Attachment 1.G

Checklist/Action Plan for the Management of High-Alert Medications

(adapted from "High-Alert Medications: Safeguarding Against Errors" by Michael Cohen and Charles Kilo, In: *Medication Errors*; edited by Michael Cohen, American Pharmaceutical Association, 1999)

The following document provides organizational guidance for the safe use of high-alert medications. Included is a list of more common high-alert medications, common problems associated with each medication, and basic principles or elements for safeguarding the use of such drugs that should be considered. Each medication category is coupled with a checklist of key improvement projects designed specifically to reduce the risks often associated with the use of these medications.

Organizations should systematically evaluate each high-risk medication and establish an action plan to improve the safe use of these medications based on the suggestions provided. When other high-alert medications are added to the formulary, apply the appropriate steps as outlined in this document to promote safe use.

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Nearly all drugs have a wide safety margin, a few drugs have a higher risk of causing harm when an error involving these agents occurs. These are referred to as "high-alert medications". Although errors may not be more common with these drugs than with others, their consequences may be much more devastating. High-alert medications can be, and should be, targeted for specific error reduction interventions.

High-alert medications commonly include:

Adrenergic agents (epinephrine, isoproterenol, and norepinephrine)	Cancer chemotherapeutic agents	Benzodiazepines
Intravenous calcium	IV Heparin, thrombolytics, thrombin inhibitors Warfarin	Drugs used for ambulatory pediatric sedation including chloral hydrate, ketamine, midazolam, etc.
IV Digoxin	IV Magnesium	Hypertonic saline
Insulin	Phosphate salts	Potassium chloride
IV Lidocaine	Neuromuscular blocking agents	Narcotics and opiates (including PCA)

Three principles may be used to safeguard the use of high-alert medications:

1. **Reduce or eliminate the possibility of error** (for example, reducing the number of high-alert medications stocked by the hospital; reducing the available concentrations and volumes; and removing high-alert drugs from clinical areas).
2. **Make errors visible** (for example, having two individuals independently check infusion pump settings for high-alert drugs is one way to make errors visible and thus caught before reaching the patient).
3. **Minimize the consequences of errors** (for example, fatal errors have occurred when the contents of 50mL vials of 2% lidocaine were injected instead of mannitol, which has a similar appearance – had lidocaine 2% been only available in the clinical area in a 10mL vial, if administered erroneously in place of another drug in a 10ml vial, the amount of lidocaine injected would likely not have been fatal).

Steps in the Ideal Medication Use Process

1. Physician enters a drug order into the computer system.
2. The computer checks for drug interations, allergy interactions and dosing.
3. A pharmacist verifies the order, reviewing system generated alerts and screens for issues not caught by the computer system.
4. The system-generated label moves to the filling area, where a technician fills the order in the pharmacy.
5. A pharmacist checks the technician's work.
6. A nurse receives the drug and checks the nursing record against the medication sent.
7. The nurse administers the drug to the patient after checking the patient's name-band against the order, telling the patient the name of the drug, the dose, and its purpose, thereby allowing the patient to also serve as a double-check (where possible).
8. Unused drugs are returned to the pharmacy, where a pharmacist/technician reviews them for mistakenly unadministered drugs.
9. Extra (missing doses) doses requested are reviewed by a pharmacist/technician to understand why the doses are not where the nurses expect.

