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# Teaching Casual Random Blood Glucose Screening to Second-Year Dental Students

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**Abstract:** In our project, archived casual random blood glucose levels of second-year dental students who were taught the mechanics of self-testing were retrieved. Material data were analyzed by calculating means, medians, standard deviations, and ranges for 161 dental students screened by this casual and random self-monitoring of blood glucose levels as described by the American Diabetes Association's 2008 Standards of Medical Care in Diabetes. Three types of data were assessed in this study. The first was the casual blood glucose levels of second-year dental students. The second was the data retrieved from student questionnaires regarding the value of teaching casual random blood glucose screening. The third was the U.S. dental schools' responses regarding inclusion of casual blood glucose screening in their current curricula. Second-year dental students self-reported hypoglycemia in three instances and hyperglycemia in eight, based on current American Diabetes Association standards. Students agreed or strongly agreed that the value of teaching was informative (92.3 percent), beneficial (95 percent), and something that might be included in their practices (78.2 percent), with 19.2 percent being neutral on the inclusion. Only six U.S. dental schools reported teaching casual random glucose screening.

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The Commission on Dental Accreditation's Standards for Dental Education Programs cite as their first goal "to protect the public welfare." To meet that goal, Standards 2-25a, b, and c list minimum competencies that dental school graduates must attain in patient assessment, diagnosis, comprehensive treatment planning, and health promotion and disease prevention.<sup>1</sup> In 2008, the American Diabetes Association in its Standards of Medical Care in Diabetes published the criteria for diagnosing diabetes,<sup>2</sup> and a committee of experts lowered the fasting plasma glucose concentration criterion from >7.8 mmol/L (140 mg/dL) to >7.0 mmol/L (126 mg/dL). The committee maintained the benchmark for the two-hour value or the oral glucose tolerance test at >11.1 mmol/L (200 mg/dL). Currently, there are four ways to evaluate glucose levels in the blood: random glucose concentrations, fasting glucose concentrations, oral glucose tolerance tests, and glycated hemoglobin levels (HbA1c).<sup>3,4</sup>

Random glucose concentrations are critically dependent on the time and carbohydrate content of the previous meal.<sup>5</sup> Blood sugar levels should be between 70 and 125 mg/dL to be considered normal.<sup>5</sup> In random non-fasting blood glucose levels, diabetes is suspected if values are higher than 200 mg/dL and are accompanied by the classic symptoms of increased

thirst, increased urination, and fatigue. The relationship between casual postprandial glucose levels and HbA1c in patients with type 2 diabetes has been studied to determine the predictive characteristics of a convenient glucose cutoff when rapid turnaround of HbA1c levels was not available.<sup>5</sup> A value of cPPG cutoff of 150 mg/dL constituted a convenient indicator that predicted HbA1c levels that were greater than 7.0 mmol/L.

A large body of evidence supports a range of interventions to improve diabetes outcomes. Random screening provides a clue to the prediabetic and the undiagnosed type I or type II diabetic such that it remains a simple, rather noninvasive and inexpensive screening mechanism. The American Diabetes Association has encouraged the use of self-monitoring of blood glucose by those patients and caregivers who are able to learn the technique, are motivated to collect accurate results, and are willing to adjust their treatment depending on the monitored levels in consultation with health care providers.<sup>2</sup> During carefully controlled conditions, hand-held glucose meters have been shown to have good correlation and acceptable clinical accuracy in determining blood glucose levels when compared with standard laboratory testing.<sup>6</sup> Community screening outside a health care setting is not recommended because people with positive tests

may not seek appropriate follow-up testing and care; conversely, there may be a failure to ensure appropriate repeat testing for individuals who test negative. Table 1 lists the criteria for testing for prediabetes and diabetes in asymptomatic adult individuals.

