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SYMPOSIUM

Miscoding and Other User Errors: Importance of Ongoing Education for Proper Blood Glucose Monitoring Procedures

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Abstract

Background:

This article reviews the literature to date and reports on a new study that documented the frequency of manual code-requiring blood glucose (BG) meters that were miscoded at the time of the patient's initial appointment in a hospital-based outpatient diabetes education program.

Method:

Between January 1 and May 31, 2007, the type of BG meter and the accuracy of the patient's meter code (if required) and procedure for checking BG were checked during the initial appointment with the outpatient diabetes educator. If indicated, reeducation regarding the procedure for the BG meter code entry and/or BG test was provided.

Results:

Of the 65 patients who brought their meter requiring manual entry of a code number or code chip to the initial appointment, 16 (25%) were miscoded at the time of the appointment. Two additional problems, one of dead batteries and one of improperly stored test strips, were identified and corrected at the first appointment.

Conclusions:

These findings underscore the importance of checking the patient's BG meter code (if required) and procedure for testing BG at each encounter with a health care professional or providing the patient with a meter that does not require manual entry of a code number or chip to match the container of test strips (i.e., an autocode meter).

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Abbreviations: (BG) blood glucose, (HCP) health care professional, (SMBG) self-monitoring blood glucose

Keywords: autocode, autocoded blood glucose meter, blood glucose, blood glucose meter, manual code, miscoded meter, patient education, user error

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Introduction

Persons newly diagnosed with diabetes who are attending diabetes education classes are dealing with mixed emotions as they participate in discussions regarding food planning, benefits of exercise, actions and side effects of medications, how and when to complete blood glucose (BG) testing, and what actions to take based on the test results. Even when the instruction is divided into multiple class sessions, it can be difficult to remember the details. This problem can be especially difficult when the patient is highly anxious about the diagnosis of diabetes. In my clinical experience, it has taken as much as 5 to 7 minutes for an individual patient to work up the courage to complete the first finger puncture for a BG test.

Methods

In my own clinical practice I documented data regarding BG code accuracy and the BG testing procedure for all patients who were referred to and seen for their initial appointment in the diabetes education program from January 1, 2007 through May 31, 2007. Patients who brought their BG meter with them were asked to perform a self-BG check so that their testing procedure could be observed. When using a manual code-requiring meter, the accuracy of the code entered prior to the appointment was checked with the test strip container. Errors in meter coding were noted and corrected. Instruction on the procedure to code their particular meter was provided at that time. A manual code-requiring meter is one that requires the patient to perform a task, such as inserting a code strip or code chip or entering a code number into the meter to assure that the meter code matches the code of the test strip. Errors in the test procedure were corrected during the process of the BG test itself.

The majority of these patients are newly diagnosed with diabetes. All are encouraged initially to test BG four to six times per day until they have achieved good BG control, after which they are encouraged to test a minimum of four times a day: before breakfast and 2 hours after each meal. The target for fasting glucose and 2-hour postprandial is 70–110 and 80–140 mg/dl, respectively. (Because of financial constraints, some patients test only one to two times per day in a rotating pattern.) Any medication adjustments were completed as needed by the physician of referral. Data were collected at the time of the patient's initial appointment with the diabetes educator. A total of 143 patients were seen for their initial appointment during the data collection period. This study was implemented/completed soon after the stringent restrictions of the Health Insurance Portability and Accountability Act regulations were implemented. Therefore, demographic data were not maintained with miscoded data.

Results

Among the 47 autocode meter users, 27 brought their autocode meter to the first visit, 5 stated that they use an autocode meter but did not bring it with them, and 15 were provided with an autocode meter and instructed how to use at the first visit **(Table 1)**.

Of the 96 patients with a meter requiring manual coding, 49 brought a correctly coded meter with them, 16 brought a meter that was coded incorrectly, 10 were provided with and instructed in the use of a meter requiring coding at the initial appointment, 19 stated that they use a meter requiring coding but did not bring it with them to the appointment, 1 brought a meter with dead batteries, and 1 brought a meter and test strips but no code-labeled test strip container.