Key Change Concepts for Safeguarding High-Alert Medications

1. **Build in System Redundancies** (e.g. unit dose drug distribution).
2. **Use Fail-safes** (e.g. pumps with electronic fail-safe clamping mechanisms to prevent free flows).
3. **Reduce Options** (e.g. instead of having the option of ordering heparin in various concentrations, like 20,000 units/250mL and 20,000 units/500mL and 25,000 units/500mL - only one option should be available).
4. **Use Forcing Functions**, which are techniques that reduce the possibility that a medication can be administered in a potentially lethal manner (e.g. using oral syringes, for oral liquid doses, that will not fit with IV tubing and to which needles cannot be attached; and computer order entry which can be used to 'force' the physician to order standardized products).
5. **Externalize or Centralize Error-Prone Processes** (e.g. centralizing all IV solution preparations).
6. **Use Differentiation** (e.g. identify and isolate look-alike and sound-alike products; use generic names which do not tend to sound alike as often as brand names).
7. **Store Medications Appropriately** (e.g. separate potentially dangerous drugs with similar names or similar packaging).
8. **Screen New Products** (e.g. Pharmacy and Therapeutics should inspect all new drugs and drug delivery devices for poor labeling and packaging).
9. **Standardize and Simplify Order Communication** (e.g. minimize verbal orders and the use of abbreviations).
10. **Limit Access** (e.g. high-alert medications should only be stored in the pharmacy where only a pharmacist can access them).
11. **Use Constraints** (e.g. pharmacy screening of all orders for high-alert medications prior to preparation and administration; automatic stop orders and dose or duration limits).
12. **Use Reminders** (e.g. use auxiliary labels on high-alert medications; computer screens with warning information about high-alert drugs).
13. **Standardize Dosing Procedures** (use standard dosing tables or charts, rather than calculate doses based upon weight or renal function which is error-prone).

High-Alert Medications – Problems and Key Improvements

High-Alert Medication	Common Problems *(Check if you have experienced similar problems)*	Key Improvements *(Check if the suggested Key Improvement should be included in an Action Plan)*
Adrenergic Agonists **Epinephrine** **Isoproterenol** **Norepinephrine**	❑ In the OR, these items are often drawn up into unlabeled syringes or put unlabeled or incorrectly labeled cups or pans ❑ These items come in varying concentrations (e.g. epinephrine comes 1:1000 and 1:10,000) ❑ Isoproterenol comes in 1 mg and 0.2 mg ampuls (if ordered as 1 ampul, the wrong amount may be administered)	❑ Communicate orders in a standard fashion ❑ Label all containers ❑ Remove phenylephrine and other adrenergic agents from the formulary if not absolutely needed and use prefilled syringes whenever possible ❑ Use premixed solutions, standardized preparation instructions and dosing charts ❑ Before administering any of these agents use a second nurse to independently check the drug and dose and pump settings ❑ Use cardiac monitors on all patients with a central line
Dopamine and Dobutamine	❑ Subject to mixup due to similar names, settings in which they are used and the types of patients which receive them, similar concentrations ❑ IV flow rates are often confusing because they are based on calculations of micrograms per kilogram per minute ❑ Extravasation is a problem when dopamine is given via a peripheral vein	❑ Use labels that differentiate critical parts of the names (e.g. "DOBUTamine" and "DOPamine") ❑ Use premixed solutions from different manufacturers to make sure they look different ❑ Differentiate packaging (e.g. purchase dobutamine in 250mL bags and dopamine in 500mL bags) ❑ Use order sets to standardize ordering and dosage and IV rates ❑ Use standard concentrations to facilitate the use of dosing charts and eliminate possibility of calculation errors and base dosing titration against clinical factors ❑ Label IV bags and pumps with dosage charts and equivalent delivery rates for these dosages

