

Perioperative Care of the Geriatric Patient with Diabetes or Hyperglycemia

Greg Maynard, MD, MSc^{a,*}, Cheryl W. O'Malley, MD, FACP, FAAP^b,
Susan R. Kirsh, MD^c

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The incidence of diabetes in the geriatric population is increasing and the resulting co-morbidities have led to corresponding increases in hospital admissions and surgeries. The weight of the evidence and national guidelines should dissuade us from allowing uncontrolled hyperglycemia in the geriatric perioperative population, but the glycemic target should be modified upwards based on the individual patient characteristics, and in environments that do not have an established track record of reaching more aggressive targets safely. Insulin is the most effective and flexible regimen to achieve inpatient glycemic control, whether by infusion or by subcutaneous basal bolus regimens. Strategies for safe and effective dosing and adjustment of insulin regimens, and methods to avoid hypoglycemia in the perioperative period are outlined. Finally, discharge planning should take into consideration a patient's HbA1c, preoperative glycemic control, inpatient glycemic regimen and control, financial and physical limitations, social support, co-morbid medical conditions, episodes of hypoglycemia, and overall prognosis to create an individualized safe and effective medication regimen for optimal glycemic control at home.

Mrs. S is an 81-year-old woman with type 2 diabetes, hypertension, hyperlipidemia, and compensated congestive heart failure. She presented to her primary care provider with recurrent right upper quadrant pain and other signs and symptoms consistent with cholecystitis. Although her symptoms were improving, the surgical consultant recommended admission and cholecystectomy. Unfortunately, previous abdominal surgeries

^a Division of Hospital Medicine, University of California, 200 West Arbor Drive 8485, San Diego, CA 92130, USA

^b Internal Medicine, Banner Good Samaritan Medical Center, 1111 East McDowell Road, Phoenix, AZ 85006, USA

^c Louis Stokes Cleveland VA Medical Center, 10701 East Boulevard, Cleveland, OH 44106, USA

* Corresponding author.

E-mail address: gmaynard@ucsd.edu (G. Maynard).

for diverticular abscess and hysterectomy have led to known abdominal adhesions, and a laparoscopic approach was not feasible.

Following Mrs. S throughout her perioperative period, the authors outline the principles of optimal management of diabetes with respect to her geriatric status, clinical status, and comorbidities.

DIABETES AND HYPERGLYCEMIA ARE COMMON IN ELDERLY SURGICAL INPATIENTS

Diabetes mellitus is an epidemic in the United States and also globally. Less active lifestyles, obesity, and the aging of the population are all factors in the accelerating prevalence of diabetes. About 10.3 million, or 20.9%, of people in the age group of 60 years or older in the United States have diabetes.¹ The number of persons with diabetes is expected to *double* by the year 2025, and adults of 60 years and older will comprise two thirds of the diabetic population at that time.^{2,3} Roughly 41 million, or 40.1%, of persons between 40 and 74 years of age have prediabetes, and the prevalence is believed to be even higher in people of 75 years and older.¹

Concurrent with the increasing prevalence of diabetes in the US population from 1980 through 2003, the number of hospital discharges with a diabetes diagnosis more than doubled between 1980 and 2003. Umpierrez and colleagues reported that 26% of general medical/surgical ward patients had a pre-existing diagnosis of diabetes, whereas another 12% had prediabetes, previously undiagnosed diabetes, or stress hyperglycemia, in an urban medical center.⁴ In elderly surgical patients, diabetes and hyperglycemia are even more common, particularly if the patients are critically ill.⁵⁻⁷

DIABETES AND COMORBIDITIES IN THE GERIATRIC POPULATION

Diabetes has multiple important comorbidities that lead to a disproportionate number of surgeries.⁸ The comorbidities can also adversely affect outcomes and have implications for perioperative evaluation and care. Delays in diagnosing diabetes in the elderly may lead to discovery of these manifestations simultaneously with the recognition of diabetes.⁹

Cardiovascular events are 2 to 4 times more common in diabetic patients than in non-diabetic age-adjusted control populations, and diabetes confers cardiovascular risk equivalent to a history of prior cardiovascular events.^{2,5-12} Sympathetic denervation can occur with diabetes, and a high index of suspicion for complications should be maintained despite a lack of classic ischemia history or symptoms.⁸ Postoperative complications are more in geriatric diabetes patients for a variety of reasons. Neuropathy from long-standing diabetes may manifest as urinary incontinence, urinary retention, constipation, or gastroparesis.^{6,13-15} This patient population is at a high risk for perioperative hypotension, because of a combination of risk factors including peripheral neuropathy, autonomic dysfunction, and polypharmacy.^{13,14,16} Alzheimers and other forms of cognitive dysfunction are more common in the elderly patient with diabetes, predisposing them to perioperative delirium. Finally, falls with injury are increased due to the same reasons listed earlier, as well as increased frailty and visual impairment.^{16,17}

