Impact of an Interactive Online Nursing Educational Module on Insulin Errors in Hospitalized Pediatric Patients

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OBJECTIVE — To determine the effectiveness of an online module for reducing insulin administration errors by nurses caring for hospitalized pediatric patients.

RESEARCH DESIGN AND METHODS — Pediatric nursing staff completed a mandatory online educational module teaching insulin pharmacokinetics and the insulin order form, using diluted insulin and finishing with 15 interactive cases. A chart audit to determine all possible insulin errors of patients receiving insulin was done before and 2–6 months after the educational module.

RESULTS — All of the medical center's 283 pediatric nurses successfully completed the educational module. A total of 24 charts were audited in the preintervention phase and 22 in the postintervention phase. The preintervention insulin error rate was 14.8%, reduced to 1.7% ($P < 0.001$) postintervention. Improvement occurred in correct insulin dosing and type, timing of administration, and timely blood glucose monitoring and documentation.

CONCLUSIONS — An interactive online educational module can be an effective strategy for reducing pediatric nurses' insulin administration errors.

Insulin administration errors pose a serious problem for hospitalized patients, specifically for children (1,2), and are responsible for 39% of the serious medication errors causing harm to patients (3). Insulin has a narrow therapeutic window, and incorrect dosing of insulin can cause hypoglycemia, hyperglycemia, and fatalities (4–6). Children (with their developing renal and hepatic systems, limited ability to communicate, and potential needs for diluted insulin) are particularly vulnerable to medication errors (7). In response, the Joint Commission (8) has mandated that health care organizations develop strategies to manage high-risk medications.

At our academic children's hospital, a failure modes effect analysis of reported insulin errors identified knowledge deficits among nurses regarding care of the child with diabetes or hyperglycemia. A root cause analysis identified problems with insulin dosing, insulin omission, and calculating and administering a diluted dose of insulin, all due to a lack of a standardized educational process and infrequent treatment of children with diabetes. This study was conducted to evaluate the effectiveness of an educational module on reducing pediatric nurses' insulin administration errors.

RESEARCH DESIGN AND METHODS

— This performance improvement study used a one-group pre- and postintervention design at an academic 150-bed children's hospital from February 2006 to January 2008. Institu-tional review board approval was obtained.

Learning module
The pediatric nursing staff (see supplemental Table 1 for demographics, available in an online appendix at http://care.diabetesjournals.org/cgi/content/full/dc10-0031/DC1) was required to complete a three-part module (view at http://rushakoff.com/rushakoff/rushakoff2).

Section one provides information regarding types of diabetes, insulin pharmacokinetics, physiological insulin dosing, calculating and administering a diluted insulin dose, recognition and management of hypoglycemia, and insulin pump therapy and explains our institution's two-RN independent check process for high-alert medications (two RNs independently determine insulin dose from physician order).

Section two provides information regarding use of the pediatric subcutaneous insulin order set, including timing of injections and glucose monitoring.

Section three consists of 15 questions related to interpreting insulin orders, determining the correct insulin dose, and identifying nursing actions based on the blood glucose and carbohydrate amount. Nurses had to discern the correct answer from other plausible but incorrect answers. For each question, if answered incorrectly, the nurse was instructed why the selected answer was incorrect and was required to try again.

Chart review
This analytic sample consisted of all pediatric patients during the study periods with a diagnosis of diabetes or hyperglycemia. Patient charts were identified for audit by a pharmacy-generated insulin list. All eligible charts were reviewed by two members of the study team (M.M.S. and C.R.O.) to identify the number of possible and actual insulin-related medication errors. Using a comprehensive audit tool (supplemental Table 2) created by the research team, retrospective chart audits were conducted for a period of 6 months before implementing the module and 2–6 months postimplementation. In-