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IV esmolol and propranolol (cont.)	❑ Esmolol comes in both vials (100 mg/10mL) and ampuls (2.5 g/10mL) and there are reports of fatal errors from confusing the ampul/vials ❑ Most common error with propranolol is the unintentional administration of an IV dose equal to the standard oral dose when a patient is switched from oral to IV. The IV dose is much smaller than the oral.	❑ Minimize the need for esmolol by promoting alternative agents ❑ Standardize order communication – do not allow esmolol to be ordered by "amp" or "vial" ❑ Store esmolol only in the pharmacy and prepare drips and IV syringes only in the pharmacy ❑ Have all IV orders of propranolol double-checked by a pharmacist and second nurse prior to administration
Benzodiazepines (midazolam or Versed)	❑ Misunderstanding about the time of onset of midazolam's sedative effect often leads to errors. Many believe the onset is immediate – however, it usually takes 5 – 10 minutes to reach peak effect. If dosed more frequently than 5 – 10 minutes, respiratory arrest, from toxic levels, can and has occurred ❑ Overdoses have been associated with confusing labels. The concentration is displayed on the front panel as "1 mg/mL or "5 mg/mL". Users have erroneously assumed that these numbers refer to the total amount in the vial. Depending on the package size, the amount varies from 2 mg (1 mg/mL in a 2 mL vial) to 50 mg (5 mg/mL in a 10 mL container)	❑ Provide appropriate monitoring during the use of midazolam (e.g., use pulse oximetry, have resuscitation equipment in the area) ❑ Restrict access – do use midazolam for preop sedation except in the OR, since appropriate monitoring equipment may not be available ❑ Limit packaging options – use only one concentration and use the smallest package size possible
IV calcium (as Gluceptate, Gluconate or Chloride)	❑ Prescribers often fail to specify the salt when order IV calcium even though the amount of elemental calcium varies: gluconate contains 4.5 m Eq of Ca++ per gram; calcium chloride contains 14 meq per gram. ❑ Calcium chloride IM is extremely irritating to tissue and should never be given by the IM route ❑ Prescribers may not be aware of the factors affecting serum calcium – including serum phosphorus and albumin	❑ Make certain that all calcium orders specify the salt ❑ Standardize IV salts – but still insist that orders specify the salt ❑ Standardize all preparation of calcium solutions in the pharmacy to provide a check for calcium-phosphate incompatibilities ❑ Have protocols (like for potassium and magnesium) for administration and monitoring

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IV calcium (as Gluceptate, Gluconate or Chloride) (cont.)	❑ Other adverse events associated with calcium include: (1) interactions with digoxin (rapid injection of calcium may cause bradyarrhythmias, especially in patients taking digoxin); (2) antagonism to calcium-channel blockers and elevations in blood pressure; (3) hypocalcemia or hypercalcemia resulting from inefficient monitoring of calcium levels; (4) incorrect calcium-phosphorate ratios in IV solutions resulting in precipitation and end organ injury or death; and (5) tissue necrosis caused by extravasation of calcium chloride	❑ Order calcium *only* in milligrams
Chemotherapeutic Agents	❑ Frequently associated with errors and due to toxic nature, errors often have catastrophic results	❑ Require certification before allowing practitioners to prescribe, dispense or administer chemotherapy ❑ Use carefully designed computer order sets for all chemotherapeutic agents ❑ Make sure all orders include the patient's current height and weight so that the BSA can be calculated and double-checked by all caregivers ❑ Standardize dosing and delivery protocols ❑ Establish and enforce dose limits: ceiling for dose of a single drug; daily dose ceiling; total dose ceiling for a course of therapy; and total lifetime dose ceiling ❑ Require two independent calculations for all orders. Make sure orders include calculated dose and mg/BSA or mg/kg on which the dose was based. ❑ Have two individuals independently check all chemotherapy pump settings before a drug is administered ❑ Develop a standard administration procedure that includes the use of checklists ❑ Avoid confusing terminology (e.g. do not allow the use of terms such as 'platinum' which may refer to cisplatinin or carboplatin)

