Paediatric Insulin Adjustment for the well young person with Diabetes

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Key Amendments

Date	Amendment	Approved by
16th October 2019	Document approved	Paediatric QIM
19th Nov 2020	Document extended for 1 year	Dr J West/Paediatric QIM
26th March 2021	Document reviewed and approved for 3 years	Paediatric Guideline Review meeting

Introduction

This guideline is for the care of children and adolescents with Type 1 diabetes across Worcestershire County and is aimed at giving consistent advice to families of children and young people with Diabetes. It is used by the Paediatric Diabetes Specialist Nurses (PDSN) and Registered Dietitians (RD) and by Orchard service. This guidance is specifically for those staff members that do not hold independent and supplementary prescribing qualifications. It is also for use by middle grade medical staff on the paediatric wards at the Alexandra Hospital and Worcestershire Royal Hospital for out of hour's advice, when the diabetes nurse team members are unavailable. The Paediatric Diabetes Specialist Nurses in Worcester, Kidderminster and Redditch work Countywide Monday – Friday 9-5pm and provide cover for each other in periods of absence. Out of hours advice will be from the Middle grade medical staff or Consultant on call who can liaise with the Consultant with a special interest in diabetes if necessary.

This guideline reflects the Adult Diabetes Service Insulin Adjustment Guideline WAHT-END-013 as it is recognised that some staff work across both disciplines, but that there are some differences in advice for the Paediatric population

When out of hours advice is given, please leave a message on the relevant answer phone below or email (copy in named Consultant) to ensure prompt follow up occurs on the next working day.

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Nursing protocol for paediatric insulin adjustment in the community

Competencies Required

- **PDSN band 6 or above working within the Paediatric Diabetes team**
- **RD band 6 or above working within the Paediatric Diabetes Team**
- **Orchard Service nurses band 6 or above with appropriate experience (mostly advising families at diagnosis).**
- **Middle Grade medical staff**

It is expected that the above staff will have understanding of;

- Normal glucose metabolism
- The time action profile of various types of insulin
- The effect of food and digestion on capillary blood glucose (capillary BG) levels of patients who require insulin.

They will also have skills in;

- Education to patients on carbohydrate counting and insulin dose adjustment (Orchard service only require an overview as they mainly work with newly diagnosed)
- Interpretation of capillary BG results within the context of the patients lifestyle
- Sharing knowledge of other aspects of diabetes care in regard to insulin (exercise, food absorption and glycaemic effects, alcohol, site rotation, injection technique, needle length, device use).

Each practitioner is responsible for ensuring their knowledge and skills are kept up to date and training attended as relevant.

- The NPSA e-learning tool on the safer use of insulin must have been completed.
- Additional training will have been completed in insulin pump therapy before advising on insulin dose adjustment for people using an insulin pump

Guideline

Each patient will be assessed individually and recommendations tailored according to their food preferences, lifestyle and physiological requirements. The role of this document is to provide staff with adequate structure to support their role in recommending **permanent insulin dose adjustments** to patients with diabetes treated with insulin. It will enable the family/young person to be empowered to take control of their own diabetes when shown how to adjust insulin doses safely. There will be individual families/young people who will find self-management of insulin adjustment difficult and may be unable to interpret instructions after education. The team will need to tailor advice given to these individuals.

The amount of insulin required is related to body weight and therefore as a child grows their insulin requirements will increase. Young children on small doses are very sensitive to insulin increases whereas older children are less sensitive as the overall total daily dose they require increases. In particular, adolescents have more resistance to insulin caused by the effects of growth hormone meaning that they often require much more insulin per kg body weight than in adulthood.

To achieve normal growth and development and reduce the risk of diabetic complications in adulthood, it is important to maintain good blood glucose control. Current NICE (2015) blood glucose targets for children and adolescents are 4-7mmol/l before meals and 4-9mmol/l two hour post meal. However, personal targets dependant on the individual may be set. Regular blood glucose (BG) monitoring is crucial to as it identifies the changing needs in insulin requirements as the child grows and develops. Patterns and trends can be established which help advise on an appropriate insulin adjustment action plan.

