

TARGET AUDIENCE	Paediatric Patients in Secondary care .
PATIENT GROUP	Paediatric patients who have hypokalaemia within secondary care

Clinical Guidelines Summary

This guideline is for use in children on ward 19/20 University Hospital Wishaw who have been identified as having low potassium and have failed to correct with oral supplementation alone or peripheral intravenous fluids with potassium supplementation, where the concentration of potassium given was 20mmol/500ml bag of IV fluids.

Normal maintenance potassium for paediatric patients is 1-2mmol/kg/day. Any additional insult is likely to require higher doses of potassium, this includes diarrhoea, vomiting and inter-current illnesses. Most patients will only need IV fluids with potassium chloride at maintenance rate with 10mmol KCl per 500ml bag to maintain a potassium level > 3.5 mmol/l. However, there will be some patients who will need additional potassium to help maintain their homeostasis. The threshold for additional treatment in patients is a potassium level < 3.5 mmol/l, or as specified by the treating clinician. Treatment should be commenced if the potassium level falls below the target level. ECG changes can occur as a result of low or high potassium and can also occur during potassium corrections. Potassium overdose can be fatal. Ready-mixed infusion solutions containing potassium should be used.

It is advised from expert sources that intravenous potassium administered peripherally should not exceed the concentration of more than 40mmol/l = 20mmol/500ml bag due to risk of phlebitis and severe extravasation injury. It should be given slowly and at a rate not exceeding 0.2mmol/kg/hour.

Higher concentrations of intravenous Potassium in fluids may be required in children who are unable to take potassium orally and who need restriction of intravenous fluids, for example in Diabetic Ketoacidosis. In these cases, the children would require a central line.

Treatment of Hypokalaemia in Children

Potassium supplementation

1. Oral/enteral is the preferred route of potassium administration if the child is able to tolerate it.
2. Intravenous potassium replacement carries a risks of inadvertent hyperkalaemia, fluid overload, and peripheral vein extravasation/thrombophlebitis. Excessive potassium supplementation can cause cardiac arrest and be fatal.
3. Monitoring of clinical/fluid status and electrolytes is important in children receiving potassium supplementation.
4. Specialist advice should be sought for critical or symptomatic hypokalaemia.

The goals of treating hypokalaemia are to:

- prevent life threatening complications: arrhythmias, paralysis, rhabdomyolysis, diaphragmatic weakness
- replace potassium deficit
- correct the underlying cause

Causes of Hypokalaemia

Decreased intake	Increased losses	Transcellular shifts	Medicines contributing to hypokalaemia	Spurious
Illness	Gastrointestinal	Alkalosis	Loop diuretics (e.g. furosemide)	Sampling error
Fasting	<ul style="list-style-type: none"> • Vomiting • Diarrhoea • Fistula 	Hypomagnesaemia	Thiazide diuretics	<ul style="list-style-type: none"> • Recent line flush • IV fluids near sampling site
Prolonged IV fluids not containing potassium	Renal	Hypernatremia	Amphotericin Cisplatin	
Eating disorder	<ul style="list-style-type: none"> • Diuretics • Osmotic diuresis • Aldosterone excess • Mineralocorticoid excess • Congenital adrenal hyperplasia • Renal artery stenosis 	Glucose/insulin infusion	Insulin	
		Diabetic ketoacidosis	Salbutamol Adrenaline	
		Refeeding syndrome		

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Treatment of Hypokalaemia in Children

Assessment

- In the history and examination consider the underlying cause and correct this where possible.
- Assess fluid status at assessment

Investigation

Consider:

- repeat electrolytes to verify the initial result
- urine electrolytes to look for excessive renal losses

Note: serum potassium level can be falsely elevated in haemolysed/finger prick samples, so a venous sample should be taken if clinical suspicion of hypokalaemia

- baseline renal function
- blood gas if concerns regarding acid-base status
- serum magnesium level, especially if hypokalaemia is refractory to treatment (hypomagnesaemia promotes potassium wasting)

Perform ECG if signs/symptoms of hypokalaemia, risk of cardiac arrhythmia, or serum potassium <3 mmol/L.

