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Impact of Bedtime Snack Consumption on Glycemic Control in Hospitalized Patients with Diabetes

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Impact of Bedtime Snack Consumption on Glycemic Control in Hospitalized Patients

A thesis submitted to the
Graduate School
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by

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Abstract

An area of concern in the hospital setting is the occurrence of hyperglycemia in patients with or without pre-diagnosed diabetes. Snack administration is used to help control blood glucose levels, however, the amount of carbohydrates consumed from snacks inside and outside of the hospital and the actual blood glucose value prior to insulin administration need to be taken into account. This study identifies the possible gaps in care that may result from poor glucose management by examining the composition of diet from snacks inside and outside of the hospital, blood glucose levels and insulin administration. Eighty-two participants were drawn from the general medical ward and tray tickets, 24 hour diet recalls, and patient charts were used to collect data. The floor dietitian referred patients who met inclusion criteria and research assistants conducted interviews. The research assistants collected information on insulin administration and dosing along with all food consumed within the past 24 hours. Ideally, insulin should be adjusted based on the amount of carbohydrates that were consumed in the snack or meal. Findings from this study showed that insulin was not adjusted based on carbohydrate intake and snacks consumed from outside of the hospital were not accounted for when administering insulin. Becoming aware of the amount of carbohydrates that patients consume from snacks inside and outside of the hospital may help all medical professionals optimize care for this patient population. Results from this study pointed out research gaps that may be taken into consideration for future research studies to optimize insulin administration for improved glucose control.
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Introduction

Hyperglycemia in hospitalized patients is a common, yet serious abnormality that is costly and comes with medical consequences. Diabetes is the fourth most common co-morbid condition complicating all hospital discharges (American College of Endocrinology, 2004). While a large amount of patients have a medical history of diabetes, patients admitting to hospitals may have unrecognized diabetes or hospital-related hyperglycemia. The overall prevalence of hyperglycemia in hospitalized adults is thought to be nearly 30 percent; which includes those patients diagnosed with diabetes prior to admission, those that have undiagnosed diabetes, and those that experience hyperglycemia that are not diabetic (Clement S., Smith E. P., Braithwaite S. S., Magee M. F., Ahmann A., Schafer R. G., et al. 2004; Falciglia M., D’Alessio D., Freyberg R., Deddens J., Hofer T. & Render M., 2004). Findings from randomized controlled inpatient clinical trials as well as prospective observational and retrospective studies have demonstrated improved outcomes resulting from the treatment of hyperglycemia (Capes S. E., Hunt D., Malmberg K., Gerstein H. C., 2000).

Snacks are an important component in maintaining blood sugar levels in patients with hyperglycemia. Snacks typically include anywhere from about 15-30 grams of carbohydrates (CHO) including a slowly absorbed or digested complex CHO, protein, and fat, and preferably no simple sugars (American Diabetes Association [ADA], 2005). Examples of such items may include peanut butter with graham crackers, cheese and crackers, half of a turkey sandwich, yogurt with fruit, cottage cheese with fruit, and 4 ounces of juice. CHO are the most important determinant of the meal plan when it comes to administering the amount of insulin needed. Approximately 90-100% of dietary CHO enter the blood stream as glucose within 15 minutes to 2 hours of being consumed (ADA, 2005). Consistency of CHO is the key at each meal and it
makes insulin dosing and timing much easier when this is monitored. Snacks can help maintain highs and lows during the day and typically are covered by one dose of the acting insulin throughout the day.

One potential problem relevant to snacking in the hospital setting arises when visitors bring outside sources of food and beverage items to patients. Hospital staff may not be aware of these items being consumed and proper insulin adjustments may not be made. When snacks are given from outside sources they can affect patient’s blood glucose levels and send the patient into hyper or hypoglycemic states, if not accounted for.