The perioperative assessment of a geriatric patient with hyperglycemia should always explore these comorbidities as well as the background of glycemic control, psychosocial factors, medications, and medication adherence. A thorough evaluation in this population frequently leads to specific measures that can minimize or avert perioperative complications. For example, antihypertensive regimens can be reduced to avoid hypotension, the patient can be placed on fall precautions, conservative

measures that reduce perioperative delirium can be put into place, and vigilance for urinary retention or constipation can catch these problems early.

Mrs. S had a preoperative evaluation revealing the following details. She has been on metformin and glipizide for diabetes. A glycosylated hemoglobin (HbA1c) measurement was obtained and revealed a value of 9.2%. She has not been checking her glucose level often. Her fasting glucose level in the office was 186 mg/dL. Due to orthostasis and recent near falls, her dose of lisinopril has been reduced from 20 to 10 mg/d. Her family members have been instructed on the importance of their involvement in the hospital to minimize delirium.

Having addressed some of the comorbidities, we turn our attention now to managing her hyperglycemia.

EVIDENCE SUPPORTING TIGHT GLYCEMIC CONTROL IN THE PERIOPERATIVE SETTING

There are many challenges to diabetes management in the perioperative setting, even in the young relatively healthy patient. Changes in nutritional intake, insulin requirements, and multiple hand-offs between health care provider teams and geographic ward settings provide many opportunities for a mismatch of glucose and antihyperglycemic agents. This mismatch can lead to iatrogenic hypoglycemia or uncontrolled hyperglycemia. A full review of the evidence is beyond the scope of this article, but an understanding of the strengths and weaknesses of the literature supporting inpatient glycemic control is in order.

A science-based rationale and a robust body of evidence link hyperglycemia to impaired physiologic function. Fluid and electrolyte balance, left ventricular function, leukocyte action, wound healing, endothelial function, and immunoglobulin function are all impaired by hyperglycemia. Even mild elevations in blood glucose lead to a prothrombotic state, enhanced platelet aggregation, and exacerbation of gastroparesis.¹⁸⁻²⁰ A strong and consistent association with hyperglycemia and adverse outcomes are seen in a wide variety of inpatient settings. A variety of observational and pilot studies associate hyperglycemia with poor outcomes in community-acquired pneumonia, renal transplantation, acute lymphocytic leukemia remission, stroke, trauma, and postoperative infections.²¹⁻²⁶

These associations are typically present in all patients who have hyperglycemia, whether they have a diagnosis of diabetes or not. In fact, in most of the studies, the association was even stronger in those lacking a pre-existing diagnosis. For example, in a retrospective review of almost 1900 general medical/surgical admissions, Umpierrez and colleagues reported an 18-fold increase in mortality in hyperglycemic patients without prior history of diabetes and a 2.5-fold increase in mortality in patients with known diabetes compared with controls. These associations persisted with adjustment for severity of illness.⁴

Additionally, outcomes get progressively worse with higher glucose level in a dose-response relationship. A large prospective, nonrandomized, observational study of 5510 consecutive diabetic cardiac surgery patients has demonstrated progressive reduction in mortality, deep sternal wound infection rates, and length of stay independently associated with achievement of progressively lower glycemic targets via insulin infusion.²⁷⁻²⁹ Mortality and deep sternal wound infection rates for diabetic patients with well-controlled glucose levels are equal to patients without diabetes. In another study, 800 mixed medical/surgical intensive care unit (ICU) patients with tight glycemic control (mean blood glucose, 130.7 mg/dL) were compared with historical controls with a mean glucose of 152.3 mg/dL. The insulin infusion group had significant reductions in mortality and median length of ICU stay.³⁰ The physiologic basis and

associated observations were finally tested in randomized controlled trials. In the most influential study to date, van den Berghe and colleagues randomized 1548 surgical ICU patients to either intensive or conventional insulin therapy.³¹ The glycemic target for those in the intervention arm was 80 to 110 mg/dL (mean glucose attained was 103 mg/dL), whereas those in the conventional therapy arm had a mean glucose level of 153 mg/dL. The intensive insulin group enjoyed statistically significant and clinically important reductions in both ICU and total in-hospital mortality, as well as reductions in blood stream infections, acute renal failure, transfusions, and the duration of mechanical ventilation ($P < .01$ for all).