Table 1—*Study demographics and insulin errors per patient*

	Preintervention	Postintervention
n	24	22
Age (years)	14.96 ± 4.4	13.68 ± 6.5
Female	17 (70.8)	16 (72.7)
Length of stay (days)	9.25 ± 8.7	7.0 ± 5.3
Type of diabetes		
Type 1	12 (50)	16 (72.7)
Type 2	4 (16.6)	2 (9.1)
Glucocorticoid-induced	5 (20.8)	2 (9.1)
Cystic fibrosis–related diabetes	3 (12.5)	2 (9.1)
Used insulin pump in hospital	1 (4.2)	5 (22.7)
Total possible errors	882	1,119
Total number of errors	131	19
Number of errors/patient	5.20 ± 6.8	0.86 ± 2.01*
Number who experienced errors (%)	21 (87.5)	5 (22.7)
Error rate	0.148	0.017†
Missed injection§	32 (24.4)	6 (31.5)
Wrong dose§	11 (8.3)	1 (5.2)
Wrong insulin type§	1 (0.7)	0
Wrong time§	1 (0.7)	0
Glucose not tested‡§	43 (32.8)	6 (31.5)
Glucose not documented‡§	43 (32.8)	6 (31.5)

Data are means ± SD or *n* (%) unless otherwise indicated. *$P = 0.003$ (pre- to postintervention). †$P < 0.001$ (pre- to postintervention). ‡These are not duplicates. Glucose may have been found in laboratory data, but not documented as mandated per nursing policy. §Percentage based on total possible errors.

ter-rater agreement was achieved through consensus. Opportunity for error was defined as each time the blood glucose should have been checked per physician order or the hypoglycemia protocol. An error was defined as any dose of insulin given or omitted that deviated from the physician order (omission of an insulin dose, wrong insulin dose or type, wrong administration time, blood glucose not checked per order or hypoglycemia protocol, and blood glucose not documented in the record).

Statistical analysis

Differences in error rates were compared using a two-tailed *t* test. All analyses were done using SPSS version 16.0.

RESULTS — Patient demographics and details of insulin errors are in Table 1. A total of 100% of the children's hospital's registered nursing staff ($n = 283$) completed the educational module. Before intervention, 131 errors were identified out of 882 opportunities for errors. The mean number of errors per patient in this sample was 5.20. In the postintervention sample, 19 errors were identified out of 1,119 opportunities for error. The mean number of errors per patient in this sample was 0.86 ($P = 0.003$). The number of patients experiencing insulin-related errors dur-

ing their hospitalization decreased from 21 out of 24 (87.5%) in the preintervention phase to 5 out of 22 (22.7%) postintervention. The overall error rate decreased from 14.8% in the preintervention phase to 1.7% in the postintervention phase ($P < 0.001$). These effects were sustained over 6 months.

CONCLUSIONS — These findings demonstrate that an interactive online nursing educational module can be an effective strategy for reducing insulin administration errors in hospitalized pediatric patients. Multiple studies have found deficits in nurses' knowledge regarding diabetes (9–11), suggesting that additional education about diabetes is needed in order for nurses to provide safe and effective care to these patients. Consistent with Phillips' (12) recommendation that educational modules provide frequent feedback to learners, our module used a self-paced technological medium that provided active learning, problem solving, and immediate feedback to the nurses. Strategies that enhanced implementation included engaging hospital administration support from the beginning of the study; recruiting nursing unit champions who took ownership of the performance improvement initiative at the unit level and acted as an educa-

tional resource for the nursing staff; and requiring that all nurses view the module.

Study limitations include limited generalizability due to a small convenience sample of pediatric nurses at a single academic medical center's children's hospital. Second, although the chart reviewers were not involved in the care of these patients, and therefore were blinded to the medication administration process and documentation, the analysis was done by the same team that collected the data, leaving the possibility of investigator bias. However, the magnitude of the difference between the pre- and postintervention findings makes it likely that a real reduction in errors did in fact occur. Finally, using a retrospective chart audit to detect errors was also a limitation, since it relies on the accuracy and adequacy of nursing documentation.

In conclusion, this study presents a first attempt to evaluate an effective and feasible method of educating a large number of nurses on the correct implementation of physiologic insulin dosing for hospitalized pediatric patients. More research is needed to validate these findings, as well as to determine how to sustain and disseminate successful educational programs.

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