Potassium chloride - Intravenous

Newborn use only

2022

<table>
<tr><td>Alert</td><td>High risk medicine.
The use of pre-mixed potassium chloride solutions are preferred where possible.
The addition of potassium chloride to the maintenance fluids is preferred over the use of a side line to minimise the risk. Additional potassium chloride must not be added to premixed potassium chloride intravenous solutions.
Recommended to store only 10 mmol/10 mL potassium chloride concentrated ampoules to avoid errors.
Concentrated potassium ampoules MUST BE DILUTED prior to intravenous infusion.
When correcting severe or symptomatic hypokalaemia – Avoid diluting with glucose solution as serum potassium level may further decrease.
Osmolality of 1 mmol/1 mL of potassium chloride = 2000 mOsm/L.(1)
Intravenous (IV) fluids with regular pre-mixed 2 mmol/100 mL (20 mmol/L) potassium chloride provides a daily maintenance dose of 2.4 to3.0 mmol/kg/day of potassium at 120 to150 mL/kg/day.
Standard Australian consensus amino-acid formulations and paediatric IV fluids have 2 mmol/100 mL potassium chloride.
Central IV administration: maximum concentration is 80 mmol potassium chloride/L (0.08mmol/mL).(2)
Peripheral IV administration: maximum concentration is 40 mmol potassium chloride/L (0.04mmol/mL).(2)
Consider all sources of potassium including parenteral nutrition when calculating total daily dose.</td></tr>
<tr><td>Safety handling of potassium chloride</td><td>• Stock of concentrated potassium ampoules should be subject to risk assessment and stored separately from ampoules of similar appearance and packaging.
• Retain in original packaging and remove just prior to use.
<u>When prescribing potassium</u>
• Rapid correction is rarely needed in neonates.
• Identify and treat the aetiology for hypokalaemia (e.g. ceasing diuretics)
• Err on the lower end of the estimate.
• Consider oral potassium replacement where possible.
• Discuss with clinician-in-charge prior to IV correction of hypokalaemia.</td></tr>
<tr><td>Indication</td><td>Treatment and prevention of hypokalaemia.</td></tr>
<tr><td>Action</td><td>Intracellular cation. Essential in the maintenance of body fluid composition and electrolyte balance. Participates in carbohydrate utilisation and protein synthesis. It is critical in the regulation of nerve conduction and muscle contraction, particularly in the heart.</td></tr>
<tr><td>Drug type</td><td>Electrolyte.</td></tr>
<tr><td>Trade name</td><td>Pfizer Sterile Potassium Chloride Concentrate, Potassium Chloride Juno</td></tr>
<tr><td>Presentation</td><td>Pfizer (Perth) Sterile Potassium Chloride Concentrate (Concentrate for infusion): 10 mmol/10 mL and Potassium Chloride Juno Concentrate: 10 mmol/10 mL.
Other strengths of potassium chloride have been intentionally excluded from this neonatal formulary.</td></tr>
<tr><td>Dose</td><td><u>Mild to moderate hypokalaemia (<3.5 mmol/L) with no ECG changes</u>
Check if the regular maintenance IV fluid has potassium chloride in the solution.
Maintenance IV fluid containing potassium may be adequate.

Parenteral maintenance dose can be provided in maintenance IV fluids as:
Not greater than 4 mmol/100 mL (20 to 40 mmol/L) of potassium chloride in peripheral IV fluids;
Not greater than 8 mmol/100 mL (80 mmol/L) of potassium chloride in central IV fluids

The daily parenteral maintenance dose of potassium:

