

## Patient Safety Tip of the Week

November 2, 2010

### Insulin: Truly a High-Risk Medication

As we were preparing this column on problems with insulin, we encountered a [2007 safety alert by ISMP on insulin-heparin mixups](#) and thought to ourselves “we haven’t seen much of this recently”. Literally 2 hours after we said that, our literature-scanning software started popping up just-released news articles about a serious event in Canada in which [four infants were inadvertently given insulin instead of heparin](#). The 2007 ISMP alert was issued after a neonate suffered severe hypoglycemia after insulin rather than heparin had been added to a bag of total parenteral nutrition (TPN). Ironically, the recent Canadian episode was an almost identical occurrence. [Heparin was intended to be added to TPN but insulin \(Humulin R\) was added instead](#) and the resultant mixture was administered intravenously to 4 neonates at the Canadian hospital. Staff noted the four infants worsening in similar ways and correctly diagnosed and managed the problem, though it is unknown whether any future neurological problems might result from the events.

Details of the root cause analysis (RCA) done at the Canadian hospital are not available though press reports indicate that similarity of the labeling on the two drugs likely played a role, as did insufficient space in the inpatient pharmacy. The hospital has apparently [changed the labeling on insulin and heparin](#), added another safety check (?an independent double check), and is looking for additional pharmacy space.

Interestingly, [ISMP Canada](#) had also just released this August a bulletin on inadvertent administration of insulin to a nondiabetic patient, in whom a mixup of heparin and insulin was considered a possibility.

ISMP’s 2007 alert highlighted multiple other instances of mixups between insulin and heparin. They noted that similar packaging, fact that both insulin come in 10 mL vials, fact that both are dispensed in “units”, and fact that vials of both are often kept near each other on countertops, in drug carts, and under pharmacy IV admixture hoods. They also noted that mental slips are involved in most instances. Perhaps contributing also is the fact that insulin infusions have been increasing in recent years.

ISMP made several recommendations to avoid such mixups during drug preparation:

- Avoid keeping insulin and heparin vials near each other.

- To avoid similar vials, use heparin from bags of 100 units/mL or heparin prefilled syringes.
- Consider use of insulin pens rather than insulin via vials.
- Require independent double checks of all TPN solutions.
- Use barcode scanning for selection of all components of TPN solutions.

However, probably the two most important issues are **whether either heparin or insulin belong in the TPN solutions in the first place**. The ISMP article discusses the pros and cons of using insulin separately or as part of TPN solutions. The issue of heparin (supposedly used to avoid IV catheter thrombosis) is also discussed in that ISMP alert. There is no evidence base to support the use of heparin for this purpose in peripheral IV lines. Though heparin flushes may improve umbilical catheter patency in neonates, there is no current good evidence to demonstrate its effectiveness and safety in peripherally placed central catheters in neonates. We've previously discussed the issue of heparin flushes on multiple occasions.

The ISMP alert also had recommendations to help avoid heparin/insulin mixups at the point of administration:

- Make sure the indication(s) for either drug are clear and compatible with the patient's diagnoses.
- Always use readback when taking verbal orders to verify understanding and accuracy.
- Require independent double checks before administration of IV insulin or heparin.

Our original intent for today's column was to review multiple aspects of insulin use in the hospital setting. Insulin, of course, is one of the top 5 high-risk medications at virtually every hospital. It is of concern not only because of the frequency with which insulin is used but also the seriousness of the consequences of incorrect administration (or failure to administer).

Fortunately, in the past year there have been multiple great resources highlighting the pitfalls associated with insulin. There was an [ISMP webinar](#) on management of insulin, [Pennsylvania Patient Safety Authority Advisory](#) on insulin errors (many of the lessons learned that appear in the ISMP webinar came from the Pennsylvania Patient Safety Reporting System so there is a lot of overlap in these two resources), and [National Patient Safety Agency \(UK\) rapid response report](#) on insulin issues. The NPSA site also has a good [e-learning tool on safe use of insulin](#). And some older but equally important resources exist, including a monograph from [ASHP](#) (American Society of Health-System Pharmacists) and a good insulin audit tool from or the [Victorian Medicines Advisory Committee](#) (Australia).

