



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

This document is intended as a “best practice” guideline and is not to be regarded as a document offering definitive legal advice in relation to the subject matter.

Publication Date: July 2013 Version 3

©IMSNI. The IMSNI allows the sharing or reproduction of this material, provided that the source of the information is appropriately acknowledged and a link to our website is supplied.

Table of Contents

About the IMSN.....	2
Introduction	3
Definition of Concentrated Potassium	3
Prescribing Issues	4
Dispensing Issues	5
Administration Issues	6
Cardiac Monitoring	6
Paediatrics	7
References.....	9

Prepared by

Niamh O’Hanlon, Chief II Pharmacist, St Vincent’s University Hospital, Dublin; Catherine Nugent, Chief Pharmacist, Beacon Hospital, Dublin; Maura O’Connor, Senior Pharmacist, Our Lady’s Children’s Hospital, Crumlin; Paul Tighe, Pharmacy Manager, Mater Private Hospital, Dublin.

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 an independent group of pharmacists and other specialists working in the acute sector, whose principal aim is to improve patient safety with regard to the use of medicines through collaboration, shared learning and action.

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

In the US in 2 years of reporting on misadministration of potassium, 10 deaths were reported to the Joint Commission, a leading international organisation that accredits hospitals internationally, and in Canada, between 1993-1996, 23 events were reported. While all medications are potentially dangerous, concentrated electrolytes are especially dangerous. Most of the time, it is not possible to reverse the effects of misadministration of KCl. In short, concentrated potassium is deadly when not prepared and administered properly.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 which do not currently have a potassium policy in place, this document can form the basis of such a policy.

Recommendations:

- It is critical that availability, access / storage, prescribing, ordering, preparation, distribution, labelling, verification, administration and monitoring of these agents 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.

Definition of Concentrated Potassium

The National Patient Safety Agency (UK) defines concentrations greater than 1.34mmol/mL of potassium chloride (KCl) and any potassium phosphate vial/ampoule or Miniplasco[®] presentation as concentrated.² In practice this includes concentrated potassium in ampoules/vials/Miniplasco[®] presentations or as a component of a product e.g. within parenteral nutrition. For example, in Ireland there are three 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)
3. Addiphos[®] 20mL contains 30mmol potassium in 20mL (1.5mmol/mL)

The Joint Commission International (JCI) defines concentrated potassium chloride as concentration greater than or equal to 2mmol/mL.³ 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.⁴

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 develops its own agreed definition of "concentrated potassium" on which to base its local policy.**

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

- **Ideally, complete removal of concentrated potassium from patient care areas is the goal.**
- **Ready-mixed potassium infusion solutions** (prefilled bags) **should be used** when possible.^{1,2,4}
- Ready-mixed potassium infusion bags should be segregated from other IV fluids in storage areas.⁴
- As a minimum, concentrated potassium must be separated from other drugs, for example, in a separate cupboard/safe or in the Controlled Drugs Cupboard. Hospitals may want to consider treating concentrated potassium products as a Controlled Drug for record keeping purposes. This may be considered both within the pharmacy and in patient 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:^{1,2,5}
 - Minimize stock of concentrated potassium with look-alike labelling and packaging
 - Segregate storage of concentrated potassium from other medicines
 - Limit access to concentrated potassium to a small number of qualified staff
 - Limit the amount of concentrated potassium stored in the clinical area

Prescribing Issues

Prescribing Potassium

- Oral potassium can be prescribed in conjunction with IV potassium.^{6,7}
- **Intravenous potassium should be prescribed in strengths that allow available ready-mixed potassium infusion solutions** (prefilled bags) **to be used where possible.** Pharmacy Departments should provide prescribers with a list of available ready-mixed potassium infusion bags.
- Always specify the potassium preparation (Phosphate or Chloride) to be used.
- To avoid confusion **always prescribe in mmol**⁴ – never in milliequivalents or grams or percentage.

Specify the diluent fluid and volume

- A final volume should always be prescribed. For example: 40mmol KCl in 1L Sodium Chloride 0.9% over 8 hours.
- Initial potassium replacement therapy should not involve glucose infusions, because glucose may cause a further decrease in the plasma-potassium concentration.⁶⁻⁸
- The normal maximum concentration of potassium for peripheral administration is 40mmol/L.⁷⁻⁹ However, pain or phlebitis may occur during IV administration of solutions containing 30mmol or more potassium per litre.⁹
- Note: Compound Sodium Lactate (Hartmann's solution) already contains 5mmol/L of potassium.¹⁰

Specify the rate of administration

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. This guidance has been implemented in many Irish hospitals. Faster administration rates are only advisable if central line and cardiac monitoring are available.^{8,9,11,12} In these situations, the IMSN recommends a maximum rate of 20mmol potassium/hour.