Differing philosophies exist about including snacks in the consistent carbohydrate meal plan. Some professionals believe with appropriate insulin or oral diabetes medication therapy, snacks should not be a requirement but instead should be given as an option to meet patient preferences or additional calorie needs (Swift C. S., Boucher J. L. 2005). Some dietitian’s believe that facilities can save time and money on wasted snacks by not making automatic bedtime snack administration to diabetic patients the standard of care due to the fact that there are long acting insulin types available to maintain blood glucose levels throughout the night. On the other hand, some professionals believe that in efforts to decrease the risk of nocturnal hypoglycemic episodes, appropriate bedtime snacks are essential in addition to regular blood glucose monitoring and insulin therapy (Allen K. V., Frier B. M. 2003). A study showed that the need for and composition of a bedtime snack depends on the bedtime glucose such that no snack is necessary at levels greater than 180 mg/dl. At levels between 126 to 180 mg/dl, any snack is advised, and at levels less than 126 mg/dl, a standard or protein snack is recommended (Kalergis M., Schiffrin A., Gougeon R., Jones J. H., Yale J. F. 2003). In the past, with limited options for insulin, snacks at bedtime were particularly important to prevent hypoglycemia overnight due to
peaks in insulin action. With the advent of insulin analogs and more physiologic basal-bolus, which is an attempt to mimic a healthy pancreas by delivering insulin constantly as a basal and as needed as a bolus, insulin regimens, bedtime snacks are no longer as critical for the majority of inpatients. Nevertheless, it is unclear how prevalent the practice of bedtime snacks remains among hospitalized individuals.

Proper treatment of inpatient hyperglycemia is difficult because of decreased appetite, erratic schedules due to diagnostic tests and treatments, enteral or parenteral feeding, and surgery (Reed C. C., Stewart R. M., Sherman M., Myers J. G., Corneille M. G., Larson N., et al. 2007). Recent efforts have focused on developing measures and approaches to improve diabetes care such as determining the optimal glucose target in order to reduce mortality risk (Swift C. S., Boucher J. L. 2005; Boucher J. L., Swift C. S., Franz M. J., Kulkarni K., Schafer R. G., Pritchett E., et al. 2007; Conner T. M., Flesner-Gurley K. R., Barner J. C. 2005; Cavan D. A., Hamilton P., Everett J., & Kerr D. 2001). Research has shown that healthcare professionals working in teams such as, physicians, nurses, and nutrition specialists to combine efforts and develop protocols and treatment will increase maintenance of consistent glycemic control (Flanagan D., Moore E., Baker S., Wright D., Lynch P. 2008).

Evidence illustrating that inpatient hyperglycemia is associated with increased morbidity and mortality has been published for a variety of disorders and settings, (Capes S. E., Hunt D., Malmberg K., Pathak P., Gerstein H. C. 2001; Bolk J., Van Der Ploeg T., Cornel J. H., Arnold A. E., Sepers J., Umans V. A. 2002; Wahab N. N., Cowden E. A., Pearce N. J., Gardner M. J., Merry H., Cox J. L. 2002, & Falciglia et al. 2009). Several published trials have provided strong evidence that lowering blood glucose levels in hospitalized patients improves outcomes, (Malmberg 1997; Van den Berghe, Wouters et al. 2001; Furnary, Wu et al. 2004; Krinsley 2004;
Van den Berghe, & Wilmer et al. 2006). Since these studies, the effect of hyperglycemia on the outcomes of hospitalized patients has received considerable attention because of the potential benefits from intervention. On the other hand, there are still many controversies related to whether or not the benefits from treatment of hyperglycemia outweigh the potential for hypoglycemia and its associated harm.

Taking into account diet and the amount of insulin administered is essential in patients with diabetes. In non-diabetic individuals, the physiologic secretion of insulin is regulated with the amount and type of CHO included in a meal. In a perfect setting, hospital staff would monitor the timing and dosage of insulin related to the patients meal time and the exact amount of CHO intake. In order to optimize the effectiveness of treatment protocols for inpatients with hyperglycemia, it is necessary to define whether a problem exists in the coordination of insulin with meals.

The purpose of this investigation was to investigate the awareness from staff of CHO consumption of snacks from both inside and outside of the hospital to determine if proper insulin adjustments are made to help control and manage inpatient glucose levels.

This study is developed to examine three areas related to inpatient hyperglycemia. Aim 1 focuses on the specific time insulin is administered relative to the time when the patient consumes meals. The hypothesis is that there is a low rate of adherence of correct insulin timing with meals, and the inaccuracies in timing result in poor glucose control. Aim 2 focuses on whether or not staff is adjusting patients scheduled insulin dosage according to the amount of meals consumed and more specifically, what portion of the meal was consumed from carbohydrates. The hypothesis is that the amount of CHO in the meal does not always result in the insulin dose to be adjusted. Aim 3 focuses on CHO and calorie consumption from snacks
given during the participants hospital stay. It also takes into account outside sources of CHO consumption and whether or not staff is aware of any unscheduled snack given and whether or not insulin adjustments are made. The hypothesis is that the unscheduled intake of snacks is not being covered by insulin, and in return this contributes to poor glucose control due to staff being unaware of this CHO consumption. This thesis focuses on aim 3 only.