Trajanoski et al. found that there is still very little data available with regard to the accuracy of blood glucose monitors when blood glucose is in the lower range.<sup>6</sup> This study noted that it has been shown previously that capillary glucose is similar to arterialized venous glucose. For mild and marked hyperinsulinemic hypoglycemia in healthy subjects, the arterialized venous glucose levels were 98.4 percent and 98.0 percent of the capillary glucose, respectively (3.09 and 2.4 vs. 3.14 and 2.49 mmol/L). Further, poor agreement between the laboratory and the glucose monitor measurements at low blood glucose values was explained by patient error and potentially influential factors such as altitude, temperature, humidity, hypotension, hypoxia, and hematocrit. In controlled studies, these factors can be excluded. Hence, the cause of the variability of the glucose measurements by the monitors at low glucose levels is likely to be analytical or a substantial difference between the meters evaluated in this study. Recent advances in analytical analysis of meters studied improved accuracy to a previously targeted variability not exceeding 5 percent for glucose monitors.<sup>7,8</sup>

Researchers have predicted that dental practitioners will be treating more patients with diabetes in the future.<sup>9,10</sup> By the year 2010, the number of people with diabetes worldwide is projected to reach 221 million; over the past two decades, the prevalence of diabetes has increased 30 to 40 percent. This is a reason for screening random nonfasting blood

glucose levels in a dental practice, and instruction should proceed at the undergraduate dental level that follows the guidelines for screening set forth by the American Diabetes Association. The dentist should be able to use a glucometer to rapidly measure blood glucose levels from a patient's fingertip. With respect to surgical procedures, the dentist should also test the patient's blood sugar with a glucometer to avoid emergency-related events such as insulin shock (profound hypoglycemia) or ketoacidosis with severe hyperglycemia before, during, or after an invasive procedure.<sup>9</sup>

In 1995, the Institute of Medicine's Committee on the Future of Dental Education reported that "dental education has arrived at a crossroads" and that "questions persist about the position of dental education within the university and its relationship to medicine and the larger health care system."<sup>11</sup> One of the four broad objectives emphasized in that report was the broadening of knowledge about oral health care problems, as they relate to systemic disease, not only among dentists "but also among primary care providers, geriatricians, educators, and public officials." Improving knowledge was another of the committee's objectives. Since then, articles have appeared that advance the understanding of the relationship between oral health and systemic disease. Kunzel et al. focused on translating the understanding of systemic disease into the clinical practice of dentistry.<sup>12</sup> They noted the lack of understanding that the majority of general dental practitioners have regarding active management of systemic diseases such as diabetes. In another article, Borrell et al. explored the reasonableness of the "dental office being a health care location actively involved in screening for un-

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**Table 1. American Diabetes Association's criteria for testing for prediabetes and diabetes in asymptomatic adult individuals**

1. Testing should be considered in all adults who are overweight (BMI  $\geq 25$  kg/m<sup>2</sup>) and have additional risk factors:
    - physical inactivity
    - first-degree relative with diabetes
    - member of a high-risk ethnic population (African American, Latino, Native American, Asian American, and Pacific Islander)
    - women who delivered a baby weighing less than 9 lbs or were diagnosed with GDM
    - hypertension ( $\geq 140/90$  mmHg or on therapy for hypertension)
    - HDL cholesterol level  $< 35$  mg/dL (0.90 mmol/L) and/or a triglyceride level  $> 250$  mg/dL (2.82 mmol/L)
    - women with polycystic ovarian syndrome (PCOS)
    - IGT or IFG on previous testing
    - other clinical conditions associated with insulin resistance (e.g., severe obesity and acanthosis nigricans)
    - history of CVD
  2. In the absence of the above criteria, testing for prediabetes and diabetes should begin at age 45 years.
  3. If results are normal, testing should be repeated at least at three-year intervals, with consideration of more frequent testing.
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identified diabetes."<sup>13</sup> Their article based a predictor of undiagnosed diabetes on clinical examinations such as a periodontal evaluation along with a family history of diabetes. Casual random blood glucose screening does not base itself on a clinical or historical relationship to diabetes but includes all patients in a dental practice when there is no predictor in the history or physical evaluation.

Marquette University School of Dentistry began teaching the use of glucose monitoring in 2007 to its second-year dental students with the help of the Sandista Corporation. The protocol established a regimen for introducing random glucose screening to these students. This project was reviewed and approved by the Institutional Review Board of Marquette University.

Our hypothesis for the project was that casual random blood glucose screening, a procedure not universally taught in U.S. dental schools, can readily be taught to second-year dental students as an adjunct in the evaluation of prediabetic and diabetic patients before treatment is rendered.

