Hypoglycemia and Hyperglycemia in the Long-Term Care Resident

This presentation is a practical overview of awareness and management of hypoglycemia and hyperglycemia in elderly residents with type 2 diabetes.
Presentation Objectives

- To provide guidance on the importance of:
  - Understanding the scope of the problem of hypoglycemia and hyperglycemia in the elderly
  - Defining hypoglycemia and hyperglycemia
  - Understanding the common causes
  - Recognizing the signs, symptoms, and potential complications in the elderly
  - Risk factors associated with hypoglycemia and hyperglycemia
  - Treating hypoglycemia and hyperglycemia
  - Reviewing key quality indicators of care

This presentation has been designed to provide guidance on the importance of:
• Understanding the scope of the problem of hypoglycemia and hyperglycemia in the elderly
• Defining hypoglycemia and hyperglycemia
• Understanding the common causes
• Recognizing the signs, symptoms, and potential complications in the elderly
• Risk factors associated with hypoglycemia and hyperglycemia
• Treating hypoglycemia and hyperglycemia
• Reviewing key quality indicators of care
Scope of the Problem

- Data suggest that approximately 25% of residents in long-term care have diabetes mellitus\(^1\)
- This prevalence may be underestimated\(^2\)
- Residents with diabetes are vulnerable to increased risks of both hypoglycemia and hyperglycemia. Frequent episodes of hypoglycemia and hyperglycemia may further increase the risk of:\(^2\):
  - Cardiovascular complications
  - Infections (especially of the skin and urinary tract)
  - Dehydration
  - Hospitalization
  - Physical and cognitive disability

- Diabetes is common in the long-term care setting, affecting approximately 25% of the resident population. More than 80% of residents also have cardiovascular disease, 56% have hypertension, and 69% have 2 or more chronic conditions in addition to diabetes.\(^1\)
- This prevalence of diabetes in nursing facilities may be underestimated.\(^2\)
- Long-term care residents may be vulnerable to increased risks of both hypoglycemia and hyperglycemic episodes. Frequent episodes may be associated with an increase in the risk of cardiovascular complications, infections (especially of the skin and urinary tract), dehydration, hospitalization, and physical and cognitive disability.\(^2\)

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2. AMDA. Diabetes Management in the Long-Term Care Setting: Clinical Practice Guideline. 2008.
The following section of the presentation will focus on hypoglycemia in the long-term care setting.
Defining Hypoglycemia

According to the American Diabetes Association, the general definition of hypoglycemia is plasma glucose <70 mg/dL.¹,²

<table>
<thead>
<tr>
<th>Mild or moderate hypoglycemia</th>
<th>Severe hypoglycemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plasma glucose ~40-70 mg/dL</td>
<td>Plasma glucose &lt;40 mg/dL³</td>
</tr>
<tr>
<td>• Residents with glucose levels in this range may be responsive, but may have symptoms of hypoglycemia²</td>
<td>• Constitutes an emergency that must receive immediate attention from staff¹,²</td>
</tr>
<tr>
<td></td>
<td>• Residents with severe hypoglycemia may be unconscious or very confused and sleepy¹,²</td>
</tr>
<tr>
<td></td>
<td>• Can progress to severe hypoglycemia if not treated promptly</td>
</tr>
</tbody>
</table>

* This definition applies to the general diabetes population and is not specific to the elderly.

- According to the American Diabetes Association, the general definition of hypoglycemia is a plasma glucose level of less than 70 mg/dL.¹ This definition applies to the general diabetes population and is not specific to the elderly.
- A resident with mild or moderate hypoglycemia may be responsive, but may have symptoms of hypoglycemia. This may progress to severe hypoglycemia, so prompt treatment is crucial.²
- A resident with severe hypoglycemia, generally defined as a glucose level of less than 40 mg/dL,³ may appear sleepy, confused, or even become unconscious.¹,²
- Severe hypoglycemia constitutes an emergency that must receive immediate attention from staff.¹,²