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Chemotherapeutic Agents (cont.)		❑ Identify look-alike and sound-alike medication pairs and implement methods to differentiate ❑ Develop protocols that require peer review in cases of disagreement between prescribers and clinical staff ❑ Never use "U" for units ❑ Do not use an IV pump if only a bolus is needed ❑ Use only premixed solutions ❑ Make sure pumps are protected from 'free flow'
Chloral Hydrate and Drugs used for Pediatric Ambulatory Sedation	❑ Often used for sedation in ambulatory seeting and overdoses are possible due to two strengths available (250 mg/5mL and 500 mg/5mL); also another major cause of overdose is that it is ordered in terms of volume (mls) and not milligrams ❑ May be ordered "as needed" for agitated patient – patient may receive multiple doses before it reaches it full effectiveness resulting in overdose ❑ Often administered by personnel unfamiliar with proper dosing ❑ Often given by parents before bringing child in – if errors occur in home, adequate treatment may be unavailable in the event of overdose and if the exact dose is not clear, additional doses may be given by nursing staff potentially resulting in an overdose	❑ Educate all staff involved about the *potential* for error ❑ Allow only properly trained staff to administer chloral hydrate ❑ Do not allow home use – if a child is to undergo a procedure, administer it after the child has arrived at the facility ❑ Stock and order only *one* concentration (ketamine, midazolam) ❑ Order *only* in milligrams, never in volume ❑ Dose child by weight, following a protocol for milligrams per kilogram ❑ Do not order on as needed basis. If such orders are essential, provide a maximum total allowable dosage (e.g. up to 500 mg) ❑ Monitor all children who have received chloral hydrate for preoperative sedation before and after the procedure. Have a resuscitation plan and equipment available
Digoxin	❑ Digoxin has a narrow therapeutic range and has a number of drug interactions; those at particularly high-alert include the elderly on a high dose and those also taking quinidine	❑ Provide patient education by trained staff on the importance of compliance with dosing and follow up blood tests and on the warning signs of potential overdosage ❑ Increase patient monitoring through more frequent clinic visits and serum level tests ❑ Improve frequency of digoxin blood testing ❑ Monitor use of Digibind and develop a protocol for the appropriate use of Digibind

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Heparin	❑ Dose errors, concentration errors and mix-ups of heparin with other drugs are common ❑ Labeling of small volume parenteral vials is a problem – the vial may be labeled 10,000/mL but the user may believe that the vial contains 10,000 units total (if a 10mL vial, then a 10-fold error can occur) ❑ Both heparin and insulin are measured in units and both are stored in medication floor stock areas ❑ Heparin has been confused with vaccines where prefilled syringes are used since they can look alike ❑ Heparin is associated with drug allergies and thrombocytopenia ❑ If heparin is ordered with only a "U" and not the word "units" the potential for the "U" to be interpreted as a "0" exists and thus a 10 fold dosage error ❑ In newborns, heparin that is not preservative free may contain benzyl alcohol ❑ Heparin solutions are often made throughout institutions and stocked in regular floor stock – potential errors	❑ Standardize heparin solutions – use premixed and reduce the number of concentrations available ❑ Standardize administration procedures – place dose stickers on heparin bags and double check all rate changes. If a bolus is ordered, give it from a syringe, rather than modifying the rate of the infusion ❑ Differentiate all look-alike products ❑ Separate the storage of all drugs ordered in units ❑ Standardize the dosing using weight-based protocols ❑ Have infusion pump rate settings and line placement on dual-channel pumps checked by two persons ❑ Develop and follow standard treatment protocols ❑ Do *not* use "U" for units ❑ Use only 'free flow' protected pumps
Hypertonic Saline	❑ Rapid changes in serum sodium concentrations caused by administration of nonisotonic, and especially hypertonic, saline are dangerous. Yet, hypertonic saline is floor stocked in many areas. Five percent saline has been confused with D5W/NS. Three percent saline has been confused with 0.3% saline. ❑ Pediatric ICUs may stock 23.4% saline for use in preparing enteral feedings ❑ Dialysis units may use hypertonic salines to increase blood volumes and reduce cramping	❑ Allow only commercially available, standard (e.g. isotonic) concentrations of sodium chloride outside the pharmacy ❑ Limit options – do not stock the 3% sodium chloride injection ❑ Develop a protocol for administering sodium chloride for use in treating hyponatremia – covering the rate and volume of administration and the frequency of serum sodium monitoring ❑ Limit addition of sodium to enteral feedings to the pharmacy ❑ In dialysis units, stock a single hypertonic concentration and store in a locked area with limited access and affix special hazard labeling

