

# Actionable Patient Safety Solutions (APSS): **Blood Glucose Management**

## How to use this guide

This guide gives actions and resources for Blood Glucose Management. In it, you'll find:

- Executive Summary .....2
- Leadership Checklist.....3
- Clinical Workflow Infographic .....4
- Performance Improvement Plan .....5
- What We Know About Blood Glucose Management.....7
- Education for Patients and Family Members.....9
- Measuring Outcomes..... 11
- Endnotes..... 12



# Executive Summary

### The Problem

Frequent and wide 'swings' in blood glucose levels are common in the hospital setting, for both diabetic and non-diabetic patients, due to factors including, but not limited to, physiologic stress, certain medications, and procedures. However, these uncontrolled swings in glucose levels can be detrimental to patients and can compromise wound healing, increase risk of infection, and delay surgical procedures and discharge ([Kodner, Anderson, & Pohlgeers, 2017](#)). Early recognition and anticipation of blood sugar swings have proven to be effective in improving outcomes but require significant infrastructural changes within the organization.

### The Cost

Early anticipation of blood sugar swings can improve the current 7 to 35% severe hypoglycemia incidence rate ([Kadayakkara et al., 2019](#)). Additionally, the normalization of blood glucose levels with intensive insulin therapy has been shown to reduce in-hospital mortality by 34%, bloodstream infections by 46%, the average number of blood transfusions by 50%, with patients receiving this intensive therapy being less likely to require mechanical ventilation ([Van Den Berghe et al., 2001](#)).

### The Solution

Many healthcare organizations have successfully implemented and sustained blood glucose management initiatives. These organizations have focused on projects that included **education around and trigger tools for early recognition and anticipation of blood sugar "swings"**.

This document provides a blueprint that outlines the actionable steps organizations should take to successfully improve blood glucose management and summarizes the available evidence-based practice protocols. This document is revised annually and is always available free of charge on our website. Hospitals who make a formal commitment to improve blood glucose management and share their successes on the PSMF website have access to an additional level of consulting services.

## Leadership Checklist

On a monthly basis, or more frequently if a problem exists, the executive team should review the outcomes of blood glucose management for diabetic and non-diabetic patients. Use this checklist as a guide to determine whether current evidence-based guidelines are being followed in your organization:

- Measure and report basal insulin usage for any duration monthly. Note trends in areas with low compliance and high rates of adverse outcomes related to blood sugar. Routinely reassess outcomes.
- If blood glucose management rates indicate room for improvement, initiate a PI (performance improvement) project. If a problem is not indicated, routinely reassess to identify gaps, and ensure integrity of the data collected.
- Ensure frontline involvement in blood glucose monitoring and management improvement activities. Maintain their engagement and remove barriers to progress.
- If a PI plan is put in place, measure the associated process outcomes.
- Ensure that blood glucose monitoring and management protocols are embedded into [clinical workflows](#), whether electronic or paper.
- Ensure there are enough staff to effectively manage necessary preventive care.
- Ensure adequate training and documentation of blood glucose monitoring and management competencies and skills.
- Eliminate barriers to making rapid changes to documentation templates and order sets.
- Debrief on a regular basis to solicit team feedback about barriers to sustained compliance. Adjust the plan quickly and nimbly as needed.
- Hold staff accountable for providing the standard of care and reward success.
- Ensure that leaders have a simple process to oversee blood glucose monitoring and management improvement work while also considering how it aligns with other initiatives across the organization.
- Consider incorporating glucose management principles from IHI's "[Global Trigger Tool for Measuring Adverse Events](#)".
- Educate all providers around the early signs and symptoms of hypoglycemia and hyperglycemia.
- Implement a hospital-wide, nurse-driven protocol for hypoglycemic and hyperglycemic treatment immediately upon indication.
- Standardize and clarify order sets.
- Create guidelines for injectable U-500 insulin to reduce adverse drug event preventable harm, including restrictions of use to specialists and in specific warranted circumstances.

# Clinical Workflow Infographic

## ADMISSION

- Identify patients at high risk for impaired glucose metabolism. See [What We Know](#), [section](#) for risk factors.
- Obtain and document names and doses of all current medications.
- Consider and appropriately adjust patient's home regimen, including diet and daily activity.
- State diabetes history and status. State whether the patient has type I diabetes, type II diabetes, or no previous history of diabetes.
- If the patient has a history of diabetes or has hyperglycemia, order an A1C.
- Screen for sepsis or infection to eliminate as a possibility. If the patient may be septic, act immediately. See [APSS: Early Recognition and Treatment of Sepsis](#).
- Assess for renal insufficiency.