### Identifying Common Causes of Hypoglycemia in Residents With Type 2 Diabetes

<table>
<thead>
<tr>
<th>Medications</th>
<th>Inconsistent food intake</th>
<th>Physical activity</th>
<th>Medical conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Too much insulin or oral antidiabetes medication(^1,2)</td>
<td>Missing a meal or not eating the whole meal(^2)</td>
<td>More exercise or physical activity than usual(^2)</td>
<td>Fever, diarrhea, vomiting; diseases of the adrenal glands, the pituitary gland, the thyroid gland, the liver, and the kidney(^3)</td>
</tr>
<tr>
<td>Injecting insulin the wrong way or in the wrong injection area(^2)</td>
<td>Not eating when ill(^2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taking medications that affect insulin(^1)</td>
<td>Irregular meal schedule(^2)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. LANTUS\(^2\) Prescribing Information. sanofi-aventis U.S. LLC; June 2009.

• What are the potential common causes of hypoglycemia in residents with type 2 diabetes? Often, it is related to medication management or to food intake. Using too much insulin or oral antidiabetes medication can cause hypoglycemic episodes. If insulin is not injected correctly, changes in absorption can occur and may result in hypoglycemia. Finally, some medications can affect how insulin is absorbed or metabolized. This can also result in abnormally low blood sugar levels.\(^1,2\)

• Consistent food intake is also critical to reduce the risk of hypoglycemia. If residents miss a meal or do not eat sufficiently at mealtime, blood sugar levels may be too low, particularly when they are taking diabetes medication. Residents are also placed at risk when they become ill and do not want to eat or when they have an irregular meal schedule.\(^2\)

• Residents who participate in greater than usual amounts of physical activity can develop hypoglycemia.\(^2\)

• Other causes may be related to medical conditions including fever, diarrhea, vomiting, and diseases of the adrenal glands, the pituitary gland, the thyroid gland, the liver, and the kidney.\(^3\)
Hypoglycemia Often Presents With Atypical Symptoms in the Elderly

- When there is a long history of diabetes, less intense or altered hypoglycemic symptoms may occur, and some residents may be unable to perceive or communicate symptoms.
- Hypoglycemia can occur without symptoms, so it is important to regularly check blood glucose levels.

In elderly populations, some hypoglycemia symptoms are more common than others. ¹
In the frail elderly, hypoglycemia is most commonly evidenced by confusion, lethargy, disorientation, incoordination, altered personality, and falls. ¹
When there is a long history of diabetes, less intense or altered hypoglycemic symptoms may occur, and some residents may be unable to perceive or communicate symptoms. ¹
Hypoglycemia can occur without symptoms, so it is important to regularly check blood glucose levels.

• When hypoglycemia occurs, there are some general guidelines for effective management.
• It is important to act quickly, because hypoglycemia can quickly result in serious medical event(s) or even death.¹
• Hypoglycemia can generally be treated in 3 steps.¹
• First, the resident should consume 15 g of glucose or fast-acting carbohydrate containing food. This is equivalent to any one of the following:
  – ½ cup juice or apple sauce
  – 1 cup milk
  – 1 tube glucose gel
  – 3 glucose tablets
• Next, wait 15 minutes.
• After 15 minutes, blood glucose levels should be rechecked. If they are still below target, the resident should consume another 15 g of glucose or carbohydrate. Possible causes for the hypoglycemia should be assessed, and the episode should be documented.
• Remember that giving the resident too much glucose may result in an episode of the opposite problem—hyperglycemia.¹

• The following section of the presentation will focus on hyperglycemia in the long-term care setting.
Defining Hyperglycemia

According to the ADA, blood glucose may be too high if it is greater than:
- 130 mg/dL fasting or before meals (preprandial)
- 180 mg/dL 1 to 2 hours after a meal (postprandial)

Possible signs and symptoms:
- Blurred vision
- New or worsening confusion
- Lethargy
- Weight loss
- Polydipsia, polyphagia
- Worsening incontinence
- Fruity breath odor

Hyperglycemia can occur without symptoms, so it is important to regularly check blood glucose.