After diagnosis insulin requirements are based on 0.5unit/kg in 24 hours because there is still some residual insulin production. This is often referred to as the "Honeymoon phase" Requirements will increase gradually or quickly as the child's own insulin production reduces until requirements will be based on 1unit/kg. An average time span for the Honeymoon period is about 4 months although it may not happen at all or could be extended to a year or more in a few cases. During adolescence insulin requirements may increase up to1.8 units/kg.

This guideline authorises a RD or PDSN or Orchard Service to make insulin dose recommendations to the patient in order to:

- Match food boluses more closely to meals to resolve post-meal hyper and hypoglycaemia.
- Improve diabetes control overall by adjusting basal and mixed insulin doses.
- Minimise hypoglycaemia / risk of hypoglycaemia through food and eating, alcohol, exercise and insulin dose adjustment.

Adjustment to insulin already prescribed to the patient and covered by this document will include:

	Analogue
Mixtures	Novomix 30®, Humalog Mix 25®
Intermediate/ Long acting	Lantus®, Levemir®, Tresiba® Semglee® Abasaglar®
Quick acting	NovoRapid®, Humalog®, Apidra®

Adjustments to insulin doses may include a range of dose suggestions for quick acting bolus insulins and basal insulin depending on whether the goal of care is to minimise hypo/hyperglycaemia or improve diabetes control.

Dose adjustment is based on 10-20% increased or decreased increments

Records

- Patients should receive written confirmation and express verbal agreement with advice recommended at the time of their appointment (Written confirmation is not possible with telephone consultations but patients should be asked to repeat back the advice to confirm understanding). In a face to face contact a note of recommended doses in their monitoring diary or on their diet sheet is adequate.

- A summary of the multidisciplinary clinic visit (including dose decisions) will be sent to the GP and a copy to the parents/young person at every 3 month visit. If a PDSN is advising for an inpatient they will also document in the Trust's main clinical notes. PDSNs/RDs will document in their own notes dose changes and inform other parties in between clinic if appropriate.

Clinical Supervision

1. It is the responsibility of the professionals covered by this policy to seek clinical supervision on an on-going basis and to discuss any specific patients who deviate from this guideline.

2. Clinical supervision should be obtained from the:
   - Consultant Paediatrician with a special interest in diabetes
   - Senior PDSN's and
   - Senior Specialist Paediatric Diabetes Dietitians

3. Clinical supervision can occur at team meetings or on a 1:1 basis as required.

In Patients

- Dietitians will not advise on insulin dose adjustments to be made during the inpatient period. They may educate an inpatient on self-management and dose adjustment following discharge.

- Diabetes nurses without prescribing qualifications will not alter inpatient prescriptions but may make recommendations to the prescriber.

- Any advice/ recommendations will be documented in the patients' medical notes.

Blood Glucose Monitoring

Blood glucose (BG) targets need to be individually tailored to the individual patient taking account of usual BG control, frequency and awareness of hypoglycaemia, presence of complications of diabetes etc. Rapid improvements in control should be avoided. .

- NICE (2015) target for HbA1c 48mmol/l.
- Capillary BG targets- general 4-7 mmol/l before meals, 4-9mmol/l post meals.
- It is often advisable to aim for slightly higher capillary BG readings before bed of 5-8mmol/l

On occasions extra testing may be advised 2 hour post prandial and also pre and post exercise to gain specific information to advise on carbohydrate ratio or particular issues. The PDSN/RD will discuss individually with each patient how to optimise and use their monitoring results.

Guidance for PDSN, RD and Orchard Service staff on adjusting insulin

The RD/ PDSN/Orchard service should encourage patients to use a systematic approach to analysing their capillary BG. The following is the stepwise approach that is encouraged on the Adult Diabetes DAFNE course and it can be applied to parents and older young people in self-management.

- What is the problem?
- Which capillary BGs are out of target?
- What are the possible causes of the problem?
- Exclude causes such as carbohydrate estimation, snacks, alcohol, exercise, overtreatment of hypoglycaemia
- If a one off BG out of target, wait 48 hours to look for a pattern before a permanent change. Unless hypoglycaemic episodes occur overnight when a change should be made without waiting for a pattern
- Which insulin(s) may be responsible?
- Review the action profile of the insulin(s)
- Adjust the responsible insulin as below
- Review capillary BG over at least the next 48 hours to ensure that the insulin dose change was appropriate

If the blood glucose is above 14mmol/l, the patient should test for blood ketones and if present the guideline for Paediatric Diabetes Illness and Ketosis Management in the Community should be followed (WAHT-PAE-039). Persistent hypoglycaemia during the day or night, or hypoglycaemia at the same time of day or night for two or three consecutive days is an indication that insulin needs to be reduced.

