Journal of HOSPITAL MEDICINE www.journalofhospitalmedicine.com

BRIEF REPORT

Inpatient Insulin Orders: Are Patients Getting What Is Prescribed?

Eli N. Deal, PharmD, BCPS[1*], Aiqun Liu, BSN, RN, CDE[2], Laura L. Wise, RN, CDE, CMS, RN[2], Kathy A. Honick, RN, CDE[2], Garry S. Tobin, MD[3]

[1]Department of Pharmacy, Barnes-Jewish Hospital, St Louis, Missouri; [2]Diabetes Education Service, Barnes-Jewish Hospital, St Louis, Missouri; [3]Division of Endocrinology, Metabolism and Lipid Research, Diabetes Center, Washington University School of Medicine, St Louis, Missouri.

BACKGROUND: In-hospital insulin administration is associated with many medication errors, but the frequency and reasons for insulin administration errors are poorly described. To document types and frequency of errors related to insulin administration, an examination of 4 units was conducted.

METHODS: Using snapshot methodology, 4 non-intensive care unit (ICU) areas (medicine, cardiology, transplant, and surgery) were examined in an observational, prospective manner for 4 weeks. Each patient on insulin on the first day was followed for 7 days. Definitions and error categories were defined prior to data collection. Error types and numbers were collected and quantified on per-day or per-patient basis.

RESULTS: A total of 116 patient audit periods covering a total of 378 inpatient hospital days were examined. Inpatient insulin regimens on day 1 included correctional insulin only (51.7% of cases), neutral protamine Hagedorn ([NPH] 12%), and glargine (28.4%). A total of 199 administration errors occurred at a rate of 1.72 errors/patient-period and 0.53 errors/patient day. Missing documentation of doses (15.5% of all patients) and insulin being held without an order (25% of patients) were the most frequently occurring events. Other errors include transcription (7.5%), timing errors (22.7%), and lack of documentation of physician notification of hypoglycemia (12.6%).

CONCLUSIONS: Errors associated with insulin in the hospital are common and reveal a number of system errors that should be addressed. These data provide a foundation for future performance improvement. *Journal of Hospital Medicine* 2011;6:526–529. © 2011 Society of Hospital Medicine

Diabetes care in the inpatient setting requires coordination between multiple service providers. Breakdowns in this process occur at all levels leading to potential serious harm.[1] Error rates focusing on multiple areas related to diabetes care, including the inpatient provision of insulin, have been described as high as 19.5% in 14,000 patients surveyed in the United Kingdom.[2] Missteps are important, as insulin prescribing errors are more commonly associated with patient harm.[3] In the United States, medication errors related to provision of care to critically ill patients has been documented, but, to our knowledge, no such reports regarding general medical or surgical wards exist.[4]

Insulin errors can result from a wide range of possible reasons including: incorrect medication reconciliation, prescribing errors, dispensing errors, administration errors, suboptimal meal timing, or errors in communication for discharge plans regarding diabetes care. Examining each of these areas as a whole could be a daunting task. As such, we sought to examine 1 portion of insulin provision as an initial focus for performance improvement at our institution. Our purpose was to describe the rates of errors associated with insulin administration at our single academic medical center on general medicine and surgical wards.

METHODS

Study patients for this observational, prospective snapshot were identified by electronic medical records in 4 consecutive weeks in April 2009 at Barnes-Jewish Hospital (St Louis, MO), a 1200 bed academic medical center. This study was approved by the Washington University in St Louis School of Medicine Human Studies Committee, and the requirement for informed consent was waived.

On day 1 of each snapshot period, all patients on the identified wards were examined to determine if insulin was currently active as part of the inpatient medication orders. If active, this patient was enrolled into the evaluation data set. No patients were excluded if insulin was currently ordered. Four inpatient areas were selected to provide a representation of the non-critically ill patient population at our institution. The 4 areas selected were: a cardiac care ward (typical

***Address for correspondence and reprint requests:** Eli N. Deal, PharmD, BCPS, Department of Pharmacy, Barnes-Jewish Hospital, Mailstop 90-52-411, 216 S Kingshighway Blvd, St Louis, MO 63110; Tel.: 314-362-5407; E-mail: end0164@bjc.org

Additional Supporting Information may be found in the online version of this article.