Although a similar study in a medical/surgical ICU did not achieve statistical significance in the overall intention-to-treat analysis for mortality, it did demonstrate reductions in mortality in patients with at least 3 days of ICU treatment and significant reductions in morbidity.³² A separate meta-analysis of 35 clinical trials evaluating the effect of intensive insulin infusion therapy on mortality in critically ill inpatients revealed a 15% reduction in short-term mortality.³³

GUIDELINES AND RECOMMENDATIONS FROM AMERICAN ASSOCIATION OF CLINICAL ENDOCRINOLOGISTS/AMERICAN DIABETES ASSOCIATION

Spurred on by the emerging controlled trial evidence, in 2004 the American Association of Clinical Endocrinologists (AACE) convened a consensus conference involving 9 other organizations. Recommendations for the management of inpatient hyperglycemia included stringent glycemic targets for critical care and noncritical care areas.³⁴ The American Diabetes Association (ADA) produced an excellent technical review on inpatient diabetes that provided the basis for ADA clinical practice guideline glycemic targets.^{18,35,36} The glycemic targets recommended are shown in **Table 1**.

CAVEATS REGARDING EVIDENCE AND GUIDELINES FOR AGGRESSIVE GLYCEMIC TARGETS

Before accepting these recommended glycemic targets for Mrs. S, it is prudent to review the shortcomings of the literature supporting them, and to consider institutional and individual patient factors that might modify the glycemic target.

Although most of the observational and nonrandomized interventional studies used valid methods to control for severity of illness and comorbidities, these methods are not perfect. Therefore, in some cases, hyperglycemia may have been a marker of a more stressed and sick patient rather than an independent source of adverse outcomes. Furthermore, a valid and independent association of hyperglycemia with poor outcomes does not guarantee that reduction of glucose levels will bring about improvement of those outcomes, highlighting the importance of the randomized controlled trials.

Organization	ICU (mg/dL)	Non-ICU, Preprandial (mg/dL)	Non-ICU, Maximum (mg/dL)
AACE/ACE	110	110	180
ADA	110	90–130	180

Abbreviation: ACE, American College of Endocrinology.

The dramatic results from van den Berghe and colleagues' 2001 study proved difficult to replicate, in part because other investigators have had difficulty in achieving stringent glycemic targets safely. Two international multicenter studies recently stopped enrollment due to excess rates of hypoglycemia when attempting to keep glucose levels lower than 110 mg/dL, 1 of which is now published.^{37,38} Although these studies raise important questions about whether the benefits of euglycemia extend to all critically ill inpatients, they also point out the variability of hypoglycemia rates in achieving the same glycemic targets in different locations and using different protocols. **Table 2** depicts the varied percentage of patients suffering from severe hypoglycemia in a variety of published trials.^{30-32,37-40} The decision about how aggressively to pursue a glycemic target therefore hinges on local factors and the safety with which glycemic targets are reached, as well as taking patient factors such as prognosis into account.

None of the landmark studies excluded or specifically targeted the geriatric patient, and there is variability in geriatric enrollment. In the study by Krinsley,^{30-32,40} for example, 431 of 1826 (24%) of the study population were geriatric, and the median age of general surgery patients was 72 years, whereas in other studies the mean ages were in the early 60s, and the results were not stratified by age. Finally, the proposed glucose targets for non-critically ill patients are based on essentially no clinical trial data in that population. In part, the glycemic targets reflect the evidence derived from landmark outpatient randomized trials,^{41,42} which again were not directed at the geriatric population.

In summary, the weight of the evidence should dissuade us from allowing uncontrolled hyperglycemia in the geriatric perioperative population. However, the glycemic target should be modified upward based on the individual patient characteristics. Furthermore, less aggressive targets should be set in environments that do not have an established track record of reaching more aggressive targets safely.

Study	Population	Target Glucose (Upper Limit), mg/dL	Percentage of Patients who have Severe Hypoglycemia
van den Berghe and colleagues ³¹	Surgical	110	7.2
van den Berghe and colleagues ³²	Medical	110	19
Devos and Preiser ³⁸	Medical and surgical	110	8.6
Brunkhorst and colleagues ³⁷	Medical	110	17
Goldberg and colleagues ³⁹	Surgical	120	0
Goldberg and colleagues ³⁹	Medical	120	1.7
Krinsley ³⁰	Medical and surgical	140	2.2
Davidson and colleagues ⁴⁰	Medical and surgical	120-140	2.6