**Methods**

**Participants**

The 82 participants were drawn from those patients admitted to a major university hospital located in an urban area. This study was approved by the Institutional Review Board of the institution where the research was conducted. Subjects were recruited from general medical or surgical wards. Inclusion criteria was that participants must be consuming discrete meals and be on a basal-bolus correction subcutaneous insulin treatment regimen during their admission. Average length of stay must be at least 24 hours in order to collect a sufficient amount of data for the 24 hour diet recall and blood glucose levels and insulin administration before and after meals were consumed. All participants were over the age of 18. Exclusions from this study included participants in Intensive care, transplant or neonatal units, obstetric patients and patients receiving total parenteral nutrition, enteral nutrition, or a liquid diet.

**Instruments**

Materials used to collect data included medical chart reviews in order to obtain information on the time of insulin administration and the amount of insulin given throughout the day. Blood glucose levels were obtained and noted to show any increases or decreases relating to hypo or hyperglycemia. Intravenous (IV) fluids were also noted to determine the amount of dextrose being administered through IV. One-day 24 hour diet recalls were collected via a one on one
interview with subjects to determine the amount of CHO from food and beverage items being consumed from the previous day. Nutrition research assistants collecting dietary data have been trained to conduct 24 hour diet recalls to collect information from the participants about their food consumption through several classes including Medical Nutrition Therapy, Communication Skills in Nutrition, and Personal Nutrition. Standardized questions developed from the Nutrition Data System for Research (NDSR, 2009) were used to obtain the food recall. The following is an example of the type of questions that were asked in order to obtain information regarding snacks consumed from the hospital and snacks that were consumed from outside sources of the hospital:

1. Did you consume any food or beverage item that was brought up to you as a snack?
   a. What type of food was it?
   b. How much of that item did you have?
   c. What time did you eat it?
   d. Did you add anything to the item? (peanut butter, cheese, sugar, etc)
   e. Did you have anything else at this time?
      i. If so, repeat b & c.

2. Was this food brought to you by the hospital staff?
   a. If no, who brought you the food? (family member, friend, etc.)
      i. Where did it come from? (restaurant, vending machine, home, etc)

Questions were open ended for the purpose of the patients to add specific details in order to optimize the data collected. In order to assure accuracy in supplementing data collection from direct chart review the research assistants participated in LastWord training at the Hospital in
order to learn how to properly access electronic patient medical records contained in patient information systems.

**Procedure**

Participants who met inclusion criteria were referred to the research assistants by the hospital staff dietitian. The research assistants then interviewed each participant after obtaining their consent. The interview took place no longer than 24 hours after the third meal was given. During the interview, demographic information, co morbidities if applicable, and admission diagnosis were obtained using a standardized form. Participants tray tickets were saved and given to the research assistants to use as an aide to help assist with memory recall during the 24 hour dietary recall, which was obtained using a standardized form created from the NDSR system. The interviewer reviewed what the subject consumed, allowing the subjects to go back and add any intake they may have forgotten or anything they may have consumed from sources outside of the hospital.

Following the interview, a chart review was used to obtain the rest of the information. Research assistants logged onto LastWord, the electronic charting system used by the hospital, and data was researched. Demographic information and blood glucose levels were verified. Insulin type, dosing and timing was recorded on a standardized form. Any dextrose containing infusions were also noted on this form in order to see any additional glucose each subject was receiving.

**Statistical Analysis**

A preliminary descriptive statistical analysis was conducted using Microsoft Excel. Nutricalc software (NutriCalc, 2009) was used to analyze the patient’s nutritional intake including calorie and CHO consumption. From this we were able to see the amount of total
CHO and calorie consumption during snack administration to determine the average intake from participants at each snack.

**Results**

The participants from this study \( n=82 \) had a mean age of 56.74 years and a mean BMI of 32.4 kg/m². The majority of the race population was non-Hispanic African American participants represented by 54% while the reminder of the participants were 40% White Non-Hispanic, 2% White Hispanic, 1% Asian, and 1% other. There were 60% female participants and 40% male. Thirty seven percent of the participants were married while 34% were single, 18% divorced, and 11% widowed. Seventy seven percent of the participants had received a high school diploma while 10% had an education level of 11th grade or less, 9% completed some college, and 5% completed a college education. Eighty-eight percent of the participants were unemployed or retired. Twelve percent of the participants were employed with 70% working full time and 30% working part time. One hundred percent of the participants were diagnosed with diabetes prior to their hospital stay with 98% being type 2 and 2% type 1.

