSI Use at Initiation (N = 2956)		Multiple Logistic Regression on SSI Use at Insulin Initiation
	N	Row %	OR (95% CI)
Insulin initiation on admission	2016	51.9	0.66* (0.58, 0.76)
No. of concurrent OAD classes			
None	2029	50.6	—
1 Class	715	61.4	1.74* (1.50, 2.01)
2 Classes	187	67.3	2.31* (1.73, 3.09)
3 Classes and above	25	75.8	2.91† (1.26, 6.72)
Admission from			
Home/Board Care/AL/Group home	287	38.6	—
NH	214	52.8	1.61* (1.24, 2.10)
Hospital	2437	56.7	1.87* (1.57, 2.24)
Other	18	47.4	1.26§ (0.68, 2.33)
Scaled BMI Index			
Normal	1066	56.9	—
Underweight	158	63.5	1.27§ (0.97, 1.66)
Overweight	839	54.5	0.94§ (0.80, 1.09)
Obese (BMI ≥30 kg/m ²)	861	49.2	0.79‡ (0.69, 0.92)
ADL Scale			
Independence	129	44	—
Limited	557	48.6	1.13§ (0.85, 1.49)
Dependent	1919	55.2	1.40† (1.08, 1.80)
Total dependence	349	62.3	1.71‡ (1.25, 2.33)
Region			
Northeast	449	52.5	—
South	1331	58.5	1.29† (1.02, 1.63)
Midwest	877	46.1	0.878§ (1.02, 1.63)
West	299	66.2	1.34§ (0.778, 2.31)
Location of facility			
Rural	671	43.1	—
Urban	2281	58.2	1.65* (1.37, 1.99)

ADL, activities of daily living; AL, assisted living; BMI, body mass index; CI, confidence interval; NH, nursing home; OAD, oral antidiabetic drug; OR, odds ratio; SSI, sliding scale insulin.

Note: Reference groups are: Insulin initiation after admission, No concurrent OAD classes, Admission from home/board care/AL/group home, BMI: normal, ADL scale: independent, Region: Northeast, Location of facility: rural. The regression controls for gender, age group, education, marital status, race/ethnicity, cognitive performance scale, heart disease, depression, dementia, and facility size.

* $P < .00001$.

† $P < .05$.

‡ $P = .001$.

§ Not significant.

dations for 2008 advise that, for hospitalized patients, “The traditional sliding-scale insulin regimens are ineffective as monotherapy and are generally not recommended.”¹⁸ Although much of the evidence against SSI is derived from studies done in hospitals, the AMDA, which specifically addresses patients in long-term care facilities, asserts that “although SSI is widely used in hospitals and in long-term care facilities, its prolonged use is generally *not* recommended . . . Widespread use of sliding-scale insulin results in greater patient discomfort and increased nursing time . . .”¹⁹ The AMDA also has stated that SSI may be useful in newly recognized diabetes “when insulin requirements are unknown, or when new therapies (eg, external nutrition or glucocorticoid treatment) are initiated.”¹⁹ Adding that patients who are on SSI when admitted should be reevaluated within 1 week, the guideline advises that, in long-term care facilities, “. . . blood glucose control can be achieved with single

or multiple daily insulin injections, with few episodes of hypoglycemia.”¹⁹

SSI has also been frequently associated with medication errors.⁷ In the University of Colorado hospital system for documenting medication errors, for example, dextrose 50% is the leading tracer drug override used in treatment of adverse drug reactions, and SSI is the culprit drug most often implicated.⁷

Most studies support the opinion that SSI is of little or no benefit to patients; nevertheless, health care providers continue to prescribe it.²⁰ It is hoped that evidence from recent trials will provide the groundwork for a paradigm shift away from this outmoded and generally ineffective treatment regimen.

The ideal subcutaneous insulin regimen is proactive, approximating physiologic insulin needs before meals and throughout the day to prevent between-meal and nocturnal gluconeogenesis and ketogenesis.¹⁶ Recent studies demon-

Table 3. Residents Who Remained on SSI After Insulin Initiation With SSI

Among Those Who Initiated Insulin With Sliding Scale	Remain with SSI (N = 2455)		Multiple Logistic Regression on Remaining on SSI During the Follow-up Period
	N	Row %	OR (95% CI)
Insulin was initiated on admission	1613	80.0	0.46* (0.36, 0.59)
No. of concurrent OAD classes			
None	1659	81.8	—
1 Class	602	84.2	1.40† (1.08, 1.80)
2 Classes and above	191	90.1	2.69* (1.66, 4.38)
Admission from			
Home/Board Care/AL/Group Home/Other	242	79.3	—
NH	168	78.5	1.04‡ (0.68, 1.58)
Hospital	2042	83.8	1.42† (1.04, 1.94)
Age group, y			
65–74	628	79.4	—
75–84	1115	83.5	1.35† (1.04, 1.75)
≥85	709	85.5	1.53† (1.09, 2.14)
Cognitive performance scale			
Intact	727	84.1	—
Some impairment	1321	82.4	0.82‡ (0.65, 1.04)
Severe impairment	280	85.6	0.95‡ (0.62, 1.46)
Very severe impairment	118	76.1	0.49† (0.27, 0.90)
Scaled BMI Index			
Underweight	132	83.5	1.02‡ (0.64, 1.64)
Normal	893	83.8	—
Overweight	698	83.2	1.02‡ (0.80, 1.32)
Obese	703	81.6	0.97‡ (0.75, 1.25)
Race/Ethnicity			
White	1903	82.6	—
Black	419	84.1	1.06‡ (0.76, 1.47)
Hispanic	65	87.8	2.10‡ (0.85, 5.16)
Other	65	80.2	0.91‡ (0.47, 1.76)
Location of facility			
Rural	545	81.2	—
Urban	1905	83.5	1.15‡ (0.88, 1.49)

AL, assisted living; BMI, body mass index; CI, confidence interval; NH, nursing home; OAD, oral antidiabetic drug; OR, odds ratio; SSI, sliding scale insulin.

