We are aware of numerous reports of serious errors associated with the misadministration of insulin. These events have involved various types of practitioners, including physician house officers (HOs), nurses, and a pharmacist. Human error (e.g., mental slips, lapses, forgetfulness) associated with insulin dose measurement and hyperkalemia treatment was the predominant proximate cause of these events; most of the human errors were associated with knowledge deficits regarding insulin concentration (specifically that “U-100” means the concentration is 100 units per mL), the differences between insulin syringes and other parenteral syringes, and a perceived urgency with treating hyperkalemia.

In the most recent event, a physician ordered intravenous (IV) dextrose 50% injection (50 mL) along with 4 units of regular insulin IV (U-100) for a patient with renal failure and severe hyperkalemia. However, a nurse drew 4 mL (400 units) of insulin into a 10-mL syringe and administered the dose IV. The patient became severely hypoglycemic and had to be transferred to a critical care unit for treatment and monitoring.

In another case, a nurse accidentally added 50 units of regular insulin to an existing IV infusion instead of 5 units. A physician had asked the nurse to add 5 units to the IV bag. The nurse felt the half-inch insulin needle on an insulin syringe was not long enough to insert into the IV bag. Thus, the nurse drew the insulin into a 3-mL syringe with a longer needle. However, she accidentally withdrew 0.5 mL (50 units) of insulin instead of the correct volume of 0.05 mL (5 units). She quickly showed the prepared dose to another nurse, who also failed to pick up the error. Later, the nurse recognized her error while preparing a subcutaneous insulin dose for another patient using a U-100 insulin syringe.

A third case involved the incorrect preparation of an insulin infusion. While the pharmacy was closed, a physician ordered an IV insulin infusion for a patient. Near the end of her shift, a new graduate nurse was asked to prepare a “1:1” insulin infusion (1 unit/mL). An experienced nurse who checked the solution failed to notice that the graduate nurse had drawn 10 mL (1,000 units) of insulin into a 10-mL syringe, instead of 1 mL (100 units) in an insulin syringe, and then added that amount to a 100-mL bag of 0.9% sodium chloride. This resulted in a 10-units/mL insulin infusion. Several hours later, both nurses—by then at home—individually called the hospital because they were worried that “something was not right” with the insulin infusion. When the error was discovered, the patient had already received 160 units of insulin over several hours instead of the prescribed 16 units. The patient’s blood glucose level dropped as low as 13 mg/dL. He was treated and experienced no additional adverse effects.

A similar event was reported in which a pharmacist prepared an insulin infusion in a 10-units/mL concentration instead of the required 1-unit/mL concentration. It is not unusual to prepare an admixture or dose using half of a vial or more when dealing with other medications that typically come in multiple-use vials. Thus, staff may not find it odd to use half of a vial or more to prepare an insulin infusion, particularly if they are busy, distracted, or preoccupied. But a 10-mL multiple-dose vial of insulin can essentially contain up to 100 doses or more.

We also recently became aware of a case in which orders were given for a patient with hyperkalemia to receive insulin and a 50% dextrose injection, but the patient received only the insulin portion of the treatment and experienced significant hypoglycemia.

In several other recent events reported to us from other countries, physicians were involved in insulin administration errors. In one case, 10 units of insulin was prescribed, but a medical staff HO inadvertently administered 100 units of insulin using a regular parenteral syringe. In a second case, a HO administered 50 units instead of 5 units of insulin. The HO failed to read the number next to the first large measurement marking (5 units) on an insulin syringe and assumed the marking on the syringe was for 1 unit of insulin. The patient developed hypoglycemic encephalopathy and later died. In another case, 10 units of insulin was prescribed, but the HO inexplicably did not use an insulin syringe and administered 8 mL (800 units) of IV insulin drawn into a 10-mL syringe.

In the final case, 8 units of insulin was ordered, but the HO drew the insulin into a 3-mL syringe and administered 300 units IV to the patient. The practitioner who reported these errors could provide no explanation regarding the confusion of 10 units with 8 mL (800 units) and 8 units with 3 mL (300 units).