Received: December 2, 2010; **Revised:** February 8, 2011; **Accepted:** April 13, 2011
2011 Society of Hospital Medicine DOI 10.1002/jhm.938
Published online in Wiley Online Library (Wileyonlinelibrary.com).

census = 24), a general medicine ward (typical census = 24), an abdominal transplant ward (typical census = 18), and a general surgery ward (typical census = 22). Taken together, these areas represent about 20% of the total non-critically ill patient population at our hospital. The transplant area was chosen because it represents a high-risk population with medication (corticosteroid)-induced diabetes. Nursing and physician care are typically exclusive in these areas, and very little crossover among these healthcare providers would have occurred among the units surveyed during the study period.

Each patient included on day 1 of each audit period was followed for a total of up to 7 days. Patients were only enrolled on day 1 of each audit period. Four survey periods were conducted, providing an evaluation of 28 days of insulin therapy in the studied units. Four periods were selected to pick up more patients on day 1 of each audit period. Electronic records of medication administration and evaluation of paper chart orders provided the information for insulin administration error rates. Additionally, physician notes regarding patients' histories and home insulin use were reviewed for background information for our patient population. Prospective daily assessments of insulin orders, doses charted, nursing notes, and blood glucose values were conducted for potential errors in insulin administration.

All definitions of insulin administration errors were defined prior to data collection. The investigators reviewed available literature involving insulin errors, and found no standardized definitions or previously published assessments at the time of inception of our study. As such, we examined our own clinical practice for areas of potential concern related to insulin administration. The following error categories were identified: transcription errors (eg, insulin glargine 10 units qpm written, but order transcribed and carried out as 20 units qpm); greater than 1 hour between obtained point-of-care blood glucose value and provision of correctional ("sliding-scale") insulin; insulin held without a physician order present in the medical records; missing documentation of insulin doses (glucose value of 150 mg/dL present, but no documented correctional dose corresponding to this value present in medical record); premeal and correctional insulin given at separate times; and no documentation of physician notification for hypoglycemia. Other reasons for potential insulin administration errors were collected if deemed pertinent by the individual auditors.

At the time of our survey, a standardized subcutaneous insulin administration order set was utilized in all of the surveyed units. As computerized physician order entry was not yet available at our institution, all orders were transcribed electronically from paper orders. This insulin order set has been in place for 5 years. Once initiated, all portions of the order set are initiated, including communication to nurses regarding glucose measuring times, requirement for documentation of hypoglycemia, and proposed glucose goals. A survey of insulin orders during the audit time revealed that >97% of all insulin orders were initiated from this standardized order set. These order sets encouraged the provision of physiological insulin (basal-bolus) using insulin glargine and insulin aspart in eligible individuals. Although no systematic, standardized goal for glucose attainment was promoted, a fasting blood glucose of 90-130 mg/dL and post-prandial value of <180 mg/dL was encouraged. The order sets had a stated requirement of physician contact for all blood glucose values <70 mg/dL. Although lack of documentation of hypoglycemia may not be directly considered an error associated with administration of insulin, the research group decided to include this provision in the definition of administration errors, given the ability of this parameter to provide a sense of overall completeness of insulin orders and as a marker of collaborative practice in the management of inpatient hyperglycemia.

Nurses documented glucose values and responses in electronic medical administration records as a matter of routine. Point-of-care glucose values were obtained by either patient care technicians or nurses on each individual ward. As an academic medical institution, physicians were frequently paged by other members of the healthcare team.

Each auditor (E.N.D., A.L., L.L.W., K.A.H.) reviewed 1 consistent unit during the audit period. All data for insulin administration errors were tabulated, and descriptive rates of errors were used on a per-patient or per-stay basis

RESULTS

A total of 116 patient-audit periods were identified during the 28-day study period (Table 1). Sixty-five patients were on surgical services, and 51 were on medicine services, representing 378 inpatient days. Median length of stay was 3.5 days. Home insulin use was evident in 49% of the surveyed population. Patients' mean A1C (data available within 3 months prior to admission) was 8.1% (n = 41). Inpatient insulin regimens on day 1 included correctional insulin only (51.7% of cases). Regimens containing neutral protamine Hagedorn (NPH) or glargine also included correctional insulin in 95% of cases, and premeal insulin in 35%. Regimens including both premeal insulin and correctional insulin occurred in 25% of the patients. Diet status indicated that 83% of the population was taking an oral diet on day 1, and 13% were nil per os (nothing by mouth [NPO]).

