Computer Order Entry System Decreased Use of Sliding Scale Insulin Regimens

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Summary

Objectives: Despite evidence documenting their ineffectiveness, sliding scale insulin is a commonly used regimen for glucose management for hospitalized patients with diabetes mellitus. At the Veterans Affairs Puget Sound Medical Center, where computer order entry has been mandated, we tested the hypothesis that an evidence-based minimal intervention order (supplemental insulin only when fasting serum glucoses exceeded 400 mg/dl) would decrease the use of sliding scale insulin orders.

Methods: Using a computerized order entry system, providers were initially offered a traditional sliding scale order or their own ad hoc orders for glycemic control of inpatients. After 34 weeks providers were offered a third option; a "minimal intervention order" with supplemental insulin only for glucose >400 mg/dl. We extracted all regular insulin orders and performed a retrospective review of insulin sliding scale orders written between December 1, 1998 and November 16, 1999. We compared the frequency of traditional insulin sliding scale orders before and after the introduction of the minimal intervention order.

Results: Nearly all orders in the first 34 weeks were traditional insulin sliding scales. We found a significant decrease in the number of traditional insulin sliding scale orders in the 16 weeks after the introduction of a computerized quick-order for minimal intervention, from 978/1007 (97.1%) to 254/398 (63.8%) ($P < 0.001$).

Conclusions: A simple, evidenced-based quick-order in a computer order entry system rapidly and significantly reduced use of sliding scale insulin regimens for glycemic control of inpatients.

Keywords

Medical records systems, computerized, diabetes mellitus, physicians practice patterns, insulin

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Introduction

The use of sliding scale insulin (subcutaneous insulin regimens based solely on intermittent blood sugar measurements) to manage diabetes mellitus in hospitalized patients is an example of medical practice that is steeped in tradition, fundamentally unsound and firmly entrenched as a universal method for inpatient glycemic control (1-3). Many experts (4-6) have advocated the abolition of "cookbook" sliding scale insulin, and several studies have suggested that these regimens result in worse glycemic control and adverse outcomes (2, 7, 8). Despite expert opinion and evidence against their use, sliding scale insulin regimens remain popular (9).

Interventions such as lectures, peer review and written clinical guidelines have been shown to be ineffective by themselves in altering provider ordering behavior (10-12). However, there is a growing body of literature that supports that ordering behavior can be influenced with computer-assisted decision support programs (13-16). Computer-based systems that provide decision support at the point of care have been linked to improved patient outcomes, decreased medication costs, improved clinician performance and decreased medication errors (17-21). Pestotnik demonstrated that computerized clinical guidelines influence providers' choice of antibiotics (17). Safran concluded that the use of electronic alerts improved adherence to HIV practice guidelines (22).

To date, many studies have focused on employing complex decision-making software aimed at supporting sophisticated clinical decision making. We sought to study the effect of a simpler intervention. We tested the hypothesis that the availability of an automated, specialty endorsed, computer "quick-order" (pre-constructed orders in a computer order entry system) would decrease inappropriate ordering of sliding scale insulin for hospitalized patients with diabetes mellitus.

Methods

Location

This study was conducted at the Seattle Division of the Veterans Affairs Puget Sound Medical Center, a 290-bed facility located in the state of Washington. VA Puget Sound cares for over 11,000 inpatients annually across all specialties and is a teaching affiliate of the University of Washington.

Patient Demographics

In order to protect patient confidentiality, no patient identifiers were extracted.

However, other studies of inpatient veterans with diabetes mellitus have demonstrated a predominantly white, older male population (mean age of 60 years) (23, 24).

Computerized Patient Record System (CPRS)

CPRS is a computerized medical record developed by the Veteran Affairs Office of Information Systems that allows review of clinical results, note entry and electronic entry of all orders related to patient care

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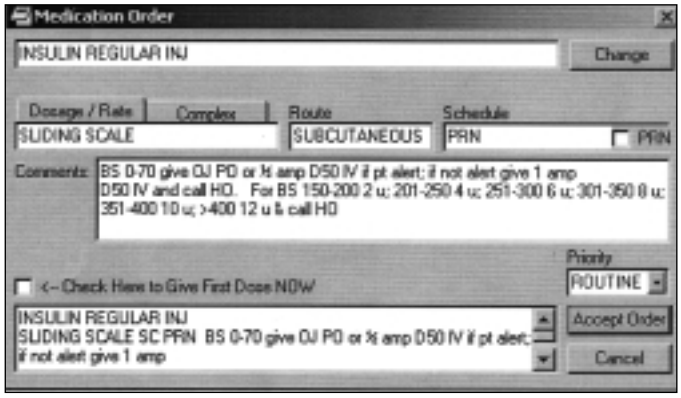

Fig. 1 Dialog box displaying content of traditional sliding scale order.