Permanent insulin dose adjustment should be based on trends in capillary BG not one off readings. Capillary BG meters are only accurate to within 15%.

1 How to Adjust

- Dose changes are often expressed as 10-20%. This is for clinician guidance and should be expressed as a number of units when giving instructions to patients.

- To avoid insulin errors 'units' should always be written in full and not abbreviated to 'u'.

- **48 hours** should be left between most insulin adjustments, to allow the full effect of the change to become apparent.

2 Twice Daily Regime /BD Regime Novomix 30/Humalog mix 25

This regimen is rarely used now in paediatrics due to it being less effective in managing blood glucose levels in range. It can be useful however, when there is persistent non-adherence to a multiple dose regimen

- For high blood glucose - give an extra 10% of normal morning and/or 10% of evening insulin doses. Maintain these increases every two days until blood glucose is between 4-8mmol/l pre meals. It is appropriate to use this calculation for any child or adolescent regardless of their insulin requirements in units/kg.

- If the blood glucose is high at lunchtime or teatime increase the morning insulin. If the blood glucose is high at bedtime or breakfast increase the teatime insulin. If all are high increase both doses.

- For hypoglycaemia reduce the normal insulin dose by 10 – 20% until blood glucose between 4-7mmol/l. Remember that you need to assess the full effect of the reduction after two days.
- If the blood glucose is low at lunchtime or teatime decrease the morning insulin. If the blood glucose is low at bedtime or breakfast decrease the teatime insulin. If all are low decrease both doses.

- The ratio of the insulin dose in a twice daily regime should, where appropriate, be maintained at 2/3rds of the daily requirements in the morning and 1/3rd in the evening. It should be recognised, however, that some individuals will not fit into this general rule.

3 Basal Bolus Regime

Bolus adjustment – NovoRapid/ Humalog/Apridra

Children and adolescents who are carbohydrate counting correctly should be encouraged to increase/decrease the insulin to carbohydrate ratio e.g. if they are using one unit of rapid acting insulin per 10 grams carbohydrate they may need to increase this to 1 unit per 8grams, 1 unit per 7 grams or 1 unit per 5 grams, or decrease from 1 unit per 10grams to 1 unit per 12grams or 15 grams. There may be a need for different ratios at different times of day in some young people. This is calculated by monitoring pre and four hour (sometimes 2 hour) post prandial blood glucose at different meal times. The insulin to carbohydrate ratio is adjusted according to the BG pattern and carbohydrate intake.

Quick acting insulin doses should be given 15-20 minutes pre meals where practical as this can improve an individuals BG profile and HbA1c significantly.

Carbohydrate ratios can be worked out as an initial guide by looking at the average total daily dose of insulin required and using the 500, 400, or 300 rule. As a general guide the 300 rule works best for children aged 5 or under, the 400 rule for mid school aged children and the 500 rule for young people 12 years and above. Remember that your complete assessment, including a food diary will also give you a guide as to what is appropriate.

Work out average total daily dose (TDD), add up 4 days TDD, then divide by 4 = Average TDD

- Example: Patient total daily dose of 25 units, child age 8 years
- 400 divided by 25 = 16
- Insulin to Carbohydrate Ratio as starting point 1 unit to 16g carbohydrate

Most parents, children and young people have been taught how to use a correction by being aware of their insulin sensitivity or correction factor to correct high blood glucose (i.e. 1 unit of rapid acting insulin lowers the blood glucose x mmol/l). This will be individual for each patient. If they have been using correction boluses daily for 3 days and it is not working this would indicate a possible need to re calculate and increase the insulin to carbohydrate ratio as above.