In the events involving physicians outside the U.S., the hospitals required physicians to administer the first dose of IV medication in case an immediate allergic reaction or other adverse drug reaction occurred. This may have contributed to the errors because many physicians have not received formal education on insulin administration. Requiring physicians to administer the first dose of IV insulin may also cause workflow disruptions and significant delays while waiting for the physician to administer the dose. Although the intention is to have the physician available in the event of an adverse drug reaction, in practice, physicians often administer the IV medication and then immediately leave the patient’s bedside. This can create even greater risk, as the nurse may not be available to perform adequate monitoring after drug administration. In fact, requir-
ing physicians to administer the first dose of IV insulin may actually add risk to the process with little or no known benefit. **Safe Practice Recommendations:** With insulin, it should not be assumed that all health care practitioners are knowledgeable and skilled with measuring doses, preparing insulin infusions, and recognizing doses that exceed safe limits. Consider the following recommendations to enhance safety with this high-alert medication.

**Provide education.** Education regarding the concentration of insulin products, the differences between insulin syringes and other parenteral syringes, how to measure doses, recognition of safe dosage ranges, and how to administer the drug should be provided to all who might prescribe, prepare, and/or administer insulin. Restrict insulin preparation and administration to those who have demonstrated competence.

**Supply insulin syringes.** Insulin syringes should be readily available in all patient care units, and steps should be taken to separate insulin syringes from other parenteral syringes so they cannot be mixed up inadvertently.

**Dispense from pharmacy.** To preserve an independent double-check, wherever possible, pharmacy should prepare, label, and dispense insulin doses to treat hyperkalemia. Some organizations dilute the IV insulin dose and dispense it in a minibag. Hyperkalemia is a medical emergency, yet the administration of insulin, in most circumstances, can wait until a pharmacy prepares a stat dose. In general, pharmacy should also prepare all insulin infusions using a standard concentration (e.g., 1 unit/mL). Proportional orders such as “1:1 ratio” should not be accepted, as they can be misinterpreted as 1 mL of drug per 1 mL of IV solution. If the pharmacy does not provide 24-hour services, consider stocking a night cabinet with a pharmacy-mixed insulin infusion and diluted insulin in a syringe (for hyperkalemia treatment) that are discarded and replaced when necessary (e.g., every 24–48 hours). There are also 3-mL vials of regular insulin available, which can be provided to lessen the risk exposure. Insulin (or any other additive) should never be added to IV solutions that are already hanging or infusing. Pharmacy should dispense a newly mixed infusion if new additives (e.g., insulin) are required after hanging an IV infusion.

**Provide reminders.** In organizations that do not dispense patient-specific insulin doses from the pharmacy, a warning should appear on automated dispensing cabinet (ADC) screens and electronic/computer-generated medication administration records that states the insulin needs to be prepared using an insulin syringe.

**Conduct an independent double-check.** Require an independent double-check of all doses before dispensing and administering IV insulin. Include a double-check of the blood glucose result if the dose of insulin being administered is based on that result. Build the double-check into daily work processes so it can be accomplished without disruption. “Smart” infusion pumps with programmed dose limits can serve as an additional check when administering insulin infusions. Verification of pump settings should be included in the checking process.

**Consider use of an insulin kit.** Two of the foreign institutions where errors occurred have developed “insulin kits” for use when implementing a hyperkalemia protocol. These kits include instructions that warn the user to administer insulin using an insulin syringe. Each kit contains an insulin vial, insulin syringes, alcohol swabs, and a photograph that clearly indicates how to measure various volumes and doses of insulin. Although we have not previously recommended such kits, they may make sense in some environments without 24-hour pharmacy services because the kits include all the necessary items, including the insulin, insulin syringes, and 50% dextrose injection. However, in light of the above-cited medication errors, supply only 3-mL vials of regular insulin in these kits instead of 10-mL vials to limit risk exposure.

**Monitor patients.** Gauge the patient’s response to insulin by obtaining blood glucose levels. For hospitalized patients, the nurse who administers the insulin should perform the glucose testing whenever possible to avoid potential communication failures. Pay special attention to patients at risk for hypokalemia and hypoglycemia (e.g., people who are fasting, have autonomic neuropathy, or are taking potassium-lowering drugs). Patients with renal or hepatic impairment may require reductions in total daily doses of insulin.