MEDICATION REGIMENS TO ACHIEVE INPATIENT GLYCEMIC CONTROL

Regardless of the specific goals that are set for glycemic control for inpatient geriatric patients, the achievement of such targets is not easy. Traditionally, providers have used “sliding scale only” regimens that are notoriously unsuccessful in avoiding extreme excursions of blood glucose.^{43,44} This problem has been increasingly recognized with emphasis on other options including continuing outpatient oral medications, intravenous (IV) insulin infusions, or scheduled “anticipatory” subcutaneous insulin regimens.^{18,45,46}

ORAL AGENTS ON HOSPITALIZATION ARE NOT PREFERRED

The continuation of outpatient oral medications is appropriate only for a small number of geriatric inpatients. Patients admitted to the hospital, especially for undergoing surgery, invariably have dynamic nutritional intake and insulin sensitivity. Additionally, they may be on medications that affect blood glucose and may have altered sensorium which impairs the ability to report symptoms of hypoglycemia. For these reasons, oral medications, such as repaglinide and nateglinide that cause hypoglycemia, sulfonylureas, and nonsulfonylurea secretagogues should be withheld.⁴⁷ Metformin is contraindicated in patients who have liver disease, renal insufficiency, heart failure, severe chronic pulmonary disease with hypoxia, and within 48 hours of receiving IV contrast due to the risk for lactic acidosis.⁴⁸ This makes it a poor choice for geriatric inpatients who are either admitted with these problems or at a high risk for developing them during the hospital stay. The only unique limitations to inpatient therapy with thiazolidinedione drugs are in patients admitted with heart failure or fluid retention. Otherwise, hospital admission should prompt a review of the expanding list of warnings for this class of medications.^{49–52} There is little experience in the hospital with the use of newer agents such as exenatide, pramlintide, glinides, and dipeptidyl peptidase-4 (DPP4) inhibitors such as sitagliptin. Therefore, with the exception of patients who have good outpatient control and are metabolically, cognitively, and nutritionally stable in the hospital, it is recommended that oral antihyperglycemic agents be discontinued on hospital admission.¹⁸ Patients admitted for scheduled surgery should be instructed to withhold metformin 24 hours preoperatively and other oral antihyperglycemics on the morning of the procedure.

INSULIN—THE PREFERRED METHOD TO ACHIEVE INPATIENT GLYCEMIC CONTROL

Insulin therapy, either via IV infusion or scheduled subcutaneous injections, is the preferred method to achieve glycemic control in the vast majority of inpatients. The decision to use insulin in the hospital for elderly patients is separate from the choice to use it for outpatients as there are different resources and challenges in the inpatient setting. The availability of intensive monitoring, nursing care, and nutritional support in the hospital create an environment that allows for insulin regimens that may not be optimal or safe in an outpatient setting.⁵³ However, new challenges that are present in the hospital, particularly in the perioperative patient, require that the insulin therapy chosen be flexible and then delivered with attention to these important changes.

Insulin infusions are the most flexible and effective way to deliver insulin in the hospital. Therefore, they are the preferred regimen for patients who had major surgery requiring prolonged nothing by mouth (NPO) status. Whereas a recent study demonstrated no additional benefit with intraoperative infusion for coronary artery bypass surgery patients (compared with starting the infusion immediately on admission to the ICU postoperatively),⁵⁴ intraoperative insulin infusion should still be

considered for those with poor preoperative metabolic control (fasting blood glucose > 180 mg/dL).⁸

As Mrs. S was on NPO status, the glipizide dose was withheld on the day of surgery. Metformin was withheld the day before surgery due to a potential risk for renal insufficiency or hypoxia leading to lactic acidosis. An insulin infusion was initiated postoperatively in the surgical ICU, with a target glycemic range of 90 to 140 mg/dL.

Patients who have hyperglycemia and are not on insulin infusions are best managed with subcutaneous insulin regimens that closely mimic the physiologic release of insulin by the pancreas. The steps for ordering insulin in this fashion are shown in **Box 1**. First, the total daily dose (TDD) of insulin should be estimated using one of several acceptable options. Next, this total dose should be divided into the appropriate basal and nutritional doses. The basal insulin is that which matches the baseline insulin production typical during fasting states. When provided as glargine or detemir, it can safely be continued through fasting and the perioperative period if the prescribed amount is approximately 50% of the TDD of insulin. Intermediate-acting neutral protamine Hagedorn (NPH) is an alternative choice for inpatient basal insulin, with one caveat: NPH has a more pronounced peak in activity, which will often lead to hypoglycemia if the dose is not reduced when nutrition is interrupted. Therefore, it is recommended to reduce the dose by 50% if fasting. Nutritional insulin, administered as rapid-acting (glulisine, lispro, or aspart) or short-acting (regular) insulin around meal time serves to prevent the expected increase in blood glucose in response to calorie intake. These individual doses are typically 15% to 20% of the TDD of insulin. Correction insulin is the final component of a physiologic insulin regimen. It is the small amount of additional insulin that is given to patients to correct hyperglycemia. Correction insulin should be the same type (rapid-acting insulin analogs or regular insulin) as the nutritional component and given in a dose according to one of a variety of scales. With any patient who is on NPO status, scheduled nutritional insulin should be withheld and small doses of correction insulin should be given if hyperglycemia occurs.

