

Hybrid Closed Loop System use in Paediatric Minor Surgery

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Who are we?

Manchester University NHS Foundation Trust

Paediatric surgery across 3 sites – Royal Manchester Children's Hospital, Wythenshawe, North Manchester General Hospital.

Large and busy elective/minor surgery caseload across several paediatric surgical specialties including gastroenterology, general surgery, urology, ENT, maxillo-facial surgery, ophthalmology

Providing surgical care for broad region covering multiple local paediatric diabetes units as well as sites at MFT.



Diabetes in Surgery - Physiology

Perioperative hyperglycaemia increases mortality and morbidity risk;

- Delayed wound healing
- Increased rate of infection
- Prolonged hospital stay

- Dogra, P., Anastasopoulou, C. and Jialal, I. (2024) Diabetic Perioperative Management

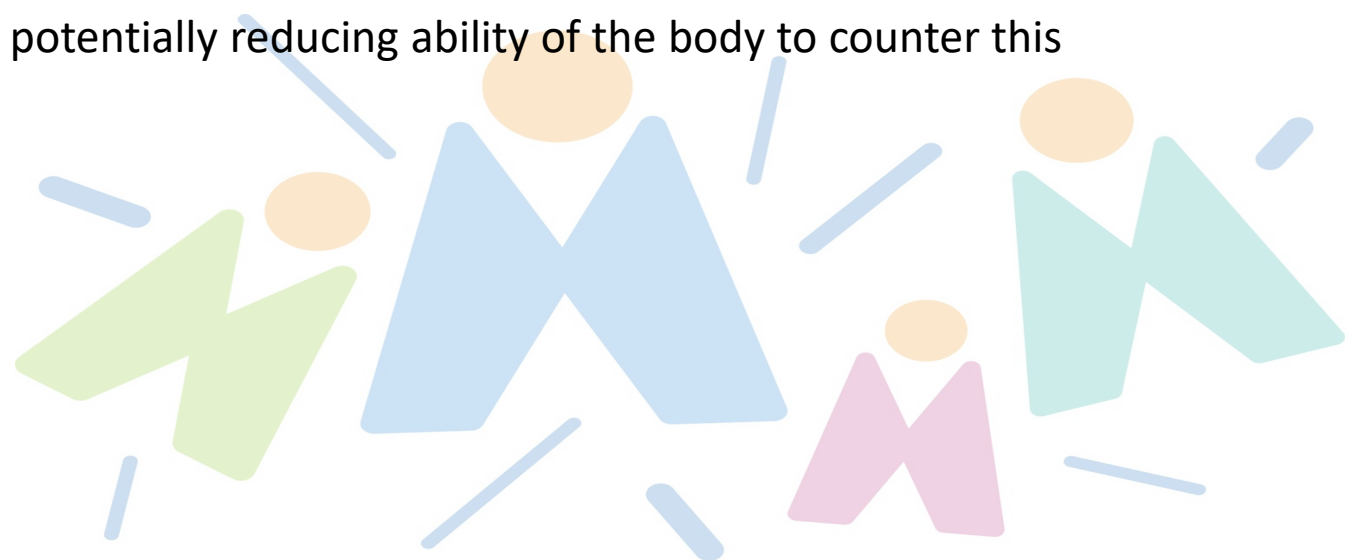
Stress in surgery causes release of counter regulatory hormones

Leads to overall catabolic effect causing hyperglycaemia

Desborough J. The stress response to trauma and surgery. Br. J. Anaesth. 2000

Fasting prior to surgery leads to less insulin on board, potentially reducing ability of the body to counter this hyperglycaemia

Will HCL Systems be able to cope??



How did we get here?

Hybrid closed loop systems for managing blood glucose levels in type 1 diabetes

Technology appraisal guidance | TA943 | Published: 19 December 2023

Implementation begins April 2024

Most recent NPDA annual (24/25) data shows 26% annual increase in patients using HCL systems

Use of diabetes-related technologies (Type 1 diabetes)



69%

were using an **insulin pump**, compared to 55% in 2023/24.



62%

were using a **hybrid closed loop system**, compared to 36% in 2023/24.

