Avoiding Medication Errors with Insulin Therapy is supported by an educational grant from Novo Nordisk Inc. and created in conjunction with the Institute for Safe Medication Practices (ISMP). This program has been accredited by the American Association of Diabetes Educators (AADE) for nurses, pharmacists, and pharmacy technicians.
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The following program is a recorded presentation by Matthew Grissinger. Matthew Grissinger is the Director of Error Reporting Programs at the Institute for Safe Medication Practices (ISMP). His responsibilities include working with healthcare practitioners and institutions to provide education about medication errors and their prevention, review medication errors that have been voluntarily submitted by practitioners to a national ISMP Medication Errors Reporting Program (MERP) as well as serving as a clinical analyst for the Pennsylvania Patient Safety Reporting System (PA-PSRS). He has extensive experience in long-term care, home care, and community pharmacy. Prior to joining ISMP, he served as a home care and long-term care pharmacy surveyor for the Joint Commission. Mr. Grissinger is a frequent speaker on pharmacy topics and current issues in medication safety. He has published numerous articles in the pharmacy literature, including regular columns in P&T, U.S. Pharmacist, and the PSA Patient Safety Advisory.

Mr. Grissinger serves on the United States Pharmacopeia’s Safe Medication Use Expert Committee, the National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP), the National Quality Form (NQF) Common Formats Expert Panel, the Editorial Board for P&T, and the Publications Advisory Board for Davis’s Drug Guide for Nurses.

He is also an adjunct assistant professor for Temple University School of Pharmacy and clinical assistant professor for the University of the Sciences in Philadelphia. Mr. Grissinger received a BS in Pharmacy from the Philadelphia College of Pharmacy and Science and is a fellow of the Institute for Safe Medication Practices as well as the American Society of Consultant Pharmacists.
Objectives

• Review the history and frequency of errors with the use of insulin
• Discuss the multifactorial nature of errors
• Explain the system-based approach to medication errors
• Identify examples of errors that occur with insulin therapy
• Describe recommendations to prevent errors associated with insulin therapy

After completing this program, participants will be able to:
• Review the history and frequency of errors with the use of insulin
• Discuss the multifactorial nature of errors
• Explain the system-based approach to medication errors
• Identify examples of errors that occur with insulin therapy
• Describe recommendations to prevent errors associated with insulin therapy
There is a long history of medication errors associated with the use of insulin. In an article published in 1975, Michael Cohen, president of the Institute for Safe Medication Practices (ISMP), provided 2 examples of insulin errors.

At the lower left of the slide is the first example and it involved an insulin order written for “4 U NPH insulin.” However, because of poor handwriting, the “U” for “units” was mistaken for a zero, and the patient received 40 units of neutral protamine Hagedorn insulin.

The right side of the slide shows another kind of error—a breakdown in communication that occurred when a physician gave a verbal order for insulin. Although the physician ordered 16 units of regular insulin, the nurse heard it as an order for 60 units; therefore, a 60-unit dose was administered.
The United States Pharmacopeia (USP) was the first organization to offer an Internet-based commercial medication error reporting program called MedMarx. Every year, USP produced the MedMarx annual report which was based on medication errors submitted to them by subscribing organizations.

In 2007, the USP MedMarx Annual Report showed that insulin was the product involved in the highest number of medication errors in calendar year 2005.

The list on the left shows the total number of medication errors by product. By far, insulin was involved in the greatest number of reported errors—more than 9000 errors. Morphine, the next product on the list, was involved in only 5230 errors.

The list on the right shows the leading products involved in harmful medication errors. Again, insulin is at the top of the list, with 386 errors, representing more than 11% of all reported harmful medication errors. This is more than twice as many as the 164 errors documented for morphine, and more than 3 times as many as the errors reported for the opioids fentanyl and hydromorphone, and the anticoagulants heparin and warfarin.
The state of Pennsylvania has a mandatory medical error reporting program called the Pennsylvania Patient Safety Reporting System or PA-PSRS. ISMP is contracted by Pennsylvania to analyze medication errors submitted to the PA-PSRS program.

Analysis of reports submitted to this program revealed that 25% of all reported medication errors involved high-alert medications.

A close look at the reports concerning high-alert medications showed that the largest percentage (44%) involved pain management products, such as morphine and hydromorphone. The second-highest percentage (16.3%) involved insulin products. Thus, the percentage of insulin-related medication errors was higher than that for the anticoagulants heparin (14.2%) and warfarin (9.4%).
This slide contains another example of national data demonstrating the high number of reports of adverse drug events with the use of insulin. These data came from the ISMP QuarterWatch™ Program, an ISMP program used to identify new drug risks and medication errors reported to the US Food and Drug Administration (FDA) MedWatch program. These data are for the third quarter of 2008.

The table shows that insulin was one of the 10 drugs involved in the highest number of serious, disabling, and fatal events during that period, with a total of 399 events.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Cases</th>
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<tbody>
<tr>
<td>interferon beta</td>
<td>1,380</td>
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<tr>
<td>digoxin</td>
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<tr>
<td>beclopent</td>
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<td>vancomycin</td>
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<td>estrogens</td>
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<td>etanercept</td>
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<td>insulin</td>
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<td>exenatide</td>
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<tr>
<td>InFLXmab</td>
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<tr>
<td>Teno NYL</td>
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<tr>
<td>QUEtaine</td>
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<tr>
<td>adalimumab</td>
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<tr>
<td>Olaneal</td>
<td>335</td>
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<tr>
<td>Natalizumab</td>
<td>319</td>
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ISMP = Institute for Safe Medication Practices.  
Budnitz and colleagues conducted a study in 2006 that identified the drug classes and medications most commonly implicated in adverse drug events treated in US emergency departments from 2004 to 2005.