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## Methodology

Two groups, each consisting of second-year dental students (one group each from 2007 and 2008), were instructed to self-test their blood sugar levels. The 2007 group used BD Test Strips and a BD Glucometer as an exercise in creating a database for clinical patients when a health history indicated there was prior treatment for diabetes. The students were divided into four subgroups of twenty. In each subgroup, testing was accomplished for ten students at 1:30 p.m. and ten students at 2:30 p.m. on successive Fridays during the fall semester at Marquette University School of Dentistry. Each student recorded his or her own blood glucose levels after the proper use of the equipment had been demonstrated. In 2007, BD glucose meters were provided to the students. Each meter had been calibrated before testing as to its accuracy and then coded for the test strips that accompanied the machine following the manufacturer's instructions. This included the calibration of the meter with the glucose testing solution provided by the manufacturer. The 2008 students were provided meters that did not require coding of test strips. These were provided by the Sandista Corporation. The second meter tests were a result of upgrades in technology that eliminated the steps in

strip and meter calibration and coding. This was a result of overall advancement in available machines in the marketplace.

For each group, students were instructed to cleanse with an alcohol wipe the tip of their ring finger on their nondominant hand. The finger tip was allowed to air dry. The lancet was prepared by inserting a sterile lancet into each spring-loaded lancet holder and cocking the trigger-releasing mechanism. The meters were prepared by inserting a test strip into the meter receptacle and checking the screen to indicate that a drop of blood should be applied according to the manufacturer's instructions. The meters provided an indication that enough blood was deposited into the strip to provide a visual read-out on the meter's screen. Following the successful introduction of the sample, students cleansed the site with an alcohol wipe. The used lancets and test strips were disposed of in a standard red sharps container. Students recorded their results anonymously on a piece of paper. This information was archived into the course material for the academic year as a spreadsheet document.

The casual random blood glucose testing was taught as an exercise in the oral medicine and diagnosis course as a laboratory exercise. Before classroom instruction, students were asked to read as background information a relevant article published in the *Journal of the American Dental Association*.<sup>10</sup> In addition to the practical demonstration and educational value of testing each other in a laboratory setting designed to demonstrate the calculating of casual random blood glucose data, students were asked to evaluate the experience as to whether the material was informative, time-consuming, beneficial, and worthy of being incorporated into private practice.

A survey of dental schools in the United States was also conducted to determine the extent to which casual random glucose screening was being taught in the predoctoral curriculum. This was accomplished by an online survey of the academic deans of U.S. dental schools.

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## Results

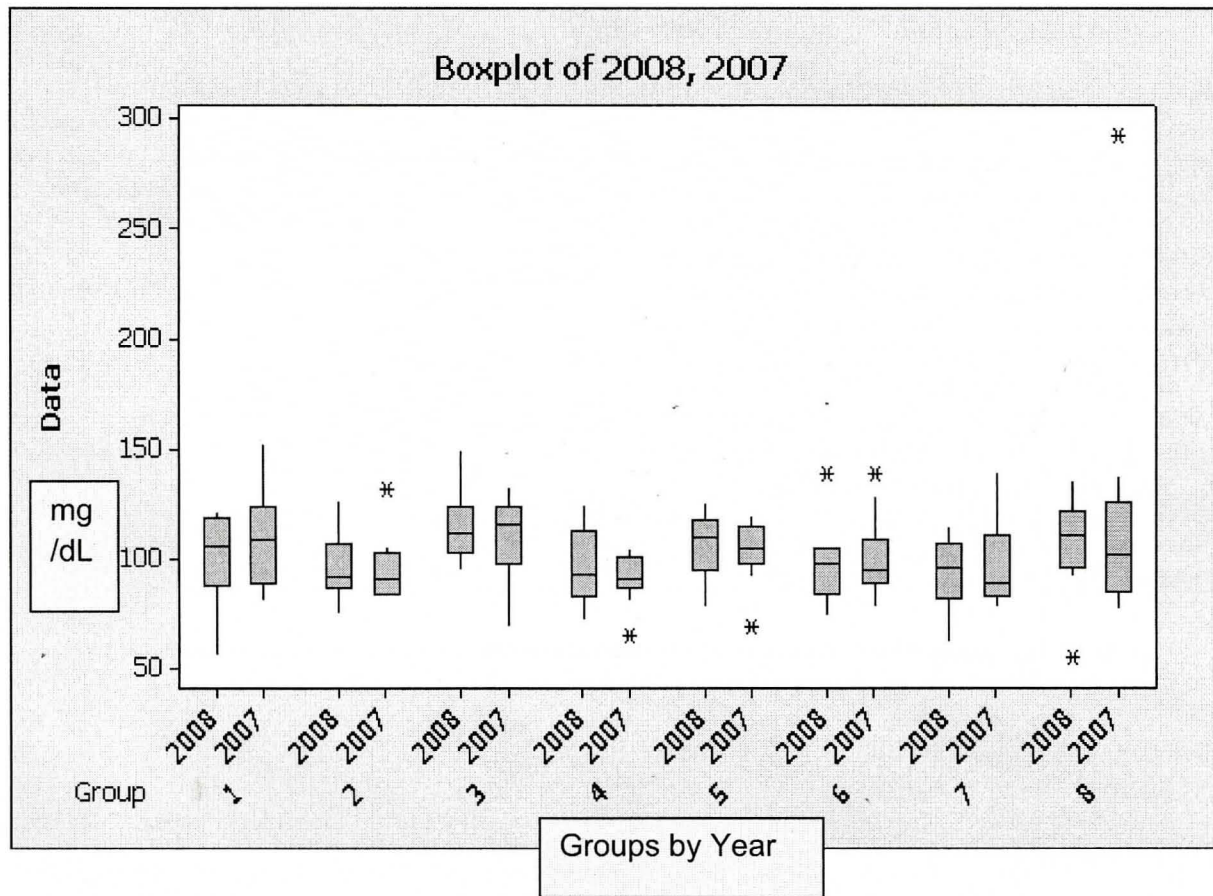
Eighty students were tested over a four-week period in the first year and eighty-one students in the second year. These represented the second-year classes for 2007 and 2008 at Marquette University School of Dentistry. The raw data were collected