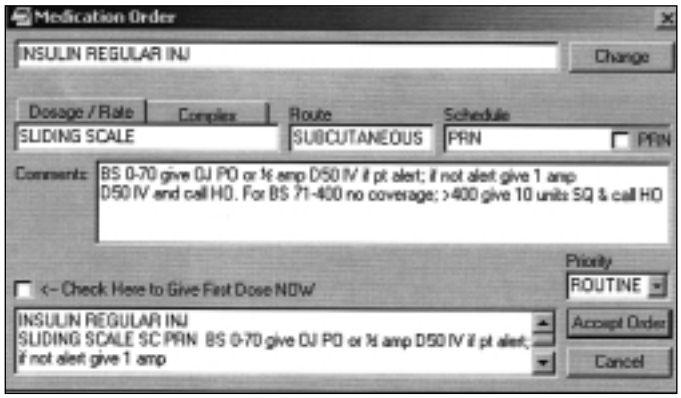

Fig. 2 Dialog box displaying content of minimal intervention sliding scale order.

including medications, laboratory, radiology, blood products and nursing orders.

Orders are entered in CPRS using a mouse to point and click on a given item which generates a dialog box. When ordering medications, providers have two choices: they may build an order by filling in fields of an empty dialog box with appropriate instructions and medication, or they may choose a "quick-order". A quick-order is a pre-constructed order where fields of the dialog box are already completed when that order is chosen with a mouse click. The content of the quick-order is generally based on accepted medical practice derived from the consensus of local clinical experts. Quick-orders appear on menus with similar items, or they appear as part of an "order set" representing a clinical protocol. The main advantage of using quick-orders is that they save time and ideally reflect the current standard of care. However, at any time, physicians may build their own order or edit an existing quick-order.

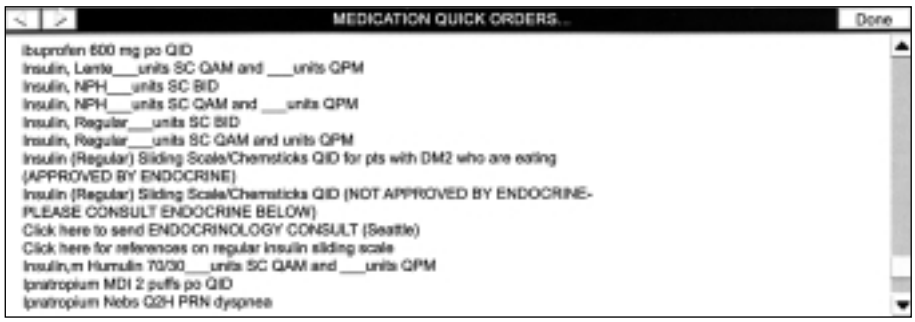

Fig. 3 Example of listing of quick-orders for ordering medications using CPRS. Physicians choose their order by clicking on the line of text.

Inpatient electronic ordering was initiated on the medical and surgical wards on December 1, 1998. All wards except the bone marrow transplantation unit are required to use computer-based order entry.

Data Collection

From December 1, 1998 to July 26, 1999, a traditional insulin sliding scale was represented as a quick-order in CPRS (Fig. 1). A traditional insulin sliding scale order is an order for supplemental insulin administration based on scheduled blood sugar measurements with the dosage adjusted based on the level of glycemia and no other factors. After this 34 week period, the Endocrinology Consult Service recommended that the quick-order for sliding scale insulin be eliminated as an option for hospitalized patients with diabetes mellitus who are eating (i.e. had a diet ordered). Instead, they advised that glycemic control be achieved with the patient's usual regimen of oral medication or regularly scheduled combination of long, intermediate and/or short acting insulin. On July 27, 1999, the insulin sliding scale quick-order was removed from the ordering menu. To help educate providers, the original insulin sliding scale order was replaced with a minimal intervention "sliding scale" order for supplemental regular insulin to be administered only for very high fasting glucose levels (>400 mg/dl) (Fig. 2). On the electronic ordering sheet, the minimal intervention order was labeled "Insulin Sliding Scale, Endorsed by Endocrine". Although physicians were still able to compose their own insulin sliding scale orders, they soon noticed the absence of the traditional insulin sliding scale quick-order and felt strongly that it should continue to be an option on their ordering menu. Because we recognize the value of physician autonomy, the original traditional insulin sliding scale quick-order was reinstated August 8, 1999 side-by-side with the order endorsed by Endocrine Service. The two versions of the insulin sliding scale were differentiated with tag lines as "approved by endocrine", and "not approved by endocrine" and the ordering physician could choose either one (Fig. 3).