When making the transition off IV insulin, subcutaneous insulin should be given before the infusion is discontinued to allow it to take effect. The first dose of basal insulin should be given 2 hours before the insulin infusion is discontinued.³⁵ Another option is to turn off the drip and give 10% of the basal dose as rapid-acting insulin along with the dose of basal insulin.⁵³ Timing of subsequent doses will depend on the specific basal insulin that is ordered as well as institutional consideration of usual care delivery and nursing workflow.

A recent randomized trial compared scheduled subcutaneous basal insulin (glargine) and rapid-acting nutritional insulin (glulisine) with sliding scale alone in nonsurgical patients with known diabetes, not previously on insulin. It demonstrated that use of a combination of basal insulin and nutritional-correction insulin achieved 66% of glucose values lower than 140 mg/dL compared with only 38% in the sliding scale group. Importantly, the improved glycemic control was achieved without any increase in hypoglycemia.⁵⁵

The pharmacokinetics of insulin analogs allow for flexibility in administration around the frequently changing meal intake. Patients who are on regimens with premixed insulin have the basal and nutritional components combined. This is convenient for outpatients but does not provide the required flexibility for the inpatient setting. Additional discussion of insulin dosing and subcutaneous regimens is available in detail elsewhere.⁵⁶

Mrs. S had an uneventful postoperative course in the ICU. In a few days, she was ready to begin an oral diet and be transferred to the general surgical ward. She required an average of 2 units/h for the preceding 6 hours, which was used to estimate

Box 1**Steps for prescribing subcutaneous insulin in the hospital**

Step 1

- Discontinue oral antidiabetic agents
- For the ICU, insulin infusion is the regimen of choice except during brief stays or in preparation of transfer to the floor
- Check HbA1c

Step 2: Calculate the estimated TDD of insulin based on *one* of the following methods:

- Transfer from *insulin drip*. Use average hourly rate for the last 6 hours, multiply by 20 to get the TDD
- Use *total insulin required at home* (all types added together)
- *Calculate/estimate insulin requirement* as follows based on weight and prediction of insulin resistance

Insulin sensitive: lean or malnourished patients (especially if type 1 diabetes) and elderly patients with acute or chronic kidney disease (especially those requiring dialysis)—use 0.3 units/kg/d

Patients with features of neither insulin sensitivity nor insulin resistance—use 0.4 units/kg/d

Likely insulin resistance: obese patients or those receiving high doses of corticosteroids—use 0.5 to 0.6 units/kg/d

Step 3: Determine the distribution of the TDD. Note: if basal insulin exceeds 50% of the TDD, the patient is at a higher risk for hypoglycemia for longer periods of time if the nutrition source is stopped

- Provide 50% of the TDD as a long-acting, “peakless” basal insulin. In certain situations, a more conservative estimate of basal insulin may be appropriate (eg, tube feeding)
- Administer the remainder of the TDD in equally divided doses of nutritional insulin, matched to the type and timing of nutrition provided, as discussed in the text
- Select a correctional insulin dose scale

Step 4: Evaluate insulin dose daily. Determine the total *dose received* for the previous day and adjust.

a total daily insulin dose of 40 units. She was given 20 units of glargine subcutaneously and then 2 hours later the insulin infusion was turned off. A dose of 7 units of rapid-acting lispro was ordered to be given with meals, but this was withheld until she ate more than 50% of her meal.

INPATIENT HYPOGLYCEMIA

Fear of hypoglycemia remains a major barrier to the achievement of glycemic control. Geriatric patients are at high risk and may have more subtle symptoms. Neuroglycopenic symptoms such as weakness, drowsiness, and confusion can be masked by underlying cognitive dysfunction or acute delirium. Other symptoms are also nonspecific and include tremulousness, palpitations, anxiety, sweating, tingling, and hunger. Some patients will not recognize their symptoms as caused by hypoglycemia and others will not have symptoms. Hypoglycemia itself induces some autonomic failure that leads to recurrent hypoglycemia and hypoglycemia unawareness.