The most egregious and potentially fatal errors with insulin have historically been related to use of the **abbreviation "U" for units**. The problem arises when the "U" looks like a zero so the patient inadvertently is given 10 times too high a dose. The same kind of

problems can arise when the abbreviation “IU” for international units is used. The solution is to never allow use of either abbreviation. It’s easy to put these abbreviations on your list of “Do Not Use” abbreviations but in practice they still keep popping up. An **area of particular vulnerability may be your IT systems**. You need to purge these abbreviations from all your computer software. We have seen examples continue to pop up unexpectedly even years after we thought all such instances had been purged! They often show up in things like “customized” order sets or in materials coming from third party vendors. So you must have continuous surveillance for these occurrences. In addition, you need to make sure that your **dictation systems** automatically prevent use of these abbreviations. But even if you always use “units” rather than abbreviations, an order can still be misinterpreted depending on the presentation. If there is insufficient space between the number and “units”, particularly if the “U” in “units” is upper case, someone reading that order may still interpret the “U” as a zero. For example, “NPH insulin 10Units” might be interpreted as 100 units.

**CPOE** (computerized physician order entry) is the best way to reduce the risk of both handwriting errors and abbreviation errors. We also highly recommend using **standardized order sets**, whether paper or electronic, and glycemia management **protocols** whenever possible.

The large **number and variety of insulin preparations** is problematic. Add to that the **look-alike/sound-alike (LASA)** issue and it is no wonder that so many insulin errors occur. Think about all the insulin preparations that could easily be mixed up: Humulin, Humalog, Novolin, Novolog, Humulin 70/30, Humulin 50/50, Humulin R, Humulin N, Humulin L, Humulin U, Humalog Mix 75/25, Novolog 70/30, Novolog Mix 70/30, Novolin R, Novolin N, Novolin L. Use of **tall-man lettering** may help prevent some LASA mixups (eg. humuLIN, humaLOG, novoLIN, novoLOG, etc.)

One problem that may apply to a variety of insulin preparations occurs when the **computer display screens**, from which a provider is choosing an insulin dose and preparation, displays **truncated** information.

Many hospitals have attempted to **limit the number of insulin preparations** they keep in their formulary and some have sought to **use multiple vendors to avoid confusion with look-alike vials**. That, however, may be problematic because patients come into the hospital on certain preparations of insulin and expect to be continued on the same preparation while an inpatient. It can also become a nightmare for medication reconciliation when patients are discharged.

Another error being seen more frequently is related to the relatively new **500 unit insulin preparations**. These preparations come in 500 unit per mL vials. The problem arises when healthcare workers use this dosage form with insulin syringes that are calibrated for 100 unit per mL insulin preparations (note there are currently no syringes calibrated for the higher concentrations). It is **recommended that the 500 unit per mL preparations be stored completely separate from the other insulin preparations** and only be used by specially designated healthcare workers who have received specific training in use of

the higher concentration product. Certainly, they should never be stored as part of “floor stock” where they might be easily mixed up with the more common 100 unit per mL preparations. **Better yet, don’t stock this 500 unit per mL insulin at all!** Unfortunately, the need for that higher concentration has been increasing in recent years as more obese patients with insulin resistance have been requiring much higher insulin doses. The higher concentrations may also be needed for patients having implanted insulin pumps. If you need to stock the higher concentration, make sure you have some mechanism (like a “hard stop”) to ensure that a pharmacist is involved in validating and preparing the dose and always have an independent double check before such preparations are administered.

Not only are incorrect doses of insulin a problem, but **omitted or delayed doses** are also a concern. Delayed doses become a concern especially **when patients are transported to other areas of the hospital** for testing, procedures, etc. We’ve often seen patients spending several hours in the radiology suite, missing scheduled doses of insulin and becoming hyperglycemic or getting a full dose of insulin on return from radiology and then getting hypoglycemia. And in several of our columns on patient safety issues in the radiology suite we have mentioned that IV infusions sometimes get turned off during imaging procedures and these may not be restarted appropriately. If you use a structured tool for your in-hospital transports, like “Ticket to Ride” (see our November 18, 2008 Patient Safety Tip of the Week “[Ticket to Ride: Checklist, Form, or Decision Scorecard?](#)”), be sure to include an item related to whether insulin should be given or held while the patient is off the floor.