- Look for wide flat T waves, ST depression, T wave inversion, tall wide P waves, prolonged PR segment, U waves, apparent prolonged QT (fusion of T and U waves), prolonged QRS, arrhythmia.

Management

Replacement

Potassium replacement is indicated if:

- serum potassium <3.0 mmol/L or
- serum potassium <3.5 mmol/L with symptoms/signs/ECG changes

If serum potassium is 3.0 mmol/L - 3.4 mmol/L in a well-child, it is reasonable to either:

- monitor electrolytes,
- increase maintenance potassium dose, or
- replace potassium depending on the clinical situation

In children with stable haemodynamics and no ECG changes, aim for a gradual correction over 24-48 hours.

Check normal renal function before giving extra potassium.

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Treatment of Hypokalaemia in Children

Choice of dosing route

Oral/enteral is the preferred route of administration if the child is stable.

- Oral potassium is well absorbed from the gastrointestinal tract.
- Best taken with or soon after food to reduce gastrointestinal irritation.

Consider intravenous replacement if:

- Child is on treatment for Diabetic Ketoacidosis (see BSPED guideline)
- Child is on intravenous Aminophylline
- Child is unable to tolerate oral or NG medication
- Serum potassium <2.5 mmol/L
- ECG changes present

Oral Potassium Preparations and Dosing

Oral Preparations stocked are:

- Kay-Cee-L® syrup containing 1 mmol/mL each of K⁺ and Cl⁻.
- Sando-K® tablet contains 12 mmol K⁺ and 8 mmol of Cl⁻. (when available)

<u>Indication</u>	<u>Oral dose</u>
Prevention of hypokalaemia (patients with normal diet)	1-2 mmol/kg daily, usual maximum 50 mmol
Potassium depletion	0.5 -1 mmol/kg twice daily, total daily dose alternatively may be given in 3 divided doses, dose to be adjusted according to plasma-potassium concentration

Intravenous Potassium Chloride Preparations and Dosing

Intravenous Potassium Preparations stocked are:

Sodium chloride 0.9% and 20mmol Potassium chloride 500ml

Sodium chloride 0.9% and Glucose 5% and 10mmol Potassium chloride, 500ml

Sodium chloride 0.9% and Glucose 5% and 20mmol Potassium chloride, 500ml

Sodium chloride 0.9% and Glucose 10% and 20mmol Potassium chloride, 500ml

Electrolyte imbalance dosing:

By Intravenous infusion

Neonate: 1-2mmol/kg daily, dose dependent on deficit or the daily maintenance requirements

Child: 1-2 mmol/kg daily, dose dependent on deficit or the daily maintenance requirements

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Intravenous dosing

Dosage

- **Rapid intravenous administration or overdose may cause cardiac arrest.** Administer via an infusion pump.
- Include all sources of potassium when calculating replacement doses and infusion rates (e.g. additives to maintenance fluids, Parenteral Nutrition, oral/enteral supplements).

Acute Peripheral replacement rate	Maintenance rate (if required)	ECG monitoring required	Repeat serum potassium level	Notes on serum potassium level monitoring
0.2mmol/kg/hour equivalent to 120ml/kg/day of 20mmol KCl per 500ml bag Recheck potassium level Avoid glucose containing fluids initially	0.1mmol/kg/hour equivalent to 120ml/kg/day of 10mmol KCl per 500ml bag	Only required if serum potassium <3 mmol/L or risk of cardiac arrhythmia Or on DKA protocol or aminophylline	Following 4 hours acute replacement infusion	Check serum potassium level and renal function before administering further potassium Continue to monitor serum potassium levels at a frequency guided by the response and clinical situation

A central line is required to give IV Potassium supplementation when the concentration of Potassium is >20mmol/500ml bag.