The study showed that insulin was the agent most commonly implicated in these adverse events and was responsible for 8% of all events. Insulin was implicated in more adverse events than anticoagulants; antibiotics such as amoxicillin, cephalexin, and penicillin; or pain medications such as hydrocodone with acetaminophen and ibuprofen.
Emphasis on Multifactorial Nature of Errors

Many factors, latent and active, must be present and in proper alignment for an error to occur.

It is important to understand that medication errors are usually not the result of incompetent health care practitioners or individuals not “being careful,” but that medication errors are multifactorial in nature. They involve many breakdowns or contributing factors within a medication-use system.

Many factors, both latent and active, must be present and in proper alignment for a medication error to occur.

Unfortunately, error investigations often concentrate on the sharp or active end, which would be frontline staff where the patient/caregiver interaction occurs. But contributing factors occur at the blunt or latent end where errors often originate due to poor organizational policies, procedures, and resource allocation decisions. Errors occur due to many causes and contributing factors such as:

• Incomplete information about a patient
• Unclear communication of drug orders
• Lack of independent double-checks before dispensing or administering medications
• Lack of computer warnings such as drug interactions, allergies, or wrong dosages
• Lack of standardized protocols or guidelines for drug therapy, and
• Drug storage issues related to look-alike medications or hazardous chemicals
Medication errors are the property of a medication-use system. They are not the result of breakdowns by individual human beings, but result from many processes that go wrong in the medication use system.

Errors can start with the prescribing of insulin and can also involve the transcribing of insulin orders, the dispensing of insulin orders, the administration of insulin, and the monitoring of patients for the effects of insulin. Therefore, medication errors are a result of breakdowns in the processes of providing insulin therapy in the medication-use system as a whole and should not be considered the acts or omissions of individual people within the system.

It is important to understand that health care providers who want to improve performance and insulin use in their organization need to make changes in their medication-use system, not in the people who staff the organization. Practitioners are already held to a standard of perfection that is not attainable.
In this presentation, we will divide the medication-use process into its various stages and look at the type of errors that originate or occur at each stage. We will begin with the prescribing phase, when orders are written for insulin.
There are many barriers to effective communication of insulin orders. These include the use of:

- Handwritten orders for insulin, both illegible and legible
- Dangerous abbreviations and dangerous dose designations
- Verbal orders (including those given on the telephone)
- Drug names and insulin product names that look and sound alike
- Sliding-scale orders and the multiple algorithms used to communicate sliding-scale or coverage orders
- Ambiguous orders for insulin, and
- Hold orders
We will address the barrier posed by handwritten orders by looking at the 3 examples on this slide.

Look at the upper image on this slide. Which type of insulin has been ordered? What did the physician intend to write in this order?

Now, look at the second image. What is the type of insulin the physician was referring to?

Finally, take a look at the third image on this slide. What types of insulin are prescribed for this patient?

These images provide 3 examples of orders for nonexistent insulin products. Even though there may be some humor in these erroneous orders, they prevented patients from getting their prescribed doses of insulin at the intended time.

In all of these situations, the written orders were sent to the pharmacy and someone at the pharmacy had to call the prescriber to clarify the order. The patients could not receive their insulin dose until these orders were corrected. Depending on the type of organization in which this situation occurs, it might take hours to clarify these orders.
The use of dangerous abbreviations is another barrier to effective communication of insulin orders. The most notable instance of this is the use of the letter “U” as an abbreviation for “units.”

The images on this slide show an example of an error caused by the use of the letter “U.” In this case, a patient entered the hospital using insulin and gave the nurse his or her medication history, which was recorded in the patient’s chart. As shown in the first image, the nurse wrote down the doses for the patient’s Humalog as 4U, 2U, and 6U. As shown in the second image, the prescriber looked at the nursing records and then wrote an order for 44U, 24U, and 64U of insulin. Why did the physician order 44, 24, and 64 units of insulin when that is not what the nurse wrote? Looking at the upper image again, the nurse used the letter “U” for units, and because the “U” consistently looked like a “4,” 4U became 44, 2U became 24, and 6U became 64.

Based on our experience at ISMP, most of the errors resulting from the use of the letter “U” for the word “units” involve the misreading of a “U” as a zero rather than as a 4. In either case, the patient is at risk of receiving a 10-fold overdose of insulin, simply because of the use of a dangerous abbreviation like the letter “U” for units.
These are some other examples of confusion with the letter “U.” In each instance, the practitioner wrote the word “unit” to communicate a dose of insulin. In each case, however, the letter “U” was separated from the letters N, I, and T in the word “unit.”

Therefore, in the top image, an order for 4 units became an order for 40 units. In the middle image, an order for 6 units of Lantus to be given at bedtime became an order for 60 units. In the bottom image, the order for 8 units of Lantus that was supposed to be given subcutaneously once a day with supper became an order for 80 units.

These examples illustrate 2 problems. First, they show how the letter “U” can look like zero, so that 4 can be misread as 40 and 6 can be misread as 60. They also show that simply writing the word “unit” does not eliminate the potential for miscommunication. It is important to separate the number indicating the size of the dose from the unit of measure, which is units. For the order shown in the bottom image, for example, there should be adequate spacing between the number 8 and the word “units.”
The images on this slide provide another example of why the use of the letter “U” is problematic.

The slide shows 3 orders for total parenteral nutrition (TPN) in a hospital setting. In the top image, the organization wanted 15 units of insulin to be added to the patient’s TPN on day 1. As shown in the middle image, the order was rewritten on day 2. This time, however, the prescriber wrote “insulin 15U” instead of writing the word “units.” On the third day of treatment, the previous day’s entry of “insulin 15U” became “insulin 154.”

This is another instance of how the letter “U” can be misread as the number 4.
Ambiguous orders are also responsible for errors with insulin therapy.

Initially, a prescriber wrote an order for Lantus to be given subcutaneously at bedtime at a dose of 10 units. However, the prescriber then changed the order to 8 units. Instead of rewriting the entire order, however, the prescriber simply crossed off the “10” and wrote “8.”