Guidelines

ACDC guidance ' Care of children under 18 years with Diabetes Mellitus undergoing Surgery or MRI under GA' 2021

Minor surgery: short procedures (always less than 2 hours, and usually less than 30 minutes) with or without sedation or anaesthesia where rapid recovery is anticipated and child is expected to be able to eat by the next meal. Examples include endoscopic biopsies, myringotomy, incision and drainage

Run the pump with APS (HCL) disabled

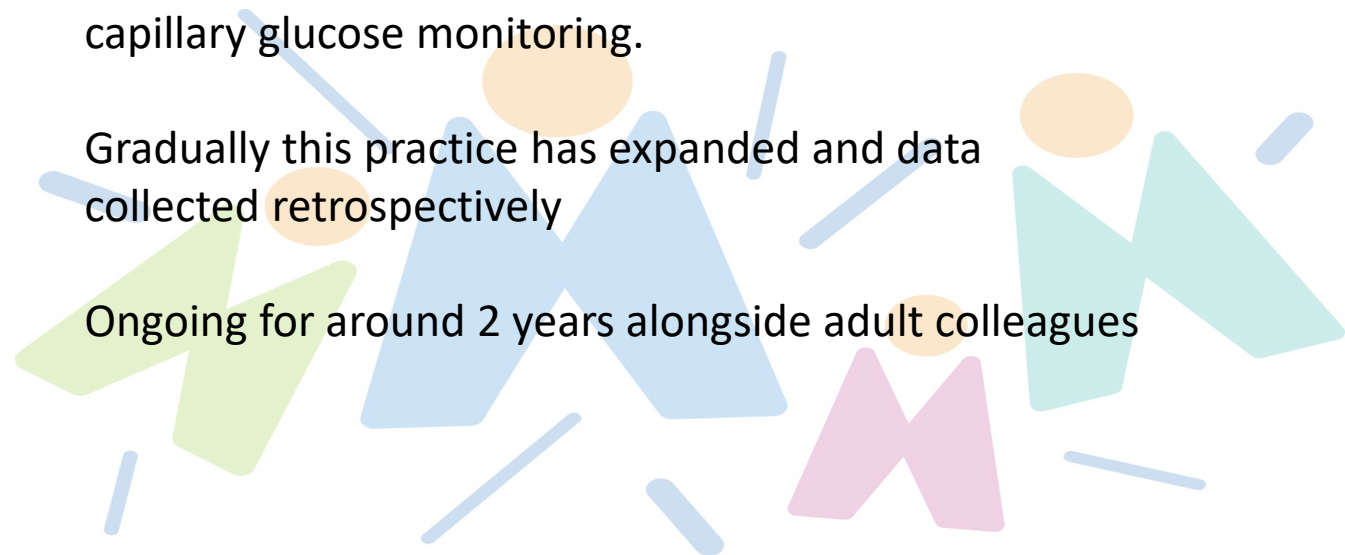
MFT - Previous guideline expiring around 2023

MDT discussions between paediatric and adult diabetes, anaesthetics and cross site collaboration led to a new guideline

Updated from ACDC guidance but added and included HCL systems, initially with manual mode but gradually, on trial basis, low risk cases tried on HCL with close capillary glucose monitoring.

Gradually this practice has expanded and data collected retrospectively

Ongoing for around 2 years alongside adult colleagues



Requirements to meet

Hybrid closed loop insulin pump therapy can only be used in minor surgery provided several prerequisites are met:

- The person with diabetes should be seen preoperatively by a registered health care practitioner who is knowledgeable about the perioperative use of HCL.
- If diabetes care is provided by separate hospital, details of management are to be provided prior to [pre op](#) assessment, this includes a review of basal rates by the home team in case of an unintentional reversion to manual mode intraoperatively.
- Documentation of discussions and decisions made with the person with diabetes and legal guardian.
- Multidisciplinary agreement that continued use of HCL is appropriate.
- Period of anticipated fasting is short (<1 missed meal)
- Surgery is elective and length of procedure is < 2 hours
- Anticipated blood loss is minimal
- [Pre op](#) HbA1c <69 mmol/mol
- Pump and sensor can be sited away from site of proposed surgery (at least 15cm if possible) and not between earthing plate and diathermy
- Use bipolar diathermy where possible
- If using monopolar diathermy, site the grounding electrode near to the surgical site and use short bursts of diathermy.
- Use lowest effective diathermy settings for electrocautery.
- No use of steel cannula
- Patient to be reviewed by a member of the diabetes team on day of surgery and determine if activity mode/ease off/temporary target is to be used perioperatively.
- Patient's phone/pump handset to be available within 6 metres of patient during surgery for HCL to continue to work
- Capillary glucose able to be monitored every 30-60 minutes