Because of the inability to verify the accuracy of coding and meter use, those who did not bring their meter, those who brought a meter with a dead battery, and those who brought test strips but no code-labeled test strip container were excluded from data analysis. Thus, 16 of the 65 patients (25%) had a miscoded meter at the time of their initial diabetes education appointment (see **Table 1**).

Two persons using a miscoded meter were using a routine preprandial dose of insulin. In addition to the premeal insulin, if the 2-hour postprandial BG reading was above target, a correction dose of insulin was to be used. On at least one occasion, based on the 2-hour postprandial BG reading, one of the persons should have taken two extra units of rapid-acting insulin for hyperglycemia correction. However, this patient reported that symptoms did not indicate a need for more insulin; fortunately, no extra insulin was taken. A correction dose of insulin based on inaccurately high readings could have the potential for severe hypoglycemia as shown in research.[1] Failure to take a correction dose for an inaccurately low reading could allow hyperglycemia to continue.[1] Based on the Raines study,[1] miscoding does contribute to errors in blood glucose results.

Table 1.

	Number	% total	% of subgroup
Total patients seen	143		
Patients with autocode meter	47	33%	
Autocode meter provided at first visit	15		32%
Patient identifies has autocode meter at home	5		11%
Autocode meter brought to first visit	27		57%
Patients with code-requiring meter qualifying for study	65	45%	
Patient brought meter requiring manual code entry, coded correctly	49		75%
Patient brought meter requiring manual code entry, coded incorrectly	16		25%
Patients with code-requiring meter not qualifying for data analysis	31	22%	
Meter requiring manual code entry provided at first visit	10		33%
Patient identifies has meter requiring manual code entry at home	19		61%
Patient brought meter requiring manual code entry with dead battery	1		3%
Patient brought meter requiring manual code entry, but no container to compare code number of meter with strips	1		3%

Discussion

Blood glucose testing is an essential component of tight glucose control for those with diabetes. Treatment decisions are based on these test results. Miscoding BG meters can lead to significant errors in the BG result.[2] The magnitude of the error is dependent on the particular monitoring system and specific combination of mismatched codes.[3,4] These errors have the potential to cause errors in the correction scale insulin dose administered.[1] Data in this study are consistent with previously reported studies documenting a high frequency of coding problems (9–16%)[5–7] but are in contrast to other reports where frequencies of 3% were found.[8,9] Therefore, accurate testing methods are important to form a basis for accurate adjustment of treatment. However, research on the impact of accurate vs inaccurate procedure for BG testing is limited.[8–10]

Klonoff[11] indicates four ways of how routine BG testing is useful. It enables the patient and/or health care provider (HCP) to detect low and high glucose so that appropriate adjustments to therapy may be implemented. It provides for immediate detection of hyperglycemia or hypoglycemia, thus giving the person with diabetes immediate feedback so that early aggressive treatment for low or high glucose can be implemented in a timely manner. The ability to test glucose gives the individual patient more responsibility for his/her own self-care. It may also serve as a motivator toward a healthier lifestyle.

Davidson *et al.*[12] found that the frequency of self-monitoring of BG is inversely proportional to hemoglobin A1c values in persons with diabetes type 1. However, achieving a consensus on an appropriate testing schedule for persons with diabetes type 2 has been difficult. Klonoff[11] indicated that adequate training to interpret the results and take appropriate remedial action has not been as readily available for persons with diabetes type 2. However, a study in France[13] and one in Germany[14] found that self-monitoring of blood glucose (SMBG) was associated with a lowered hemoglobin A1c in noninsulin-treated diabetes type 2.

Barriers to Accuracy of Blood Glucose Test Results

There are many barriers to accurate BG testing. One study[15] identified the top five barriers to following a prescribed test schedule:

- Frequent finger sticks
- Painful testing
- Questioning the accuracy of results
- Difficulty obtaining an adequate sample
- Error messages requiring a retest.

In addition to these factors, Kristensen and colleagues[6] found that patient testing errors included use of an inadequate blood sample, failure to recognize an inadequate blood sample, and failure to code the BG meter correctly. These top testing barriers are consistent with a problem in the testing procedure.