Results show that the majority of patients received one snack a day from the hospital. The hospital distributed automatic bedtime snacks that are built into the diabetic diet order. These snacks consist of about 15-30 grams of CHO at each snack, depending on the calorie level selected. The snack was pre-set and included either half of a sandwich or half of a sandwich with milk or juice. If the patients ask they can have the snack changed to whatever they prefer, however in this hospital, that is not reported to happen often.

There were six patients who consumed two snacks a day. Of those six patients, two consumed snacks from outside of the hospital. Table 1 shows that the first patient consumed 100% (4 grams CHO) of their first snack at 00:05 and had a blood glucose reading of 245 mg/dl.
at 07:11. The same patient consumed 100% (47 grams CHO) of a second snack from an outside source at 09:00 and had a second blood glucose value of 198 mg/dl at 12:13. No insulin was administered throughout the day to correct for this hyperglycemia. The second patient consumed 100% (34 grams CHO) of only one snack from an outside source at 21:00 and had a blood glucose reading of 256 mg/dl at 20:11. Since this blood glucose reading was taken before the snack was consumed this reading would have been even higher than 256 mg/dl after the snack was eaten. No insulin was administered to correct the hyperglycemia.

**Table 1.** Comparison between the two occasions when patients consumed snacks from outside sources and no insulin was given to correct for hyperglycemia.

<table>
<thead>
<tr>
<th></th>
<th>Snack 1 Time and percent CHO (g) eaten</th>
<th>Insulin administered (units)</th>
<th>Time blood glucose obtained and value(mg/dl)</th>
<th>Snack 2 Percent CHO (g) eaten</th>
<th>Insulin administered (units)</th>
<th>Time blood glucose obtained and value(mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient 1</td>
<td>00:05, 100%</td>
<td>0</td>
<td>07:11, 245 mg/dl</td>
<td>09:00, 100%</td>
<td>0</td>
<td>12:13, 198 mg/dl</td>
</tr>
<tr>
<td>Patient 2</td>
<td>21:00, 100%</td>
<td>0</td>
<td>20:11, 256 mg/dl</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1 shows the absolute values of the grams of CHO served at each snack compared to the grams of CHO eaten. The most CHO served at a snack was 52 grams. Comparisons between the amounts of CHO served at snacks to the amounts of CHO eaten showed that every patient consumed 100% of the snack or less.
**Figure 1.** Comparison between the absolute value of the amount of CHO (g) served and the amount of CHO (g) eaten by each patient at a snack served from the hospital.

![Graph showing CHO served vs. eaten](image)

Table 2 shows the occurrences of more, less and the same amount of CHO eaten compared to what was served. Twenty eight percent of the patients consumed less amount of CHO than what was served, 72% consumed the same amount and no patients consumed more CHO than what was served. Figure 2 shows a graph representing the average amount of CHO served, which was 28 grams, and the average amount of CHO eaten, which was 22 grams. The average percent of CHO consumed at each snack was 78%.
Table 2. Proportion of the amount of CHO (g) eaten to the amount CHO (g) served at each snack given from the hospital

<table>
<thead>
<tr>
<th>Number and percent of occurrences of more CHO eaten than served</th>
<th>Number and percent of occurrences of the same amount CHO eaten as served</th>
<th>Number and percent of occurrences of less amount CHO eaten than served</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (0%)</td>
<td>59 (72%)</td>
<td>23 (28%)</td>
</tr>
</tbody>
</table>

Figure 2. The average amount of CHO (g) served compared to the average amount CHO (g) eaten by the group at each snack.

Figure 3 shows that the average calories served at a snack was 237 kcal and the average calories consumed at a snack was 189. Results also show that every patient who consumed a snack had an even or negative CHO and calorie difference, meaning that they never consumed more CHO or calories than were served. Table 3 shows the same relationship between calories served to calories eaten by the group at each snack. Seventy four percent of the patients consumed the same amount of calories served and 26% consumed less than what was served.
Figure 3. The average number of calories served compared to the average number of calories eaten by the group at each snack.

Table 3. Proportion of the number of calories served to the number of calories eaten at each snack.

<table>
<thead>
<tr>
<th>Number and percent of occurrences of more calories eaten than served</th>
<th>Number and percent of occurrences of the same amount of calories eaten than served</th>
<th>Number and percent of occurrences of less amount calories eaten than served</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (0%)</td>
<td>61 (74%)</td>
<td>21 (26%)</td>
</tr>
</tbody>
</table>

Table 4 indicates that 7 of the 82 patients (9%), whether they ate snacks or not, were not given insulin to correct for their hyperglycemia. Table 4 also shows that 46% of the time there was a lack of agreement for the blood glucose readings and 30% of the time the timing of insulin
administration and snack consumption was inaccurately recorded. Twelve percent of the patients ate a snack and received only rapid acting insulin after their snack was consumed.