A total of 199 administration errors occurred at a rate of 1.72 errors/patient-period and 0.53 errors/patient day (Table 2). Missing documentation of doses (15.5% of all patients) and insulin being held without an order (25% of patients) were the most frequently occurring events. Errors classified as other were found

TABLE 1. Baseline Demographics

Characteristic	Result
Mean age, years	59
Mean body mass index	30.9
Male	58%
Reason for admission	
Diabetes-related	7 (6%)
Cardiovascular	23 (19.8%)
Infection/sepsis	12 (10.3%)
Transplant	10 (8.6%)
Vascular surgery	10 (8.6%)
Transplant complication	8 (6.9%)
Other	46 (39.6%)
History of diabetes	
DM1	7 (6%)
DM2	77 (67%)
Steroid-induced	8 (7%)
No history of diabetes	24 (20%)
Most recent A1C (n = 41) (mean)	8.1%
Home insulin use	57 (49%)
Hospital NPH, day 1	14 (12.0%)
Hospital glargine, day 1	33 (28.4%)
Hospital correctional insulin only, day 1	60 (51.7%)
Day 1 diet	
Prudent diabetic	58 (50%)
NPO	15 (13%)
Other	38 (32.7%)
Tube feeds	3 (2.6%)
TPN	2 (1.7%)

Abbreviations: A1C, glycated hemoglobin; DM1, diabetes mellitus type 1; DM2, diabetes mellitus type 2; NPH, neutral protamine Hagedorn; NPO, nil per os (nothing by mouth); TPN, total parenteral nutrition.

TABLE 2. Insulin Administration Error Results

Category	No. of events (% Out of 199 Total Errors)
Transcription error	15 (7.5)
Greater than 1 hr between blood sugar evaluation and insulin administration	20 (10.1)
Insulin held without a physician order	36 (18.1)
Missing documentation of insulin doses	58 (29.1)
Premeal and correctional insulin given at separate time	19 (9.5)
No documentation of physician notification of hypoglycemia	25 (12.6)
Other	26 (13.1)

in 13.1% of the defined events. These other errors consisted of not carrying out correctional dose insulin orders appropriately (eg, blood sugar value of 149 mg/dL should have resulted in a correctional dose of 2 units, but 3 units were documented as given instead), timing errors related to provision of mealtime insulin apart from documented provision of a meal, or not following the required documentation for insulin pumps.

Forty-two patients (36%) experienced no errors in insulin administration, 18 patients experienced 1 error, 21 patients had 2 errors, and 11 patients had 3 errors. The remainder of the patients (n = 23; 19.9%) had 4 or more errors during their observation period. Were similar across the units surveyed. Frequency of errors remained consistent regardless of reason for admission, history of diabetes or insulin use at home, or length of stay. Most errors occurred on days 1 and 2 of the hospital stay. Error rates and types were consistent across all units surveyed.

DISCUSSION/CONCLUSION

We found that insulin administration errors were common in our inpatient snapshot of non-critically ill patients. In our observational evaluation, 64% of patients had at least 1 error related to insulin administration. Errors related to missing documentation of scheduled doses, or doses held without a prescriber order, were the most common. Implications of missed or held doses could range from unclear approaches for dose adjustment due to missing information, incorrect titration due to incomplete information, or hypoglycemia and hyperglycemia.

This observed rate of error is much higher than the described error rate of 19.5% reported in the United Kingdom.[2] This difference in error rates most likely reflects a difference in focus, as investigators in that national effort focused on prescriber error, aberrations in blood glucose values, and readmission rates. Our evaluation in assessing error rates regarding insulin administration supports the use of personnel keenly aware of the processes related to insulin administration, and provides insight into the importance of evaluating small portions of insulin provision (administration vs prescribing, etc) in assessing grounds for improvement in care. It is important to note that our findings may be exaggerated and are not entirely comparable to a study with a different scope and size.