**Table 2. Average, median, and STDEV for all groups of casual random blood glucose screening**

	2008	2007	All
Average	101.5	103.3	
Median	103	98.5	
STDEV	18.3	28.0	
Min	55	65	
Max	150	153	
<65	3	0	1.9
>135	3	5	5.0
% <65			6.8
% >135			
% <75 and >125			

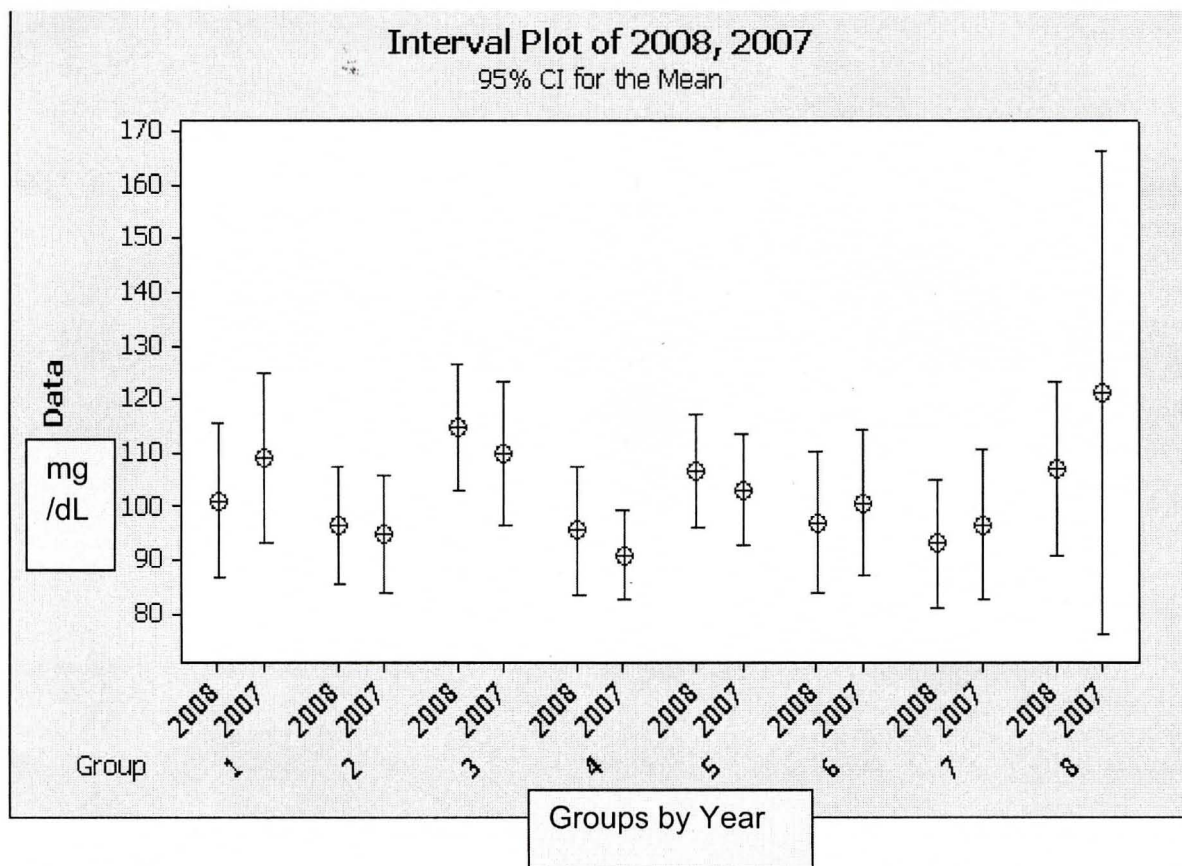
and placed in spreadsheet form. The averages for the 1:30 and 2:30 groups along with the standard deviation, medians, and high/low values for each of the two groups are found in Table 2. Of note is the incidence of abnormal screening results, in that 6.8 percent of otherwise healthy young adults fell outside the range considered normal by the American Diabetic Association of 75 to 125 mg/dL.<sup>2</sup> Hyperglycemia was found in 5 percent and hypoglycemia was found in 1.9 percent as defined in the 2008 standards.<sup>2</sup>