We extracted electronic copies of all regular insulin orders written for hospitalized patients on medical wards between December 1, 1998 – November 16, 1999 from a centralized database. We excluded orders written by surgical providers, one-time orders to supplement regular insulin and any orders written on wards not using full-computerized order entry. We then classified each order as an insulin sliding scale ($T_{traditional}$) or minimal intervention order ($T_{minimal}$).

Table 1 The proportion of insulin orders that were traditional sliding scales decreased after the introduction of a computerized quick-order.

	Number of orders written before quick-order introduced	Number of orders written after quick-order introduced
Traditional sliding scale orders (n=1232)	978 (97.1%)	254 (63.8%)
Minimal intervention orders (n=173)	29 (2.9%)	144 (36.2%)
Total	1007 (100%)	398 (100%)

Statistical Analysis

We used the chi-square statistic to test the following null hypothesis: the proportion of traditional sliding scale orders, $T_{traditional}/(T_{minimal} + T_{traditional})$, written on inpatients for administering regular insulin on the basis of capillary blood sugar readings was no different before and after the introduction of the minimal intervention quick-order. The chi-square statistic was calculated on a 2×2 table, with one degree of freedom, using STATA (College Station, Texas). An α of 0.05 (two tailed) was considered statistically significant.

Human Subjects Review

Our research protocol was reviewed and approved by the University of Washington Human Subjects Division. Identity of individual providers and patients were masked from the investigators.