Recognition of hypoglycemia risk factors can lead to proactive measures preventing iatrogenic hypoglycemia.^{57,58} A variety of predisposing conditions have been reported including renal insufficiency, malnutrition, liver disease, sepsis, shock, malignancy, dementia, or other cognitive disorders that impair the ability of patients to report symptoms, congestive heart failure, stroke, alcoholism, tapering doses of steroids, and adrenal or thyroid disorders.⁵⁷ Additionally, specific triggering events include transportation off the ward causing a delay in meal intake, new NPO status, and interruption of continuous venovenous hemodialysis, IV dextrose therapy, total parenteral nutrition, or enteral feedings. The presence of some of these may be triggers for increasing the frequency of monitoring, other responses may be a reduction in the initial TDD of insulin and following standing orders for withholding nutritional insulin. Physicians should not only prescribe an insulin regimen that is flexible to match the changing insulin needs of their patients, but also include orders that explicitly instruct nursing staff when to hold, reduce, or give the full dose of insulin. This is best accomplished by order sets that are unique to each institution.⁵⁹ They share important key orders including those for the treatment and recognition of hypoglycemia but are specific to the workflow, formulary, meal delivery, and policies of the individual hospital.⁵⁹

Mrs. S began eating full meals on the second day onward but still suffered from intermittent nausea and emesis. Her dose of glargine insulin continued at 20 units at bedtime. Her rapid-acting analog insulin was withheld until 15 minutes after she started eating, to ensure that she ate her full meal, and hypoglycemia was averted while glycemic control was maintained.

Withholding scheduled insulin and relying solely on reactive sliding scale insulin to control hyperglycemia is not the best strategy to minimize hypoglycemia. The more effective and preferred strategies include matching the antihyperglycemic regimen to nutritional intake by prescribing flexible insulin regimens, educating staff to anticipate and act on specific situations which are of high risk, recognizing the often subtle symptoms of hypoglycemia, regular monitoring of individual blood glucose levels (values), prompt treatment with an appropriate amount of carbohydrate, and institutional monitoring with targeted interventions.

ISSUES SURROUNDING THE TRANSITION OUT OF THE HOSPITAL

Mrs. S continues to recuperate. She has fasting glucose levels between 90–150 mg/dL on glargine 16 units at bedtime and 5 units of rapid-acting analog insulin with each meal. Her admission HbA1c level was 9.2%. In addition to other problems, she had cataracts and moderate diabetic retinopathy, and is no longer driving due to visual impairment.

As the geriatric patient nears discharge, a number of decisions must be made for optimization of outpatient care. In particular, the inpatient clinician must assess and address outpatient glycemic targets and the best means to achieve them (medication or nonmedication therapies) and consider the patient's educational needs regarding therapies. All information then needs to be communicated to outpatient clinicians and the care team.

AGGRESSIVENESS OF THERAPY: CHOOSING THE LONG-TERM GLYCEMIC TARGET

ADA guidelines³⁶ generally endorse goals of an HbA1c level lower than 7.0% and fasting glucose values of 90 to 130 mg/dL for most patients. However, they now also reflect the guidelines published by the California Healthcare Foundation and American Geriatric Society,^{60,61} advocating individualization of glycemic targets for

geriatric patients. Life expectancy, functional status, cognitive status, social support, and patient preferences should all be considered.^{60,62}

CHOOSING THE BEST REGIMEN FOR THE PATIENT AT DISCHARGE

Once an outpatient glycemic target is chosen, the process of choosing the optimal outpatient regimen begins. An HbA1c level is the single best method to determine the adequacy of the glycemic control regimen before admission. Other important considerations in choosing a regimen include glycemic control in the hospital, medication interactions, or new contraindications to prior therapy, current acute medical problems, nutritional status, physical disabilities, hypoglycemia risk factors, goals of care/life expectancy, expected adherence to medications and monitoring, and financial/insurance resources. It is also important to remember that the hyperglycemia associated with stress of illness and hospitalization often recedes as the patient is discharged from the hospital. An outpatient regimen that is correspondingly less aggressive than the regimen used to achieve glycemic control as an inpatient is often appropriate.

The postoperative geriatric population is at a higher risk for comorbidities (eg, cognitive impairment, depression, injurious falls, or polypharmacy) that may affect therapy choices.¹⁶ Additionally, patient disposition (eg, hospice or nursing care facility) is necessary to determine the optimal discharge medication regimen. Disposition to long-term care facilities with distinct formularies, processes, and staffing issues are important considerations. Optimally, therapy decisions should be made in consultation with the outpatient physicians.