## ROUTINE CARE

- Allow patients to self-manage when appropriate. See [Houlden and Moore \(2014\)](#) for more specific guidelines.
- Use and follow standard order sets.
- Help patients and family members of patients with both diabetic and non-diabetic circumstances understand symptoms of hypoglycemia and hyperglycemia and when to call for help. See [Education for Patients and Family Members](#) section.
- Regularly measure blood glucose. Blood glucose monitoring can be essential in identifying asymptomatic and early signs of hypoglycemia and hyperglycemia.
  - Outside of the hospital, diabetic patients should test their blood glucose levels frequently (6-8 times daily suggested, and adapted to each particular case), prior to meals and snacks, at bedtime, prior to exercise, when they suspect low blood glucose, and prior to critical tasks.
  - In the patient receiving nutrition, monitor glucose to match food intake. In the patient not receiving nutrition, monitor glucose every 4-6 hours. In the patient receiving intravenous insulin, monitor glucose between every 30 minutes to every 2 hours ([American Diabetes Association, 2016](#)).
- Coordinate insulin administration, glucose monitoring, and food intake. Assess and adjust diabetic medication regimen as appropriate. Schedule subcutaneous insulin injections every 4-6 hours if the patient does not receive meals or if continuous enteral therapy is applied. Perform point of care glucose testing immediately before meals in those with good nutritional intake. In those with poor oral intake, administer short-acting insulin immediately after eating or match the insulin with the carbohydrates ingested. See [Appendix A](#) for further information. Evaluate the individual patient's circumstance to determine an appropriate diet. Consult a registered dietitian for complex nutritional needs.
- Consider a continuous glucose monitoring device in the setting of uncontrolled blood sugar management.
- Exercise caution in blood sugar correction to avoid hypoglycemic events.
- Increase monitoring for patients administered medication in an emergency situation.
- Hyperglycemia and Hypoglycemia**
  - Initiate insulin therapy for persistent hyperglycemia greater than 180 mg/dL. Once insulin is initiated, target a glucose range of 140-180 mg/dL for most patients. More stringent goals may be appropriate for certain patients, such as those with acute ischemic cardiac or neurological events, assuming the targets can be maintained without hypoglycemia.
  - Administer intravenous insulin infusions based on validated protocols that allow for predefined adjustments in the infusion rate, dependent on glycemic changes and insulin dose.
  - Justify insulin dose at every administration and adjust as needed. Potentially adjust:
    - With changes in non per oral status
    - With changes in diet and hydration
    - With changes in trajectory glucose measures
    - With changes in illness severity
    - Post-sedation
    - With changes in potassium
    - Worsening renal sufficiency
    - Based on steroid or other medication administration or changes.
  - Employ safe medication practices, especially for polypharmacy patients and patients administered U-500 insulin. U-500 insulin is an uncommon concentration, which can cause serious harm if given with syringes designed for U-100 insulin. Follow your organization's policy and restrictions for its use. See the [Medication Errors APSS](#) for more information about safe medication practices to prevent adverse drug events.
  - Incorporate hypoglycemia and hyperglycemia considerations in the perioperative routine. Target glucose range of 80-180mg/dL for the perioperative period. Remove any oral hypoglycemic agents the morning of the procedure.
  - If symptoms of hypoglycemia occur, provide a simple carbohydrate to the patient for immediate consumption. If the patient is NPO, use an alternative such as 50% dextrose IV or intramuscular glucagon ([Tomky, 2005](#)).
- Diabetic Ketoacidosis (DKA)**
  - Monitor for early warning signs of DKA. DKA is characterized by a serum glucose level  $\geq 250$  mg/dL, a pH  $< 7.3$ , an elevated serum ketone level, and a serum bicarbonate level  $< 18$  mEq/L. In these cases, follow the DKA guidelines from the [American Family Physician](#) for adults and the [Diabetic Ketoacidosis Emergency Department Pathway from Children's Hospital Philadelphia](#) for children.
  - DKA management should include goals oriented towards optimizing volume status, hyperglycemia, electrolytes, and precipitating factors. Refer to 1) a [workflow pathway diagram](#) outlining the steps for DKA management and 2) a [checklist](#) for DKA management milestones for scenario-specific steps.

## DISCHARGE

- Upon transitioning from intravenous to subcutaneous insulin, the patient should receive basal insulin 1-2 hours before discontinued ([American Diabetes Association, 2016](#)).
- Spend time discussing glycemic management, glucose monitoring, and coping with the patient and family members in the days leading up to discharge. If applicable, watch the patient perform insulin administration.
- Do not discharge until optimal glucose regulation is achieved.
- Clearly communicate all relevant information to outpatient care providers. This would include, but is not limited to, medication changes, pending tests, follow up needs, provision of care in the hospital, and patient condition upon discharge.
- Perform thorough medication reconciliation before discharge to ensure critical medications were not stopped and to ensure safety of new medications with existing medications and allergies.
- Resume medications 1-2 days before discharge if the patient was admitted with this in their home regimen.
- Spend as much time as possible with the patient and family members to facilitate education and answer their questions. See "[Education for Patients and Family Members](#)" section.
- Coordinate an outpatient follow-up visit with a diabetes specialist and primary care provider within one month post-discharge.
- Perform an A1C for patients who experienced hyperglycemia during times of illness to reconcile whether this hyperglycemia was instead undiagnosed diabetes. Test these patients in the outpatient setting after their full recovery.

# Performance Improvement Plan

Follow this checklist if the leadership team has determined that a performance improvement project is necessary:

- Gather the right project team.** Be sure to involve the right people on the team. You'll want two teams: an oversight team that is broad in scope, has 10-15 members, and includes the executive sponsor to validate outcomes, remove barriers, and facilitate spread. The actual project team consists of 5-7 representatives who are most impacted by the process. Whether a discipline should be on the oversight team or the project team depends upon the needs of the organization. Patients and family members should be involved in all improvement projects, as there are many ways they can contribute to safer care.

**Complete this Lean Improvement Activity:** Conduct a [SIPOC](#) analysis to understand current state and scope of the problem. A SIPOC is a lean improvement tool that helps leaders to carefully consider everyone who may be touched by a process, and therefore, should have input on future process design.