<table><tr><td><u>Weight</u></td><td><u>Dose</u></td></tr><tr><td><1500 g</td><td>2 to 5 mmol/kg/day</td></tr><tr><td>≥1500 g</td><td>1.5 to 3.0 mmol/kg/day</td></tr></table>
<u>Severe (Serum potassium <1.5 mmol/L) or symptomatic hypokalaemia with ECG changes (2)</u>
Discuss with clinician in-charge prior to rapid IV correction of hypokalaemia. Dose and administration may be altered as the clinical condition dictates.</td></tr>
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	0.1-0.2 mmol/kg/hour over 2-3 hours. **Do not exceed rate of 0.2 mmol/kg/hour** Repeat dose if serum potassium level is not corrected.
Dose adjustment	Therapeutic hypothermia – Ensure adequate urine output and renal function. ECMO – Determined by renal function. Renal impairment – Ensure adequate urine output prior to supplementation. Hepatic impairment – No specific dose adjustment.
Maximum dose	
Total cumulative dose	
Route	IV
Preparation	**Addition of potassium chloride to maintenance IV fluids** Note: Preferable to use premixed maintenance IV fluid with potassium chloride (e.g. Baxter 0.225% sodium chloride + 10% glucose + 2 mmol/100 mL potassium chloride). If premixed bags are not available, potassium chloride 10mmol/10 mL strength can be added by following the steps below: 1. Calculate potassium requirement for infant in mmol/day Infant weight x mmol/kg/day required = mmol/day E.g. 3 kg x 2 mmol/kg/day = 6 mmol/day 2. Calculate IV maintenance fluid requirement in mL/day (deduct enteral feeds or other IV infusions) Infant weight x mL/kg/day = mL/day of IV maintenance fluid E.g. 3 kg x 90mL (TFR) = 270mL/day of IV maintenance fluid 3. Calculate volume (mL) of potassium chloride to be added to 500 mL bag mmol/day ÷ mL per day of IV maintenance fluid x 500 = mmol potassium chloride required. E.g. $\frac{6}{270} \times 500$ mL = 11.1 mmol potassium chloride required ≡ 11.1 mL potassium chloride required 4. From 500 mL bag, **remove** the amount of fluid that will be replaced by potassium chloride E.g. Remove 11.1 mL of IV fluid from 500 mL bag. 5. **Add** the calculated volume of potassium chloride to 500 mL bag. E.g. Add 11.1 mL of potassium chloride to 500 mL bag. 6. The bag must be inverted ten times to ensure potassium chloride is thoroughly mixed throughout the solution. 7. Apply a fluid label, clearly identifying addition of potassium chloride as per NSW health policy **IV infusion for severe or symptomatic hypokalemia** Draw up 10 mL (=10 mmol) Potassium chloride and add 10 mL of sodium chloride 0.9%* to make a final volume of 20 mL with a concentration of 0.5 mmol/mL. Dose = 0.1-0.2 mmol/kg/hour over 2-3 hours. Repeat dose if serum potassium level is not corrected. *Do not dilute with glucose solutions as glucose can cause further drop in serum potassium.
Administration	For rapid correction: IV infusion over 2-3 hours When added to IV maintenance fluid bag: continuous infusion over 24 hours
Monitoring	Injection site for pain or phlebitis. Continuous cardio-respiratory monitoring Serum electrolytes – serum potassium.
Contraindications	Hyperkalaemia.(3) Hyperadrenalism associated with adrenogenital syndrome. Tissue breakdown. Acute dehydration.