Although a basal-nutritional-correction dose subcutaneous insulin regimen is often the preferred method for inpatient glycemic, it is important to realize that this method is rarely appropriate and realistic for geriatric outpatients. Clinicians may refer to the consensus-based algorithms for initiation and adjustment of therapy from the ADA and European Association for the Study of Diabetes for guidance on treatment options with a goal HbA1c of less than 7.0%.^{63,64} The AACE Inpatient Glycemic Control Resource Center⁶⁵ extends these recommendations to specific HbA1c values because it may be appropriate to initiate therapy at a more advanced stage in the algorithm. The guidance from these sources is depicted in **Fig. 1**. American Geriatric Society recommendations⁶⁰ regarding appropriate modifications of the goal HbA1c need to be taken into account when using this guidance.

Selection of oral agents in the geriatric population with diabetes must be done judiciously given the side effect profile and potential drug–drug interactions. On average, each oral agent can decrease the HbA1c by about 1% compared with insulin, which has no limit to its ability to lower HbA1c. The strongest risks for severe hypoglycemia in elderly patients are advanced age, recent hospitalization, the use of glyburide, and polypharmacy.^{66,67} Therefore, glyburide should be avoided and doses of other sulfonylureas may need to be adjusted. If a patient has a new contraindication to metformin or sulfonylureas but does not need insulin, a TZD or DPP4 inhibitor may be considered, but evidence for DPP4 inhibitors is new. Another option that may be considered in this situation is exenatide. In the case that patients are going to be discharged on basal insulin in addition to oral agents, it is advised to either reduce the doses of oral agents or choose more conservative insulin starting doses.⁶⁸ A conservative option for this population of patients is to start 0.2 units/kg or 10 units of NPH, glargine, or detemir at bedtime or in the morning. NPH has the advantage of lower cost compared with glargine or detemir. However, one study comparing glargine to NPH found that it took an equal time to reach goal HbA1c, but that hypoglycemia was reduced with

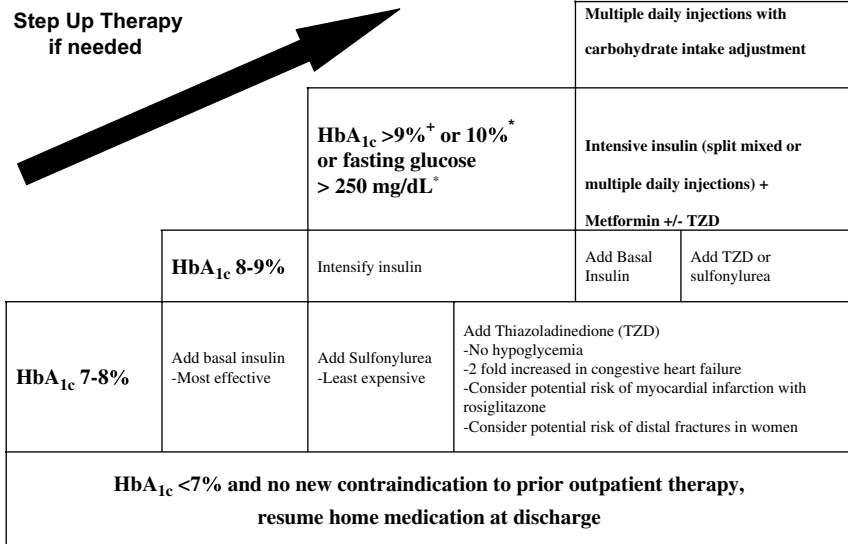


Fig. 1. A stepwise approach to intensifying type 2 outpatient glycemic control regimens around hospital discharge. HbA_{1c} targets may vary for individual geriatric patients as per American Geriatric Society recommendations.⁶⁰ (Data from Refs [63–5]; and Nathan DM, Buse JB, Davidson MB, et al. Management of hyperglycemia in type 2 diabetes: a consensus algorithm for the initiation and adjustment of therapy: update regarding thiazolidinediones: a consensus statement from the American Diabetes Association and the European Association for the Study of Diabetes. Diabetes Care 2008;31:173–5.)

glargine.⁶⁹ Once discharged, the patient’s blood glucose should be monitored appropriately and the basal dose should be titrated by several different validated methods.⁷⁰ Appropriate orders for necessary supplies for insulin therapy, including a meter with test strips, lancets, syringes, needles, and a hypoglycemia treatment kit, should also be made.⁶⁵

It is decided by the inpatient team that Mrs. S needs intensification of her outpatient regimen based on her admission HbA_{1c} of 9.2% (goal < 8.0%). Her metformin and glipizide are reinitiated and she is started on a dose of 10 units of basal insulin at bedtime. Because she has poor vision with a normal mental status, her bedtime basal insulin is given in the form of an insulin delivery device, an insulin pen.