The graphic representation for the two groups with regards to average, standard deviations, and medians is found in Figure 1 along with box plots of the 2007 and 2008 data. Figure 2 shows the box



**Figure 1. Boxplots of results of casual random blood glucose screening in all groups**

Note: The asterisk (\*) indicates the outliers in each group where they exist. The "x" axis indicates groups by year, and the "y" axis is glucose readings in mg/dL.



**Figure 2. Interval plot of casual random glucose screening for all groups**

Note: Plot is for the 95% confidence interval where ranges in mg/dL are on the "x" axis and groups by year are on the "y" axis. High, low, and median values are indicated for each group.

plot of interval for a confidence incidence (CI) at 95 percent for the mean intervals of the casual random blood glucose screening for each group over the two-year period. Of note in these results are the points in Figure 1 that graphically represent the 6.8 percent of tested students with casual random blood glucose levels in the hypoglycemic or hyperglycemic range. One individual had a casual random blood glucose level of 292 mg/dL in the 2007 group. This result expanded the interval plot for group 8 in the 2007 class. With this exception, the interval plots for the two years studied did not show a great deal of difference. Groups 1, 3, 5, and 7 were tested at 1:30 p.m. Groups 2, 4, 6, and 8 were tested at 2:30 p.m. With the exception of group 8, the 2:30 groups had lower casual random glucose screening results.

Figure 3 shows the results of a survey of U.S. dental schools as to whether they offer teaching of casual random blood glucose screening in a clinical setting. Six U.S. dental schools surveyed responded that casual random glucose screening was being taught in the predoctoral dental curriculum. Fourteen schools responded that it was not taught, and thirty-two schools did not respond to the survey. The response rate was 38.5 percent.

Students evaluated the benefits of the experience for the 2008 session only (Figure 4). The reason for the limitation was the availability of students to respond and the program design available in 2007 did not allow for evaluation of a single classroom event in that year. The response rate for the survey from 2008 was 97.5 percent. In the 2008 group, 92.3