In a prospective study, Raine[5] found that 16% ($p < 0.0001$) of patients had not coded their glucose meter properly to match the container of test strips in use at the time. All patients in this study had been taught to use the

meter by a clinic nurse, diabetes educator, or pharmacist. The study completed by Kristensen and associates[6] had similar findings. A bulletin from the Department of Health[10] in England reported a potential of 4 mmol error when code-requiring meters were coded incorrectly.

Options to Improve Accuracy of BG Test Results: Patient Education

Mulcahy and colleagues[16] stated that the purpose of diabetes education is to improve one's ability to make decisions about self-care so as to improve health outcomes in the long term. Fennel *et al.*[17] believe that educating the patient to routinely make informed decisions regarding diabetes self-care and glucose control appropriately puts the responsibility for those decisions on the one who will benefit from good control or suffer the consequences of poor control.

It is important to base the educational framework on basic principles of teaching and learning. Adult learners are self-directed and problem-oriented learners. When one is encouraged to immediately practice a newly acquired skill, learning the correct procedure for BG monitoring is reinforced. If one is then assisted with immediate use of the information gained as a result of completing the procedure (i.e., BG testing), the likelihood of continuing to complete the skill (BG testing), despite the potential for small discomfort and inconvenience, is increased. By teaching BG testing very early in the educational process, the fear of pain is decreased. Additional learning can occur more readily once the fear of pain as a barrier to learning is diminished. It is then possible to progress to teaching how to correlate food intake, activity, medications, and stress with BG fluctuations.

There are many details to demonstrate when teaching a person the procedure for SMBG. Two major points of entry for error are obtaining an inadequate blood sample[6] and failure to code the BG meter properly to match the test strips.[1] Keeping the processes required for completion of a skill simple facilitates ease of education. By using a meter that does not require manual code entry, fewer critical steps in the procedure are required, thus diminishing the potential for procedural error.

Autocode Meter

Since one of the significant procedural problems for patients testing BG is failure to enter the correct code when using a manually coded meter, over- or undertreating BG may result.[1] The Raine 2007 study compared autocoded meters, correctly coded manually coded meters, and the same brand of meters requiring coding by the patient that were purposely miscoded. Findings indicated maximal median percentage biases of +29% and –37% for miscoded meters. Those coded correctly, including both autocode and manually coded meters, had maximal median percentage biases as great as + 0.64% and –10.45%.

When Monte Carlo simulation was used to estimate the frequency of insulin dose errors using a low-dose algorithm, miscoded manual code meters had the greatest potential of insulin dose errors. The risk of correction scale insulin dose errors was significantly less for manually coded meters that were coded correctly. However, the risk of correction scale insulin dose errors was least when data from autocoded meters were used in the calculation.

Cost

There could be wasted test strips if the meter is identified immediately as miscoded and a second test is performed or if the HCP realizes that the patient's meter was miscoded and therefore could not trust data from a logbook or meter memory. The cost of medical care and potential cost savings from good control of diabetes and related acute and chronic complications has been well documented.[18,19] When inaccurate information, obtained by an improper procedure, is used for daily self-management decisions and overall treatment plan adjustments, the long-term outcome may be affected adversely. This practice could lead to more frequent emergency room visits, hospitalizations, and development of long-term complications. Therefore, it is important to obtain the best, most reliable information possible as persons with diabetes monitor their day-to-day levels of BG. Using an autocode meter eliminates one step of the procedure that can be easily missed.

Conclusion

The patient's take-home knowledge of procedures required for good diabetes self-management and how to use the information gained as a result of BG testing is influential in the long-term health outcomes of the person diagnosed with diabetes. When code entry is required, it is important to check the patient's meter for accurate coding at each visit with the HCP. In addition, observing the patient complete a test allows the HCP to correct any procedural errors. It is also important to ask the patient how they store and care for the BG meter and test strips. Failure by the HCP to verify accuracy

of the patient's meter code, if required, and monitoring procedures may contribute to more frequent emergency room visits, hospitalizations, and development of long-term complications, as well as increased health care costs.

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