RECOMMENDED BLOOD GLUCOSE MANAGEMENT IMPROVEMENT TEAM	
<ul style="list-style-type: none"> <li>• Admitting and registration staff</li> <li>• Quality and safety specialists</li> <li>• Physicians</li> <li>• Pharmacists</li> <li>• Nurses</li> </ul>	<ul style="list-style-type: none"> <li>• Case managers</li> <li>• Long term healthcare professionals</li> <li>• Diabetic educators</li> <li>• Phlebotomists</li> </ul>

Table 1: Understanding the necessary disciplines for a blood glucose management improvement team

- Understand what is currently happening and why.** Reviewing objective data and trends is a good place to start to understand the current state, and teams should spend a good amount of time analyzing data (and validating the sources), but the most important action here is to go to the point of care and observe. Even if team members work in the area daily, examining existing processes from every angle is generally an eye-opening experience. The team should ask questions of the frontline during the observations that allow them to understand each step in the process and identify the people, supplies, or other resources are needed to improve patient outcomes.

**Create a [process map](#) once the workflows are well understood that illustrates each step and the best practice gaps the team has identified ([IHI, 2015](#)).** Brainstorm with the advisory team to understand why the gaps exist, using whichever [root cause analysis tool](#) your organization is accustomed to ([IHI, 2019](#)). Review the map with the advisory team and invite the frontline to validate accuracy.



BLOOD GLUCOSE MANAGEMENT PROCESSES TO CONSIDER ASSESSING	
<ul style="list-style-type: none"> <li>• Insulin adjustment after, including, but not limited to, procedures, nutrient changes or intake, sleep, or medication changes</li> <li>• Process for addressing home regimens and medications</li> <li>• Timeliness of provision of simple carbohydrates</li> </ul>	<ul style="list-style-type: none"> <li>• Timeliness of sepsis screening upon admission</li> <li>• Coordination of food intake, insulin administration, and glucose monitoring</li> <li>• Anticipation of overcorrection</li> </ul>

Table 2: Consider assessing these processes to understand where the barriers contributing to poor blood glucose management may be in your organization

- **Prioritize the gaps to be addressed and develop an action plan.** Consider the cost effectiveness, time, potential outcomes, and realistic possibilities of each gap identified. Determine which are a priority for the organization to focus on. Be sure that the advisory team supports moving forward with the project plan so they can continue to remove barriers. Design an experiment to be trialed in one small area for a short period of time and create an action plan for implementation.

**The action plan should include the following:**



- Assess the ability of the culture to change and adopt appropriate strategies
- Revise policies and procedures
- Redesign forms and electronic record pages
- Clarify patient and family education sources and content
- Create a plan for changing documentation forms and systems
- Develop the communication plan
- Design the education plan
- Clarify how and when people will be held accountable

**TYPICAL GAPS IDENTIFIED IN BLOOD GLUCOSE MANAGEMENT**

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li>• Insulin stacking and incorrect insulin administration</li> <li>• Insufficient glucose monitoring</li> <li>• Poor drug administration (wrong dose, wrong time, wrong technique)</li> <li>• Use of long acting insulin</li> <li>• Basal insulin heavy regimen</li> <li>• Emergency medication administration</li> <li>• Glucose trend not recognized</li> <li>• Sole use of sliding scale insulin</li> <li>• Home regimen continued as inpatient</li> <li>• Steroid dosing</li> <li>• Lack of coordination of insulin administration and food intake</li> <li>• Glucose reading not linked to insulin administration</li> </ul> | <ul style="list-style-type: none"> <li>• Glucose reading not in sync with food intake</li> <li>• Lack of adjustment of antidiabetic regimen after treatment of hypoglycemia</li> <li>• Lack of consideration of changes in creatinine clearance</li> <li>• Changes in nutritional regimen and/or delay in meal delivery</li> <li>• Previously unaddressed hypoglycemia</li> <li>• Lack of adjustment post-sedation</li> <li>• Lack of adjustment with nothing by mouth or NPO status</li> <li>• Lack of timely and accurate conversion from oral agents to subcutaneous or intravenous agents</li> <li>• Treating blood glucose reactively</li> <li>• Lack of restrictions and clear guidelines for the prescribing of U-500 regular insulin</li> </ul> |
|--|---|

Table 3: By identifying the gaps in blood glucose management, organizations can tailor their project improvement efforts more effectively

- **Evaluate outcomes, celebrate wins, and adjust the plan when necessary.** Measure both process and outcome metrics. Outcome metrics include the rates outlined in the leadership checklist. Process metrics will depend upon the workflow you are trying to improve and are generally expressed in terms of compliance with workflow changes. Compare your outcomes against other related metrics your organization is tracking.

Routinely review all metrics and trends with both the advisory and project teams and discuss what is going well and what is not. Identify barriers to completion of action plans, and adjust the plan if necessary. Once you have the desired outcomes in the trial area, consider spreading to other areas ([IHI, 2006](#)).

It is important to be nimble and move quickly to keep team momentum going, and so that people can see the results of their labor. At the same time, don't move so quickly that you don't consider the larger, organizational ramifications of a change in your plan. Be sure to have a good understanding of the other, similar improvement projects that are taking place so that your efforts are not duplicated or inefficient.

