Irish Medication Safety Network

Best Practice Guidelines For the Safe Use of Intravenous Potassium in Irish Hospitals

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This revision prepared by:

Niamh O'Hanlon (Chair), Chief II Pharmacist, St Vincent's University Hospital, Dublin; Karen Lavelle, Medication Safety Officer, Children's Health Ireland at Crumlin; Michelle English, Medication Safety Officer, ULHG; Catherine Nugent, Chief Pharmacist, Beacon Hospital; Niamh McKenna, Naas General Hospital; Aisling Beakey, Drug Safety Facilitator, Mater Misericordiae University Hospital; Karolina Holacka, Senior Pharmacist, Drug Safety, Mater Misericordiae University Hospital; Joanne Moran, Chief II Pharmacist, Regional Hospital Mullingar on behalf of the Irish Medication Safety Network in consultation with Irish Medication Safety Network members.

About the IMSN

The Irish Medication Safety Network (IMSN) is a voluntary, independent group, comprising hospital pharmacy based specialists actively involved in medication safety and Medication Safety Facilitators/Coordinators which aims to promote patient safety and safe medication practices through collaboration and shared learning within the network and with the wider community.

Website: **www.imsn.ie** Email: **enquiries@imsn.ie**

Introduction

In 2007, the World Health Organisation (WHO) issued a 'Patient Safety Solution' bulletin in which it identified concentrated potassium chloride (KCl) as a high-risk medication.[1]

The WHO/Joint Commission recommends that health-care organisations have systems and processes in place for the promotion of safe practices with potassium chloride and other concentrated electrolyte solutions. For hospitals that do not currently have a potassium policy in place, this document can form the basis of such a policy.

Evidence of Harm

In the US, between 1996-1997, 10 deaths from misadministration of potassium were reported to the Joint Commission and 23 similar events were reported in Canada, between 1993-1996. While all medications are potentially dangerous, intravenous concentrated electrolytes are especially dangerous, as it is often not possible to reverse the effects of misadministration. Concentrated potassium can be deadly when not prepared and administered properly, as it may cause fatal arrhythmia and cardiac arrest if administered too quickly.[1]

Despite published practice recommendations to reduce instances of patient harm, and the trend of decreased deaths, in 2019 the Institute of Safe Medication Practices (ISMP) Canada reported two fatal incidents involving children and the intravenous administration of concentrated potassium phosphate or potassium chloride. These cases illustrate the need for sustained nationwide vigilance to recognise the threat to patient safety when concentrated injectable electrolyte solutions are not appropriately stored, monitored, and administered.[2]

Definition of Concentrated Potassium

International agencies vary in what they define as concentrated potassium. The National Patient Safety Agency (UK) for example, defines concentrations **greater than 1.34mmol/mL** of potassium chloride (KCL) and any potassium phosphate **vial/ampoule or Miniplasco®** presentation as concentrated.[3] The Joint Commission International (JCI) defines concentrated potassium chloride as concentration **greater than or equal to 2mmol/mL**[4]. The Australian Commission for Safety & Quality in Healthcare focuses on removal of potassium chloride ampoules from ward stock, and the importance of dilution before use, rather than defining a specific concentration.[5]

According to the definitions above, in Ireland there are **two licensed presentations** of concentrated potassium:

1. Potassium chloride 15% 10mL contains 20mmol potassium in 10mL (2mmol/mL)
2. Potassium phosphate 20mL contains 20mmol potassium in 20mL (1mmol/mL)

There may also be unlicensed preparations available e.g. Addiphos® 20mL contains 30mmol potassium in 20mL (1.5mmol/mL).

Note: **Sterile Concentrate for Cardioplegia Infusion** (used in specialist centres only where cardiac surgery is performed) contains potassium chloride 1.193g in 20mL = 0.8mmol/mL.