Another problem in insulin omission we have encountered relates to the **timing of admission orders**. Some pharmacy computer systems are programmed to dispense the “every morning” doses of drugs at 8AM the **next** morning. We have seen examples where a diabetic patient has admission orders written in the emergency room at 7:30AM but does not have those orders transcribed and entered into the computer system until 8:30 AM. In such cases, there is a risk that a patient could go 24 hours without an insulin dose (and without his or her other daily medications). **Handoffs in such situations are critical** in ensuring that patients get their intended doses of medications on the correct day.

One error we have encountered on numerous occasions is failure to inquire during medication reconciliation about the **time the last dose was taken**. We have seen this lead to failure to give any insulin on the day of admission or to delays in insulin administration when patients undergo long delays between presentation to the emergency room and ultimate admission to the hospital. On the other hand, it can also lead to inadvertent administration of two doses in one day (i.e. the patient took a dose at home and gets a repeat dose in the hospital). Your medication reconciliation forms, whether paper or electronic, need a column for time last dose taken. While that may be of little consequence for many drugs, it is clearly very consequential for high-risk drugs like insulin.

An excellent patient safety intervention for high-risk drugs is setting **dose range limits** on your CPOE or pharmacy IT systems. This is very valuable in preventing, for example,

overdoses of chemotherapy agents. For insulin, it is much more difficult than it sounds. That is because the dosages of insulin used are so variable across patients. But it is worth looking at your data and saying “we’ve seldom used a dose of insulin exceeding x units” and then adding an alert that helps physicians, pharmacists or nurses question orders for large doses of insulin.

A discussion about “**sliding scale**” insulin therapy is beyond the scope of today’s column. However, suffice it to say that such practice has become frowned upon (though every hospital we’ve ever visited has examples where someone is still using it!). The [PPSA Advisory](#) on insulin errors has a good discussion on this issue and provides numerous examples of problems arising from “sliding scale” or “insulin coverage” orders. When insulin is being given based on the results of bedside glucose testing (glucometers), there have been multiple instances where nursing notes scribbled on a pad for multiple patients have led to patient weights or even room numbers being mistaken for glucose levels!

The **syringes** used to administer insulin have been a source for errors in insulin management. Insulin is supposed to be prepared and administered in special syringes calibrated in units. These are usually one mL syringes standardized for 100 units per mL insulin preparations. A serious problem arises when someone tries to administer insulin from **regular intravenous syringes**. In the latter the calibrated markings indicate volume, not units. So a provider erroneously using such a syringe might fill it to 4 mL, thinking this means 4 units, and actually be administering 400 units of insulin!

Use of **insulin pens** has increased substantially in recent years, with many advantages. However, one must be very careful that insulin pens are never used on more than one patient since there have been numerous examples of [cross contamination with blood-borne diseases from insulin pens](#) (FDA 2009).

Another practice being used more and more is the **insulin drip**. A good recent article ([Maguire 2010](#)) discusses how in many hospitals insulin drips are not just being used in ICU settings but are also being managed on regular floors. Note, however, that the [PPSA Advisory](#) on insulin errors noted several cases where IV bags containing insulin were mistakenly hung instead of other IV medications.

A real problem nowadays is related to the use of hospitalists. While we are huge advocates of hospitalist programs, we are seeing problems arising when patients are **co-managed by more than one physician**. In particular, we often see patients on surgical services having their diabetes managed by hospitalists (or other consultants). In such cases it needs to be made very clear to nursing staff who will be responsible for the insulin and diabetes management orders.