2. AMDA. Diabetes Management in the Long-Term Care Setting: Clinical Practice Guideline. 2008.

• According to the ADA, blood glucose may be too high if it is greater than:
  – 130 mg/dL fasting to before meals (preprandial)
  – 180 mg/dL 1 to 2 hours after a meal (postprandial)
• Like hypoglycemia, hyperglycemia often presents with atypical symptoms.
• Possible signs and symptoms:
  – Blurred vision
  – New or worsening confusion
  – Lethargy
  – Weight loss
  – Polydipsia, polyphagia
  – Worsening incontinence
  – Fruity breath odor
• Hyperglycemia can occur without symptoms, so it is important to regularly check blood glucose.
Uncontrolled Hyperglycemia Increases the Risk of the Development of Complications

- A blood glucose of 200 mg/dL is regarded as an important threshold.
- Cardiovascular complications
  - Worse outcomes seen in patients following stroke and MI as compared with outcomes in patients with normal levels.
- Neuropathy (foot ulcers)
- Retinopathy (possibly leading to blindness)

- Blood glucose levels that remain above 200 mg/dL increase the risk of complications.
- Poor glycemic control may be associated with worse cardiovascular outcomes following stroke or myocardial infarction as compared with patients with normal blood glucose levels.
- Other complications may include neuropathy and the formation of foot ulcers. If foot ulcers become infected and go undetected and untreated, the consequence may be amputation. Prolonged uncontrolled hyperglycemia may also lead to complications affecting vision and blindness.

Morbidity and Mortality in Hyperglycemic Residents Are Increased by a Higher Rate of Pressure Ulcers

- Patients with diabetes often lose zinc as a result of hyperglycemia. This can lead to zinc deficiency, which is associated with poor wound healing.
- Diabetes can cause alterations in blood flow to the feet, which is one of the major causative factors in the development of foot ulcers, and eventually, of infection and amputation.
- The prevalence of pressure ulcers has been reported to be as high as 28% in long-term care residents.
- Two-thirds of all amputations occur in people over 65 years of age, and two-thirds of these occur in people with diabetes.

The Medicare State Operations Manual presents F-tag 314:

* A resident who enters the facility without pressure sores does not develop pressure sores unless the individual’s clinical condition demonstrates that they were unavoidable; and (2) A resident having pressure sores receives necessary treatment and services to promote healing, prevent infection and prevent new sores from developing.

- Patients with diabetes often lose zinc as a result of hyperglycemia. This can lead to zinc deficiency, which is associated with poor wound healing.
- Diabetes can cause alterations in blood flow to the feet, which is one of the major causative factors in the development of foot ulcers, and eventually, of infection and amputation.
- The prevalence of pressure ulcers has been reported to be as high as 28% in long-term care residents.
- Two-thirds of all amputations occur in people over 65 years of age, and two-thirds of these occur in people with diabetes.
- The Medicare State Operations Manual tags pressure ulcers (F-tag 314) and indicates that long-term care residents should not develop pressure ulcers unless clinically unavoidable and that the facility provides care and services to promote the prevention of pressure ulcer development; promote the healing of pressure ulcers that are present (including prevention of infection to the extent possible)—and managing associated risk factors and co-morbid conditions (diabetes); and prevent development of additional pressure ulcers.

Residents with diabetes are 2.6 times more likely to fall

In a prospective cohort study of 139 elderly (88 ± 7 years, [range 75-106]) in a long-term care facility followed over a mean of 299 days, 18 residents (13%) were classified, by use of hypoglycemic agents, as having diabetes.