Based around already existing ACDC definitions of minor surgery



Expected Journey of HCL patient

Minor Elective Morning Surgery for patients on HCL

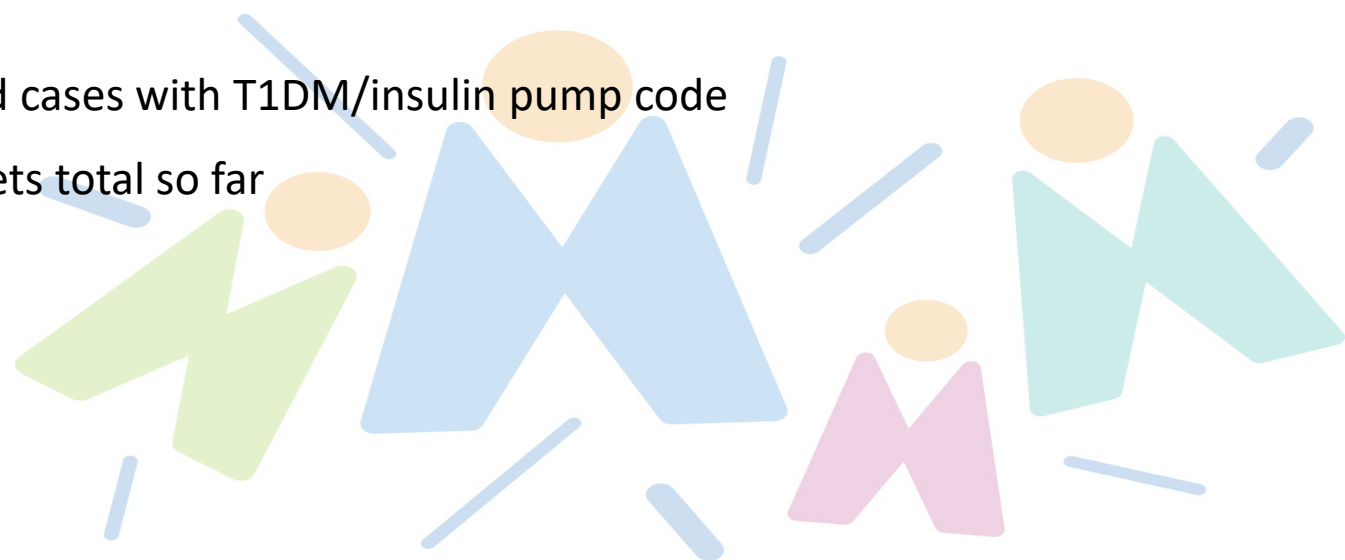
Day before procedure	Advise usual diet and insulin regime.
Morning of procedure	- Child can be admitted on the morning of surgery and should be the first case on the list - Run the pump on the normal hybrid closed loop settings - Consider switching pump into Activity mode/Ease off/ temporary target 60-90 minutes before surgery after consultation with diabetes team
Peri-operatively	- Measure the capillary BG hourly preoperatively and half hourly during the operation. - Ensure sensor and pump are sited distant to surgical site and diathermy earthing plate. - Should continue their pump if their BG remains 5-11mmol/L - Treat hypoglycaemia as per MFT guidance. – give bolus of IV 10% glucose 3ml/kg; recheck BG 15 minutes later and repeat if necessary, aiming for a target BG 5mmol/L. - If 2 consecutive CBGs >11mmol/L, remove the pump, store safely and commence a VRIII. (as per sliding scale in 7H & 7I). If ketones are >0.6mmol or there are any other concerns, contact the diabetes team.
After procedure	- BG should be checked hourly until patient is awake post anaesthetic or until IV fluids & insulin stopped (if VRII commenced). - Patient to come out of activity/ease off/temporary target mode once recovered if set pre op - Once eating, give usual dose of insulin taken with that meal through the pump - Patients can usually go home once eating and drinking. Please contact the Diabetes team if ketones > 0.6mmol/l or there are any other concerns prior to discharge.