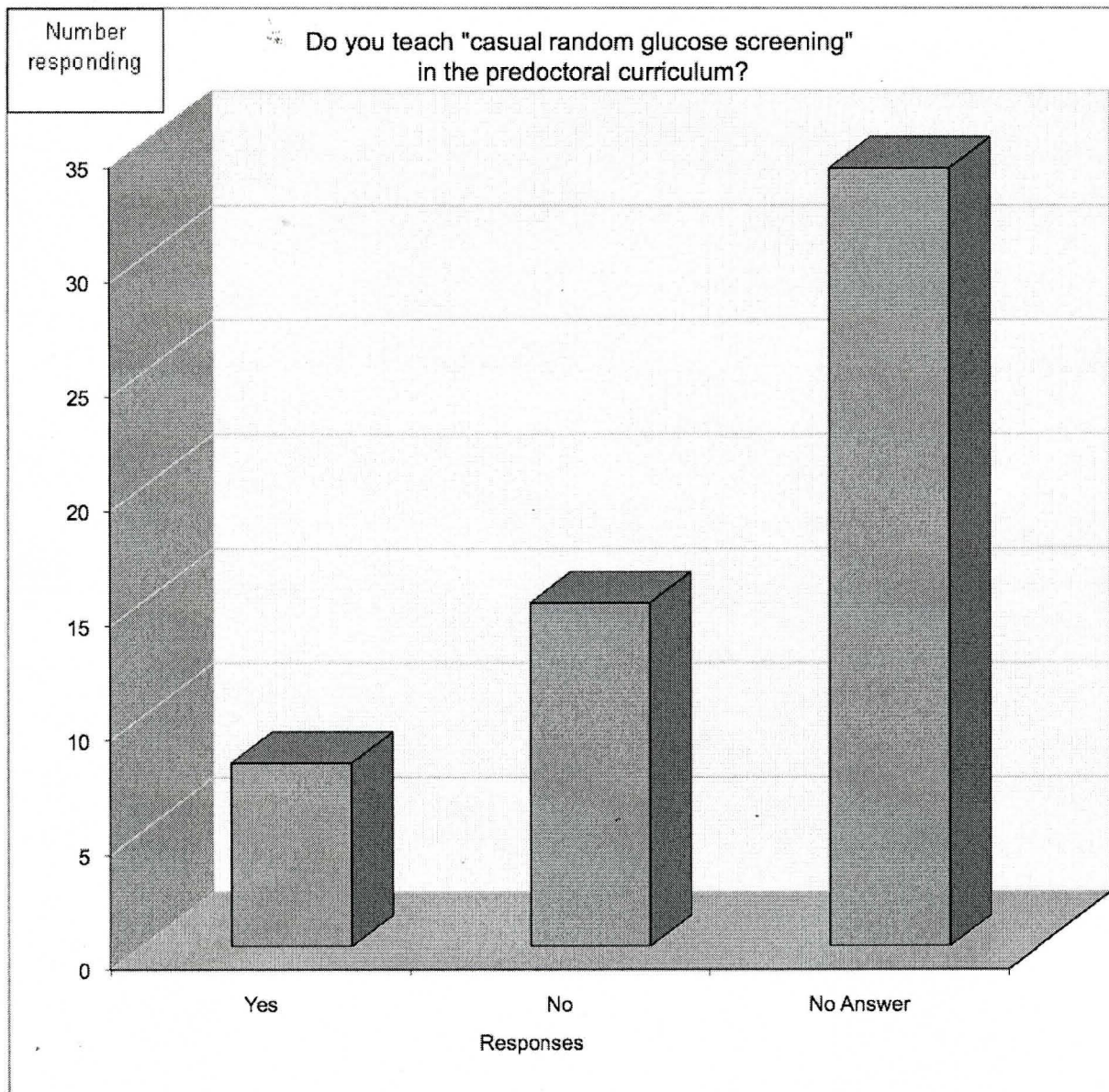


Figure 3. Survey results of U.S. dental schools: "x" axis indicates the type of responses and "y" axis indicates number of schools responding

percent agreed or strongly agreed that the blood glucose monitoring instruction was informative, while 1.2 percent disagreed and 6.4 percent were neutral. In that group, 2.5 percent of those surveyed felt that the teaching was time-consuming, and 97.4 percent felt it was not a factor or had a neutral position. Seventy-four out of seventy-eight (95 percent) of the

students surveyed felt the instruction was beneficial, and 5.2 percent were neutral on this question. In the 2008 group, 78.2 percent felt that monitoring was something they might incorporate into their practices, while 19.2 percent were neutral and 2.5 percent disagreed. None of the students surveyed strongly disagreed on the questions regarding the informative

nature, the benefit, or that the practice was something that might be incorporated into their practice. In addition, none strongly agreed that the teaching of blood glucose monitoring was time-consuming.