Each hospital should develop its own agreed maximum rate of administration with regard to the current evidence available.

Dispensing Issues

- **Ready-mixed potassium infusion solutions** (prefilled bags) **should be dispensed and used when possible**, in preference to concentrated potassium ampoules.^{1,2,4,5} These are available from a number of manufacturers. Pharmacy Departments should provide prescribers with a list of available ready-mixed potassium infusion bags.
- **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.^{1,5}
Existing label manufacturers in Ireland can provide these labels.
- Hospitals dispensing concentrated potassium should ensure that specific procedures are in place involving location, storage and use of potassium in areas of specialist use (e.g. perfusion department).

Administration Issues

Safe administration practice: 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.¹³

- Potassium infusions must always be administered using a rate-controlled infusion pump.¹² This should be taken into account when transporting a patient between clinical areas.
- Consider using a high risk warning label on prepared IV potassium solutions prior to administration.¹
- **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. This guidance has been implemented in many Irish hospitals. Faster administration rates are only advisable if central line and cardiac monitoring are available.^{8,9,11,12} In these situations, the IMSN recommends a maximum rate of 20mmol potassium/hour.
- Continuous cardiac monitoring is advised if the rate of infusion is greater than 10mmol potassium/hour,¹² and must be used if the rate of infusion is 20mmol potassium/hour.^{8,9,11}
- The normal maximum concentration of potassium for peripheral administration is 40mmol/L.⁷⁻⁹ However, pain or phlebitis may occur during IV administration of solutions containing 30mmol or more potassium per litre.⁹
- Repeated measurements of plasma potassium concentration are necessary to determine whether further infusions are required and to avoid the development of hyperkalaemia.

Cardiac Monitoring

- Continuous cardiac monitoring is advised if the rate of infusion is greater than 10mmol potassium/hour,¹² and must be used if the rate of infusion is 20mmol potassium/hour.^{8,9,11}
- Continuous cardiac monitoring is required if the patient's serum potassium (K^+) is **less than or equal to 2.5 mmol/L**.⁶
- Continuous cardiac monitoring is required if the **K^+ concentration being administered exceeds 80 mmols per litre**.¹¹
- Consider a baseline ECG if K^+ is less than 3mmol/L.

Paediatrics For full guidance see latest BNF for Children.¹⁴

Prescribing in Paediatrics

- Oral potassium can be prescribed in conjunction with IV potassium.^{6,7}
- **Intravenous potassium should be prescribed in strengths that allow available ready-mixed potassium infusion solutions (prefilled bags) to be used where possible.**
- Always specify the potassium preparation (Phosphate or Chloride) to be used.
- To avoid confusion **always prescribe in mmol⁴**, never in milliequivalents or grams or percentage.

Specify the diluent fluid and volume

- A final volume and a rate of administration should always be prescribed. For example: 10mmol KCl in 500mL Sodium Chloride 0.9% at 60mL / hour.
- The normal maximum concentration of potassium for peripheral administration is 40mmol/L.⁷⁻⁹ However, pain or phlebitis may occur during IV administration of solutions containing 30mmol or more potassium per litre.⁹
- Initial potassium replacement therapy should not involve glucose infusions, because glucose may cause a further decrease in the plasma-potassium concentration.⁶⁻⁸
- Note: Compound Sodium Lactate (Hartmann's solution) already contains 5mmol/L of potassium.¹⁰

Specify the rate of administration of potassium

- Current practice guidelines supported by the IMSN, suggest prescribing a **maximum rate of administration of 0.2mmol/kg/hour (not to exceed 10mmol/hour) potassium chloride** for general ward areas. Faster administration rates are only advisable if central line and cardiac monitoring are available.^{8,9,11,12}

Dispensing in Paediatrics

- **Ready-mixed potassium infusion solutions (prefilled bags) should be dispensed and used when possible**, in preference to concentrated potassium ampoules.^{1,2,4,5} These are available from a number of manufacturers. Pharmacy Departments should provide prescribers with a list of available ready-mixed potassium infusion bags.
- **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.^{1,5} **Existing label manufacturers in Ireland can provide these labels.**
- Hospitals dispensing concentrated potassium should ensure that specific procedures are in place involving location, storage and use of potassium in areas of specialist use (e.g. perfusion department).