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Insulin	❑ IV insulin is lethal if given in substantially excessive doses or in place of other medications (insulin and heparin are often mistaken for one another since both are ordered in units and typically stored near each other on nursing units) ❑ Problems may arise if pumps are programmed incorrectly ❑ If insulin is ordered with only a "U" and not the word "units" the potential for the "U" to be interpreted as a "o" exists and thus a 10-fold dosage error ❑ Mix-ups may occur because of sound-alike names (e.g. Humalog and Humulin), multiple types of insulins (e.g. animal source and human source) and varying concentrations (U500 and U100) ❑ Insulin has reportedly given to the wrong patient	❑ Use "units" instead of "U" ❑ Store heparin and insulin separately ❑ Require two independent checks of all pump settings ❑ Take extra precautions when writing and interpreting orders for insulin mixtures (Mixtard 70/30 premixed insulin) ❑ Standardize preparation and administration (e.g. never prepare U100 insulin doses in tuberculin syringes – always use insulin syringes; use only a tuberculin syringe for U500 insulin) ❑ Do not use slash marks to separate NPH and regular insulin doses (e.g. NPH 10/12 regular has been confused with 10 NPH and 112 regular because the slash mark was read as the numeral one ❑ After dispensing/using insulin do not return to the box it came in – this increases the risk that a vial might be placed in the wrong box and the next person may automatically select the wrong product ❑ Nurses should inform the patient that they are to receive insulin – patients not expecting this will immediately question the need
Potassium Chloride (KCl) (see also Phosphate Salts)	❑ If potassium chloride (KCl) is injected too rapidly (i.e. at a rate exceeding 10 mEq/hr) or in too high a dose, it may cause cardiac arrest. KCl should never be given as an IV push and initiation of an infusion is not an emergency. Therefore, there is no need to store concentrated KCl outside of the pharmacy. ❑ Some MDs use the term "bolus" when ordering potassium at a rapid rate to treat hyperkalemia. This term has been interpreted to mean IV push.	❑ Remove all KCl vials from floor stock. Centralize KCl infusion preparation in the pharmacy. Use premixed containers. ❑ Use protocols for KCl delivery, including: • indications for KCl infusion • maximum rate of infusion • maximum allowable concentration • guidelines for when cardiac monitoring is required • stipulation that all KCl infusions must be given via pump • prohibition of multiple simultaneous KCl solutions (e.g. no IV KCl while KCl is being infused in another IV) • allow for automatic substitution of oral KCl for IV KCl when appropriate

High-Alert Medications – Problems and Key Improvements

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Lidocaine	❑ Lidocaine mix-ups have occurred when lidocaine and heparin are obtained from the same manufacturer – the labeling is similar. Errors have also occurred when 50mL vials of lidocaine were confused with other drugs also available in 50mL vials. ❑ Multidose vials of lidocaine used as a local anesthetic may be contaminated as a result of poor aseptic technique ❑ Problems may arise because of misunderstanding how topical lidocaine is absorbed ❑ The use of topical (viscous) lidocaine in the oral cavity for painful mouth lesions has caused aspiration due to oropharyngeal anesthesia and loss of sensation of food bolus that may be present in the oral cavity	❑ Use lidocaine only in single-dose vials. Do not place vials that hold more than 500 mg in patient care areas. Single-dose vials reduce the risk of overdose and eliminate the risk of contamination. ❑ Use premixed, adequately labeled solutions for all cardiology patients.
Intravenous Magnesium	❑ Errors have resulted from mix-ups between the abbreviations "MS" or "MSO_4" for morphine sulfate and "$MgSO_4$" for magnesium sulfate ❑ Other terminology problems have also led to errors; for example "mg" (milligrams) and "mL" (milliliters) are confused, as are "mg" and "mEq" (milliequivalents) ❑ Infusion pump settings have led to fatal overdoses with free-flow intravenous solutions ❑ Health professionals are often unaware that an excessive dose has been ordered and administer an overdose	❑ Require protocols for the use of magnesium ❑ Educate staff about proper dosing ❑ Establish and publicize maximum doses ❑ Do not permit the use of abbreviations for morphine and magnesium ❑ Store containers containing more than 2mL only in the pharmacy ❑ Use only premixed containers for patients on IV magnesium replacement therapy and for women with preeclampsia ❑ Standardize ordering methods (i.e. either in grams or milliequivalents) ❑ Require independent, redundant checks of all calculations, dose preparations, and infusion pump settings
Narcotics and Opiates including Patient-Controlled Analgesia (PCA)	❑ Narcotic accidents are among the most frequent of all serious incidents reported. One reason for errors with these drugs is that parenteral narcotics are usually stored in nursing areas as floor stock. They are often identified, prepared, and administered by a single nurse; no redundant checks are performed.	❑ Educate staff about the potential for mixing up hydromorphone and morphine ❑ Standardize concentrations of intravenous solutions ❑ Minimize the amount of drug in a single container