Although the change looks fairly clear on the slide, the pharmacist did not receive the original copy shown here but rather a carbon copy that was underneath the original. Because the slash through the “10” was not evident on the copy, the pharmacy dispensed this order as 108 units of Lantus.

The pharmacist knew that the prescribing physician was a diabetologist, so he did not question the order. The dose was entered as 108 units, which appeared on the computer-generated medication administration record (MAR). The following day, a nurse gave the patient 108 units of Lantus. As with the pharmacist, the nurse thought this was an unusually large dose, but she also did not question the order since the insulin dose had been prescribed by a well-respected diabetologist. The error was discovered when the patient developed significant hypoglycemia, but thankfully, no permanent harm occurred.

As in an earlier example, this error resulted in a 10-fold overdose of insulin.
Problems can also result from the nonstandard ways in which orders for coverage or sliding-scale insulin are written.

The images shown here are from an organization that did not have a standardized approach to writing coverage orders, but let prescribers write orders however they wished. In the first image, there is an order for Lantus on the first line. The second line is an order for NovoLog to be given with meals, which was written as: NovoLog 14 units, subcutaneous, three times a day. But on the third line, the prescriber took a shortcut. Instead of writing each appropriate range or dose, the prescriber wrote: add 1 unit of insulin for every 50 milligrams of blood glucose greater than 150. For example, for ranges of 151 to 200 give 14 plus 1 unit, for ranges of 201 to 250 give 14 plus 2 units, etc.

The second image shows another instance when a physician took shortcuts and did not write the insulin doses appropriately. Shortcuts of this type can easily lead to misinterpretation by nurses, pharmacists, and patients.
Sliding-Scale Insulin

One hospital reported that physicians typically prescribe a sliding scale of insulin as:

“2 units Humulin R for each BG 50 > 150”

• The intended interpretation is 2 units of Humulin R insulin for a BG of 151-200, 4 units for a BG of 201-250, 6 units for a BG of 251-300, and so on.
• When pharmacists began providing coverage at another affiliated hospital, they learned that this order was being interpreted differently.
• In that hospital, staff felt that “BG > 150” implied that the scale should begin at 200. Thus, patients were receiving 2 units of Humulin R insulin for a BG of 200-250, 4 units for 251-300, 6 units for 301-350, and so on.

BG = blood glucose.

This is another example of an ambiguous cover order for sliding-scale insulin. At one hospital, prescribers typically wrote sliding-scale dose orders for insulin in the following way: Give 2 units of Humulin R for each blood glucose of 50 >150. The intended interpretation of that order was that nurses should give 2 units of Humulin R insulin for a blood glucose reading of 151 to 200, 4 units for a reading of 201 to 250, and so on.

The pharmacist who provided this example then started providing coverage at another hospital that is affiliated with the first hospital. However, the same order was being interpreted differently at the second hospital. At that institution, the staff thought that the “…for each BG 50>150” implied that the scale should begin at 200. Therefore, patients at the second hospital were receiving 2 units of Humulin R insulin for a blood glucose reading of 200 to 250, 4 units for a level of 251 to 300, and so on.

This example shows the different ways in which a single ambiguous order can be interpreted by 2 different organizations.
As you look at this order, you are probably thinking that it does not include an order for insulin. It says to do a CBC this morning, hold the dose of SSRI and potassium chloride today, and recheck the BMP the next morning.

But, what does “SSRI” stand for in this order? Most health care providers are likely to reply that SSRI stands for “selective serotonin reuptake inhibitor.” In this situation, however, the prescriber wanted to hold the patient's morning dose of sliding-scale regular insulin.

The patient in this example was actually taking sertraline, an SSRI. Therefore, the sertraline dose was held even though the prescriber’s intention was to hold the patient’s insulin for that day.
Another barrier to effective communication of insulin orders involves hold orders. This problem often arises with patients who are receiving supplemental feedings, such as TPN therapy (or enteral feedings), and need to have their feedings held because they are going to have a medical test, such as a CT scan. In that situation, health care providers often forget to hold the insulin, which is necessary because the patient is not taking any food.

This slide summarizes a situation reported to ISMP. A patient with diabetes was on continuous enteral feeding and receiving subcutaneous NPH insulin at a dose of 24 units twice a day. Although the feedings were to be held for a CT scan, no one discontinued the insulin. With insulin and no food intake, the patient’s blood glucose had fallen to 26 mg/dL by the time it was checked.

The challenge in this situation is to link a hold order related to an enteral feeding with a corresponding insulin order.
We will now consider several recommendations for preventing errors associated with the prescribing of insulin. The most important recommendation is to standardize the way in which we communicate insulin orders. Problems with handwriting can be greatly reduced by using standardized forms to communicate orders.

A preprinted order sheet that lists specific insulin products and has the word “units” already printed on the form is very useful. With this form, prescribers need only fill in the number of units, specify the times of day when the insulin should be given, and indicate whether the insulin should be given with or without meals. These order forms can also include an organization’s standardized protocol on how to respond to episodes of hypoglycemia.

The organization should also consider standardizing its protocols for how and when to administer insulin. Instead of having individual clinicians write their own orders for insulin and for coverage, there should be an organizationwide standardized protocol. This would establish a standard for every patient who receives insulin.

It is also important to establish and enforce safe ordering guidelines. Dangerous abbreviations like “U” for unit should not be used. Accreditation organizations, such as The Joint Commission, has implemented a standard prohibiting the use of this abbreviation.

Consider eliminating both trailing zeros and leading zeros in insulin orders.

It is important to establish procedures for communicating verbal orders for insulin. As we saw earlier, a prescriber’s instructions to give 16 units of insulin was misinterpreted as an order for 60 units.

Finally, it is important to eliminate the use of nonstandard symbols, such as plus signs, in insulin orders.
This is an example of a preprinted insulin order form. The section at the top allows the prescriber to enter the number of units of prandial and basal insulin that should be given throughout the day. The word “units” is preprinted to avoid confusion, and the prescriber checks off the type of prandial and basal insulin to be used.