Minor Elective Afternoon Surgery for patients on HCL

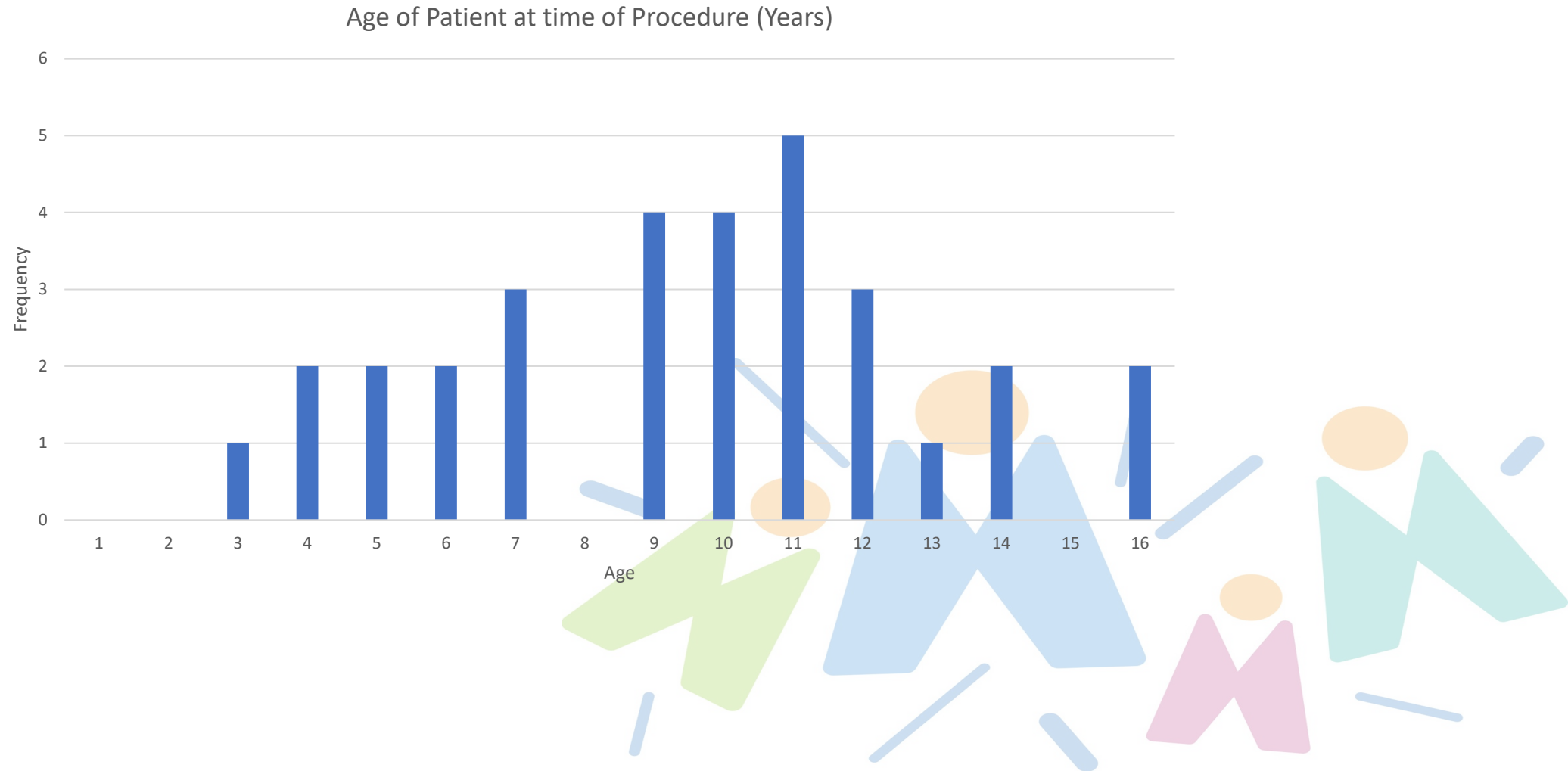
Day before procedure	Advise usual diet and insulin regime
Morning of procedure	- Patient to have a normal breakfast no later than 7.30 am with insulin via pump - Run the pump on the normal hybrid closed loop settings. - Consider switching pump into Activity mode/Ease off/ temporary target 60-90 minutes before surgery after consultation with diabetes team
Peri-operatively	- Patient should have their capillary BG measured on arrival and should be first on the list. Measure the capillary BG hourly preoperatively and half hourly during the operation - Ensure sensor and pump are sited distant to surgical site and diathermy earthing plate - Should continue their pump if their BG remains 5-11mmol/L - Treat hypoglycaemia as per MFT guidance. – give bolus of IV 10% glucose 3ml/kg; recheck BG 15 minutes later and repeat if necessary, aiming for a target BG 5mmol/L. - If 2 consecutive CBGs >11mmol/L, remove the pump, store safely and commence a VRIII. (as per sliding scale in 7H & 7I). If ketones are >0.6mmol or there are any other concerns, contact the diabetes team.
After procedure	- BG should be checked hourly until patient is awake/alert post anaesthetic or until IV fluids & insulin stopped (if VRII commenced). - Patient to come out of activity/ease off/temporary target mode once recovered if set pre op - Once eating, give usual dose of insulin taken with that meal through the pump - Patients can usually go home once eating and drinking. Please contact the Diabetes team if ketones > 0.6mmol/l or there are any other concerns prior to discharge