- Both hypoglycemia and hyperglycemia in skilled nursing facility residents with diabetes may increase the risk of injurious falls.1,2
- Consequences of injury from falls may lead to decreased activity, social isolation, depression, and functional decline.3
- Prolonged hyperglycemia over time impacts neuropathy, which may increase the risk of falls as well.2

Quality Indicators Are Key to Monitoring the Quality of Both the Process and Outcomes of Care

- Quality Indicators and the Quality Indicator Reports are tools used to provide assurance that you are doing everything possible to promote quality of care and quality of life for residents.
- Quality Indicators assess the following domains:
  - Accidents
  - Nutrition/Eating
  - Behavior/Emotional Patterns
  - Physical Functioning
  - Clinical Management
  - Psychotropic Drug Use
  - Cognitive Patterns
  - Quality of Life
  - Elimination/Incontinence
  - Skin Care
  - Infection Control

- Quality indicators are used to monitor the quality of care delivered to residents.¹
- The areas or “domains” listed here do not represent every care category or situation that could occur in the long-term care setting, but they do represent common conditions and important aspects of care and life to residents.¹

Reducing hypoglycemia and hyperglycemia may lead to better outcomes.\(^1\)

Here is a list of Quality Indicators that may be related to hypoglycemia and hyperglycemia\(^1\):

- QI 1. Incidence of new fractures
- QI 2. Prevalence of falls
- QI 4 & 5. Prevalence of symptoms of depression with and without antidepressant therapy
- QI 6. Use of 9 or more different medications
- QI 8 & 9. Prevalence of bladder or bowel incontinence
- QI 13. Prevalence of weight loss
- QI 15. Prevalence of dehydration (considered a sentinel health event)
- QI 24. Prevalence of Stage 1-4 pressure ulcers

\(^1\) Center for Health Systems Research and Analysis. Facility Guide for the Nursing Home Quality Indicators. Madison, WI. 1999.
Treatment Strategies
### Glycemic Goals for Patients with Diabetes

<table>
<thead>
<tr>
<th>Goals</th>
<th>FPG (mg/dL)</th>
<th>PPG (mg/dL)</th>
<th>A1C (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Geriatrics Society (AGS)</td>
<td>—</td>
<td>—</td>
<td>&lt;7 to &lt;8</td>
</tr>
<tr>
<td>American Medical Directors Association (AMDA)</td>
<td>—</td>
<td>—</td>
<td>&lt;7</td>
</tr>
<tr>
<td>American Diabetes Association (ADA)</td>
<td>70-130a</td>
<td>&lt;180</td>
<td>&lt;7</td>
</tr>
</tbody>
</table>

- ADA glycemic goals are not specific to elderly residents.
- The more conservative A1C range of <7 to <8% (based on life expectancy, frailty, presence of comorbidities, cognitive impairment, and functional disability) has been proposed by the AGS for elderly residents with life expectancy of <5 years.

* Preprandial plasma glucose.

FPG, fasting plasma glucose; PPG, postprandial plasma glucose.

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• This algorithm represents the 2009 consensus statement of the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD); statement used clinical trials results and clinical experience to provide general strategies for management of type 2 diabetes. It takes into account benefits, risks, and costs associated with the treatment of diabetes, but is not specific to the elderly population.1

• The goal of all interventions is to achieve and maintain glycemic levels within or as close as possible to the normoglycemic range.1

• According to the ADA guidelines, A1C should be checked every 3 months until it is below 7%, after which it should be checked at least every 6 months.1

• For elderly residents with life expectancy of <5 years, the American Geriatrics Society recommends less aggressive therapy.2


**Additional Strategies for Management of T2DM**

**AMDA 2008 Clinical Practice Guideline**

- **Option 1:** 3-tier approach to diabetes management
  - **At diagnosis:** Lifestyle
  - **Lifestyle + Oral agents**
  - **Lifestyle + Oral agents + Insulin therapy**

- **Option 2:** First-line insulin therapy when appropriate
  - **At diagnosis:** Insulin therapy if BG is consistently >180 mg/dL

**The Medicare State Operations Manual Addresses Sliding-Scale Insulin Use**

- Related F-tag 329 from guideline from the CMS:
  - "Continued or long-term need for sliding-scale insulin for non-emergency coverage may indicate inadequate blood sugar control"  