- Initial Insulin sensitivity is worked out by using the 100 rule and a patients average total daily dose (TTD)
  - Eg: Take a patients last 4 days total daily doses, add up and then divide by 4 = average TDD
  - Example: Patient total daily dose of 25 units
  - 100 divided by 25 = 4
  - Insulin sensitivity or correction factor is 1 unit drops BG 4mmol/l

For high blood glucose readings – remember to look for patterns and trends and not to adjust after one high reading. Assess using questions on page 4-5. If the child or young person does not carbohydrate count then rapid acting insulin (Novo Rapid or Humalog or Apidra) with meals can be increased by 10% for every meal if necessary. Maintain these increases every two days until blood glucose is between 4-8mmol/l.

- If blood glucose is high at lunchtime increase breakfast insulin. If blood glucose is high at teatime increase lunchtime insulin. If blood glucose is high at bedtime increase teatime insulin. If blood glucose is high at breakfast increase long acting insulin.
- For low blood glucose- if the child or young person does not carbohydrate count then rapid acting insulin (Novo Rapid or Humalog or Apidra) with meals can be decreased by 10-20% for every meal if necessary.

Basal insulin adjustment

(Lantus®, Levemir®, Tresiba® Semglee® Abasaglar®

If basal insulin dose is correct then fasting morning capillary BG levels will usually be similar to pre bed capillary BG (within 1-2mmol/l). However sometimes in young people this is not always straight forward with other variables such as growth, food fads, heavy exercise, excitement and stress.

Hyperglycaemia: If the trend is for capillary BG to increase overnight, basal insulin may need to be increased by 10-20%. This increased dose should be maintained for 3 days before further dose increases (of 10-20%). **With Tresiba®** it is more appropriate to wait for 5 days before further increasing the dose. This applies in the absence of ketones or need for sick day rules. In the presence of ketones, dose increases may be suggested as per the WHAT-PAE-039 Management of illness and ketosis in the Community guideline.

If on once daily basal insulin taken in the morning consider whether the insulin may not be lasting 24hours. In which case an increase in dose will not be appropriate. Consider a change to BD basal insulin if using Levemir or moving the time of the basal insulin to later in the day. If changing the time the usual dose is omitted and then given at the new later time. Any hyperglycaemia can be managed with corrections of quick acting insulin as above. If you are considering a change in basal insulin seek senior team advice first.

- A 3am capillary BG test should be advised to rule out the possibility of night time hypoglycaemia before an increase in background insulin is made.

If **hypoglycaemia** is verbally described or recorded in a capillary BG diary or there is evidence on continuous glucose monitoring (nocturnal or dawn hypoglycaemia), basal insulin should be reduced by 20%. If people have to snack to prevent hypoglycaemia, insulin doses need to be reduced.

When background insulin doses are reduced quick acting insulin may need to increase- often in line with more accurate carbohydrate counting.

NB: There are now Biosimilar insulins on the market which are cheaper and may be used more often in the future within our paediatric population as CCG's consider the cost of medication. These include Abasaglar® and Semglee® (Insulin Glargine) which are biosimilars of Lantus (Insulin Glargine). Neither of these insulin brands offers a half unit dose adjustment pen so it will not be suitable for young people under the age of 10-12 years should it be decided to use them in the future.

Dose adjustment for exercise

If exercising within 90 minutes after quick acting insulin it is appropriate to reduce insulin dose before exercise by 20-50%. Basal insulin could also be reduced by 10-20% following exercise if on Levemir (or CSII) to avoid delayed or night time hypoglycaemia. For young people attending heavy prolonged activity weekends Lantus particularly should be reduced by 10-20% starting from the night before the activity. It is also important to consider continuing the reduction the night after a heavy few days of exercise. This is a general guide only, some young people will need to reduce their insulin more particularly for intense activity holidays such as Skiing, Hill walking, Duke of Edinburgh award expeditions and any heavy activity over a few days at a time. Tresiba is difficult to reduce for exercise as it takes up to 5 days to notice a change. Encourage increased BG monitoring to help with future advice & self management in all cases.

See leaflet 'Exercise and diabetes- a guide for people with type 1 diabetes mellitus'.

Dose adjustment for sick day rules and missed insulin doses

Additional temporary insulin adjustments may be required if during illness especially with type 1 diabetes mellitus when ketones are present. See **Paediatric Diabetes Management of Illness and ketosis in the community** which also covers missed insulin doses

PDSN's/ RDs if taking on this role need to have proven extra training on insulin pump management.