Administration of concentrated potassium in Paediatrics:

Safe administration practice: 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.¹³

- Potassium infusions must always be administered using a rate-controlled infusion pump.¹² This should be taken into account when transporting a patient between clinical areas.
- Consider using a high risk warning label on prepared IV potassium solutions prior to administration.¹
- **Rate of administration:** Current practice guidelines, supported by the IMSN, suggest prescribing a **maximum rate of administration of 0.2mmol/kg/hour¹⁴ (not to exceed 10mmol/hour) potassium chloride** for general ward areas. Faster administration rates are only advisable if central line and cardiac monitoring are available.^{8,9,11,12} In these situations, the IMSN recommends a maximum rate of 20mmol potassium/hour.
- The normal maximum concentration of potassium for peripheral administration is 40mmol/L.⁷⁻⁹ However, pain or phlebitis may occur during IV administration of solutions containing 30mmol or more potassium per litre.⁹
- Repeated measurements of plasma potassium concentration are necessary to determine whether further infusions are required, and to avoid the development of hyperkalaemia.

Cardiac Monitoring in Paediatrics

- Continuous cardiac monitoring is advised if the rate of infusion is greater than 0.2mmol/kg/hour¹⁴, not to exceed 10mmol potassium/hour¹², 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.^{8,9,11}
- Continuous cardiac monitoring is required if the patient's serum potassium (K⁺) is **less than or equal to 2.5 mmol/L**.⁶
- Continuous cardiac monitoring is recommended if the concentration being administered exceeds 40mmol/Litre and required if the K⁺ concentration being administered exceeds 80 mmol/Litre.¹¹

References

1. Joint Commission, Joint Commission International, World Health Organisation. Control of concentrated electrolyte solutions. Patient safety solutions; volume 1, solution 5, May 2007 Available from: <http://www.who.int/patientsafety/solutions/patientsafety/PS-Solution5.pdf>
2. National Patient Safety Agency. Patient Safety Alert: *Storage and handling of potassium chloride concentrate and other strong potassium solutions* (2002). Available from: <http://www.npsa.nhs.uk/nrls/alerts-and-directives/alerts/potassium-chloride-concentrate/>
3. Joint Commission International. Joint Commission International Accreditation Standards for Hospitals, 4th ed (2012). Accessed online 6 Nov 2012
4. The Australian Council for Safety & Quality. Medication Alert 1: *Intravenous potassium can be fatal if given inappropriately* (October 2003). Available from www.safetyandquality.gov.au
5. WHO World Alliance for Patient Safety. High 5s Standard Operating Procedures: Managing Concentrated Injectable Medicines Standard Operating Protocol Fact Sheet. Available from: http://www.who.int/patientsafety/implementation/solutions/high5s/ps_concentrated_injectable_medicines_fs_2010_en.pdf
6. Mount D., Sterns R., & Emmet M. *Clinical manifestations and treatment of hypokalemia* (2012). Available via subscription from www.uptodate.com Accessed 17 Oct 2012
7. Joint Formulary Committee. *British National Formulary*. 65th ed. London: British Medical Association and Royal Pharmaceutical Society of Great Britain; 2013. Accessed online eBNF via subscription www.medicinescomplete.com 2 Jul 2013
8. Medusa NHS Injectable Drugs Guide. Available via subscription from www.injguide.nhs.uk Accessed 2 Jul 2013
9. AHFS Drug Information. Potassium chloride (updated June 2013). Accessed online via subscription www.medicinescomplete.com 3 Jul 2013
10. SPC Compound Sodium Lactate Intravenous Infusion BP, Ecobag (Hartmann's Solution). Available from www.imb.ie. Accessed 17 Oct 2012
11. UCLH Injectable Medicines Administration Guide. Potassium chloride monograph 3rd ed (2010), Wiley – Blackwell
12. Gahart & Nazareno. *Intravenous Medications*. Potassium acetate and Potassium chloride monograph (2013). Elsevier publications
13. Gray A, Wright J, Goodey V, Bruce L. *Injectable Drugs Guide*. Potassium chloride monograph Accessed via www.medicinescomplete.com 2 Nov 2012.
14. British National Formulary for Children. *Chapter 9 Nutrition and Blood* (Sept 2012) Accessed online eBNFC via subscription www.medicinescomplete.com 16 Oct 2012