Data Collection

- Obtained via EPIC Slicer-Dicer
- All T1DM/diabetes code, less than 18, with anaesthetic event since 2023
- Excluded those not on HCL systems at time of surgery
- 28 patients, further exclusion of 6 patients who underwent theatre at WYT/Trafford prior to most recent HCL in surgery guidance or who were on CEPOD/emergency list
- Leaving total 22 patients
- Ongoing weekly report runs to check for new listed cases with T1DM/insulin pump code
- Ongoing data collection as cases occur – 31 data sets total so far

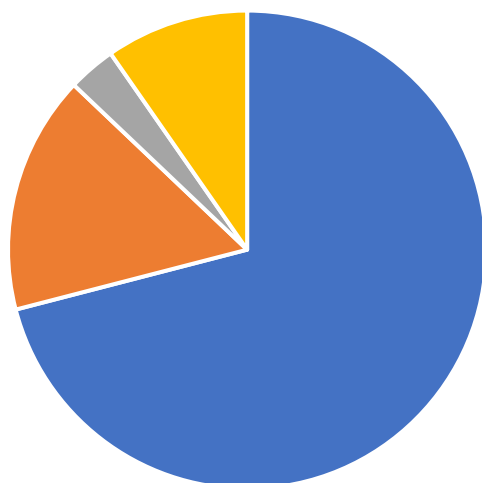


Data Collection – Age