Special Circumstances

This can occur when the child still has hypokalaemia and is already on 20 mmol per 500ml bag.

This is most likely to occur in Diabetic Ketoacidosis as the commonest scenario.

BSPED guidance states:

If Potassium is low at presentation (3.0mmol/l). This may require high concentrations of intravenous Potassium in fluids which children **would require a central line.** Where obtaining central access is likely to result in significant delays to starting insulin then oral Potassium can be considered following discussion with an intensivist to correct hypokalaemia.

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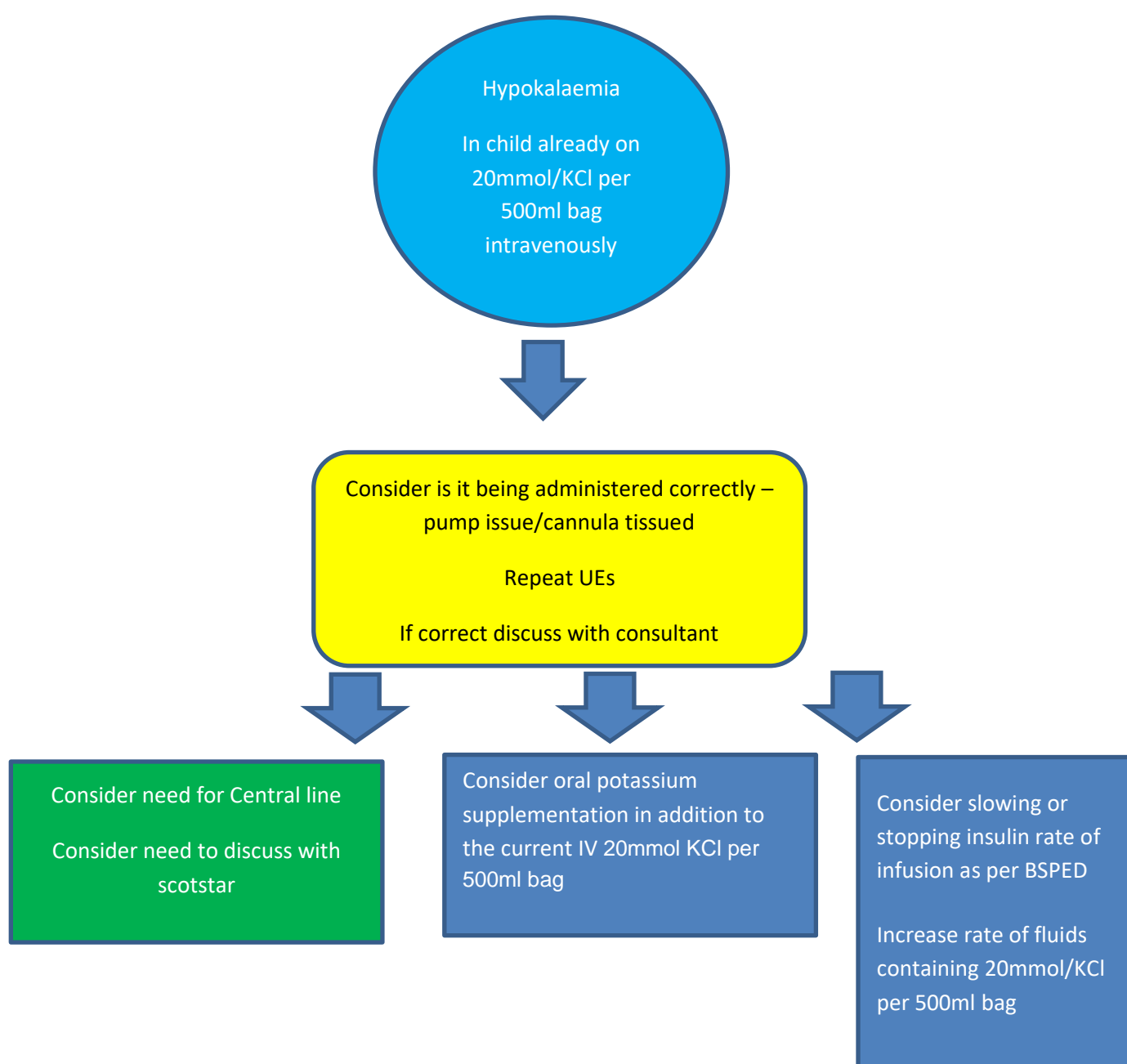
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Treatment of Hypokalaemia in Children

