# Glucose Control in a Hospitalized Person With Diabetes

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Hyperglycemia in hospitalized people with diabetes contributes to increased mortality and morbidity by increasing the susceptibility to infection and lengthening hospital stays. The underlying causes of hyperglycemia range from decompensated diabetes with metabolic changes associated with stress and illness to alterations in medications or therapeutic interventions that increase glucose levels.

No matter what the cause, hyperglycemia in the hospital setting has not been treated in the aggressive manner seen in the outpatient setting. Fear of hypoglycemia and its ability to trigger life-threatening complications such as cardiac arrhythmias contributes to the reluctance to set target goals < 200 mg/dl for inpatient glycemic management.

With the recent American Diabetes Association (ADA) publication of the technical review "Management of Diabetes and Hyperglycemia in Hospitals,"[1] the importance of glucose control in achieving positive outcomes in hospitalized patients has been underscored. Aggressive glucose goals aimed at reducing hyperglycemia and its negative effects on recovery are identified and supported by research such as the DIGAMI study.[2] A review of published studies indicates that elevated glucose levels increase post-surgical infection rates, reduce the ability to heal, contribute to increased cardiac morbidity and mortality, increase intensive care unit admissions, and increase lengths of stay.

The following case study illustrates the pitfalls in diabetes care frequently seen in hospitalized patients and identifies ways in which hospital management must change to achieve positive outcomes. The need for aggressive treatment of hyperglycemia and the importance of diabetes education within this setting is addressed.

## Case Presentation

J.M. is a 69-year-old man who presents to the emergency room (ER) with fever, shortness of breath, and persistent cough for 4 days. Based on his chest X-ray findings, co-morbidities, age, and medical history, he has been admitted to the hospital with the diagnosis of community-acquired pneumonia.

He has had type 2 diabetes for 8 years, and his treatment program includes a weight reduction diet in addition to metformin and glyburide. His hemoglobin $A_{1c}$ (A1C) results are usually 7.8–8.9% (normal: 4–6%). He has been reluctant to start insulin therapy despite his elevated glucose readings.

During the previous month, J.M. has been following his diet carefully in an increased effort to lose weight and avoid insulin therapy. Overweight for most of his life, he has lost 15 lb in the past month, but his glucose control has not substantially improved. He tests his glucose levels before breakfast and occasionally before supper, and his results range from 189 to 267 mg/dl.

J.M. has lived alone since the death of his wife 3 years ago. His children live 1–2 hours away in a neighboring state. He cooks for himself and does not smoke or drink alcohol. He is involved with the local Senior Citizen Center and eats lunch there 3–4 days per week. He received an immunization for influenza through the community program but has not been immunized for pneumococcal pneumonia.

His medical history includes hypertension diagnosed in 2000, coronary artery disease with recurrent angina since 1999, dyslipidemia since 1998, and type 2 diabetes diagnosed in 1992.

On admission, his blood pressure is 144/82 mmHg, pulse is 98 bpm, respiration is 24 rpm, oral temperature is 102.2°F, capillary fasting blood glucose is 302 mg/dl, weight is 248 lb, and height is 6'0".

J.M.'s current medications include atorvastatin, 40 mg daily; enalapril, 20 mg daily; atenolol, 50 mg daily; hydrochlorathiazide, 25 mg daily; metformin, 1,000 mg twice daily; and glyburide, 10 mg twice daily. He also takes nitroglycerin, 0.4 mg sublingual, as needed.

Physical examination reveals an obese, white man in mild respiratory distress with persistent hacking cough. He appears dehydrated, pale, and feverish. Examination of head, ears, eyes, nose, and throat reveals that he is normocephalic; pupils are equal, round, and reactive to light and accommodation; and ear canals and tympanic membrane are without signs of infection and has mild sinus congestion with red, dry mucus membranes and no exudates.

J.M.'s neck is supple without lymphadenopathy or thyromegaly. Chest exam reveals dullness to percussion, auscultation diminished to left lower lobe of the lung, rales on expiration, and scattered rhonchi noted in the area of consolidation at the left base. Cardiac rate and rhythm were regular, no S3, S4, and no gallops or murmurs.

His abdomen is soft, non-tender, with no organomegaly. Musculoskeletal assessment shows full active range of motion and lax skin turgor.

Neurological assessment shows diminished response to monofilament on both feet from toes to ankle, no ankle jerks, dorsalis pedis pulse 1+, and nails horny.