**Table 4.** Number and percent of occurrences in the lack of agreement related to the administering of insulin, recording timing of snacks consumed, and timing of when blood glucose was checked.

<table>
<thead>
<tr>
<th>Number and percent of patients that didn’t receive insulin to correct for hyperglycemia¹</th>
<th>Number and percent of lack of agreement of recordings for blood glucose²</th>
<th>Number and Percent of patients who received Rapid Acting insulin <em>after a snack was consumed</em></th>
</tr>
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<td>7 (9%)</td>
<td>38 (46%)</td>
<td>10 (12%)</td>
</tr>
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</table>

¹ Hyperglycemia is defined as >180mg/dl

² Lack of agreement of recordings of blood glucose checks are considered 0:01 minute - 1:59 hours after a snack is consumed

**Discussion**

It is known that snack and insulin administration in hospitalized patients influences hyperglycemia in an inpatient setting. In addition, any snack brought to a patient from outside of the hospital also contributes to episodes of hyperglycemia due to the lack of insulin given to these patients. Although in the outpatient setting rapid-acting insulins are supposed to be administered 5-15 minutes prior to the meal because its action onset is less than 15 minutes and its peak time is between 1-2 hours, in the hospital where meal delivery and patient location is unpredictable, many experts suggest giving insulin at the time of the meal to avoid hypoglycemia from insulin administration. Therefore, if this type of insulin is being administered after a meal or snack is consumed then it can cause hypoglycemia and be ineffective to lower postprandial blood sugars.

This study shows that snacks from outside of the hospital were not consumed frequently, but when they were, patients were not given any insulin to cover the CHO consumed, likely due
to the fact that the hospital staff was not aware of this situation. The two patients who did
consume outside sources of snacks had blood glucose readings that indicated hyperglycemia.

This study shows that 12% of the patients received rapid acting insulin less than 1 hour
after a snack was consumed. Also, 46% of the time, blood glucose values were obtained
considerably later than the snack was consumed. This recording ideally should occur prior to the
meal. If the glucose level is assessed after the meal the value is misleading and potentially
dangerous since any individual’s blood glucose will rise after eating and does not necessarily
require treatment; for instance a glucose reading one hour after a meal may be elevated,
prompting the clinician to administer insulin that is unnecessary and possibly resulting in
hypoglycemia.

These are important findings because there is a need to be aware that the timing of insulin
administration in relation to how much and what time a snack is eaten is crucial to help maintain
blood glucose levels.

Overall, these outcomes are in line with previous research showing that there is a need to
have standardization of care in hospitals in this case, relevant to dietary issues, in which to
normalize blood glucose levels in patients with hyperglycemia. Previous studies have shown the
importance of regulating patient’s blood glucose in order to prevent episodes of hyper and
Previous research also shows that bedtime snacks should only be administered to patients who
show a pattern of needing the snack to help prevent hypoglycemia and accelerated ketosis
overnight (Kalergis M, Schiffrin A, Gougeon R, Jones JH, Yale J.F. 2003). Due to the
availability of long acting insulin that do not peak during the hours of sleep, the need for bedtime
snacks may not be necessary in all cases. Institutions may benefit from making bedtime snacks a patient, doctor, dietitian, nurse, etc. request, rather than the standard of care.

To the best of our knowledge, this is the first study to investigate the relationship between insulin administration, blood glucose levels, and the amount of CHO eaten in snacks from the hospital and from outside sources for patients with hyperglycemia. However, this study is not without limitations. First, the study sample size used was not very large and therefore did not show many participants consuming snacks that were not administered by the hospital staff. Also, there may have been inaccuracies when obtaining information from the food recall due to under or over estimation to the degree that the participant recorded and lack of memory as to what was actually consumed the previous day. Our findings suggest that hospital staff need a way to monitor all carbohydrate consumed in order to regulate blood glucose levels. Additionally hospital staff needs to become more conscious of the foods patients are consuming and adjust insulin doses according. For this reason, future studies with a larger sample size should be done to further investigate the possible relationship between snacks given from both the hospital and outside sources which may be unaccounted. Consequently, the hospital staff can make appropriate insulin correction changes that may prevent patients from going into hyper and hypoglycemic states.
References