In the middle of the form are suggested lag times for administering prandial insulin. Below that are instructions for nurses on how to treat a patient whose blood glucose level is less than 60 mg/dL. Further down, the prescriber can specify whether insulin lispro or insulin aspart should be used to correct premeal hyperglycemia.

The bottom third of the form shows standardized low-dose, medium-dose, and high-dose algorithms to be used for premeal correction doses. At the lower right is a table where a prescriber can create an individualized algorithm for premeal correction doses.

The beauty of this form is that everything is already spelled out on a single piece of paper. All the prescriber needs to do is to write in the doses of insulin, specify the types of insulin to be used, and indicate which algorithm should be used for premeal correction doses. This type of form could eliminate most of the dangers associated with handwritten insulin orders.
The next phase in the medication-use process is dispensing.
This section will review what happens after the order for insulin has been written and the pharmacy receives the order. It will concentrate on the process that takes place in the pharmacy, focusing on any problems that arise at this stage.
First, we will discuss what pharmacists need to consider when they review orders for insulin, enter those orders into a computer system, and dispense those orders to the floor.

The pharmacist needs to know the patient’s laboratory values. It is valuable to have the history of the patient’s blood glucose levels, along with other lab values that might affect a patient with diabetes. The pharmacist also needs to know about comorbidities that might have an impact on the patient’s blood glucose and affect the insulin being dispensed. It is also important for the pharmacist to know about concurrent medications or other substances the patient is receiving that might have an impact on blood glucose levels. Is the patient receiving dextrose or other IV solutions? Is the patient receiving drugs that might raise blood glucose levels?

The second major category to consider is the nutritional status of the patient. Is the patient receiving enteral feedings? Is the patient on a no food by mouth status? Is the patient taking anything orally? This type of information helps the pharmacist to determine whether the dose that has been ordered is appropriate to the patient’s situation.

When reviewing orders for insulin, the pharmacist’s job is to decide whether the ordered regimen is appropriate. There should also be appropriate alerts in the computer system to support the pharmacist.

Finally, is the pharmacist involved in the therapeutic monitoring of the insulin therapy in their institution?
This is an example of a common challenge that pharmacists face, especially in the community pharmacy setting.

What you see on the slide is not a handwritten order, but an order generated by a prescriber order entry system in an outpatient setting. The order was printed on a piece of paper and sent to the pharmacy. The problem here is the way in which the prescriber altered the order after it was printed.

The original order was for Humulin R, 100 units per mL of insulin. However, the prescriber accidentally selected the concentrated Humulin R U-500 insulin in the order entry system rather than the more frequently used Humulin R U-100 product, then manually changed the strength field by scratching out the 500 and writing 100 next to it. Instead of changing the drug name, the prescriber just scratched out the “500” in the strength field and wrote “100.”

If this problem had not been caught by the pharmacy, the patient might have received the concentrated U-500 insulin which would have resulted in a 5-fold insulin overdose.
Another challenge that pharmacists face when they are preparing and dispensing prescriptions for insulin products is the similarity of many of the brand and generic names for insulin.

ISMP has received many reports of medication errors stemming from the look-alike names of insulin products. Humalog and Humulin products are often confused, as are NovoLog and Novolin products.

These look-alike name pairs have an impact on both the order entry process when selecting medications, as well as the filling process when reading the labels and pulling the insulin from the refrigerator.
This slide shows a reprint of an article from the Pennsylvania Patient Safety Advisory. The article presents the top 25 medication pairs involved in wrong drug errors reported to the Patient Safety Reporting System.

Most of the medications on this list consist of opiate medications. For example, the pairing responsible for the highest number of wrong drug errors is morphine and hydromorphone, which is followed by hydrocodone with acetaminophen and oxycodone with acetaminophen pairs.

There were 2 pairs of insulin products that made their way to this list. As you can see, the NovoLog Mix 70/30 and Novolin 70/30 pair is number 8 on the list and the NovoLog and regular insulin pair is number 16.
As mentioned earlier, the similar names of many insulin products can also lead to errors when a pharmacist or prescriber enters orders into a computer system.

The image on the slide is a screenshot from a hospital pharmacy whose computer lists available insulin products by their generic names and also includes prebuilt orders for insulin. The result is a long list of drugs with similar names as well as multiple dosing schedules for those insulin products.

Another thing to notice about this screen is that it includes only 3 types of insulin. You can imagine how many screens would be needed to cover all of the available insulin products.
This is another example of a pharmacy order entry system from an acute care hospital.

Again, notice the similarities in the insulin names and the fact that generic and brand names are mixed together.

Also notice that the products numbered 7, 8, 10, 11, 12, 13, and 15 are all Regular insulin. If you were doing order entry today, which item would you select for a Regular insulin?
An additional challenge for pharmacists who are preparing prescriptions for insulin is the similar appearance of many insulin vials.

The image on the left shows older vials of Apidra® and Lantus®. Notice how similar the vials were in terms of their size, shape, and label format.

As a result of error reports that practitioners have submitted to ISMP, manufacturers have made some changes to their insulin vials. If you look at the pair of vials on the right, you can see that the manufacturer has made some major format changes to the label on the Apidra vial to differentiate it from the Lantus label. The format of the Lantus label has recently changed as well.

Although these changes in label format represent an improvement, more should be done to differentiate insulin products. The fact that Lantus and Apidra still have vials of the same size and shape, with the same silver tops, can cause problems, especially on nursing units. If the vials are turned halfway around so that the labels are no longer visible, it is impossible to differentiate these insulins.
Here is another example of changes that have been made to insulin packaging in response to problems that arose from the similarity of earlier packaging.

The images show the results of Lilly’s differentiation project, whereby a different color was chosen for each of their insulin products. As you can see, these product-specific colors are consistently used for the outer packaging of vials and for the labels on vials and insulin pens.