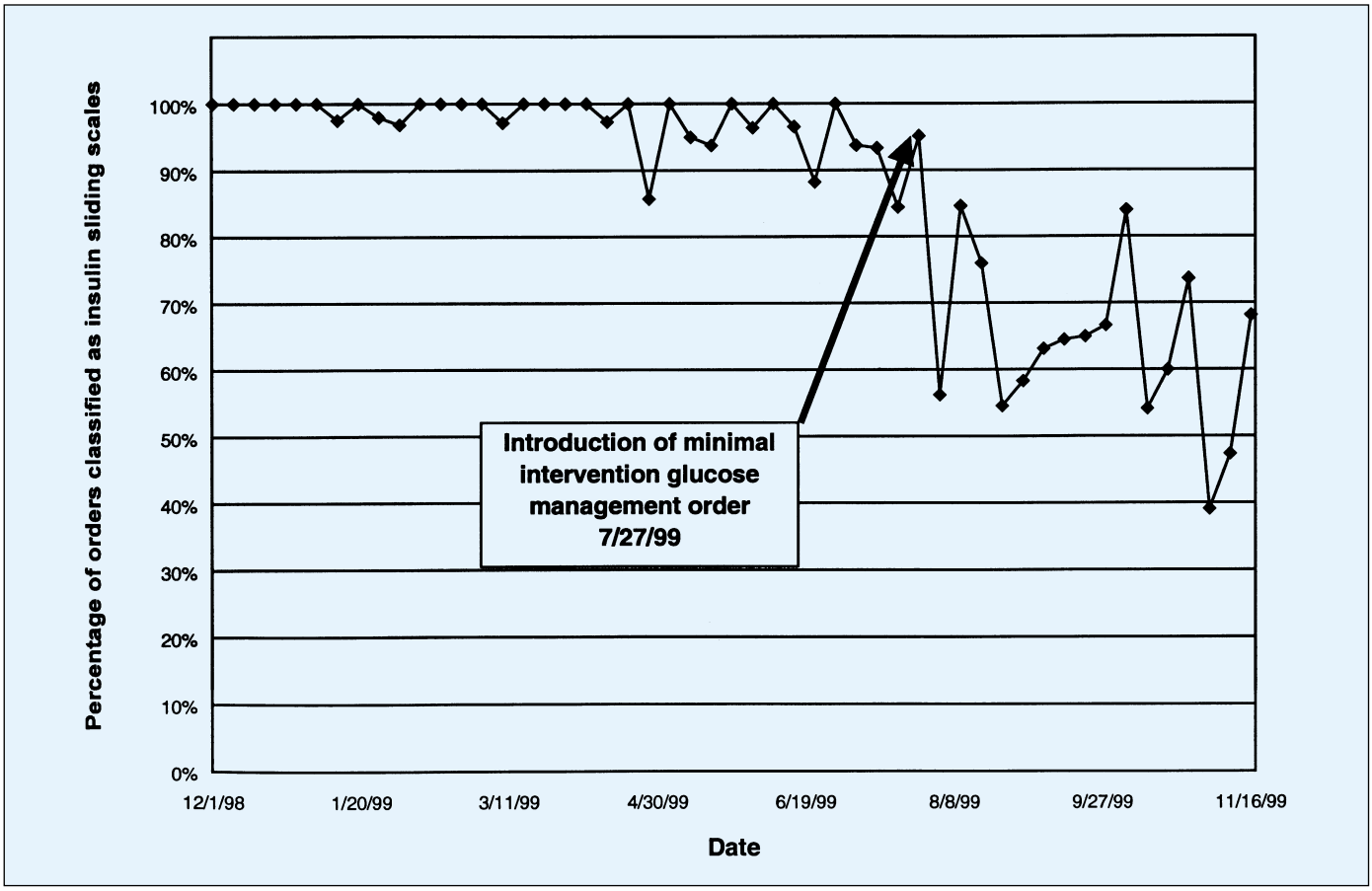

Fig. 4 Quick-order for minimal intervention decreased use of traditional insulin siding scale orders. Minimal intervention order initiated on 7/27/99. Original sliding scale order was re-instated on 8/8/99.

Results

There were 1405 orders written by medicine service providers for supplemental insulin on hospitalized patients between December 1, 1998 and November 16, 1999. These orders were written by 186 medical residents, six staff physicians and two physician assistants. Table 1 shows the distribution of these orders before and after the introduction of the minimal intervention quick-order. The introduction of the minimal intervention quick-order significantly decreased the proportion of traditional sliding scale orders ($P < 0.001$; Fig. 4).

Discussion

Insulin sliding scale orders are commonly used for the management of inpatients with diabetes in our center and elsewhere despite evidence and expert opinion that they should not be used (1, 6, 7). Studies suggest that the sliding scale insulin results in worsened glycemic control and increased hypoglycemia in hospitalized patients (8, 9). After the introduction of a specialty endorsed automated quick-order, we observed a significant decrease in insulin sliding scale orders. This effect is sustained over the 16-week period of measurement. This finding is consistent with others who have shown a change in behavior as a result of automated guidelines (17, 20, 21). However, the intervention studied in our investigation is simpler for the provider than the intervention in Pestotnik (17) and Evan's (20) studies. These studies influenced providers' ordering behavior utilizing a series of computer generated guidelines and alerts regarding multiple aspects of antibiotic use and infection. They influenced ordering behavior using complex decision-making tools in a complex domain. Our results suggest that behavior might be influenced with a simple intervention. In our study, physicians were presented only with pre-formatted options on an electronic order screen containing an expert endorsed evidence based insulin management regimen and a traditional sliding scale. Yet, this intervention was sufficient to influence ordering behavior towards the endorsed regimen. Thus, our study indicates that clinically important changes in provider ordering might be accomplished through simple, easy to implement changes in a computer-based order entry system.

There are several limitations to this study. First, it is not randomized. For technical reasons, we were not able to randomly assign the new quick-order to some providers but not to others. The effect we observed might be due to adoption of appropriate blood sugar management practices by providers for reasons other than the presence of the quick-order. Other influences, such as changes in teaching, new journal articles, or added resources might have contributed to the change in behavior. However, the temporal relationship between the introduction of the minimal intervention management quick-order and the change in physician ordering patterns strongly suggests a causal association.

Our study was conducted in a teaching hospital where orders were written largely by housestaff. The same effect might not be seen in other practice settings such as non-academic institutions or in other provider populations. Additionally, our study examined only the 16-week period after the addition of the quick-order for minimal intervention management. Further research needs to be done to determine if this effect is sustained and leads to persistent change in how an individual prescribing habits. Finally, we did not study patient outcomes.However, data from other studies suggests that a shift away from traditional sliding scale regimens for inpatient glycemic control would be beneficial for patient outcomes (7).

Computer-based order entry has the potential to improve patient care. Our findings demonstrate that it may be an effective teaching tool or adjunct to education for modifying ordering behavior. We recognize that these results are only relevant where computer-based order entry is available and that few organizations have this infrastructure in place. Order entry is costly to implement, requires more intensive up-front training and might take more time (25, 26). However, our study suggests that a computer order entry system could improve patient care by improving practitioner prescription choice without sacrificing autonomy and individual decision-making.