	Renal impairment with oliguria and azotaemia. Untreated Addison's disease. Ventricular fibrillation. Atrioventricular or intraventricular heart block. Conditions with increased sensitivity to potassium : Adynamia episodica hereditaria, congenital paramyotonia (3)
Precautions	Renal impairment, adrenal insufficiency, impaired potassium excretion, heart block associated disease, bradycardia; cardiac, renal, sickle cell disease, acidosis.(3)
Drug interactions	Potassium sparing diuretics, including spironolactone: Increase serum potassium. Amphotericin B Liposomal: – Can cause hypokalaemia.(4) Doxapram: Can cause hypokalaemia.(5) ACE inhibitors, including enalapril and captopril: Elevate serum potassium. Beta adrenergic blockers: - Increase both peak serum potassium and the time required for serum potassium to return to basal levels. Nonsteroidal anti-inflammatory drugs (NSAIDs): May cause hyperkalaemia by inducing secondary hypoaldosteronism. Heparin: Reduces the synthesis of aldosterone which may result in hyperkalaemia. Digitalis glycosides: Potassium supplements are not recommended for concurrent use in digitalised patients with severe or complete heart block. In treating hyperkalaemia in digitalised patients, too rapid a lowering of the serum potassium concentration can produce digitalis toxicity.(3) Sodium bicarbonate: Concurrent use may decrease serum potassium.
Adverse reactions	Hyperkalaemia: Can develop rapidly and asymptomatically and is potentially fatal. Pain or phlebitis may occur. Cardiovascular: Hypotension, cardiac depression, arrhythmias and heart block. ECG abnormalities: - Disappearance of P wave, widening and slurring of QRS complex, changes of the ST segment, tall peaked T waves. Gastrointestinal: Vomiting, diarrhoea and abdominal discomfort. Other: Listlessness, flaccid paralysis.
Compatibility	**Fluids:** Sodium chloride 0.9%, sodium chloride 0.45%, Hartmann's, Ringer's, pre-mixed amino-acid formulations(6). Glucose containing solutions, but NOT PREFFERED as glucose may further decrease serum potassium level. **Y-site:** Do not add other drugs to pre-mixed potassium chloride bags. Aciclovir, aminophylline, amiodarone, ampicillin, atracurium, atropine, azathioprine, aztreonam, calcium gluconate, caspofungin, cefazolin, cefotaxime, cefoxitin, ceftazidime, ceftriaxone, clindamycin, dexamethasone, dexmedetomidine, digoxin, dopamine, ephedrine sulfate, fentanyl, fluconazole, furosemide, ganciclovir, gentamicin, glyceryl trinitrate, heparin, hydrocortisone, insulin, labetalol, lidocaine, linezolid, magnesium sulfate, metoclopramide, midazolam, milrinone, morphine, neostigmine, noradrenaline, paracetamol, piperacillin-tazobactam, ranitidine, remifentanil, sodium bicarbonate, tobramycin, vancomycin, verapamil, zidovudine.(6)
Incompatibility	**Fluids:** Fat emulsion. **Y site:** Amoxicillin, azithromycin, cefalotin, methylprednisolone, sodium nitroprusside, suxamethonium, thiopental.
Stability	Ampoule: Store below 25°C.(6) Infusion solution: Stable for 24 hours at 2 to 8°C.(6)
Storage	Store vials below 25°C. For single use only and discard any remaining portion.
Excipients	Water for Injection.
Special comments	Patients with hypokalaemia may also have hypomagnesemia as a result of concurrent loss of magnesium with diarrhoea, diuretic therapy or medications such as amphotericin B. If hypomagnesemia is present, it should be treated prior to the administration of potassium.(7)
Evidence	**Efficacy** There are no reported trials on the efficacy and safety of potassium therapy in hypokalaemia in neonates. **Parenteral potassium:** Dose of 0.3 to 0.5 mmol/kg/dose (up to a maximum of 1 mmol/kg/dose) has been suggested to treat severe hypokalaemia.(2)