EDUCATION, COMMUNICATION, AND OTHER ISSUES

Insulin delivery devices can help avoid medication errors in the inpatient setting⁷¹ and can be useful to educate patients starting on insulin. The insulin delivery device (ie, the insulin pen) can deliver long- and short-acting insulin and is easy to dispense. The dose is set by clicks for each unit or increment and is therefore a good choice for patients who have good cognitive function but poor vision. Studies comparing insulin delivery devices with insulin syringes do not demonstrate a clear advantage for all patients, however, those with visual impairment and barriers to needle use may significantly benefit.

Additional education and family support may be needed for optimal glucose meter use. Whenever possible, patients should be given a choice of meters and certain meter characteristics may lend themselves to preferred usage by a particular individual. Unique technological features such as “voice-activated” meters and those with large

display may help geriatric as well as nongeriatric patients in reducing errors.⁶ As with any geriatric patient with poor nutrition, cognitive status, and functional capacity, engaging family members can have a major impact on clinical outcomes.

As this patient's care progresses back to the outpatient setting, it is important to consider care and its coordination at the patient and family as well as the health care system levels. Assessment and recommendations of an inpatient health care team, which can include dietitians, diabetic educators, nurses, social workers, and pharmacists for education of family members and the patient, can be of great help in facilitation of the education and resources needed for new regimens. They can offer additional social support after discharge. If there are temporary physical or self-care limitations, then a visiting nurse may need to be arranged to ensure safe transition home with the optimal therapy. Throughout their hospital stay, patients can begin to practice new skills including blood glucose monitoring and logbook use, drawing up and administering insulin, sharps disposal, basic diabetic diet information, and sick-day management. The specific topics addressed in each session can be tracked as part of an interdisciplinary education record that allows coordination among the individuals involved in teaching.⁴⁶ It is important to give patients the basics, support them with minimal written information, and provide them appropriate follow-up diabetes education.⁷² There are many barriers to diabetes self-management education in the inpatient setting but there are also numerous resources and opportunities. Furthermore, the inpatient team should view the patient's glycemic control education as something that needs to continue across the continuum of care and develop communication strategies that connect with the follow-up clinical team.

At the time of discharge, it is essential that written documentation and communication with outpatient care providers be completed, which is usually in the form of a discharge summary. It is important to ensure that the admission medication list is accurate and reconciled completely with the modified list at discharge. Discharge checklists and tools for assessing patient acceptance of the discharge plan can be an important part of the discharge summary communicated to those who will provide ambulatory management to the patient. Follow up with the primary care physician should occur within 7 to 14 days. Protocols for information on discharge summaries and mechanisms for distribution to their physicians help in making the transition a safer one. Protocols developed with inputs from inpatient and outpatient health care professionals are to be optimal and should include hospital course, complications, discharge medications, functional status, posthospital disposition, and social support.⁶⁴

Education of the patient and her niece regarding the use of the insulin pen and glucose monitoring is achieved in the hospital and follow up is arranged. A discharge summary done by her inpatient physician references the pertinent details of her perioperative course and includes her inpatient glycemic control. The discharge summary is done at a hospital with an electronic medical record and is sent electronically to the outpatient primary care doctor on discharge.

SUMMARY

This case illustrates some of the unique management challenges surrounding the perioperative geriatric patient with diabetes. Multiple comorbid conditions and geriatric status can affect the prognostic, diagnostic, and therapeutic course.

Although the aggressiveness of glycemic control regimens must be tempered by individual patient characteristics and preferences, uncontrolled hyperglycemia is strongly associated with poor outcomes in the perioperative setting. The approach to inpatient glycemic control must be flexible due to fluctuating insulin requirements

and variable nutritional intake, and is generally best accomplished using insulin infusion or multiple doses of scheduled subcutaneous insulin.

Hospitalization should be viewed as an opportunity to assess the adequacy and safety of the patient's outpatient diabetes regimen. An HbA1c level is useful in assessing the patient's prehospitalization glycemic control and guiding the decisions regarding the need for a change in therapy. The heterogeneity of the geriatric diabetic population and frequent presence of polypharmacy, impaired functionality, and comorbid conditions demands a customized approach to the goals of therapy and the means to arrive at them.

Engaging multiple health care professionals to participate in the development and implementation of standardized care protocols throughout the perioperative course can improve patient safety and quality of care. Involving caregivers as well as patients in preparations for the transition out of the hospital, and communicating pertinent details regarding diabetes/hyperglycemia to outpatient clinicians is essential in this vulnerable population.

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