Given that the dangers associated with potassium can have the same consequences in lower concentrations, individual hospitals may have varied definitions of what is considered concentrated. **It is therefore essential that each hospital develop its own agreed definition of "concentrated potassium" on which to base its local policy.**

These guidelines recommend that low volume premixed potassium bags also be considered as concentrated potassium products for the purpose of segregated storage. These include:
Potassium Chloride 20mmol in 100mL Sodium Chloride 0.9% w/v
Potassium Chloride 40mmol in 100mL Sodium Chloride 0.9% w/v

Best Practice Guidance

It is critical that availability, access / storage, prescribing, ordering, preparation, distribution, labelling, verification, administration and monitoring of intravenous potassium be guided in such a way that the potential for error is minimised or eliminated. The approach to this issue should be multidisciplinary and involve medical, nursing, patient safety and pharmacy representatives.

The guidance below for adults and ***paediatrics*** has been developed and updated with a view to ensuring safest practice with the use of intravenous potassium in Irish Hospitals. Every hospital should develop their own local policy taking this guidance, and best international practice into account.

Storage of Intravenous Potassium

Removal of concentrated electrolyte solutions, specifically potassium chloride, from patient care units has had a marked positive impact on the reduction of death and disabling injury associated with these agents.[1]

- **Complete removal** of concentrated potassium vials/Miniplasco® presentations from patient care areas is the overall aim.
- **Premixed potassium infusion solutions** should be used when possible.[1,3,5] For large volume fluids containing potassium (500mL or 1 Litre bags with 20mmol/40mmol of potassium chloride), hospitals should decide locally if segregated storage is feasible, based on local practice and storage capacity at ward level.
- Supply and use **of low volume premixed potassium bags** (i.e. 20mmol/100mL and 40mmol/100mL) should be restricted to designated critical care areas.
- Where concentrated potassium must continue to be stored and prepared in a clinical area, the risks of using this product should be managed by implementing **multiple precautionary measures** including the following:[1,3,6]
    - As a minimum, concentrated potassium must be **separated from other drugs**, for example, in a separate concentrated electrolyte cupboard / safe or in the Controlled Drugs Cupboard. Hospitals may want to consider treating concentrated potassium products as a Controlled Drug. This may be considered both within the pharmacy and in patient care areas
    - Minimize stock of concentrated potassium with look-alike labelling and packaging
    - Limit the amount of concentrated potassium stored in the clinical area

Prescribing Intravenous Potassium

- **Intravenous potassium should be prescribed in strengths that allow available premixed potassium infusion solutions to be used where possible.** *Note*: in ***paediatrics*** *suitable premixed bags may not be available depending on the specific requirements of this patient cohort.*
- **Specify the diluent fluid.** Initial potassium replacement therapy should not involve glucose infusions, because glucose may cause a further decrease in the plasma-potassium concentration.[7-9] Note: Compound Sodium Lactate (Hartmann's solution) already contains 5mmol/L of potassium.[10]
- Always **specify the potassium preparation** (phosphate or chloride) to be used. Potassium chloride is usually the salt of choice in the treatment of potassium depletion, since the chloride ion is required to correct hypochloremia which frequently accompanies potassium deficiency.[11]
- To avoid confusion **always prescribe in mmol**[5] – never in milliequivalents or grams or percentage.
- A **final volume** should always be prescribed. For example, potassium chloride 40mmol in 1L sodium chloride 0.9% w/v or in ***paediatrics***; potassium chloride 10mmol in 500mL of sodium chloride 0.9% w/v.
- The normal **maximum concentration of potassium for peripheral administration** in adults and children is 40mmol/L.[8,9,11] However, pain or phlebitis may occur during IV administration of solutions containing 30mmol or more potassium per litre.[11] Concentrations >40mmol/L (e.g. 40mmol in 500mL) can be given peripherally through a large vein in emergency situations but this must be guided by a consultant using appropriate monitoring.[9]
- **Oral potassium** can be prescribed in conjunction with IV potassium.[7,8] The **rate of administration should always be specified** on the prescription: See under 'Administration of Intravenous Potassium' section below.

Dispensing Intravenous Potassium

Hospitals dispensing concentrated potassium should ensure that specific procedures are in place involving location, storage and use of potassium including in areas of specialist use (e.g. Perfusion Department).