[Read this paper from the Institute for Healthcare Improvement to understand how small local steps can integrate into larger, system changes](#)



**BLOOD GLUCOSE MANAGEMENT COMPARATIVE OUTCOMES**

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>• Readmission</li> <li>• Length of stay</li> </ul> | <ul style="list-style-type: none"> <li>• Infection cases</li> <li>• Mortality</li> </ul> |
|---|--|

Table 4: Consider evaluating related metrics to better understand blood glucose management presence and contributing factors

# What We Know About Blood Glucose Management

Hyperglycemia is defined as a blood glucose of greater than 140 mg/dL. Severe hypoglycemia is a low blood glucose level that requires the help of another person to recover. Typically, a blood glucose level  $\leq 70$  mg/dL warrants a classification of hypoglycemia and a blood glucose level of 40 mg/dL warrants a classification of severe hypoglycemia.

Hypoglycemia is most prevalent in the elderly, in the severely ill population, and in those with diabetes. Risk can increase with polypharmacy, decreased or delayed caloric intake, presence of hypoglycemia-associated autonomic failure, organ failure, comorbidities (e.g., renal failure or sepsis), mechanical ventilation, intensive glucose management, and presence of other illnesses which warrant the use of insulin at high doses ([Hulkower et al., 2014](#)). Increased mobilization after an illness or major amputations can enhance insulin sensitivity ([Hulkower et al., 2014](#)).

Consider incorporating glucose management principles from IHI's "Global Trigger Tool for Measuring Adverse Events".



## "Trigger" Events

Iatrogenic hypoglycemia may be triggered by the rapid reduction of corticosteroid dose, change in patient's ability to report symptoms, decreased nutritional intake, vomiting, change in NPO status, poor alignment of insulin with meals, and/or interruption of feedings.

Persistent hyperglycemia can escalate to DKA when the body's blood sugar levels are too high for too long. This is commonly due to physiologic stressors, including infection, myocardial infarction, stroke, pancreatitis, pregnancy, trauma, some drugs, including corticosteroids and thiazide diuretics, lack of physical activity, and nutrition via feeding tubes.

## Signs and Symptoms of Hypoglycemia

Hypoglycemia can present without symptoms, which is why vigilance and monitoring is essential. Symptoms all patients, providers, and family members should be aware of include those listed on the [Edinburgh Hypoglycemia Scale](#):

- Sweating
- Palpitations
- Shaking
- Hunger
- Confusion
- Drowsiness
- Odd behavior
- Speech difficulty
- Incoordination
- Headache
- Nausea

The incidence rate of severe hypoglycemia is between 7 to 35% in hospitalized patients ([Kadayakkara et al., 2019](#)).



It is important to note that patients who have experienced a recent or recurrent hypoglycemic episode before may not be able to properly display these symptoms. This is known as hypoglycemia unawareness or hypoglycemia-associated autonomic failure.

Strategies for these patients are varied, from pharmacologic interventions up to and including islet transplantation. Ultimately, prevention of hypoglycemic events is key and includes self monitoring of blood glucose and continuous glucose monitoring ([McGill et al., 2017](#), [Martin-Timon et al., 2015](#)).

## Signs and Symptoms of Hyperglycemia

- Frequent urination
- Increased thirst
- Blurred vision
- Fatigue
- Headache
- Sweet-smelling breath and/or urine
- Nausea and vomiting
- Dry mouth
- Weakness
- Confusion

Hyperglycemia is reported in 22-46% of non-critically ill hospitalized patients ([Corsino, Dhatariya, & Umpierrez, 2000](#)).



## Signs and Symptoms of DKA

- Excessive thirst
- Frequent urination

- Nausea and vomiting
- Abdominal pain
- Weakness
- Shortness of breath and/or fruity breath
- Cognition impairment or confusion

DKA hospitalizations are associated with a cost of approximately 2.4 billion US dollars, with neglect of insulin as the most common precipitating factor ([Gosmanov, Gosmanova, & Dillard-Cannon, 2014](#)).



### Clinical and Financial Implications

There is a question whether hypoglycemia is the direct cause of worsening condition and mortality or if hypoglycemia is instead a biomarker of the exacerbated and worsening disease burden ([Hulkower et al., 2014](#)). Regardless, the clinical implications listed hereafter are just as compelling to warrant an immense prioritization.

Moderate and severe hypoglycemia are strongly linked to increased risk of death, especially from distributive shock through:

- Decline of autonomic function
- Changes in blood flow
- Immune system activation
- Vasoconstriction
- Inflammatory mediator and cytokine release

The excess insulin can prompt the uptake of potassium from the bloodstream, resulting in hypokalemia, which is associated with significant effects on cardiac and brain function ([Christensen et al., 2009](#)). Sudden death in sleep - "dead in bed" - due to abnormal cardiac repolarization associated with hypoglycemia is not uncommon ([Robinson et al., 2003](#)).

Repeated and recent episodes of hypoglycemia are associated with damage to the counter-regulatory system, which can directly prompt development of hypoglycemia unawareness. Complications of diabetes-related hypoglycemia include acute cerebrovascular disease, myocardial infarction, brain damage, and loss of vision ([Kalra et al., 2013](#)).

It has been suggested that hypoglycemia occurs in 35-42% of type 1 diabetes patients ([Pedersen-Bjergaard et al., 2004](#)). Diabetes-related death is the most common cause of death in patients under 30 years old and although hypoglycemia represents only approximately 12% of these deaths, this percentage may be higher due to the nearly-doubled presence of unexplained diabetes-related deaths ([Rickels, 2019](#)).