### Course of Treatment
IV antibiotic therapy was started in the ER to treat the suspected pneu-

monia and to replace fluids. A full set of electrolytes, complete blood count including differential, and blood and sputum cultures were ordered. While in the ER, J.M. was placed in a cardiac-monitored bed and received oxygen via nasal canula at 2 L/minute. An O2 saturation level at room air and pulse oximeter showed diminished saturation (92%).

J.M. had taken his metformin and glyburide at home. His glucose levels had been consistently > 300 mg/dl during the illness with little response to the oral agents. In the ER, he was given lispro, 10 units subcutaneously, and placed on glucose monitoring every 4 hours.

On transfer to the hospital unit, he was taken off the electrocardiogram monitor and determined to be cardiac stable. The oxygen therapy was continued. His vital signs remained unchanged. However, his glucose level has continued to rise and was now 387 mg/dl.

The resident noted that J.M. had not eaten while in the ER. The nurse ordered a dinner tray for the patient. Admission orders stated to continue all of the patient's usual medications, including the oral diabetes medications. Acetaminophen was added for fever > 101.0°F. It had been only 2 hours since the lispro had been administered in the ER; therefore, the resident did not order any further insulin doses.

The receiving nurse decided not to take a full nursing assessment that evening because J.M. was exhausted and clearly in need of rest. She reported that he only took some juice from his dinner tray and ate no solid food. He remarked he had an upset stomach. No glucose level was measured that evening because he had not eaten.

During the night shift, J.M. asked for his glucose level to be measured. The glucose had continued to rise and was now 403 mg/dl. The resident was notified, and a sliding scale for rapid-

### Table 1. J.M.'s Blood Glucose Measurements (mg/dl) by Day and Time

|  | 8:00 a.m. | Noon | 5:00 p.m. | 9:00 p.m. |
|---|---|---|---|---|
| **Tuesday** | 287 | 333 | 391 | 277 |
| **Wednesday** | 301 | 286 | 275 | 409 |
| **Thursday** | 335 | 312 | 278 | 299 |

acting insulin was ordered. The sliding scale orders called for coverage to begin when the glucose level was > 200 mg/dl and to continue as follows:
- 200–250 mg/dl          2 units
- 251–300 mg/dl          4 units
- 301–350 mg/dl          6 units
- > 350 mg/dl          Call resident

J.M. received lispro, 8 units subcutaneously. The IV fluid rate was increased to assist with hydration.

During the next two days, the blood and sputum cultures showed that J.M.'s pneumonia was caused by Haemophilis influenzae, and the appropriate antibiotic treatment via IV was started. All of the results of lab work ordered in the ER were consistent with the diagnosis of pneumonia and mild dehydration. Of note was his increased glucose level of 399 mg/dl with small urine ketones present.

Although his fever was reduced and his appetite somewhat improved, J.M. felt weak and preferred to rest, only increasing his activity when encouraged by the nursing staff. His glucose levels continued to be > 200 mg/dl, and he received insulin coverage every 4 hours when awake per the initial sliding scale, in addition to glyburide and metformin. The patient's glucose report is shown in Table 1.

J.M. voiced concerns to the resident that his glucose levels were higher than they had ever been before. The resident discussed the stress response to illness, and assured him that once the pneumonia was cleared, his glu-

cose levels would be much improved.

After 4 days of IV therapy, he was changed to an oral antibiotic (clarithromycin) in anticipation of discharge to home. His fever had subsided, he was tolerating food, but he still felt totally exhausted. His glucose levels were consistently > 300 mg/dl after the dinner meal, and he continued to have nocturia that awakened him every 3 hours.

On the planned day of discharge, he spiked a fever of 101.0° F, which extended his stay by another day. A chest X-ray showed the area of consolidation to be unchanged. When finally discharged 2 days later, J.M. was told to continue his antibiotic therapy for 10 days instead of seven and to return to his usual medication regimen. Despite having received insulin in the hospital, his glucose levels were still suboptimal, and he was given a follow-up appointment with his health care provider for diabetes management.

Once home, he experienced diarrhea related to the oral antibiotic. He adhered to the pre-hospital medication regimen, which included hydrochlorathiazide for hypertension control. Within 3 days, he was re-admitted to the hospital after having been found unconscious on his kitchen floor by a neighbor who had stopped by to deliver a hot meal. He was admitted to the intensive care unit with hyperosmolar hyperglycemic nonketotic syndrome (HHNKS), pneumonia, and severe dehydration.

