Objectives

Rapid and appropriate investigation and treatment of severe hypocalcaemia.

Peripheral IV infusion of calcium gluconate

Definition

Hypocalcaemia is a symptom complex, and can be regarded as:

1) Biochemical
2) Mildly symptomatic (distal paraesthesia)
3) Severely symptomatic (tetany, seizures)

All children with symptomatic OR severe biochemical hypocalcaemia (≤ 1.8 mmol/L) should be discussed with and admitted under the Paediatric Endocrinology Team at Starship.

Background

Hypocalcaemia in children is potentially life-threatening due to cardiac arrhythmias and stridor (usually at values of total Calcium <1.6 mmol/l). Calcium is vital for most biological functions and hence the serum calcium level is maintained within a narrow range, at the expense of sequestration of bone (potentially leading to rickets), and retention of calcium by kidneys at the expense of phosphate loss. Hypocalcaemia in this setting is therefore a late presentation of a chronic disease process and indicates that a child has significant total body calcium depletion (termed bone hunger).

Large and continuous doses of calcium are normally required for replacement; weaning of calcium infusion is usually over 48 hours as oral calcium is initiated, and stopping infusions usually results in rebound hypocalcaemia.

Common Causes of Infant and Childhood Hypocalcaemia

<table>
<thead>
<tr>
<th>Causes</th>
<th>Features</th>
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<tr>
<td></td>
<td>PO₄</td>
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<tr>
<td>Vitamin D deficiency</td>
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<tr>
<td>Hypoparathyroidism (Transient or permanent)</td>
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<tr>
<td>Pseudohypoparathyroidism</td>
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Investigations

- **Blood tests**  
  *Critical to draw at time of hypocalcaemia*
  Serum calcium, ionised calcium, phosphate, ALP, albumin, creatinine, urea, magnesium, PTH, & 25(OH)D₃ (25 hydroxyvitaminD)

- **Urine**  
  Calcium, calcium/creatinine ratio & phosphate

- **In Neonates**  
  Check maternal PTH, 25 hydroxyvitamin D, calcium, phosphate, ALP & HbA₁c

Management Principles

1. To stabilize serum calcium to a safe range (>1.8 mmol/L total Calcium or >1.1 mmol/l ionised) quickly and maintain it while transitioning to oral therapy.
2. To avoid complications of treatment: in particular extravasations of IV calcium infusion.
3. To establish the underlying cause.

Management Details

- Obtain blood for appropriate investigations before commencing treatment.
- Bolus or infusions of IV calcium should ONLY be given in CED, PICU, 23B or 26A HDU with continuous cardiac monitoring, and frequent checks of iv site due to high risk of extravasation.
- Do not give calcium with phosphate or bicarbonate as precipitation will occur.

**Symptomatic Hypocalcaemia (Seizures / Tetany / Stridor)**

1. **Always perform the ABC**
2. **Treat seizures** with anti-epileptics as per seizure protocol
3. **Continuous cardiac monitoring** - if arrhythmia discuss with Cardiologist
4. **Treat hypocalcaemia with IV calcium** (See page 3 for dosing)
   - ➔ **Bolus** if Tetany, seizures or stridor
   - ➔ **Continuous infusion** if bolus completed or if asymptomatic but Ca²⁺ < 1.8 mmol/L

5. If serum Mg²⁺ is ≤ 0.6 mmol/L, **consider** IV magnesium sulphate (2 mmol/mL).  
   Dose: 0.2-0.4 mmol/kg every 12 hours as slow iv infusion. See Paediatric Medication Administration Guideline on the ADHB intranet

6. Monitoring
   - Check Ca²⁺ level at 6 hours to ensure improvement, then 12 hourly as indicated.
   - Aim to keep Ca²⁺ >1.9 mmol/L, and then gradually wean the infusion as GI absorption of Ca²⁺ improves.
   - Stopping the calcium infusion is likely to result in a rapid fall in serum Ca²⁺ level due to uptake into bone (“bone hunger”). Suggest reducing infusion in 10-20% increments as Calcium normalises.

7. **Oral Therapy** (Assuming Vitamin D deficient rickets or hypoparathyroidism)
   - Commence oral calcium and vitamin D supplementation early as it takes 2-3 days to increase absorption from the GI system.
   - Calcium gluconate (gluconate and carbonate as Calcium Sandoz® brand) 100 mg/kg/day of elemental in 4 divided doses (1000mg per tablet)
   AND
   - 1, 25-dihydroxycholecalciferol = calcitriol (as Rocaltrol® brand) 0.03-0.06 micrograms/kg/day (max. 1-2 micrograms/day)
   This is the most active from of Vitamin D; increases absorption of calcium in 1-2 days.
PERIPHERAL CALCIUM INFUSION

Note:
- Calcium gluconate comes as a 10% standard stock solution.
- For peripheral infusions always make calcium to a 1% solution as follows: 1 part 10% calcium gluconate diluted to 9 parts with “water for injection”.
- Also compatible with 5% Dextrose, 0.9% sodium chloride, and dextrose/saline solutions.
- More concentrated solutions may be used via central lines.
- Only if secure IV access is obtained.

**TETANY or SEIZURES (OR RECENT SEIZURE)**

<table>
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<tr>
<th>BOLUS IV calcium</th>
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<tr>
<td>Six (6) mL/kg of 1% Calcium gluconate solution (diluted as above) over 2 hours</td>
</tr>
<tr>
<td>Ensure cardiac monitoring, followed by an continuous infusion (see below).</td>
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<tr>
<td>This bolus dose equates to ~ 0.13 mmol/kg.</td>
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<tr>
<td>This will ameliorate tetany for ≥ 15 minutes to several hours.</td>
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<td>Can repeat if required.</td>
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See Appendix for concentrations of calcium gluconate.

**If ASYMPTOMATIC BUT Ca²⁺ < 1.8 mmol/L or FOLLOWING ABOVE BOLUS**

Always make calcium to a 1% solution for peripheral administration: 1 part 10% calcium gluconate diluted to 9 parts with “water for injections” to obtain 1% solution. Alternatively can use dextrose which makes it less irritant. More concentrated solutions may be used via central lines.

<table>
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<tr>
<th>CONTINUOUS INFUSION IV Calcium</th>
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<tr>
<td>Sixty (60) mL/kg/DAY of the 1% Calcium gluconate solution (diluted as above)</td>
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<tr>
<td>Ensure cardiac monitoring</td>
</tr>
<tr>
<td>Repeat Calcium levels at 6 hours then 8-12 hourly accordingly</td>
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<tr>
<td>Adjusting calcium total to &gt;1.9 mmol/l</td>
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Monitoring and observation

- Monitor ECG in case of arrhythmia: unusual with this protocol
- Monitor the site for local reaction/redness - **must be directly observed regularly as risk of tissue necrosis if any extravasation**
- Review site if patient complains of pain
- Monitor Blood pressure
- Monitor serum calcium’s as described above

Other

- Do not add any other medications as calcium precipitation may occur

Appendix – Concentration of calcium gluconate

1. 10% calcium gluconate = calcium gluconate 100 mg/mL = elemental Ca of 0.22 mmol/mL = elemental Ca of 8.9 mg/mL

2. The daily elemental calcium estimation requirement is ~73 mg/kg.

3. If IV calcium gluconate not available can use calcium chloride. 10% CaCl (100 mg/mL) (elemental Ca = 0.68 mmol/mL; 27 mg/mL). This is 3X more elemental calcium.
References

- Sperling MA. Pediatric Endocrinology. 2nd Edition.
- Hospital for Sick Children Resuscitation Card 2003-2004