Researchers have found that between 38-40% of hospitalized patients experience hyperglycemia. This figure increases to 70-80% in diabetic patients with critical illness and cardiac surgery ([Clement et al., 2004](#)). Hyperglycemia is associated with compromised immune function, increased blood pressure, increased thrombotic events, increased inflammation, and oxidative stress ([Clement et al., 2004](#)). Furthermore, insulin is associated with 11% of medication errors ([Clement et al., 2004](#)).

Sole use of sliding scale insulin regimens is strongly discouraged. These regimens are reactive in nature to elevated blood glucose levels and do not treat a patient's basal insulin needs ([Kodner et al., 2017](#)). Sliding scale regimens are associated with an increased rate of wound infection, pneumonia, bacteremia, respiratory failure, and renal failure ([Umpierrez et al., 2011](#)).



Infection is the most common case for both hyperglycemia and subsequently DKA, occurring in 30-50% of DKA cases ([Umpierrez et al., 2003](#)). Patients presenting to the emergency department with DKA have increased by 35% from 1996 to 2006 ([Mendez et al., 2017](#)) and continue to increase. DKA treatment is estimated to account for 1 out of every 4 healthcare dollars spent on medical care of patients with type 1 diabetes in the US ([Umpierrez et al., 2003](#)).

### Blood Glucose Management Goals for Hospitalized Patients with Diabetes

- Ensure adequate nutrition.
- Minimize disruption of metabolic state.
- Prevent swings in blood sugar that may lead to adverse glycemia events.
- Maintain a stable glycemia balance.
- Plan for a smooth transition to outpatient care.

## Resources



### For blood glucose management and improvement:

- [American Diabetes Association: Hypoglycemia Prevention in Hospital Patients: A Quality Improvement Project to Prevent Severe and Recurrent Hypoglycemia](#)
- [American Diabetes Association: Detection, Prevention, and Treatment of Hypoglycemia in the Hospital](#)
- [Understanding Hypoglycemia in Hospitalized Patients](#)
- [Multidisciplinary Strategies to Treat Severe Hypoglycemia in Hospitalized Patients with Diabetes Mellitus Reduce Inpatient Mortality Rate: Experience from an Academic Community Hospital](#)
- [Temporal Occurrences and Recurrence Patterns of Hypoglycemia During Hospitalization](#)
- [Diabetes Care in the Hospital: Standards of Medical Care in Diabetes](#)
- [Glucose Management in Hospitalized Patients](#)
- [Effects of a Subcutaneous Insulin Protocol, Clinical Education, and Computerized Order Set on the Quality of Inpatient Management of Hyperglycemia: Results of a Clinical Trial](#)
- [Modeling Inpatient Glucose Management Programs on Infection Control Programs: An Infrastructural Model of Excellence](#)
- [Management of Adult Diabetic Ketoacidosis](#)

### For general improvement:

- [CMS: Hospital Improvement Innovation Networks](#)
- [IHI: A Framework for the Spread of Innovation](#)
- [The Joint Commission: Leaders Facilitating Change Workshop](#)
- [IHI: Quality Improvement Essentials Toolkit](#)
- [SIPOC Example and Template for Download](#)
- [SIPOC Description and Example](#)

## Education for Patients and Family Members

The outline below illustrates all of the information that should be conveyed to the patient and family members by someone on the care team in a consistent and understandable manner.

**Explain why blood glucose control is important.** Both diabetic **and** non-diabetic patients and their family members should understand the importance of blood sugar regulation during their stay in the hospital. Diabetic patients may be familiar with the treatment that can be expected but their plan of care should still be articulated every step of the way. Non-diabetic patients may not understand the need for blood glucose monitoring. As such, healthcare providers should explain the importance of limiting blood glucose ‘swings’ as it relates to their recovery.

Tailor the discussion to the patient’s condition. If the patient has other diseases, explain the dynamics of the relationship of these diseases with their blood glucose management requirements.

**Indicate what to watch out for.** Family members can serve as an extra pair of eyes and ears and can alert medical staff if something might be wrong. Both diabetic and non-diabetic patients and their family members should understand the signs and symptoms of the patient that may indicate deterioration, as articulated in the [What We Know](#) section. In order to adequately welcome patients and family members into the care team, it is not enough to explain “what” patients and family members should look for or “what” is going to happen in their care. The “what” must always be followed with a “why” to aid in genuine understanding.

Additionally, family members should know exactly when to call for help, where to go for help, and with whom they should speak. It is essential that patients and family members understand that they should not be ashamed to ask any of their questions and that many patients in similar situations often have similar questions.

Instead of employing a directive conversation style, an active, engaging conversation should take place, leaving capacity for questions and repeat-back strategies. When patients and family members understand the signs and symptoms that could be indicative of a problem, they are able to serve as an extra set of eyes in order to elevate this concern as early as possible.

**Describe what can be anticipated.** In addition to explaining when to call for help in the case of a potential emergency, healthcare providers should also thoroughly explain the typical treatment that can be expected before, during, and after their hospital stay. The patients and family members should understand how the healthcare team recognizes, treats, and prevents hypoglycemia and hyperglycemia. A member of the healthcare team should help the patient understand any changes to their diet and medication regimen and why these changes are being made. Clinicians should provide a high-level overview of the processes in place at their organization to ensure blood glucose management as it relates to the individual

patient's circumstance and risk factors. This demonstrates competence of the organization, will likely bolster patient and family comfort, and will provide the patient and family members with information for which to reference if they may be suspicious of a problem.