## Discussion

As the number of prediabetic and diabetic cases increases worldwide, the addition of competent screenings will become more relevant to a patient's overall health. Since dentists occupy a unique position in the provision of health care, their patients return on a regular basis, and casual random screening is cost-effective, it makes sense to include instruction on proper use of hand-held monitors in the dental curriculum. The ability of the second-year dental student to complete accurate random blood glucose by self-testing in a controlled setting demonstrates that dentistry can contribute significantly to meeting the standards set by the American Diabetes Association.<sup>2</sup> The use of casual random blood glucose screening in a dental environment has many advantages. Reports on where dental education should be headed in the twenty-first century have strongly supported public "policies that promote individual and community health."<sup>11</sup> The American Academy of Periodontology has noted the strong association between periodontal disease and chronic inflammatory diseases such as diabetes.<sup>14</sup> Kunzel et al. and Borrell et al. discussed the relationship of undiagnosed diabetes to periodontal disease and the general practitioner's ability to actively manage systemic diseases.<sup>12,13</sup> Van Dyke reported that more than 9,000 articles in a four-week period in 2008 focused on inflammatory conditions and health.<sup>15</sup> King correlated the inflammatory process and diabetes with microvascular diseases such as retinopathy, nephropathy, neuropathy, cardiovascular disease, and periodontal disease.<sup>16</sup> Teaching casual random glucose screening can aid the dental practitioner in the correlation between the clinical findings of a periodontal inflammatory disease and the presence of a hyperglycemic state. An additional advantage of casual random blood glucose screening in the dental practice is that patients who have a tendency to develop diabetes, such as the obese, return to the dental office for periodic exams, and negative results from prior screenings can be monitored for possible early changes in the diabetic onset.

A major disadvantage of the casual random blood glucose screening test is that results could be

assumed to be diagnostic when, in fact, the American Diabetic Association in its 2008 Standards of Medical Care in Diabetes cautions that the preferred diagnostic test is fasting plasma glucose levels.<sup>2</sup> Both dental students and dental practitioners who incorporate casual random glucose screening need to understand that the screening test, as it is presented in class, merely generates the suspicion that a diabetic state exists. This finding, in addition to a clinical finding of inflammatory periodontal disease, should lead the dentist to counsel the patient on the need to follow-up with his or her primary care physician.

Overall, the number of schools teaching random screening needs to increase to make the dentist member of the health care delivery team more effective in diabetic screening and ultimately diagnosis. This can be easily achieved in the dental curriculum when students are instructed on creating a database for patients who become part of their dental school practice. The time needed for instruction at Marquette University School of Dentistry fell in the second year of instruction during the Dent 450 or oral medicine and diagnosis course. It accounted for a supervised laboratory exercise requiring approximately thirty minutes during which ten students per session were taught in two successive groups. All students in a class completed the exercise during the first four weeks of the fall term. Equipment was readily available to the course from manufacturers of the meters at no cost to the school. Course supervision required one dentist instructor providing four hours of laboratory supervision. Meters, readily available to the public, would cost approximately \$60 to \$80 each, and the cost per test strip is approximately one dollar.

The material presented was, overall, well received by the students. Most of them reported a favorable or strongly favorable response when asked whether or not the material was worthwhile. More importantly, we feel, is whether it would be something to include in their practices upon graduation. Clearly, the majority of students agreed or strongly agreed to this question. The practical medical-legal argument of missed or failure to diagnose needs to be addressed. Since casual random blood glucose screening is not a diagnostic test, the question of whether this is a primary responsibility of dentistry or medicine needs to be addressed. Graskemper, in a review of the standards of care, pointed out that this "continually evolves with the advent of new materials, new procedures, and new court rulings."<sup>17</sup> Casual random blood glucose screening is not in the realm of the average dentist's practice at this time. Our survey