## Discussion

This case study is a clinical picture of missed opportunities to improve diabetes care and poor clinical decision making that prolonged illness and length of stay, ultimately resulting in readmission for a life-threatening

complication.

Studies have shown a clear association between poorly controlled diabetes and increased susceptibility to infection. Aspects of immune function, such as leukocyte function and immunoglobu-

lin complement fixation, are impaired in ambient glucose concentrations between 200 and 250 mg/dl.[3]

The pneumonia exacerbated J.M.'s already existing hyperglycemia. With glycemia poorly controlled with gly-

buride and metformin, his susceptibility to infection was increased, and his ability to recover once afflicted by the pneumonia was compromised. J.M.'s admission to the hospital was in keeping with the American Thoracic Society's practice guidelines for the treatment of community-acquired pneumonia.[4] His age, complicating factors (multiple co-morbidities), and lack of family caregivers supported the decision to hospitalize him for treatment of the pneumonia.

Once it was determined that J.M. was dehydrated, his metformin should have been discontinued. The risk of lactic acidosis is increased in patients who are fluid-depleted.

Although the ER was correct in the decision to give him insulin to reduce his hyperglycemia, once the patient was transferred to the hospital unit, the admitting resident and nursing staff failed to consistently follow his glucose readings and adjust insulin coverage to adequately control his glucose levels. He received the same insufficient sliding scale amounts throughout his entire stay. He never reached a glucose level < 180 mg/dl, nor did he attain a glucose level that allowed him to be, at a minimum, symptom-free from hyperglycemia, as evidenced by his continuing frequent nocturia.

According to the new ADA technical review on inpatient management of diabetes and hyperglycemia,[1] target plasma glucose levels are < 110 mg/dl preprandially and < 180 mg/dl at peak postprandial measurements.

After 24–48 hours of poor glucose control on the sliding scale regimen for rapid-acting insulin, intermediate- or long-acting insulin should have been added to the insulin therapy to improve and stabilize J.M.'s glucose control. When sliding scales are used alone, they may lead to erratic glucose control with peaks and valleys of systemic insulin supply.[3] Another alternative may have been to initiate an insulin drip. In patients who are NPO or not eating well, insulin given intravenously provides a smoother delivery and can easily be adjusted to match patient needs, resulting in improved glucose control.[5]

Weak and tired, J.M. ate and drank small amounts during his hospitalization. The IV fluids helped him to remain hydrated. However, once he was changed to an oral antibiotic, he no longer had the fluid support. In the presence of his increasingly high glucose levels over the course of his illness, he was in a precarious position at discharge. The failure to control his glucose level during his illness and the underlying dehydration set the stage for his readmission with HHNKS.

Because the nursing assessment for diabetes care was never conducted, the nursing staff was unaware of the patient's previous problems with glucose control and his attempts to lose weight to avoid insulin therapy. No one addressed his limited diabetes self-care knowledge regarding sick day management or his infrequent glucose testing at home. Thus, not only did he suffer the consequences of poor glucose management while hospitalized, but the nursing staff also missed an opportunity to educate him to assist in improving his care on a long-term basis. In fact, J.M.'s limited understanding of sick day guidelines and failure to contact his health care provider when the diarrhea occurred may have directly contributed to his readmission.

The discharge plan for this patient was inadequate from a number of standpoints. Although he was told to increase the clarithromycin therapy from 7 to 10 days, he was not educated about the possible side effects of the medication and what action to take if those effects occurred. J.M.'s condition on discharge was improved, but still precarious. He needed assistance with both medical care and activities of daily living for full recovery. A referral to a home care agency or a visiting nurse service would have provided him with a nursing assessment of his respiratory status and diabetes control, patient education, and possible nutrition services and physical assistance. An appointment to see his health care provider in 3 weeks created a lapse in care and did not address his imminent needs, further increasing his risk for readmission.

The majority of patients with diabetes are hospitalized for reasons other than diabetes. In these cases, diabetes management can be overlooked and not given the attention it rightly deserves. Hospital care providers must recognize hyperglycemia as a significant risk factor in contributing to the morbidity and mortality of patients with diabetes. Careful glucose monitoring and aggressive treatment to target goals are necessary to ensure patient safety and recovery.

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