By engaging in these conversations before a problem arises, family members can be prepared in the circumstance of necessary treatment and will have an understanding of where to go to find out more information about their loved one's condition.

Each conversation with a patient and family member should be inclusive and void of bias. Additionally, these conversations should leave ample time for discussion and the facilitator should encourage questions from the patient and family members



**Explain what is expected of them during their care.** By giving patients and family members a “job” while they are in the hospital, they can be immersed fully in the routine care, can hold other team members accountable, can feel more confident voicing their concerns or opinions, and can serve as an extra set of informed and vigilant eyes to optimize safety. This team involvement can also reduce their anxiety by transforming concern into proactive action. Patients and family members can:

- Ask about the patient's risk factors for blood sugar swings.
- Ask about an A1C for the patient if the patient has not yet been diagnosed with diabetes.
- Understand symptoms and early warning signs that may indicate the need for intervention and elevate these concerns to the healthcare team.
- Keep track of changes to the patient's diet and medication regimen.
- Ask for clarification around blood glucose management standards at that hospital.
- Monitor for hand hygiene in all healthcare providers and visitors.
- Monitor for signs of an infection.
- Inform the healthcare team if the patient has or is at risk for an infection.

**Explore next steps.** Planning for life after the hospital, whether in assisted living, returning home, or another option, should begin as early as possible between the healthcare providers and the patient and family.

- Provide thorough instructions to the patient and family members in the days leading up to discharge regarding self monitoring of blood glucose, nutritional requirements, proper use and disposal of needles and syringes, medication regimens that should be followed, and instructions for when to return to the hospital if a problem is suspected.
  - Set aside time with the patient and family members more than once to ensure their understanding and confidence.
  - Help the patient and family members understand what to do in a diabetic emergency.
  - Practice insulin administration with the patient and monitor the patient's insulin administration performance.
- Help the patient set realistic at home blood glucose goals.
  - Explain why the patient was originally admitted and discuss strategies to avoid readmission, if applicable.
- If the patient is a smoker, the healthcare team should encourage smoking cessation and provide additional resources for further information, groups, or strategies for smoking cessation.
  - Try to understand what specific barriers that patient as an individual faces in cessation.
- Describe the organization's glucose management safety standards that were followed.
  - If any of the protocols changed due to this specific patient's circumstance, articulate that to the patient and family members.
- Have a discussion with the patient and family around end of life care and advanced directives.
  - Make an attempt to thoroughly understand the religious or cultural nuances in any of the patient's or family members' decisions or questions.
- Ensure thorough explanation of necessary post-discharge appointments, therapies, medications, and potential complications. Identify the provider who will provide diabetes care after discharge.
  - Assess for patient preference in time and location of follow-up appointments, if possible.
  - Help the patient understand what information their outpatient diabetes provider might ask and work with these patients to understand what information they should relay to their outpatient diabetes provider.
- Provide patients and family members resources, including direct contact phone numbers, to the hospital for post-discharge questions.
  - Make sure the resources are in their own language

Patients and family members should understand that, although all clinicians in the hospital do their best, no one is ultimately coordinating their care. Patients and family members should understand that they are the managers of their care and as such, should demand to be an active part of the care team including conversations and decisions.

## Measuring Outcomes

Examples of process metrics include, but are certainly not limited to:

- Admissions with a blood glucose level of <40 mg/dL where a antihyperglycemic medication was given within 24 hours prior and no subsequent test for glucose with a result >80 mg/dL within 5 minutes of the low glucose result
- Modification in regimen following a hyper or hypoglycemic episode
- Assessment of baseline A1c level upon admission or during hospital stay
- Routine tracking and documentation of blood sugar levels
- Insulin adjustment in parallel with nutritional, procedural, or medication changes
- Timeliness of provision of simple carbohydrates
- Timeliness of sepsis screening upon admission
- Coordination of food intake, insulin administration, and glucose monitoring

Examples of outcome metrics include, but are certainly not limited to:

- In-patient mortality in all diabetes patients
- 30-day readmission of all diabetes patients
- Frequency of hyper or hypoglycemic episodes

# Endnotes

## Conflicts of Interest Disclosure

The Patient Safety Movement Foundation partners with as many stakeholders as possible to focus on how to address patient safety challenges. The recommendations in the APSS are developed by workgroups that may include patient safety experts, healthcare technology professionals, hospital leaders, patient advocates, and medical technology industry volunteers. Workgroup members are required to disclose any potential conflicts of interest.