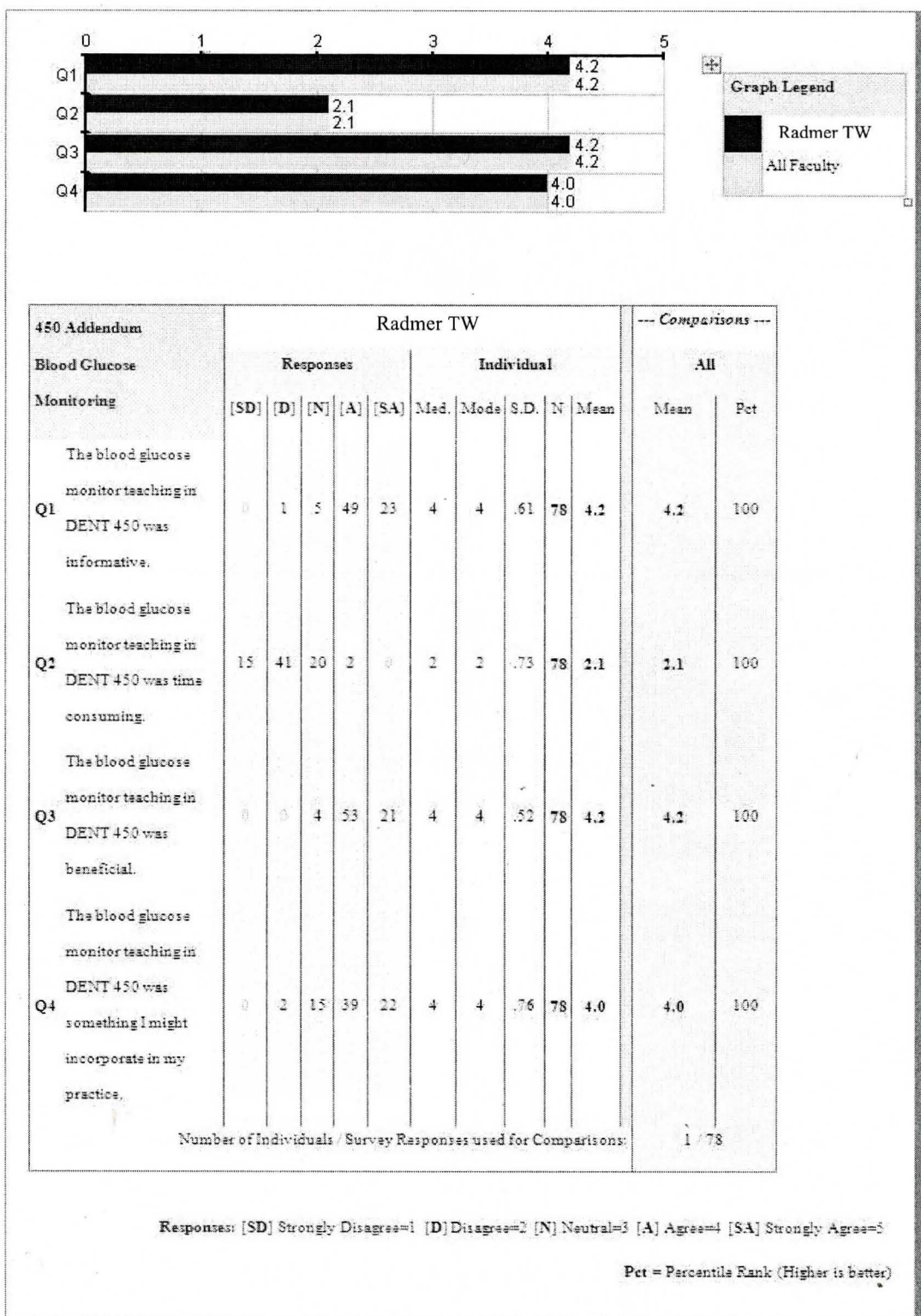


Figure 4. Student responses for the 2008 group

of U.S. dental schools found that the majority of those responding do not teach the screening method described. Those practicing dentists who do not screen continue to practice under the concept of "the best he or she can do under the circumstances."<sup>17</sup> Keeping abreast of professional developments is the responsibility of the individual dentist. As dentistry evolves in the twenty-first century, the medical-legal ramifications of casual random blood glucose screening may well become the motivating factor in incorporating the procedure into the general dental practice.

Finally, as is the case with all student participation, there were a certain number of individuals who wished to challenge the process. This was most likely the case with the extreme outliers found in the box plot graphs. Follow-ups at the end of the session were accomplished by asking those with abnormally high results to consult their family physician if they felt further testings were warranted.

## Conclusion

Casual random blood glucose screening in the dental practice and dental school environment is easily taught with a minimum of training time involved. The benefits to screening for the public health of the population are clear. Linking dental disease with the overall systemic health of a patient continues to develop at a rapid rate. The correlation of periodontal state with other disease processes, including diabetes, continues to be reported in large numbers. As newer monitors develop, the need for significant invasive procedures to screen for disease is declining. The ability of the general dentist to recognize the current state of either the diagnosed diabetic or the prediabetic in planning treatment is enhanced with casual random blood glucose screening.

We feel that casual random blood glucose screening can be effectively taught to second-year dental students as part of the overall teaching of oral medicine and diagnosis. The difference between casual random screening and diagnosis must be stressed with the introduction of creating a patient database. In this way, it is possible for the dentist to become a screening resource but not a diagnostic agent for diabetic conditions that present in the dental office.

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