	Enteral potassium: Limited evidence in infants and children suggests enteral potassium replacement may be an equally efficacious alternative first-line therapy in treating hypokalaemia. (8) (LOE II GOR C) Merchant et. al. (8) performed an open-label randomised trial to study the serum potassium changes with enteral versus IV potassium in hypokalaemic infants and children (aged 1 month to 15 years), undergoing surgical repair/palliation of a congenital heart lesion. In the IV arm, dilutions were 80 mmol/L for a peripheral line and 150 mmol/L for a central line. In the oral potassium chloride group, the concentration used was 13.33 mmol/5 mL. The parenteral/enteral dose used was 0.1-0.3 mmol/kg dose for serum potassium 3.5-4.4 mmol/L; 0.5 mmol/kg/dose for serum potassium 3.0-3.4 mmol/L and 0.7-1.0 mmol/kg/dose for serum potassium <3.0 mmol/L. There was no statistically significant difference in change in potassium levels after either enteral or parenteral route. **Safety** In Merchant's trial of enteral and intravenous potassium, no mortality was reported in either arm. A few episodes of vomiting were reported in enteral route presumably because of poor taste or rapid administration.(8) **Pharmacokinetics** Almost all of potassium ingested through diet is absorbed. The kidneys excrete more than 90% of daily intake and are the organs primarily responsible for the elimination of potassium. Under normal conditions, potassium excretion via the gastrointestinal route is negligible.(9)
Practice points	**General** Hypokalaemia is defined as serum potassium < 3.5 mmol/L. • Mild hypokalaemia: serum potassium of 2.5 to 3.5 mmol/L • Moderate hypokalaemia: serum potassium < 2.5 mmol/L with **no** ECG changes. • Severe hypokalaemia: serum potassium < 1.5 mmol/L or with ECG changes.(2) A decrease of 1 mmol/L in serum potassium concentration refers to a 10% to 30% decrease in body potassium. (9, 10) In the absence of an independent factor causing transcellular potassium shifts, the magnitude of the deficit in body stores of potassium correlates with the degree of hypokalaemia. On average, serum potassium decreases by 0.3 mmol per litre for each 100 mmol reduction in total body stores, but the response is extremely variable. Because potassium repletion is rarely an urgent undertaking, err on the low end of this estimate to avoid inducing hyperkalaemia (11) Hypokalaemia can cause functional changes in striated muscle, smooth muscle, and the heart. Severe hypokalaemia can lead to electrocardiography (ECG) changes including increase in the amplitude of P-waves, prolongation in PR and QT intervals, decrease in the amplitude of T-waves, inversion in T-waves, depression in ST segments, and the appearance of U-waves. Paralytic ileus and gastric dilatation develop when the smooth muscles are affected. Rhabdomyolysis, myoglobinuria, severe muscle weakness, paralysis, respiratory distress and respiratory arrest are observed. Fasciculation and tetany are observed in muscles. Persistent metabolic alkalosis develops with hypokalaemia.(9) **Dose** Dosing for daily parenteral potassium supplementation is based on ESPGHAN 2018 recommendations:(4) 1. Potassium administration should regard initial phase of oliguria and the risk of non-oliguric hyperkalaemia in VLBW infants. A deferment of parenteral potassium supply might be required to avoid hyperkalaemia. 2. Parenteral potassium requirement during Phase I (Transition phase) – from birth until maximal weight loss (e.g. until Day 5 of life): 0 to 3 mmol/kg/day 3. Parenteral potassium requirement during Phase II (Intermediate phase) – period from maximal weight loss to regaining birthweight: 1 to 3 mmol/kg/day 4. Parenteral potassium requirement during Phase III (Stable phase) – regular weight gain phase a) Preterm neonates <1500 g: 2 to 5 mmol/kg/day and b) Infants≥1500 g: 1.5 to 3.0 mmol/kg/day. Treatment of mild to moderate hypokalaemia is based on expert opinion. (5)

	Treatment of severe or symptomatic hypokalaemia with correction dose of 0.3-0.5 mmol/kg/dose over 1 hour is based on expert opinion. (5)
References	1. Potassium chloride injection. https://wwwaccessdatafdagov/drugsatfda_docs/label/2017/019904s014lblpdf. 2. Bonilla-Félix M. Potassium regulation in the neonate. Pediatric Nephrology. 2017;32(11):2037-49. 3. Potassium chloride injection. MIMS online. Accessed on 15 September 2020. 2020. 4. Kobayashi R, Keino D, Hori D, Sano H, Suzuki D, Kishimoto K, et al. Analysis of Hypokalemia as a Side Effect of Liposomal Amphotericin in Pediatric Patients. The Pediatric infectious disease journal. 2018;37(5):447-50. 5. Shimokaze T, Toyoshima K, Shibasaki J, Itani Y. Blood potassium and urine aldosterone after doxapram therapy for preterm infants. Journal of Perinatology. 2018;38(6):702-7. 6. Potassium chloride. Australian Injectable Drugs Handbook, 8th Edition Accessed on 15 September 2020. 2020. 7. Daly K, Farrington E. Hypokalemia and hyperkalemia in infants and children: pathophysiology and treatment. Journal of Pediatric Health Care. 2013;27(6):486-96. 8. Merchant Q, Hasan BS, Rizvi A, Amanullah M, Rehmat A, ul Haq A. Comparison of enteral versus intravenous potassium supplementation in hypokalaemia in paediatric patients in intensive care post cardiac surgery: open-label randomised equivalence trial (EIPS). BMJ open. 2017;7(5):e011179. 9. Sarici D, Sarici SU. Neonatal hypokalemia. Research and Reports in Neonatology. 2012;2:15-9. 10. Galloway E, Doughty L. Electrolyte emergencies and acute renal failure in pediatric critical care. Clinical Pediatric Emergency Medicine. 2007;8(3):176-89. 11. Gennari FJ. Hypokalemia. New England Journal of Medicine. 1998;339(7):451-8.

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