## Workgroup

### Co-Chairs

**Ron Jordan**

Chapman University School of Pharmacy

**Jerika Lam**

Chapman University School of Pharmacy

### Current Members

This list represents all contributors to this document since inception of the Actionable Patient Safety Solutions

**Steven Barker**

Patient Safety Movement Foundation; Masimo

**Michael Dejos**

Methodist Le Bonheur Healthcare

**Mitchell Goldstein**

Loma Linda Medical Center

**Michele Holt**

University of Florida, Jacksonville

**Soojin Jun**

Patient Advocate

**Ariana Longley**

Patient Safety Movement Foundation

**Olivia Lounsbury**

Patient Safety Movement Foundation

**Donna Prosser**

Patient Safety Movement Foundation

**Leila Sales**

Red Cross of Higher School of Health

**Nat Sims**

Massachusetts General Hospital

**Sun Yang**

Chapman University School of Pharmacy

**Rena Zhu**

University of California, Irvine

### Metrics Integrity

**Robin Betts**

Kaiser Permanente, Northern California Region

### Previous Members

**Michel Bennett**

Patient Safety Movement Foundation (formerly)

**Jacob Lopez**

Patient Safety Movement Foundation (formerly)

**Flannery Nangle**

Monarch Medical Technologies

## References

- Adler, G. K., Bonyhay, I., Failing, H., Waring, E., Dotson, S. and Freeman, R. (2008). Antecedent Hypoglycemia Impairs Autonomic Cardiovascular Function: Implications for Rigorous Glycemic Control. *Diabetes*, 58(2), 360-366. doi:10.2337/db08-1153
- American Diabetes Association. (2016). Diabetes Care in the Hospital. *Diabetes Care*, 39:S99-S104. DOI: 10.2337/dc16-S016
- Boucai, L., Southern, W. N. and Zonszein, J. (2011). Hypoglycemia-associated Mortality Is Not Drug-associated but Linked to Comorbidities. *The American Journal of Medicine*, 124(11), 1028-1035. doi:10.1016/j.amjmed.2011.07.011
- Christensen, T.F., Baekgaard, M., Dideriksen, J.L., Steimle, K.L., Lause ogensen, M., Kildegaard, J., Struijk, J.J., Hejlesen, O.K. (2009). A Physiological Model of the Effect of Hypoglycemia on Plasma Potassium. *J Diabetes Sci Technol*, 3(4):887-894. doi: 10.1177/193229680900300436
- Clement, S., Braithwaite, S.S., Magee, M.F., Ahmann, A., Smith, E.P., Schafter, R.G., Hirsch, I.B. (2004). Management of Diabetes and Hyperglycemia in Hospitals. *Diabetes Care*, 27(2): 553-591. <https://doi.org/10.2337/diacare.27.2.553>
- Deal, E. N., Liu, A., Wise, L. L., Honick, K. A. and Tobin, G. S. (2011). Inpatient Insulin Orders: Are Patients Getting What is Prescribed?. *Journal of Hospital Medicine*, 6(9), 526-529. doi:10.1002/jhm.938
- DiNardo, M., Noschese, M., Korytkowski, M. and Freeman, S. (2006). The Medical Emergency Team and Rapid Response System: Finding Treating, and Preventing Hypoglycemia. *The Joint Commission Journal on Quality and Patient Safety*, 32(10), 591-595. doi:10.1016/s1553-7250(06)32077-6
- Elliott, M. B., Schafers, S. J., McGill, J. B. and Tobin, G. S. (2012). Prediction and Prevention of Treatment-Related Inpatient Hypoglycemia. *Journal of Diabetes Science and Technology*, 6(2), 302-309. doi:10.1177/193229681200600213
- Forum, N. Q. (2010). Safe Practices for Better Healthcare-2010 update. Retrieved from [http:// patient.sm/nqm-safe-practices](http://patient.sm/nqm-safe-practices)
- Hulkower, R.D., Pollack, R.M., Zonszein, J. (2014). Understanding hypoglycemia in hospitalized patients. *Diabetes Manag (Lond.)*, 4(2):165-176. doi: 10.2217/DMT.13.73
- Kodner, C., Anderson, L., Pohlgeers, K. (2017). Glucose Management in Hospitalized Patients. *Am Fam Physician*, 96(10):648-654
- Kalra, S., Mukherjee, J. J., Venkataraman, S., Bantwal, G., Shaikh, S., Saboo, B., Das, A. K., Ramachandran, A. (2013). Hypoglycemia: The neglected complication. *Indian journal of endocrinology and metabolism*, 17(5), 819-834. <https://doi.org/10.4103/2230-8210.117219>
- Martin-Timon, I., del Canizo-Gomez, F.J. (2015). Mechanisms of hypoglycemia unawareness and implications in diabetic patients. *World J Diabetes*, 6(7):912-926. doi: 10.4239/wjd.v6.i7.912
- McGill, J.B., Ahmann, A. (2017). Continuous Glucose Monitoring with Multiple Daily Insulin Treatment: Outcome Studies. *Diabetes Technol Ther.*, 19:S-3-S-12. doi: 10.1089/dia.2017.0090
- Mendez, Y., Surani, S., & Varon, J. (2017). Diabetic ketoacidosis: Treatment in the intensive care unit or general medical/surgical ward?. *World journal of diabetes*, 8(2), 40-44. <https://doi.org/10.4239/wjd.v8.i2.40>
- Milligan, P. E., Blackburn, M. C., Dachroeden, R. R. (2014). Multi-faceted Improvement Initiative to Detect and Improve Prevention of Severe Hypoglycemia. Retrieved from: <http://www.ashp.org/DocLibrary/Abstract-Archive/SM14-Session-Abstracts.pdf>
- Moghissi, E. S., Korytkowski, M. T., DiNardo, M., Einhorn, D., Hellman, R., Hirsch, I. B., ... & Umpierrez, G. E. (2009). American Association of Clinical Endocrinologists and American Diabetes Association Consensus Statement on Inpatient Glycemic Control. *Diabetes Care*, 32(6), 1119-1131.
- (2012). *New England Journal of Medicine*, 367(12), 1108-1118. doi:10.1056/nejmoa1204942 Schwartz, A. V., Vittinghoff, E., Sellmeyer, D. E., Feingold, K. R., d. Rekeirene,