The pump uses rapid acting insulin because it is more immediately responsive to changes in food, exercise or blood glucose. The pump delivers a continual basal rate of insulin over 24 hours. The basal rate can be increased or decreased during the day according to blood glucose levels. Most young people have between 2-8 different basal rates.

The young person will learn to bolus an extra dose of insulin for all meals and snacks counting the carbohydrate content of the food that they choose to eat. They can programme in how much insulin they need at a push of a button using the on board bolus advisor. This gives the young person with diabetes more freedom of choice in what and when they eat and will also contribute to better control of their overall blood glucose if used correctly.

As with other insulin regimes checking for patterns and trends in increasing blood glucose levels, by assessing BG diaries or looking at an insulin pump download will indicate if a change in insulin pump settings needs to take place. If the blood glucose is above **14mmol/l**, test for blood ketones **immediately** and if present the guideline WAHT-PAE-039 for Paediatric Diabetes Illness and Ketosis Management in the Community should be followed

When making any adjustment to doses on an insulin pump – make only one or two changes as a maximum and the reassess a minimum of 2- 3 days later before making a further change.

Adjusting Basal Rates on an insulin pump

For accurate adjustment of basal rates, a series of fasting readings over the problem time frame can identify more specifically where basal rate adjustments need to be made, although this can be a challenge with younger children or young people who like their food!.

Only do the test if:

- If testing overnight, evening meal no later than 8pm, or allow least 4 hours with no food before start of test.
- BG in range 5-13mmol/l
- No alcohol in the last 24 hours
- No strenuous activity within 8 hours pre test
- No illness or other stress factors present

Testing

- Do not eat during the test period and drink water/ sugar free fluids
- Do not do any extra activity
- Do not give correction doses unless BG rises above 14mmol/l
- STOP the test if there is hypoglycaemia or a correction has to be given for hyperglycaemia

When basal rates are set correctly BG should not increase or decrease more than 2mmol/l:

- **If BG has risen by more than 2mmol/l identify the problematic BG level time and increase the basal rate by 20% 2 hours before the highlighted problem**

- **If BG has decreased by more than 2mmol/l identify the problematic BG level time and decrease the basal rate by 20% 2 hours before the highlighted problem**

Temporary reduced basal rates of 10-20% are useful for periods of prolonged exercise and increase basal rates of 10-20% for illness or stress. This is only a guide, advice can vary widely here and will be adjusted according to a full assessment of the situation, BG pattern and trend and any effect of previous changes you have made.

Adjusting Bolus Ratios on an insulin pump

The following test can be done to verify if the insulin: carbohydrate ratio is correct, however it should be acknowledged that it is sometimes quite difficult to do the test successfully with children due to their spontaneous nature regarding eating and exercising. Seek advice from a senior team member if you are unsure how to proceed.

Only do this test if:

- BG in target – 4-10mmol/l
- Do not give a correction at start or during test
- Last food 4 hours prior to test to ensure no active insulin
- No hypoglycaemia in 24 hours pre test
- No alcohol in last 24 hours
- No strenuous activity within 8 hours pre test
- No illness or other stress factors present

Testing

- Have a meal that can confidently be carbohydrate calculated
- Have a meal that is at least 1g per kg of your weight a 20kg child would have 20g carbohydrate in that meal
- Have a meal that is low in fibre and moderate in fat and protein (eg: cereal and milk, toast, sandwich, yoghurt or fruit

Do each test twice (2 separate days) to establish a pattern before a change is made.

- Give insulin bolus for food and no correction
- Take blood glucose before meal and 4 hours after
- Do not eat anything else during the test period
- Do not do any extra activity
- **STOP** the test if hypoglycaemia occurs and treat.