Our snapshot tool and baseline evaluation is a simple method that could be undertaken at many institutions. As such, this methodology and error estimate serves as a gauge for future comparisons and areas for intervention. Limitations of our assessment include the small portion of patients audited during our evaluation versus using a snapshot of our entire hospital, utilizing nonstandardized criteria for determination of insulin errors, and the lack of correlation of clinical significance (aberrations in glucose values) with errors observed. Also, this single-institution review may not be generalizable to all institutions. Additionally, we only examined errors related to administration of insulin. Other areas that would complete the picture, related to diabetic therapies and outcomes, would need to include prescribing errors or dispensing errors and relate these to glycemic outcomes. Assessment of these additional errors may have revealed more clinically important events that were not revealed in this small snapshot. Lastly, clinical endpoints such as intensive care unit (ICU) transfers, mortality, or readmissions were not assessed in this small study.

We are fortunate that many of these errors were apparently clinically silent, but in a subset of patients, the risk is real and life-threatening. Risk occurs at

both ends of the glucose spectrum, with the low end receiving the greatest attention. Severe hypoglycemia with harm and inpatient diabetic ketoacidosis have been qualified as newer events by Medicare. Hypoglycemia in the ICU population (<40 mg/dL) is an independent marker of mortality.[5] Hypoglycemia (<50 mg/dL) has been associated with heart attacks, strokes, and death in the outpatient setting.[6]

The ability to safely control blood sugar in the hospital requires that medications are administered on time, and that communication occurs between the prescribing provider and the nursing staff providing care. Along with the case-by-case implications regarding the need for accurate administration of insulin for subsequent titration and determination of discharge prescriptions for patients with diabetes, there are many implications regarding the assessment of inpatient provision of insulin on determining institutional practices based on previous performance. If insulin administration is not accurately provided or documented, institutions will find it difficult to correctly make changes to insulin protocols for targeting future improvements. Our evaluation indicates an obvious need for quality improvement with 18.1% of the errors reflecting holding insulin without an order, and 12.6% of the errors showing no documentation for the physician being notified of hypoglycemia requiring treatment. The need to foster structured nurse-physician communication will play a critical role in any process improvement. Communication is key for the optimal provision of insulin in the inpatient setting. Computerized order entry and bar-code guided administration of doses of insulin may fix some types of the errors (transcription and missed documentation, respectively). That said, one of the largest impacts of this survey may reveal that these errors may not be fixed by technology, but may require more targeted and difficult interventions, such as continuing education and holding clinicians accountable. This study provides insight into the complicated issues regarding inpatient insulin administration and, due to its systematic approach, has given direction for process and system improvements.

Disclosure: All authors disclose no pertinent or perceived conflicts of interest for the conductance of this study or during preparation of the manuscript.

References

1. Hellman R. Patient safety and inpatient glycemic control: translating concepts into action. *Endocr Pract*. 2006;12:49–55.
2. Lamont T, Cousins D, Hillson R, Bischler A, Terblanche M. Safer administration of insulin: summary of a safety report from the National Patient Safety Agency. *BMJ*.341:883.
3. Calabrese AD, Erstad BL, Brandl K, Barletta JF, Kane SL, Sherman DS. Medication administration errors in adult patients in the ICU. *Intensive Care Med*. 2001;27(10):1592–1598.
4. United States Pharmacopeia. MEDMARX 5th anniversary data report. A chartbook of 2003 findings and trends 1999–2003. Available at: http://www.usp.org/products/medMarx/index.html?USP_Print. Accessed December 1, 2010.
5. Van den Berghe G, Wilmer A, Hermans G, et al. Intensive insulin therapy in the medical ICU. *N Engl J Med*. 2006;354:449–461.
6. The ADVANCE Trial Collaborative Group. Intensive blood glucose control and vascular outcomes in patients with type 2 diabetes. *N Engl J Med*. 2008;358:2560–2572.