If the child or young person with DKA develops hypokalaemia (potassium below 3.0 mmol/litre) despite being on 20mmol KCl per 500ml bag then consider the following:

- Discuss with on call consultant paediatrician
- Oral /NG Potassium can be considered in certain circumstances where there is not ready access to a central line
- think about temporarily stopping the insulin infusion
- discuss urgently with scotstar, because a central venous catheter is needed for intravenous administration of potassium solutions above 40 mmol/litre.

Treatment of the child with persistent hypokalaemia despite IV fluids with 20mmol/500ml bag.



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Treatment of Hypokalaemia in Children

Consider consultation with local retrieval service and/or renal team when

- serum potassium <2.0
- ECG changes
- renal impairment (including oliguria or high/rising creatinine)
- risk of cardiovascular arrhythmia
- fluid overload
- neonates
- complex children with renal, oncological, haematological, cardiac, endocrinological, and metabolic conditions

References/Evidence

<http://www.library.leicestershospitals.nhs.uk/PAGL/Shared%20Documents/Potassium%20Administration%20UHL%20Childrens%20Hospital%20Guideline.pdf>

https://www.rch.org.au/clinicalguide/guideline_index/hypokalaemia/

https://www.piernetwork.org/uploads/4/7/8/1/47810883/hypokalaemia_flowsheet_afmcc15-12-16.pdf

<https://starship.org.nz/guidelines/hypokalaemia/>

https://www.schn.health.nsw.gov.au/_policies/pdf/2021-009.pdf

https://www.emeesykidney.nhs.uk/Users/Renal_Potassium_Intravenous_v1.pdf

https://www.rch.org.au/clinicalguide/guideline_index/Diabetic_Ketoacidosis/

<https://teachmepaediatrics.com/endocrinology/diabetes/diabetic-ketoacidosis/>

BSPED |BSPED DKA Guidelines <https://www.bsped.org.uk/clinical-resources/bsped-dka-guidelines/>

https://cdn.ymaws.com/www.ispad.org/resource/resmgr/consensus_guidelines_2018_/guidelines2022/Ch.11. Pediatric Diabetes - .pdf

E Kardalas et al. Hypokalaemia: A clinical Update. *Endocrine Connections* (2018) 7, R135–R146.

<https://doi.org/10.1530%2FEC-18-0109>;

Bangbola, O.F. Review of the Pathophysiologic and Clinical Aspects of Hypokalemia in Children and Young Adults: an Update. *Curr Treat Options Peds* 8, 96–114 (2022). <https://doi.org/10.1007/s40746-022-00240-3>

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Appendices

1. Governance information for Guidance document

Lead Author(s):	Adrienne Sullivan and Lynsay McAulay
Endorsing Body:	ADTC
Version Number:	V1
Approval date	
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Responsible Person (if different from lead author)	

CONSULTATION AND DISTRIBUTION RECORD	
Contributing Author / Authors	
Consultation Process / Stakeholders:	
Distribution	

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CHANGE RECORD			
Date	Lead Author	Change	Version No.
28/12/23	Dr A Sullivan	Delete duplication as per ADTC request	1
			2
			3
			4
			5

2. You can include additional appendices with complimentary information that doesn't fit into the main text of your guideline, but is crucial and supports its understanding.

e.g. supporting documents for implementation of guideline, patient information, specific monitoring requirements for secondary and primary care clinicians, dosing regimen/considerations according to weight and/or creatinine clearance

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