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Narcotics and Opiates including PCA (cont.)	❑ Mix-ups between hydromorphone and morphine are common; hydromorphone is five times more potent than morphine ❑ Oral liquid morphine is available in much more concentrated forms – errors have been reported resulting in overdoses ❑ PCA accidents may involve errors in concentration, rate, drug and route. PCA use by patient and their families may be problematic when, believing that the patient is in pain, families may activate the PCA ❑ PCA and epidural lines are sometimes confused, leading to errors in route of administration ❑ Allergic reactions are common ❑ Pump-related errors have occurred	❑ Ensure that naloxone or an equivalent is available in all areas where narcotics might be used ❑ Limit oral liquid items available as floor stock to conventional concentrations. Limit concentrated oral morphine and hydromorphine only in areas where chronic pain is treated ❑ Do not use potentially confusing abbreviations such as "$MgSO_4$" and "MSO_4" ❑ Implement protocols for the use of PCA and epidural medications that ensure independent double-checks of the appropriateness of drug, dose, pump setting and line placement ❑ Label the distal ends of epidural lines and intravenous lines to differentiate them ❑ Question all patients receiving opiates about allergies ❑ Use only generic names
Neuromuscular Blocking Agents	❑ Outside of the operating room (e.g., in the ED, radiology, ICU) neuromuscular blocking agents (NMB) have been inadvertently used in patients who are not receiving proper ventilatory assistance – patients who have then suffered respiratory arrest and, in some cases, death ❑ Patients have been extubated while an order for one of these agents still exists ❑ Vials of NMBs have been mixed up with other agents, such as vaccines	❑ Educate staff about the potential for problems ❑ Standardize ordering; never allow "use as needed for agitation" orders; never refer to NMB as "relaxants" ❑ Develop protocols to ensure proper storage and administration. These protocols should stipulate that NMBs must be automatically discontinued when the patient is extubated and removed from the ventilator ❑ Implement warnings to staff of potential adverse effects. For example, some hospitals place signs near where these products are stored. Some place labels reading "WARNING: PARALYZING AGENT" on these drug vials. Some manufacturers place these warnings prominently on package labels. Use these brands whenever possible ❑ Limit access – NMBs are best handled by anesthesia personnel ❑ Do not store these agents outside of critical care areas

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Phosphate Salts (Sodium and Potassium)	❑ Phosphate is often given intravenously as potassium phosphate. The person ordering the phosphate may fail to consider the amount of potassium in the product. ❑ Some prescribers order phosphate in terms of "amps" or "vials" rather than amount (expressed in millimoles).	❑ Administer phosphate replacement therapy via the oral route whenever possible. ❑ Use sodium phosphate instead of potassium phosphate whenever possible ❑ Store intravenous potassium concentrated solutions in the pharmacy only ❑ Use guidelines for administration of potassium phosphate based on the patient's level of inorganic phosphate and other clinical factors. The normal dose should not exceed 0.32 mmol/kg over 12 hours, repeated until serum phosphate is greater than 2 mg/dl. ❑ Use strict criteria for delivery rates when administering intravenous phosphate. Always deliver via a pump.
Warfarin	❑ Dosages are often improperly adjusted ❑ Drug-food interactions are not appreciated. ❑ Monitoring via prothrombin time/INR is not consistently appropriate	❑ Use pharmacy-run anticoagulation clinics ❑ Provide patient education by certified staff in a structured setting ❑ Increase monitoring (e.g., more frequent clinic visits or home testing)

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