- **Premixed potassium infusion solutions** (prefilled bags) **should be dispensed and used when possible**, in preference to concentrated potassium ampoules.[1,3,5,6] These are available from a number of manufacturers. Pharmacy Departments should provide prescribers with a list of available premixed potassium infusion bags. Note: in ***paediatrics*** suitable premixed bags may not be available depending on the specific requirements of this patient cohort.
- **Low volume premixed potassium bags (**containing 20mmol potassium chloride in 100mL sodium chloride 0.9% w/v or 40mmol potassium chloride in 100mL sodium chloride 0.9% w/v) should be available for use in critical care areas.
- **Labelling:** Potassium vials, if stored in a patient care area, should have a warning label that states "MUST BE DILUTED". The WHO recommends that this should be a visible fluorescent warning.[1,6] Existing label manufacturers in Ireland can provide these labels. Low volume premixed potassium bags should have a 'High Risk Medicine' sticker on the outer box.

Administration of Intravenous Potassium

- **Addition of potassium concentrate to an infusion bag:** The rapid infusion of potassium is toxic to the heart and may be fatal. If potassium concentrate must be added to an infusion bag, care must be taken to ensure that the bag is thoroughly mixed. Incomplete mixing may result in a layer of concentrated potassium at the base of the infusion bag and inadvertent administration of a toxic bolus. To avoid this risk, after the correct quantity of concentrated potassium has been added mix thoroughly by squeezing and inverting the bag at least 10 times.[12]

- **Infusion pumps:** Potassium infusions must always be administered using a rate-controlled infusion pump.[13] This should be taken into account when transporting a patient between clinical areas. Consideration should also be given to the infusion of potassium via a programmable infusion pump utilizing dose error-reduction software (Smart pumps) where available and if not available, hospitals should endeavor to invest in this technology.

- **Rate of administration**: Current practice guidelines, supported by the IMSN, suggest prescribing a **maximum rate of 10mmol/hour potassium chloride administration for general ward areas**. Faster administration rates are possible if central line and cardiac monitoring are available.[9,11,13,14] In these situations, the IMSN recommends a maximum rate of 20mmol potassium/hour. (See below for advice about continuous cardiac monitoring) **Each hospital should develop its own agreed maximum rate of administration with regard to the current evidence available.**

- In ***paediatrics*** the current practice guidelines, supported by the IMSN, suggest prescribing a **maximum rate of administration of 0.2mmol/kg/hour[15] (not to exceed 10mmol/hour) potassium** for general ward areas. Faster administration rates are possible if central line and cardiac monitoring are available.[9,10,13,14] See below under 'Continuous Cardiac Monitoring' for further details.

- The normal **maximum concentration of potassium for peripheral administration** in adults or children is 40mmol/L.[8,9,11] However, pain or phlebitis may occur during IV administration of solutions containing 30mmol or more potassium per Litre.[11,12] Concentrations >40mmol/L (e.g. 40mmol in 500mL) can be given peripherally through a large vein in emergency situations but this must be guided by a consultant using appropriate monitoring.[9]

- Consider using a **'High Risk Medicine'** warning label on prepared IV potassium solutions prior to administration.[1]

- Repeated **measurements of plasma potassium concentration** are necessary to determine whether further infusions are required and to avoid the development of hyperkalaemia. The potassium content of any concurrent **parenteral nutrition** should also be taken into account.

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Continuous Cardiac Monitoring requirements:

- Advised if the **rate of infusion** is greater than 10mmol potassium/hour,[13] and must be used if the rate of infusion is 20mmol potassium/hour.[9,14]
- Required if the patient's **serum potassium is *less than or equal to* 2.5mmol/L.**[7]
- Required if **the potassium concentration being administered exceeds 80mmol per litre.**[14]
- Consider a **baseline ECG if serum potassium is less than 3mmol/L.**
- **Peaking of the T wave or other ECG changes** associated with hyperkalemia indicate that the rate of potassium infusion is excessive and should be reduced.[11]
- ***Paediatrics:*** Continuous cardiac monitoring is advised if the rate of infusion is greater than 0.2mmol/kg/hour[15], not to exceed 10mmol potassium/hour[13], and must be used if the rate of infusion is equal to or greater than 0.5mmol/kg/hour not to exceed 20mmol potassium/hour.[9,11,14]
- Continuous cardiac monitoring is recommended in ***paediatrics*** if the concentration being administered exceeds 40mmol/L and required if the potassium concentration being administered exceeds 80mmol/L.[12,14]

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