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References

1. Katz CM. How efficient is sliding scale insulin therapy? Problems with a “cookbook” approach in hospitalized patients. Postgrad Med 1991; 89: 46-57.
2. Macmillan DR. Insulin adjustment by the sliding scale method – a straw man who won’t stay down? J Ky Med Assoc 1991; 89: 211-2.
3. Gill G, Macfarlane I. Are sliding – scale insulin regimens a recipe for diabetic instability? [letter]. Lancet 1997; 349: 1555.
4. Sawin CT. Action without benefit: the sliding scale of insulin use [editorial]. Arch Intern Med 1997; 157: 489.
5. Paauw DS. Did we learn evidence-based medicine in medical school? Some common medical mythology. J Am Board Fam Pract 1999; 12: 143-9.
6. Hirsch IB, Paauw DS, Brunzell J. Inpatient management of adults with diabetes. Diabetes Care 1995; 18: 870-8.
7. Queale WS, Seidler AJ, Brancati FL. Glycemic control and sliding scale insulin use in medical inpatients with diabetes mellitus. Arch Intern Med 1997; 157: 545-52.
8. Gearhart JG, Duncan JL 3rd, Replogle WH, Forbes RC, Walley EJ. Efficacy of sliding-scale insulin therapy: a comparison with prospective regimens. Fam Pract Res J 1994; 14: 313-22.
9. Queale WS, Seidler AJ, Brancati FL. The use of sliding scales for medical inpatients with diabetes [Abstract]. JGIM 1995; 10 (Suppl): 47.
10. Cabana MD, Rand CS, Powe NR. Why don't physicians follow clinical practice guidelines? A framework for improvement. JAMA 1999; 282 (15): 1458-65.
11. Eisenberg JM, Williams SV. Cost containment and changing physicians’ practice behavior. Can the fox learn to guard the chicken coop? JAMA. 1981; 246: 2195-201.
12. Greco PJ, Eisenberg JM. Changing physicians’ practices. N Engl J Med 1993; 329: 1271-3.
13. Bates DW, Leape LL, Cullen DJ, et al. Effect of computerized physician order entry and a team intervention on prevention of serious medication errors. JAMA 1998; 280 (15): 1311-6.
14. Bates DW, Kuperman GJ, Rittenberg E, et al. A randomized trial of a computer-based intervention to reduce utilization of redundant laboratory tests. Am J Med 1999; 106: 144-50.
15. Hunt DL, Haynes RB, Hanna SE, Smith KS. Effects of computer-based clinical decision

support systems on physician performance and patient outcomes: a systematic review. JAMA 1998; 280 (15): 1339-46.
16. Mcdonald CJ, Wilson GA, McCabe GP. Physician response to computer reminders. JAMA 1980; 244 (14): 1579-81.
17. Pestotnick SL, Classen DC, Evans RS, Burke JP. Implementing antibiotic practice guidelines through computer-assisted support: clinical and financial outcomes. Ann Intern Med 1996; 124: 884-90.
18 Johnston ME, Langton KB, Haynes RB, Mathieu A. Effects of computer-based clinical decision support systems on clinician performance and patient outcome. A critical appraisal of research. Ann Intern Med 1994; 120: 135-42.
19. Bates DW, Cohen M, Leape LL, et al. Reducing the frequency of errors in medicine using information technology. J Am Med Inform Assoc 2001; 8: 299-308.
20. Evans RS, Pestotnik SL, Classen DC, et al. A computer-assisted management program for antibiotics and other anti-infective agents. N Engl J Med 1998; 338 (4): 232-8.
21. Evans RS, Classen DC, Pestotnik SL, Lundsgaarde HP, Burke JP. mproving empiric antibiotic selection using computer decision support. Arch Intern Med 1994; 154: 878-84.
22. Safran C, Rind DM, Davis RB, et al. Guidelines for management of HIV infection with computer-based patient's records. Lancet 1995; 346: 341-6.
23. Geraci JM, Ashton CM, Kuykendall DH, et al. In-hospital complications among survivors of admission for congestive heart failure, chronic obstructive pulmonary disease or diabetes mellitus. J Gen Intern Med 1995; 10: 307-14.
24. Ashton CM, Kuykendall DH, Johnson ML, Wray NP, Wu L. The association between the quality of inpatient care and early readmission. Ann Intern Med 1995; 122: 415-21.
25. Bates DW, Boyle DL, Teich JM. Impact of computerized physician order entry on physician ime. Proceedings - the Annual Symposium on Computer Applications in Medical Care 1994: 996.
26. Overhage JM, Perkins S, Tierney WM, Mcdonald CJ. Controlled trial of direct physician order entry: effects on physicians' time utilization in ambulatory primary care internal medicine practices. J Am Med Inform Assoc 2001; 8: 361-71.

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