Data Collection – HCL Systems

HCL Systems Used in Theatre

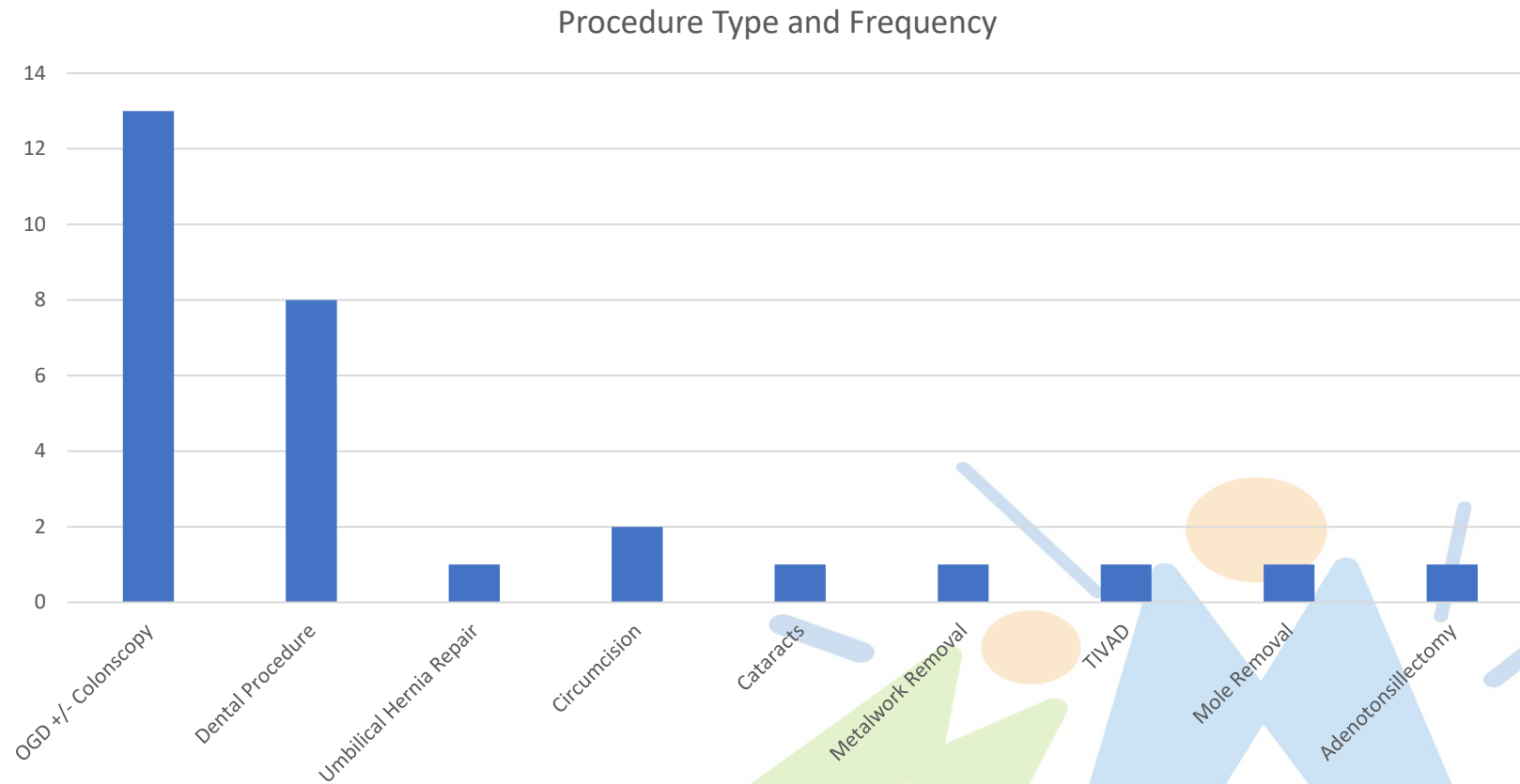


■ OP5 ■ T-Slim ■ Ypso ■ 780G

- OP5 – 22
- T-Slim – 5
- Ypso – 1
- 780G - 3



Data Collection – Procedure Type

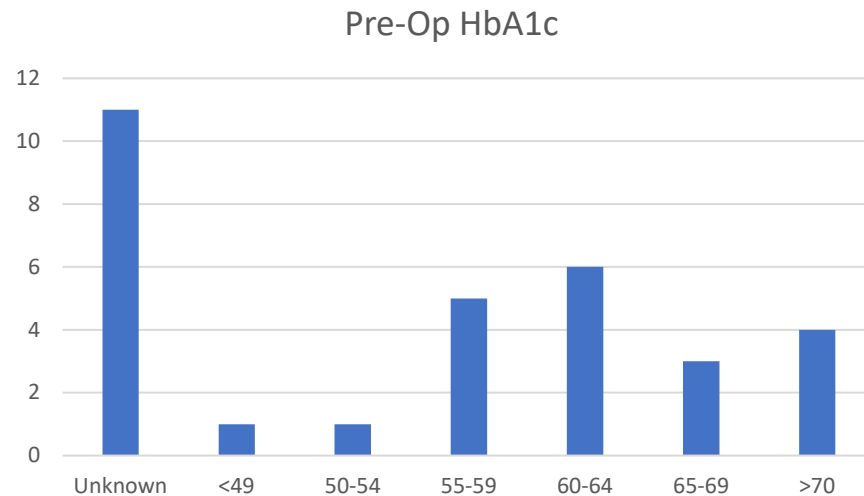


Glycaemic Control and System Settings

Review

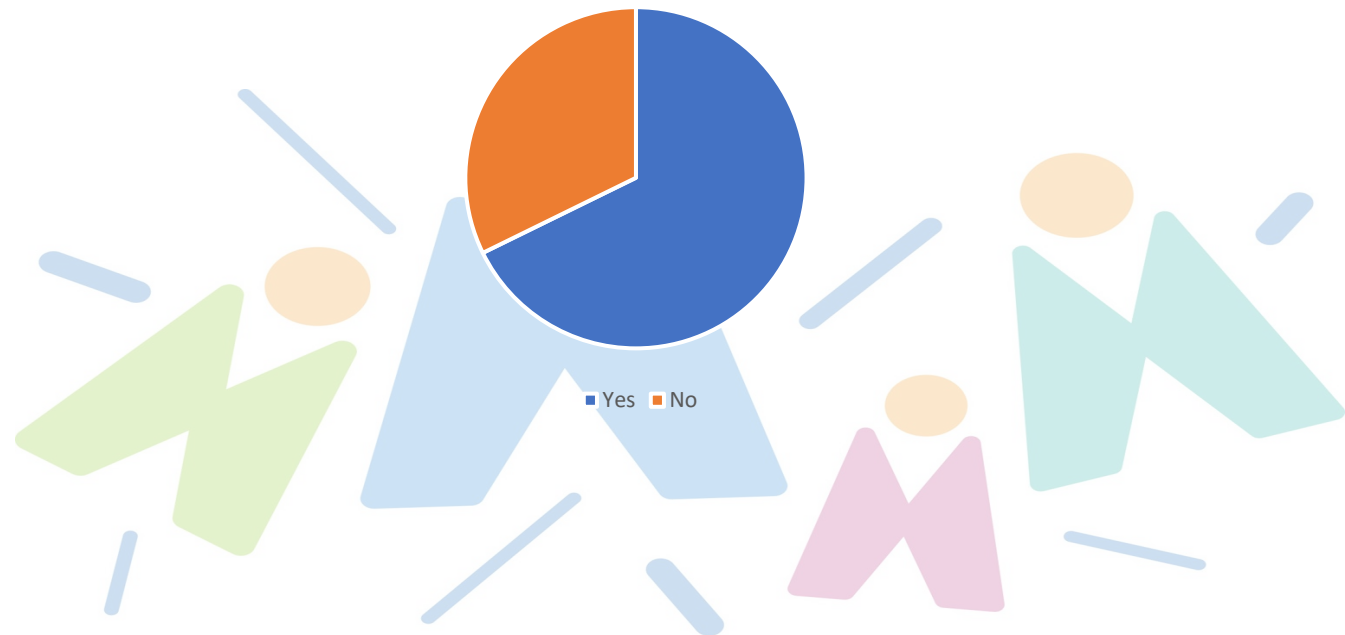
- Pre op HbA1c <69 mmol/mol
- If diabetes care is provided by separate hospital, details of management are to be provided prior to pre-op assessment, this includes a review of basal rates by the home team in case of an unintentional reversion to manual mode intraoperatively.