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- The AMDA Clinical Practice Guideline recommends lifestyle modification as the preferred approach at diagnosis of type 2 diabetes when feasible.
- Oral agents may be initiated if lifestyle modification is not possible or if diet and exercise are not effective interventions alone.
- Initiate insulin therapy in residents with type 2 diabetes who do not achieve adequate control with lifestyle modification and oral agents alone.
- Initiating insulin as a first-line therapy may be appropriate when a resident’s BG levels are consistently >180 mg/dL.
- In addition to the AMDA Clinical Practice Guideline, the Medicare State Operations Manual addresses use of the sliding scale.
- The Centers for Medicare and Medicaid Services (CMS) State Operations Manual has called out sliding-scale use as a red flag for poor glycemic control, as follows:
  - F-tag 329 from the guideline from the CMS states, "Continued or long-term need for sliding-scale insulin for non-emergency coverage may indicate inadequate blood sugar control"  

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The following section of the presentation will focus on the different diabetes treatment options that are available.
**Oral and Other Noninsulin Antidiabetic Drugs**

<table>
<thead>
<tr>
<th>Class</th>
<th>Examples</th>
<th>Major Mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biguanide¹</td>
<td>Metformin</td>
<td>Decrease hepatic glucose output; some increase in muscle glucose uptake (decrease in insulin resistance)</td>
</tr>
<tr>
<td>Sulfonlurea¹</td>
<td>Glyburide, glipizide</td>
<td>Stimulate insulin secretion from β-cells</td>
</tr>
<tr>
<td>Meglitinides (glinides)¹</td>
<td>Repaglinide, Nateglinide</td>
<td>Increase insulin release from β-cells</td>
</tr>
<tr>
<td>Alpha-glucosidase inhibitors¹,²</td>
<td>Acarbose, Miglitol</td>
<td>Reduce postprandial glucose absorption</td>
</tr>
<tr>
<td>Thiazolidinediones¹ (TZDs)</td>
<td>Pioglitazone, Rosiglitazone</td>
<td>Increase the sensitivity of muscle, fat, and liver to endogenous and exogenous (&quot;insulin sensitizers&quot;)</td>
</tr>
<tr>
<td>GLP-1 agonists (incretins)¹,²</td>
<td>Exenatide (administered by injection)</td>
<td>Improve β-cell insulin secretion in response to glucose; incretins also slow gastric emptying</td>
</tr>
<tr>
<td>DPP-4 inhibitors¹,²</td>
<td>Sitagliptin</td>
<td>Enhance the effects of GLP-1, increasing insulin secretion in response to glucose</td>
</tr>
</tbody>
</table>

¹Pioglitazone is currently the only American Diabetes Association approved TZD.

- Oral antidiabetic drugs are used to lower blood glucose. The major mechanisms vary according to drug class, as shown here.
### Some Characteristics of Oral and Other Noninsulin Antidiabetic Therapy

<table>
<thead>
<tr>
<th>Drug Class</th>
<th>Resident Characteristics</th>
<th>Expected A1C Reduction With Monotherapy&lt;sup&gt;2,3&lt;/sup&gt;</th>
<th>Some Known Side Effects&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biguanide</td>
<td>Obese</td>
<td>1.0% - 2.0%</td>
<td>GI side effects, rare lactic acidosis</td>
</tr>
<tr>
<td></td>
<td>Normal kidney and liver function (residents aged ≥80 years should have renal function tested; maximum titrated dose not recommended in the elderly&lt;sup&gt;1,3&lt;/sup&gt;)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No CHF or acute illness&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thiazolidinediones (TZDs)</td>
<td>Obese, signs of insulin resistance</td>
<td>0.5% - 1.4%</td>
<td>Fluid retention, 2-fold increased risk of CHF, potential increase in MI, weight gain, atherogenic lipid profile, fracture risk</td>
</tr>
<tr>
<td></td>
<td>Normal liver function</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No moderately severe (Class III or IV) CHF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulfonylurea</td>
<td>Nonobese/mildly obese</td>
<td>1.0% - 2.0%</td>
<td>Weight gain, hypoglycemia</td>
</tr>
<tr>
<td></td>
<td>No severe renal or liver disease or severe allergy to sulfas</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