Although this product-specific color differentiation represents an improvement, the packages, vials, and insulin pens all have the same size and shape, which continues to invite confusion.
Novo Nordisk has also begun to use product-specific colors for their insulin pens. As you can see from the picture, Levemir®, their long-acting insulin analog, NovoLog®, their rapid-acting insulin analog, and NovoLog® Mix 70/30, their premixed insulin analog, each has a distinctive color.

As with the Lilly products, this color-based differentiation represents an improvement, since it has the potential to reduce medication errors. However, the size and shape of the insulin pen is the same for each product, which may cause some confusion.
“Flag” Insulin Pen Labels

- Mix-ups happen when patient-labeled caps on insulin pens are accidentally switched.
- One patient receives another patient’s insulin before errors are detected

Despite changes in the appearance of insulin pens, some problems still arise with their use. An ongoing challenge for pharmacists is how to label an insulin pen device.

In the community pharmacy setting, pharmacists often label the box, but not the device itself.

In the acute or long-term care setting, the label is usually placed on the device. However, the pharmacist often puts the label on the cap to avoid covering the manufacturer’s label on the main part of the pen.

The problem with this approach is that all pen caps are interchangeable among the members of a brand. If you are using Lilly or Novo Nordisk pen devices and put a label on the cap of pen A, the cap could easily be switched with the cap for pen B. Given this situation, it is easy to understand how mislabeled devices wind up at the nursing station.
Another issue involves insulin storage, both in pharmacies and at the nursing unit. How are products with similar names and appearances stored?

This picture shows Novolin® products in their former packaging. As you can see, both Novolin N and Novolin R insulins are being stored in the same refrigerator bin. In this situation, what do you think the chances are of picking up the wrong insulin product? This problem is most likely to occur on nursing units, where the refrigerators tend to be much smaller than they are in the pharmacy.

How can you prevent errors associated with the use of insulin when you are retrieving a product from the refrigerator?
Separate Problem Products

- Look-alike packaging
  - Separate storage of drugs with look-alike packaging/names
  - Separate bin for each insulin
- Look-alike drug names
  - Computer mnemonics designed so similar names do not appear on same screen

Pharmacists can take several steps to prevent errors associated with the dispensing of insulin products.

First, problem products can be separated. It is helpful to separate the storage of drugs that have similar packages and names. If space permits, it would be ideal to have a separate bin for each type of insulin.

If you already store insulins separately, with each type of insulin in its own bin, it may be beneficial to alternate the storage of manufacturers. For example, one bin could have Novolin R, the next bin could have Humulin R, the next could have Novolin N, and so on.

Second, the way in which look-alike drug names appear on order entry screens could be changed. You might alter the sequence of the products so that look-alike names are not right next to each other on the screen.

Another possibility is to review your formulary computer system and remove the name of any product that is no longer being used, thus reducing the number of insulin product selections on the order entry screen.
Another technique that pharmacies can use to prevent errors associated with the dispensing of insulin products is to use differentiation. First, you could consider purchasing different types of products from different sources. Rather than having a full line of Lilly or Novo Nordisk products, you might buy some products from one manufacturer and some products from the other. (We will discuss this strategy in greater detail with the next slide.)

Second, you could apply uppercase lettering to different portions of similar names, a technique often called “tall-man lettering.” As you see on this slide, Humalog® and Humulin® have been differentiated by capitalizing the “A-L-O-G” in Humalog and the “U-L-I-N” in Humulin; similarly, NovoLog® and Novolin® can be differentiated by capitalizing the “L-O-G” in NovoLog and the “L-I-N” in Novolin.

You might use both brand and generic names on an order set, so that the brand name can help to distinguish one type of insulin from another.

In addition to physically separating products, you can also make products look different or call attention to important information by using stickers, labels, and highlighters.

Remember that health care providers and patients alike need to understand the reasons for product differentiation. Applying a sticker that says, “Be careful. Look-alike medication” or “High-Alert Medication,” is not meaningful unless nurses and patients are educated about what these warnings mean.
This picture, taken several years ago, shows the way in which one hospital used differentiation to its advantage when purchasing insulin products. As far as possible, the hospital bought only one type of insulin product within each product category.

For example, the organization bought vials of regular short-acting and NPH insulin from Novo Nordisk, but obtained vials of long-acting insulin analog, Lantus®, from sanofi-aventis. They purchased only NovoLog® insulin pens. They also bought the InnoLet® insulin delivery device for dosing NPH insulin from Novo Nordisk. (Note that Novo Nordisk discontinued the InnoLet device at the beginning of 2010.)

The fact that 4 of these 5 products have a distinctive appearance greatly reduces the risk of dispensing the wrong insulin product on the basis of a similar appearance.
Now, we will discuss medication errors related to insulin administration and patient monitoring of the effects of insulin.

Our focus shifts to the ways in which nurses obtain products, administer them to patients, and monitor blood glucose levels in patients.
Here we see a printout of a nurse’s MAR.

The red arrows indicate 2 potential problem areas: the way in which the insulin names are shown and the overly complex and confusing directions for administering the insulin products.
This slide shows the bottom part of the MAR that was presented on the previous slide. First, notice the text underlined in red. Errors have occurred with injectable products, including insulin, because of the way in which the product is identified and the way in which the concentration is displayed on the MAR.

In this example, you see “Insulin Aspart (NovoLog),” the word “High,” and “100 unit per M.” Reports submitted to ISMP and PA-PSRS indicate that nurses have read the first line of a MAR like this and interpreted the prescribed insulin dose as 100 units. Understand that the way the information appears on the MAR is based on the pharmacy order entry system. This information also appears on the pharmacy label. Although this information is important for the pharmacist, it is not what the nurse needs to know. A nurse needs to be able to answer the questions, “What drug should I be giving?” and “How much should I be giving?”