N., Strotmeyer, E. S.,...and,T.B.H. (2007). *Diabetes-Related Complications Glycemic Control, and Falls in Older Adults*. *Diabetes Care*, 31(3), 391-396. doi:10.2337/dc07-1152

Pedersen-Bjergaard, U., Pramming, S., Heller, S. R., Wallace, T. M., Rasmussen, A. K., Jørgensen, H. V., Matthews, D. R., Hougaard, P., & Thorsteinsson, B. (2004). Severe hypoglycaemia in 1076 adult patients with type 1 diabetes: influence of risk markers and selection. *Diabetes/metabolism research and reviews*, 20(6), 479-486. <https://doi.org/10.1002/dmrr.482>

Rickels M. R. (2019). Hypoglycemia-associated autonomic failure, counterregulatory responses, and therapeutic options in type 1 diabetes. *Annals of the New York Academy of Sciences*, 1454(1), 68-79. <https://doi.org/10.1111/nyas.14214>

Robinson, R.T.C.E., Harris, N.D., Ireland, R.H., Lee, S., Newman, C., Heller, S.R. (2003). Mechanisms of abnormal cardiac repolarization during insulin-induced hypoglycemia. *Diabetes*, 52(6):1469-74doi: 10.2337/diabetes.52.6.1469

Swanson, C., Potter, D., Kongable, G. and Cook, C. (2011). *Update on Inpatient Glycemic Control in Hospitals in the United States*. *Endocrine Practice*, 17(6), 853-861. doi:10.4158/ep11042.or

Tomky, D. (2005). *Detection, Prevention, and Treatment of Hypoglycemia in the Hospital*. *Diabetes Spectrum*, 18(1):39-44. <https://doi.org/10.2337/diaspect.18.1.39>

Umpierrez, G.E., Kitabchi, A.E. (2003). Diabetic ketoacidosis: risk factors and management strategies. *Treatments in endocrinology*, 2(2), 95-108. <https://doi.org/10.2165/00024677-200302020-00003>

Umpierrez, G.E., Smiley, D., Jacobs, S., Peng, L., Temponi, A., Mulligan, P., Umpierrez, D., Newton, C., Olson, D., Rizzo, M. (2011). Randomized Study of Basal-Bolus Insulin Therapy in the Inpatient Management of Patients With Type 2 Diabetes Undergoing General Surgery (RABBIT 2 Surgery). *Diabetes Care*, 34(2):256-261. <https://doi.org/10.2337/dc10-1407>

Wright, R. J. and Frier, B. M. (2008). Vascular Disease and Diabetes: Is Hypoglycaemia an Aggravating Factor?. *Diabetes/Metabolism Research and Reviews*, 24(5), 353-363. doi:10.1002/dmrr.865

Van Den Berghe, G., Wouters, P., Weekers, F., Verwaest, C., Bruyninckx, F., Schetz, M., Vlasselaers, D., Ferdinand, P., Lauwers, P., Bouillon, R. (2001). Intensive Insulin Therapy in Critically Ill Patients. *The New England Journal of Medicine*, 345(19): 1359-1367. DOI: 10.1056/NEJMoa011300

## Appendices

### Appendix A: Adapted directly from [Corsino, Dhatariya, and Umpierrez \(2000\)](#).

DIET	REGIMEN	GLUCOSE MONITORING SCHEDULE	SPECIAL CAVEATS
NPO	Intravenous insulin infusion	Every 1-2 hrs	
NPO	SC regular insulin every 6 hrs (6am, noon, 6pm, midnight)	Every 6 hrs (6am, noon, 6pm, midnight) prior to SC insulin dose	
NPO	Basal insulin alone	Every 6 hrs (6am, noon, 6pm, midnight)	
Eating 3 meals per day	Basal/bolus regimen with long acting and rapid-acting insulin with meals	4 times per day: before breakfast, before lunch, before dinner, and bedtime	Consider a 3am blood glucose check in patients at risk for hypoglycemia
Nocturnal tube feeds and daytime oral intake	Regimen varies depending on clinical status. Basal insulin plus corrections or basal bolus with long and rapid-acting insulin. Basal in AM and low-dose NPH insulin at the start of the nocturnal tube feeds.	5 times per day: before breakfast, before lunch, before dinner, bedtime, and 3am	
Continued tube feeds	Basal insulin plus correction with regular insulin every 4-6 hours. NPH 2 or 3 times daily or regular insulin every 6 hrs.	Every 6 hrs (6am, noon, 6pm, midnight)	
Patients eating small multiple meals per day (e.g. cystic fibrosis)	Basal/bolus with long acting insulin and rapid-acting insulin with meals (carbohydrate counting).	At least 4 times per day: before breakfast, before lunch, before dinner, and bedtime	More frequent checks might be warranted in order to include postprandial blood glucose.
Patient on high-dose corticosteroids	Basal/bolus with long acting insulin and rapid-acting insulin with meals. May add small dose of NPH to basal bolus regimen in patients on morning dose of steroids.	4 times per day: before breakfast, before lunch, before dinner, and bedtime	
NPO or eating 3 meals per day	Patients on insulin pumps	4-8 times per day, before breakfast, lunch, dinner, and bedtime. Consider postprandial checks.	