- Choice of an oral antidiabetic drug can be influenced by resident obesity, tolerability considerations, comorbidities, and the amount of A1C reduction needed.<sup>1-3</sup>
## Some Characteristic of Oral and Other Noninsulin Antidiabetic Therapy (cont’d)

<table>
<thead>
<tr>
<th>Drug Class</th>
<th>Resident Characteristics</th>
<th>Expected A1C Reduction With Monotherapy</th>
<th>Some Known Side Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meglitinides (glinides)</td>
<td>Nonobese/mildly obese</td>
<td>0.5% - 1.5%</td>
<td>Hypoglycemia</td>
</tr>
<tr>
<td></td>
<td>Tendency to postprandial hyperglycemia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alpha-glucosidase inhibitors</td>
<td>Milder disease presentation</td>
<td>0.5% - 0.8%</td>
<td>Frequent GI side effects</td>
</tr>
<tr>
<td></td>
<td>Predominant symptom is postprandial hyperglycemia</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No gastrointestinal comorbidities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLP-1 agonists</td>
<td>Milder disease presentation</td>
<td>0.5% - 1.0%</td>
<td>Frequent GI side effects, hypoglycemia</td>
</tr>
<tr>
<td></td>
<td>Obese</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No gastrointestinal comorbidities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DPP-4 inhibitors</td>
<td>Milder disease presentation</td>
<td>0.5% - 0.8%</td>
<td>Upper respiratory infections, headache</td>
</tr>
<tr>
<td></td>
<td>Nonobese/mildly obese</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. AMDA. Diabetes Management in the Long-Term Care Setting: Clinical Practice Guideline. 2008.

- Guidelines for the selection of an oral antidiabetic drug is continued here for additional drug classes.
Basal and Prandial Insulins Play a Role in the Management of Blood Glucose Levels

**Basal Insulin**
- Reduces glucose production between meals and overnight\(^1\)
- Maintains a nearly constant level of glucose throughout the day\(^1\)

**Prandial insulin**
- Secreted in response to food intake; limits spikes in glucose after meals\(^1\)
- Makes it possible to compensate for premeal and postprandial elevations in blood glucose\(^2\)

Hypoglycemia is the most common side effect of insulin therapy. Other adverse reactions commonly associated with insulin are allergic reaction, injection site reaction, lipodystrophy, pruritus, and rash.

- Basal and prandial insulins play a role in the management of hyperglycemia in residents with diabetes.
- Basal insulin reduces glucose production between meals and overnight to maintain a nearly constant level of glucose throughout the day. When treating a patient with diabetes, fine-tuning of an exogenous long-acting basal insulin may be required to achieve tight control of hyperglycemia, which usually involves adjustments in the timing and dosage of rapid-acting prandial insulin.\(^1\)
- Physiologic prandial insulin is secreted in response to a meal or snack and limits spikes in glucose after meals. It rises immediately after food intake and reaches a sharp peak at 1 hour.\(^1,2\)
  For a patient with diabetes, exogenous prandial insulin, such as a rapid-acting insulin, makes it possible to compensate for premeal and postprandial elevations in blood glucose, ideally, without exceeding healthy insulin levels in the blood between meals and at night.\(^2\)
### Human Insulins and Insulin Analogs

<table>
<thead>
<tr>
<th>Insulin Type</th>
<th>Onset</th>
<th>Peak (hours)</th>
<th>Duration (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-acting¹,²</td>
<td>~1-2 h</td>
<td>Relatively flat profile</td>
<td>Up to 24</td>
</tr>
<tr>
<td>Intermediate-acting¹:</td>
<td>NPH</td>
<td>1-3 h</td>
<td>6-8</td>
</tr>
<tr>
<td>Rapid-acting¹</td>
<td>5-15 min</td>
<td>1</td>
<td>3-5</td>
</tr>
<tr>
<td>Short-acting¹:</td>
<td>Regular human insulin</td>
<td>30-60 min</td>
<td>2-5</td>
</tr>
</tbody>
</table>

¹ Both long-acting and intermediate-acting insulins may be used as basal insulin. Note that split self-mixed regimen may combine different types of insulins. Some insulins cannot be mixed.