The second problem with this MAR is the way in which the administration directions have been written. This organization has chosen to display their coverage order or sliding-scale coverage orders on the MAR in this fashion. If a patient had a blood sugar level of 349 mg/dL, what dose of insulin should be given? Although the print on this slide looks big, the actual font size is fairly small. Numerous errors are made simply because the nurse selected the wrong value from this mix of numbers.

Finally, notice the last line on the MAR: “Caution, may look/sound like other drugs.” With everything else that needs to be read, do you think the nurse will notice this line at the very bottom of the MAR? The alert is so far removed from the drug name and the administration directions that the caution statement probably has little impact on the nurse’s work process throughout the day.
Wrong Patient and Blood Glucose?

• A nursing assistant advised a nurse that the patient’s blood sugar was 217 mg/dL.
• The nurse thought the assistant was talking about a different patient and administered a dose of insulin to a patient whose blood sugar was 116 mg/dL.
• The error was soon recognized and the patient was fed and monitored.

Many reports of problems related to insulin administration involve miscommunications about patients’ blood glucose levels. In these situations, glucose values were incorrectly communicated or recorded, resulting in the administration of the wrong dose of insulin.

According to a report submitted to ISMP, for example, a nursing assistant advised a nurse that one patient’s blood sugar was 217 mg/dL. However, the nurse thought the assistant was referring to a different patient, and administered a dose of insulin to a patient whose blood sugar was actually 116 mg/dL. Fortunately, the error was detected quickly and the patient was fed and monitored.
Room Numbers or Blood Sugar Levels?

- The nurse picked up a piece of scrap paper that listed several patients with a number next to each name. All of the numbers were well above 200.
- Assuming the numbers were blood sugar levels, she gave each patient insulin using a sliding-scale protocol.
- Afterwards, she realized that the numbers were actually patient room numbers!

Problems arise not only when blood glucose values are communicated verbally between health care practitioners, but also when these values are recorded in a nonstandard fashion.

In this example, a nurse picked up a piece of scrap paper that listed several patients with a number next to each name. All of these numbers were well above 200.

Assuming that the numbers were blood glucose values, the nurse administered insulin to each of these patients using a sliding-scale protocol. She later realized that the numbers were the patients’ room numbers, not their blood glucose levels. The result was several patients received unnecessary doses of insulin.
We will now discuss the use of insulin pen devices during the administration phase of the medication-use process. Earlier we spoke about pen-related issues in the pharmacy setting. Now, we will focus on how the labeling of insulin pens affects the nursing staff.

We have discussed the ways in which labels are applied to insulin pens in the pharmacy. Now look at the insulin pens on this slide and think about where you would apply a pharmacy label. The likely answer is on the cap of the pen, where there is enough space for a second label. However, if you are using multiple pens made by a single manufacturer and the caps are switched, you have the wrong label on the wrong pen.
From a nursing perspective, there are many advantages to using insulin pen devices.

Several institutions have transitioned from insulin vials and syringes to patient-specific insulin pens to prevent needlestick injuries and to reduce the risk of errors. Since the pen has a window that displays the actual insulin dose a patient is going to receive in an easily read format, it is easier to administer the correct dose of insulin.
In the hospital setting, another advantage of having insulin pen devices on the nursing units is that nurses who have learned how to use the pens correctly can teach patients how to use the devices before they are discharged.

Furthermore, there is a smaller volume of insulin in a pen than in a vial. This may provide a cost advantage for patients with short hospital stays or low insulin requirements.
Despite the advantages of these devices, using insulin pens in an acute care setting can be challenging. First, some nurses dislike the technique involved in using the pen on a patient. Some are uncomfortable because you are unable to see how much insulin is being drawn up. Furthermore, you do not actually see the insulin being injected. Instead, you need to trust the pen device to perform this process. Although insulin pens are very reliable, it is often difficult for health care providers who have used a vial and syringe for many years to transition to an insulin pen.

Some nurses who dislike using insulin pens will use them as vials, withdrawing insulin from the pen cartridge with an insulin syringe. Not only does this damage the pen’s integrity, but it can also leave large pockets of air within the cartridge. Once the insulin has been withdrawn, it is carried around the floor, from patient to patient, in an unlabeled syringe.
A more serious problem is that some organizations have actually replaced their insulin vials with insulin pens—really just using the cartridges inside the pens—from which patient doses are taken.

In some cases, a cartridge is used as a multiple-dose vial for a specific patient. In other cases, a cartridge is used as a floor stock vial from which to obtain insulin doses for multiple patients.

Insulin pen cartridges are not intended to be used in either of these ways.
Another challenge with the use of insulin pens is the method by which the pen is primed.

After nurses have given a dose of insulin to a patient, they may notice a wet spot at the injection site. This is the result of the priming step, which may leave some residue on the skin. However, when some nurses see this residue, they conclude that the patient did not get the full dose of insulin. Therefore, they administer another dose, thinking that part of the first dose never entered the patient’s body.

Another challenge is that nurses may have to give 2 injections of individual insulin products because those products are not available in combination.
The way that the selected dose is displayed on the pen can present another problem.

For example, this slide shows an OptiClik® insulin pen device. As you can see, a 12-unit dose of insulin has been selected. The assumption underlying this product’s design is that the person who holds the pen will be right-handed. At the right of the screen you can see the knob used to select and inject the insulin dose. People who are right-handed would hold the pen in their left hand and turn the dial with their right hand to select the dose.

But what happens if the user is left-handed? The lower image shows what can happen. People who are left-handed would probably hold the pen in their right hand and turn the dial with their left hand. In this case, the dose displayed on the screen appears to be 21 units, although it is actually 12 units.
Another concern related to the use of insulin pen devices is the possibility of cross-contamination. This issue alone has prompted some organizations to stay with the traditional vial and syringe administration method rather than changing to pen devices.