**Independent double checks** are often recommended when we are dealing with administration of high-risk medications. Even though we have emphasized that double checks are a relatively weak intervention (we know from all industries that the error rate when a supervisor checks someone else’s work may be 10% or higher), the literature supports a medication error reduction of about 30% when using a double check system

(see our July 15, 2008 Patient Safety Tip of the Week “[Heparin Flushes.....Again!](#)”). Also, for any high-risk medications you need to do truly independent double checks (see our March 30, 2010 Patient Safety Tip of the Week “[Publicly Released RCA’s: Everyone Learns from Them](#)” for a description of independent double checks). Another nice article on independent double checks in preventing medication errors ([ISMP Canada 2005](#)) describes the independent double check process and calculates that independent double checks would reduce the error rate of a process having an error rate of 5% all the way down to 1 in 400.

One last problem in managing patients on insulin deals with those patients having insulin pumps. Both external and implantable **insulin pumps may present risks during MRI procedures** ([Shellock 2010](#)). The pump motors may be damaged by exposure to the high electromagnetic fields generated during MRI. So in many cases the pump (and in some cases the transmitters or sensors) may have to be removed prior to entering the MRI environment. The Shellock article provides details for each pump by manufacturer for what to do prior to MRI and also what to do if a patient with an insulin pump is inadvertently exposed to MRI.

So what should your organization be doing to reduce errors related to use of insulin? We have several recommendations:

- First, do an inventory of the various insulin preparations currently in stock in your organization (what they are, which manufacturers, where they are, who has access to them, etc.).
- Look at all the vials containing insulin to determine which ones look alike.
- Make sure that other medications in vials that may be confused with insulin (such as heparin) are not stored in proximity to insulin vials. In particular, don’t allow vials of insulin to be kept on counter tops or carts or under pharmacy medication hoods where they might be easily confused with heparin vials.
- If necessary, consider using different manufacturers for different preparations to avoid look-alike vials.
- Query your pharmacy IT system to see what types of insulin have actually been prescribed in the past 6-12 months.
- In particular, see whether you stock and use the 500 units/mL preparation of insulin. If you rarely use it, don’t stock it. Then, if you need to use it for an individual patient, make sure you remove it after that patient has been discharged. If you must use it, restrict the number of nursing or pharmacy staff who may prepare this high dose preparation.
- Review and revise, if necessary, your TPN policies as they relate to use of insulin and heparin.
- Make sure that “U” is on your “do not use” abbreviation list and that abbreviation has been purged from all your software.
- Use “tall man” lettering to help distinguish insulin products with look-alike names.

- Include “last dose taken” on your medication reconciliation forms for insulin and other high-risk drugs.
- Review your policy on how daily medications are given in relation to admission orders (to make sure you do not omit an insulin dose today because the hospital policy moves the first dose to the next day after a certain time).
- Use standardized order sets or protocols wherever possible for insulin.
- Make sure your computer displays don’t truncate critical information about each insulin formulation.
- Make sure you know who is responsible for ordering insulin when patients are being “co-managed” by more than one physician.
- Make sure you have correct insulin syringes available on all units where insulin is prepared or administered and that all staff are competent in correct use of insulin syringes.
- If you use insulin pens in your facility, make sure you follow all the recommendations in the [FDA alert about insulin pens](#).
- Determine whether you would be able to use alerts on your computerized systems if an order for a certain dosage of insulin were exceeded.
- Use independent double checks in both the preparation and administration phases for insulin.
- Make sure that instructions on what to do regarding insulin are included on handoff tools when patients are transported to radiology or other areas of the hospital
- Make sure your MRI unit is aware of the issues regarding insulin pumps noted above.
- Have a monitoring plan in place for glycemia management. Use trigger tools such as flagging any use of 50% glucose as a likely sign of an insulin error.
- Most importantly, learn from your mistakes and from the mistakes others have made in use of insulin.
- Educate and re-educate all your staff on insulin issues. While we always say that education and training are “weak” patient safety interventions, there is a real value in promoting a culture of patient safety when high risk situations are reiterated. Remember, **tell stories** – that’s what gets staff to think “could that happen here?”.
- Use an audit tool such as those available through the [ASHP](#) or the [Victorian Medicines Advisory Committee](#) (Australia) to see how your organization stacks up in its safe approach to insulin management

We have developed over the years a healthy respect for the complexities associated with use of insulin and its potential dangers. Insulin is truly a high risk medication and deserves a unique position in your patient safety activities.

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