Note: Reference groups are: Insulin initiation after admission, No concurrent OAD classes, Admission from home/board care/AL/group home, Age 65 to 74, White, Cognitive Performance: Intact. The regression controls for gender, education, marital status, activities of daily living, heart disease, depression, dementia, region, and facility size.

* $P < .0001$.

† $P < .05$.

‡ Not significant.

strate the superiority of basal-bolus insulin over SSI regimens for achieving glycemic control. In a pilot trial of algorithm-based insulin treatment of 20 hospitalized patients with type 2 DM, half were treated with algorithm-based 70/30 insulin, the other half with traditional SSI dosing as written by the treating physician.²⁰ Over a 10-day period during which the number of insulin units was similar in both groups, SSI patients had more variations in blood glucose concentrations in contrast to algorithm-treated patients, whose blood glucose levels declined steadily and did not fluctuate. Mean blood glucose levels were significantly lower than those in patients using SSI (151.3 versus 175.6 mg/dL respectively; $P = .04$).²⁰

Hypoglycemia represents a major barrier to advancing insulin therapy and is a documented risk factor for poor patient outcomes. Although the inclusion of reported hypoglycemia is beyond the scope of the current analysis, rates of hypogly-

cemia were reported in The Randomized Study of Basal Bolus Insulin Therapy in the Inpatient Management of Patients with Type 2 Diabetes (RABBIT 2) Trial. This prospective, multicenter study, randomized 130 hospitalized insulin-naive patients to either a basal-bolus regimen (insulin glargine with insulin glulisine) or SSI using regular insulin.²¹ The basal-bolus regimen resulted in significantly lower glucose levels compared with the SSI regimen for mean fasting glucose (147 versus 165 mg/dL, respectively; $P < .01$) and mean glucose during the hospital stay (166 versus 193 mg/dL; $P < .001$).²¹ There was no difference in the rate of hypoglycemia between SSI and basal-bolus regimen with the rate of events at 3% of patients in each treatment group and no severe hypoglycemic episodes (glucose <40 mg/dL) reported. It is clear that the same glycemic goals cannot be adopted for all NH patients with diabetes and treatment should be individualized based on prognosis, functional status, degree of cognitive impairment,

Table 4. Residents Who Converted to SSI After Insulin Initiation

Among Those Who Initiated Insulin Without Sliding Scale	Converters From Non-SSI to SSI (N = 834)		Multiple Logistic Regression on Converting From Non-SSI to SSI
	N	Row, %	OR (95% CI)
Race/ethnicity			
White	626	31.0	—
Black	170	44.9	1.66* (1.28, 2.15)
Hispanic	20	54.1	2.44‡ (0.94, 6.35)
Other	18	19.6	0.57‡ (0.28, 1.15)
Scaled BMI			
Normal	284	35.2	—
Underweight	37	40.7	1.24‡ (0.80, 1.92)
Overweight	230	32.8	0.88‡ (0.70, 1.10)
Obese	265	29.8	0.76† (0.60, 0.97)
Location of facility			
Rural	11	50.0	—
Urban	236	26.6	1.65* (1.31, 2.09)

BMI, body mass index; CI, confidence interval; OR, odds ratio; SSI, sliding scale insulin.

Note: Reference groups are: Race/ethnicity: White, BMI: Normal, Location of facility: rural. The regression controls for insulin initiated upon admission, number of concurrent oral antidiabetic drug classes, admission from home/board care/assisted living/group home, gender, age group, education, marital status, activities of daily living, cognitive performance scale, heart disease, depression, dementia, region, and facility size.

* $P < .001$.

† $P < .05$.

‡ Not significant.

and patient or caregiver preference.²² Other factors that may expand the current analysis include assessing the role of patients' diet, meal times, activity levels, nursing staffs' experience regarding the best time to obtaining a fasting or HS blood sugar, as well as frequency of adjustment of insulin regimens by practitioners. These factors may lead to glucose excursions.

CONCLUSION

The present retrospective analysis of insulin treatment regimens in elderly NH residents with diabetes reflects a highly prevalent and persistent use of SSI regimens, especially in patients who are particularly vulnerable to the detrimental effects of glycemic excursions. A preponderance of data indicate that SSI use in hospitalized patients results in erratic and potentially dangerous blood glucose levels. Emerging evidence suggests that basal-bolus regimens may be a more rational and reliable approach to glycemic control. The frequent use of SSI in the study population is clearly inconsistent with guidelines of the AMDA, the American Association of Clinical Endocrinology (AACE) as well as the ADA and the American College of Endocrinology. A greater effort should be made to reevaluate insulin regimens in NH patients in whom prolonged SSI use is encountered, and shift the choice of insulin regimens toward closer alignment with physiologic insulin activity using current guidelines. (Figure 1).

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AUTHOR QUERIES

AUTHOR PLEASE ANSWER ALL QUERIES

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AQ1— Please provide page numbers for the quotes in the preceding paragraph.

AQ2— Please define HS.

AQ4— Ed: Please cite Fig. 1 in text.

AQ3— Ref 5: Is this a book or journal reference? If a journal, please provide the journal title and volume number; if a book, please provide the name and location of the publisher.