When insulin pens are used in a hospital or other organization, it is possible that one patient’s pen might be used for another patient. Because of the design of insulin pens, air bubbles and pathogenic contaminants might enter the cartridge after an injection, while the needle is still attached to the pen. If a nurse borrows a pen used for the first patient, attaches a new disposable needle, and injects an insulin dose into a second patient, that patient might be contaminated with anything that entered the cartridge as a result of the first patient’s injection.
Two publications have reported problems associated with the use of insulin pen devices by demonstrating the possibility of contaminants entering the cartridge after an injection.

In one study, hemoglobin was detected in 4.1% (6 of 146) of cartridges of patients with diabetes.

In the other study, which included 120 patients, noninert material, including squamous cells and other epithelial cells, was found in 58% of the cartridges.
One example of the problems with the use of a single insulin pen for more than 1 patient involves a US Army hospital. In early 2009, the hospital announced that more than 2000 patients with diabetes who were admitted between August 2007 and January 2009 were at risk for developing a blood-borne disease because of incorrect procedures for using pen devices.

To underscore the seriousness of this issue, the FDA also issued warnings about this risk in its Patient Safety News segment.
A final problem related to insulin administration deals with confusion between insulin syringes and tuberculin syringes. Both ISMP and the PA-PSRS have received reports of mix-ups caused by the similar sizes, shapes, and colors of these different types of syringe.

Picture a situation in which a nurse or pharmacist accidentally picks up a tuberculin syringe before administering the dose or while compounding a TPN solution and adding insulin in the IV room.

The markings on a tuberculin syringe are in tenths of milliliters rather than units. Therefore, a practitioner might see 0.9 on a syringe, think it means 9 units, and give that amount to the patient. In the first example on the slide, a nurse who was inadvertently using a tuberculin syringe intended to give a 9-unit dose of insulin. But because the wrong type of syringe was used, the nurse actually administered a 0.9-mL dose, which equals 90 units of insulin. Thus, the patient received a 10-fold insulin overdose.

Other patients have received 60 units of insulin rather than 6 units or 40 units instead of 4 units.
In this section, we will discuss problems that have recently arisen due to the increased use of concentrated U-500 insulin.
The first challenge occurs when a prescriber or a pharmacist enters insulin orders into the computer system.

Look at the product descriptions on this screen. As you can see, both lines begin with “Humulin R Injection Solution.” Practitioners who are not aware that the U-500 product exists could easily overlook the concentration information at the end of the line.

This problem is exacerbated by the limited number of characters that are visible on many order entry screens. Only practitioners who are aware of the existence of both the U-100 and U-500 products might be able to determine whether the same product had been listed twice or whether 2 different products were actually available.
Prescribing U-500 Insulin

• An endocrinologist wrote an order for “25 units of U-500 insulin” to be given in the morning.
• In reality, he wanted the patient to receive 125 units.
• Since each mL of U-500 insulin contains 5-fold more insulin than U-100, he was actually citing the “25 units” marking on the U-100 insulin syringe scale.

The biggest challenge with the use of U-500 insulin is that there are no U-500 syringes available for administering the medication. Therefore, practitioners have the choice of administering the U-500 insulin dose with either a U-100 insulin syringe or a tuberculin syringe.

Here is an example of the confusion that can result from using a U-100 insulin syringe. An endocrinologist wrote an order for 25 units of U-500 insulin. What he actually wanted was 125 units rather than 25 units. However, he wrote the order citing the “25 unit” marking on a U-100 syringe. He intended for the nurse to get a U-100 syringe, draw back the U-500 insulin to the 25-unit marking, and thereby give a dose of 125 units.

You can imagine the problems that might arise with this prescribing and dosing method, especially for a patient self-administering U-500 insulin at home.
The last part of this presentation will deal with issues surrounding patient education about insulin.
Failure to Educate Patients Adequately

• Lack of pharmacist involvement in direct patient education
• Failure to provide patients with understandable written instructions
• Failure to involve patients in check systems
• Not listening to patients when they question therapy

There are several key issues related to patient education about insulin use. First, pharmacists are seldom involved in direct patient education, either in the hospital or community pharmacy setting.

Second, many patients do not receive instructions about their insulin regimen that are written at the appropriate level or in the language that they speak and read.

Third, many health care providers fail to involve patients in check systems. In the hospital setting, this might entail showing a patient how much insulin they will be giving and asking the patient to double-check the dose. In the community pharmacy setting, this might involve having the patient look at the product and verifying that it is correct before dispensing vials of insulin.

Finally, some health care providers do not listen to patients when they question the therapy they are about to receive. For example, the provider should double-check the insulin dose if a patient asks, “Why is this dose different from the one I take at home?” It is essential that providers be responsive to patients’ questions rather than disregarding them.
Earlier we mentioned that one of the benefits of having an insulin pen device on the nursing unit is that nurses can teach patients how to use their insulin pen correctly before discharge.

Sometimes, providers in the acute care setting fail to check a patient’s health insurance status. In that situation, a patient who has been taught how to use an insulin pen may be forced to use the vial and syringe administration method because the insurance company will not pay for an insulin pen. Therefore, the patient’s education does not correspond to the way in which insulin will be administered at home. Patients who have just transitioned to insulin therapy and have been taught to use only a pen device will not be prepared to draw a dose from a vial into a syringe.

In addition, patients may not use the same type of insulin pen during predischarge education that they will use at home. This often happens because the patient’s insurance company will pay for one brand of insulin pen, but not another.
An important topic that is sometimes overlooked during patient education is the correct way to prepare the insulin pen for use.

Patients who use suspended insulins may not have been taught to tip or roll their insulin pens enough to assure proper mixing. Failure to do this results in the clumping of aggregated insulin in the insulin pen.