² The values for insulin activity profile parameters vary somewhat among studies due to slight differences in study methodologies and in subjects studied. Within individual variability exists as well.

NPH: neutral protamine Hagedorn

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*In elderly patients with diabetes, the initial dosing, dose increments, and maintenance dosage should be conservative to avoid hypoglycemic reactions. Hypoglycemia may be difficult to recognize in the elderly.*

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- Many types of insulin are available. They are usually categorized according to their onset, peak, and duration of action.¹
- The major types of insulin are:
  - **Basal insulin**: This is a term used to describe the insulin released slowly and steadily to supply energy to cells when no food is being digested¹,²
    - *Long-acting insulin*: begins to work anywhere from 1 to 2 hours after injection and can work for up to 24 hours
    - *Intermediate-acting insulin*: begins to work 1 to 3 hours after injection, peaks in 6 to 8 hours, and works for 12 to 20 hours¹
  - **Mealtime insulin**:
    - *Rapid-acting insulin*: begins to work about 5-15 minutes after injection, peaks in about an hour, and works for 3 to 5 hours¹
    - *Regular or short-acting insulin*: begins to work in about 30-60 minutes, peaks 2 to 5 hours after injection, and works for between 5 and 8 hours¹

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A goal of insulin therapy is to improve glycemic control. Hypoglycemia is a common side effect of insulin therapy, which can be serious. Blood glucose levels and dosing should be carefully monitored to reduce the risk.1

3. Adapted from Leahey JL. In: Leahey JL, Cefalu WT, eds. Insulin Therapy; 2002: 87-112
Premixed Insulins

Insulins are characterized by their onset, peak, and duration. In elderly residents with diabetes, the initial dosing, dose increments, and maintenance dosage should be conservative to avoid hypoglycemic reactions. Hypoglycemia may be difficult to recognize in the elderly.

<table>
<thead>
<tr>
<th>Premix</th>
<th>Onseta</th>
<th>Peak³</th>
<th>Durationa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular 70/30</td>
<td>30-60 min</td>
<td>Dual</td>
<td>10-16 h</td>
</tr>
<tr>
<td>Lispro mix 75/25</td>
<td>5-15 min</td>
<td>Dual</td>
<td>10-16 h</td>
</tr>
<tr>
<td>Lispro mix 50/50</td>
<td>5-15 min</td>
<td>Dual</td>
<td>10-16 h</td>
</tr>
<tr>
<td>Aspart mix 70/30</td>
<td>5-15 min</td>
<td>Dual</td>
<td>10-16 h</td>
</tr>
</tbody>
</table>

The values for insulin activity profile parameters vary somewhat among studies due to slight differences in study methodologies and in subjects studied. Within-individual variability exists as well.

- Sometimes rapid- and intermediate-acting insulins are provided together in predetermined amounts in a type of insulin called premix. Many types of premix insulins are available. They are also usually categorized according to their onset, peak, and duration of action. All premix insulins have dual peaking action and work for 10-16 hours.
- The major types of premix insulin are:
  - Regular 70/30: begins to work in about 30-60 minutes
  - Lispro mix 75/25: begins to work in about 5-15 minutes
  - Lispro mix 50/50: begins to work in about 5-15 minutes
  - Aspart mix 70/30: begins to work in about 5-15 minutes
This graph is a conceptual profile that shows how 2 different twice-daily premix regimen profiles each compares to the body’s natural physiologic insulin secretion.

Long-term care residents may be vulnerable to increased risks of both hypoglycemic and hyperglycemic episodes, which may further increase the risk of:

- Cardiovascular complications
- Infections
- Dehydration
- Hospitalization
- Physical and cognitive disability

The prevalence of functional disability and multiple comorbid conditions in the long-term care population increases the complexity of diabetes management.

Hypoglycemia and hyperglycemia often have an atypical presentation and are both common. The risk of developing each of these can be reduced through the following:

- Early detection
- Proper management strategies to achieve and maintain target glucose levels