If BG at 4 hours is within 2mmol/l of pre meal glucose, carbohydrate ratio is correct

If BG decreases at 4 hours:

- **If BG has decreased more than 4mmol/l 4 hours after the meal, increase the carbohydrate g in the bolus advisor by 20% and repeat the test**

- **If BG has decreased by 2-4 mmol/l 4 hours after the meal, increase the carbohydrate g in the bolus advisor by 10% and repeat the test**

If BG increases at 4 hours:

- **If BG has increased more than 4mmol/l 4 hours after the meal, decrease the carbohydrate g in the bolus advisor by 20% and repeat the test**

If BG has increased by 2-4 mmol/l 4 hours after the meal, decrease the carbohydrate g in the bolus advisor by 10% and repeat the test

Converting back to insulin injections from an insulin pump and vice versa

There may be occasions when patients using an insulin pump may need to convert back to multiple daily injection. This could be due to pump failure, loss of pump or no infusion sets. All patients in the service will have received written information on how to do this and will be reminded, particularly when travelling abroad.
The following steps should be followed;

Medtronic Pump

1. Work out **current total daily basal rate**:

- Veo Pump - Menu – Basal Review – Pump Total Basal Insulin Dose = units
- 640G Pump – Menu – Hisotry – Summary – Pump total basal daily dose = units
- Work out **Injection Daily Total** by increasing Pump Total Daily Basal insulin dose (PTDBID) by 25%:
- PTDID x 1.25 = units for injection of Levemir/Lantus
- If two background insulin injections per day usually given split equally, 12 hours apart

2. Continue with current carbohydrate ratio and insulin sensitivity factor

Roche Pump

1. Work out **current total daily basal rate**:
Handset – menu - highlight pump -press middle button, then left arrow until basal programming, press tick – Pump Total Daily Basal Insulin PTDBID) will be on screen

- Work out **Injection Daily Total** by increasing PTDBID by 25%:
- Pump TDD x 1.25 = units of Levemir/Lantus insulin to be given in 24 hours
- If two background insulin injections per day usually given split equally, 12 hours apart

2. Continue with current carb ratio and sensitivity factor

Omnipod Insulin Pump

1. Work out **current total daily basal rate**:

Omnipod pump – menu – my records – insulin delivery- TDD (total daily dose) for that day – scroll up/down button to see previous days

- Work out **Injection Daily Total** by increasing Pump Total Daily Basal insulin dose (PTDBID) by 25%:
- PTDID x 1.25 = units for injection of Levemir/Lantus
- If two background insulin injections per day usually given split equally, 12 hours apart

2. Continue with current carbohydrate ratio and insulin sensitivity factor

Starting back on the pump

When you start back on the pump after using injections planning is needed, taking into account your background insulin and the possible need for a temporary basal rate. **Always start back on the pump in the morning and use your original settings already stored in your pump.**

Background insulin:

Lantus or Levemir once per day:

- If inject in the **morning:**
    - Miss morning background insulin
    - Have usual quick acting insulin for carbohydrate and correction in the morning starting back on the pump
    - No temporary basal rate is required
- If inject in the **evening**:
    - Reduce by 50% the night before
    - Have usual quick acting insulin for carbohydrate and correction on the morning starting back on the pump
    - Put a temporary basal rate of 50% for the first 8 hours

NPH, Lantus or Levemir twice per day:

- Reduce by 25% the night before
- Miss the morning background insulin
- Have usual quick acting insulin for carbohydrate and correction on the morning starting back on the pump
- Put a temporary basal rate of 50% for the first 8 hours

Educating families and young people to self manage their diabetes

RDS and PDSNs have a key role in educating and supporting patients to self-manage their diabetes and make adjustments to their insulin doses in groups and 1:1 settings.

Diabetes Structured Education is seen as key to empowering young people and families. Currently young people and their families receive 1:1 semi structured education at diagnosis.
There is an ongoing education programme offered with an education day, updates for pump patients, coeliacs and additional carbohydrate sessions as required.

Insulin pump starts are delivered in groups with a structured curriculum and an update educational day is organised every year.

If young people choose not to attend our programmes then there is the “Goals of Diabetes” package which is a semi structured education programme to ensure that young people receive appropriate education for each stage of development. This can be delivered on a 1:1 basis.
There is also an extra curricular programme with a residential activity weekend once a year for the 8-13 age group and a teen activity day. Education in a fun way can be key to help improve skills in self management including exercise management and carbohydrate counting as well as gaining peer support and increased confidence.

DAFNE (Dose Adjustment for Normal Eating) Course

This is an evidence based structured education course for people with type 1 diabetes mellitus on a basal bolus insulin regimen which is delivered by the Adult Diabetes Service Team. Young people can attend this at the age of 17 years and above. As per the Transitional policy this is discussed and offered in the later transition process

References

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