If the clumping occurs at the bottom of the cartridge, the patient will not receive the full amount of insulin with the first doses administered. On the other hand, if the clumping occurs at the needle end of the cartridge, patients will receive more than the required amount of insulin for the first few doses. Depending on where the clumping has occurred, the patient could experience either hyperglycemia or hypoglycemia.
Unusual Explanation for Hyperglycemia

- **NovoFine® Autocover® insulin pen needle**
  - User holds cover while the system is screwed onto the insulin pen.
  - The cover is then removed, exposing a plastic needle shield that initially covers a 30-gauge needle.
  - As the insulin is injected, the shield slides and allows the skin to be punctured, needle unseen

- **Differs from standard insulin pen needles that patients purchase at their pharmacy**

Confusion can also arise when patients do not have the necessary education about the type of insulin pen needle they will be using.

For example, Novo Nordisk makes the NovoFine® Autocover® 30-gauge insulin pen needle. With this product, the user holds the cover while screwing the needle assembly into the insulin pen. When the pen cover is removed, the patient sees a plastic shield that covers the needle. Once the insulin is injected, the shield slides up, allowing the skin to be punctured. This movable shield prevents the patient from seeing the needle and protects the nurse or caregiver from needlestick injuries. This specialized needle is very different from the standard insulin pen needles that patients typically encounter.
Some patients who learn to use the NovoFine® Autocover® insulin pen needle while they are hospitalized are confused when they are provided with a standard pen needle, such as the BD Ultra-Fine® III, after discharge.

The BD Ultra-Fine® III also has a cover that, when removed, exposes a needle shield.

However…
NovoFine® Autocover® has outer cover that must be removed, but the plastic needle shield slides back during injection.

BD Ultra-Fine® III pen needle has clear outer cover and gray needle cover that must be removed prior to injection.

The NovoFine® Autocover® insulin pen needle is shown on the left. In the picture you can see the device’s outer cover. You can also see the needle shield that retracts when the injection is given and then slides out again post-injection to prevent needlesticks.

Now look at the image on the right, which shows a BD Ultra-Fine® III pen needle. You can see the translucent outer cover at the top of the picture, as well as the gray needle cover that must be manually removed before the injection is given.

However, some patients whose initial experience has been with the NovoFine Autocover needle were not taught that the BD Ultra-Fine needle is not the same type of device. Because they do not realize that they need to remove the inner cover as well as the outer cover, they do not receive any insulin when they attempt to inject themselves. Therefore, these patients may experience episodes of hyperglycemia.
Another issue related to educating patients who are taking insulin is how we teach and the questions we ask.

A good example of this is a patient who was newly diagnosed with diabetes in the hospital. A nurse educator came into the patient’s room to teach the patient how to self-administer insulin. To avoid multiple sticks to the patient, the educator used an orange to demonstrate the proper injection technique. The patient learned how to withdraw insulin from the vial and inject it into an orange.

So what do you think the patient did after returning home? That’s right. The patient injected the insulin into an orange and then ate the orange.
Another educational issue is the prevalence of low health literacy in the United States.

Studies conducted by the American Medical Association have shown that more than 40% of patients with chronic illnesses, such as diabetes, are functionally illiterate.

Studies have also shown that almost one quarter of all adult Americans read at or below a fifth-grade reading level, although medical information leaflets are typically written at or above a tenth-grade reading level.

Research has also shown that approximately 3 out of 4 patients discard medication leaflets before reading them. This applies both to patients who may be discharged from the hospital with a stack of leaflets and to patients in the community setting who have an information leaflet stapled to the bag that contains their medication. Since many patients understand little, if any, of the information contained in drug leaflets, it is not surprising that they discard these seemingly useless pieces of paper.

At the time of the study it was estimated that low health literacy skills increase health care expenditures in the United States by about $73 billion per year.
Here are some recommendations on providing appropriate patient education about insulin use. First, we need to emphasize the ramifications of diabetes and the long-term consequences of uncontrolled diabetes. This education needs to be done at a fifth-grade comprehension level so patients will clearly understand the material.

Second, while teaching a patient how to prepare and administer insulin, we should discuss errors that often occur with insulin therapy. These include problems caused by look-alike, sound-alike names and similar packaging. Where will patients be storing their vials or their pen devices? Do they know the difference between Humulin® N and Humulin® R insulin or between Novolin® N and Novolin® R? How can they differentiate their products so that they do not confuse their different vials or pens?

How is information about sliding-scale orders or coverage orders for meals communicated to patients? Certainly, information of that complexity does not fit on a pharmacy label. What are patients using as a guide to what basal, prandial, and correction doses should be administered throughout the day, and how the resulting blood glucose levels should be documented?

A valuable educational exercise is requiring a “return demonstration”—having patients use an actual vial and syringe to show you how much insulin should be drawn up to correspond to their prescribed doses.

If necessary, make sure that patients understand the difference between U-100 syringes and tuberculin syringes, and know the type of syringe they should be using. This is especially important for patients who may have been using U-100 insulin and are changed over to U-500 insulin.

Also be sure that they understand the importance of preparing their insulin for administration. If they use an insulin pen to administer a suspended insulin product, it is especially important that they understand the importance of rolling or tipping the device to prevent insulin clumping and incorrect doses.
In closing, it is important to understand the patient’s role in medication safety. An informed patient is one of the best safeguards against medication errors.

Patients who are involved in their care, ask questions, and double-check themselves with health care providers are more likely to detect medication errors and avoid harm due to these errors.
Medication Errors Reporting Program

Operated by the

Institute for Safe Medication Practices

Report medication errors in confidence:
1-800 FAIL-SAF(E)
www.ismp.org

(ISMP is a FDA MEDWATCH partner)

It is important for health care providers to share their stories about errors that have occurred with the use of insulin. The content of this presentation, including the anecdotes and pictures, was based on medication error reports submitted to the ISMP.

It is also important to report medication errors internally, so that professionals within your organization can learn about the different types of errors that involve insulin, and determine how future errors can be prevented throughout the organization.

It is also important to report these errors externally to organizations like ISMP so that we can help the medical community to learn why errors occur and to adopt strategies for preventing medication errors associated with the use of insulin therapy.