HbA1C

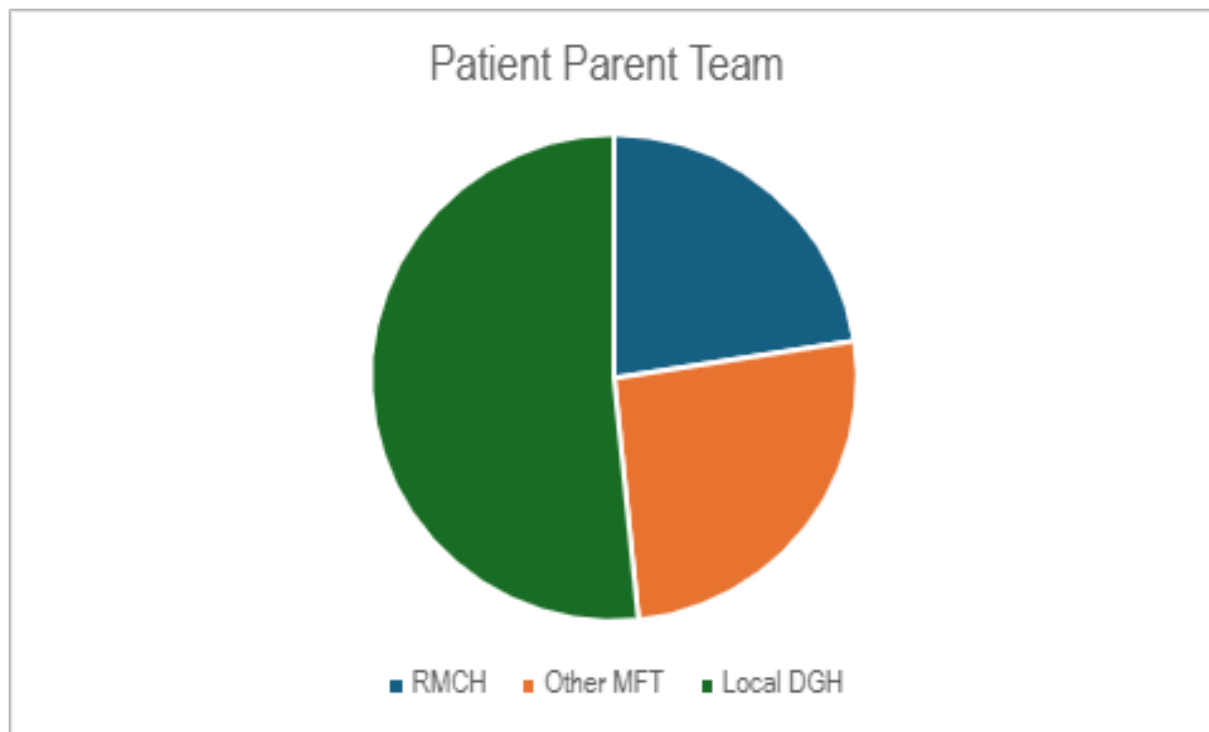


Insulin Regimes

Insulin Regime Reviewed and Documented Pre-operatively

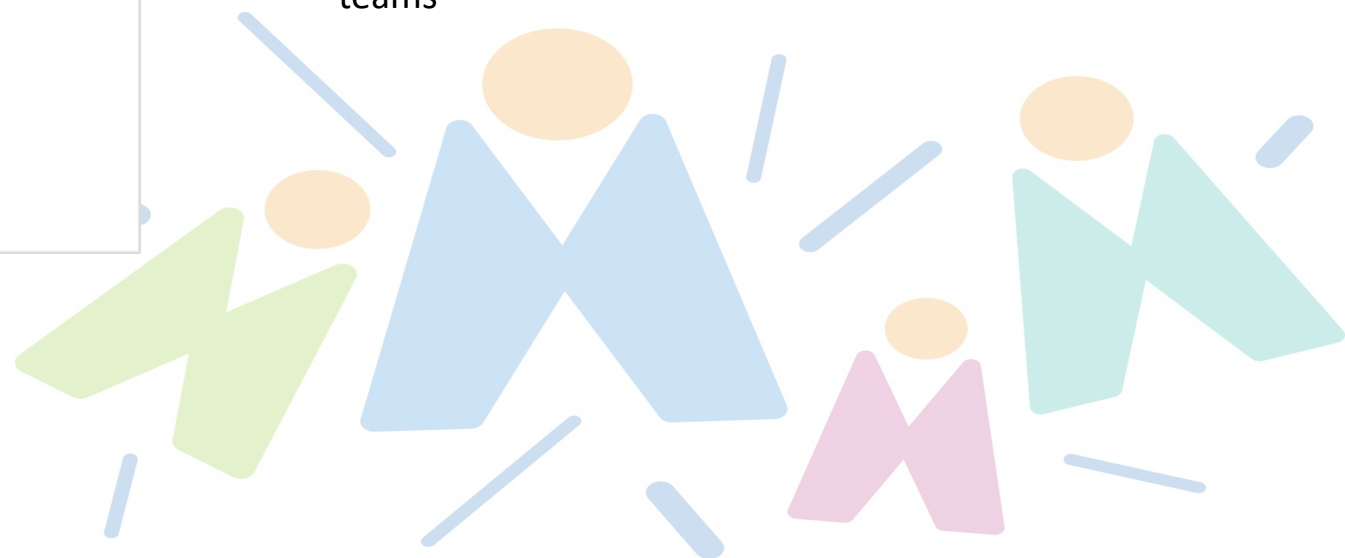


Patient Parent Team



Over half of the patients managed on HCL systems were based at trusts outside of MFT.

Highlights regional aspect of paediatric surgery/procedures and the need for robust communications between tertiary centre and local DGH teams



HCL Information Request Form

Dear _____,

Our records show that one of your patients with type 1 diabetes is scheduled to undergo surgery at RMCH:

Name

DOB

NHS Number

Procedure:

Date of surgery:

We have recently revised our surgical diabetes policy to allow most patients to remain on their HCL system during surgery, provided the following criteria are met:

- MDT agreement
- Expected duration of surgery < 2 hours
- Short fasting period (< 1 missed meal)
- Anticipated blood loss is minimal
- Pre-operative HbA1c < 70 mmol/mol
- Pump and CGM sensor can be sited away from the surgical field:
 - Ideally ≥ 15 cm from the operative site
 - Not positioned between the earthing plate and diathermy
- No steel cannula in use

As your patient uses a HCL system, we would be grateful if you could provide/review the following information by _____:

- Most recent HbA1c (including date obtained)
- Current pump settings
- Review of basal rate profile (in case of unintended reversion to manual mode peri-operatively)

On the morning of the procedure, please advise the family to use Activity Mode / Temp Target / Ease-Off (as applicable to their system) if glucose levels are trending low or lower than their target glucose whilst fasting, to reduce hypoglycaemia risk.

During the fasting period, whilst only clear fluids are permitted, hypoglycaemia should be treated with Lift glucose shots or Glucogel only. After the cut off period for clear fluids, only Glucogel can be used, as other treatments may result in postponement/cancellation of surgery.

HCL System Information Request Form

Name

DOB

NHS Number

Pump and Sensor

Most recent HbA1c

Date HbA1c obtained

Current pump settings (ICR, ISF, AIT, etc.)

Basal rate profile (24hr schedule)

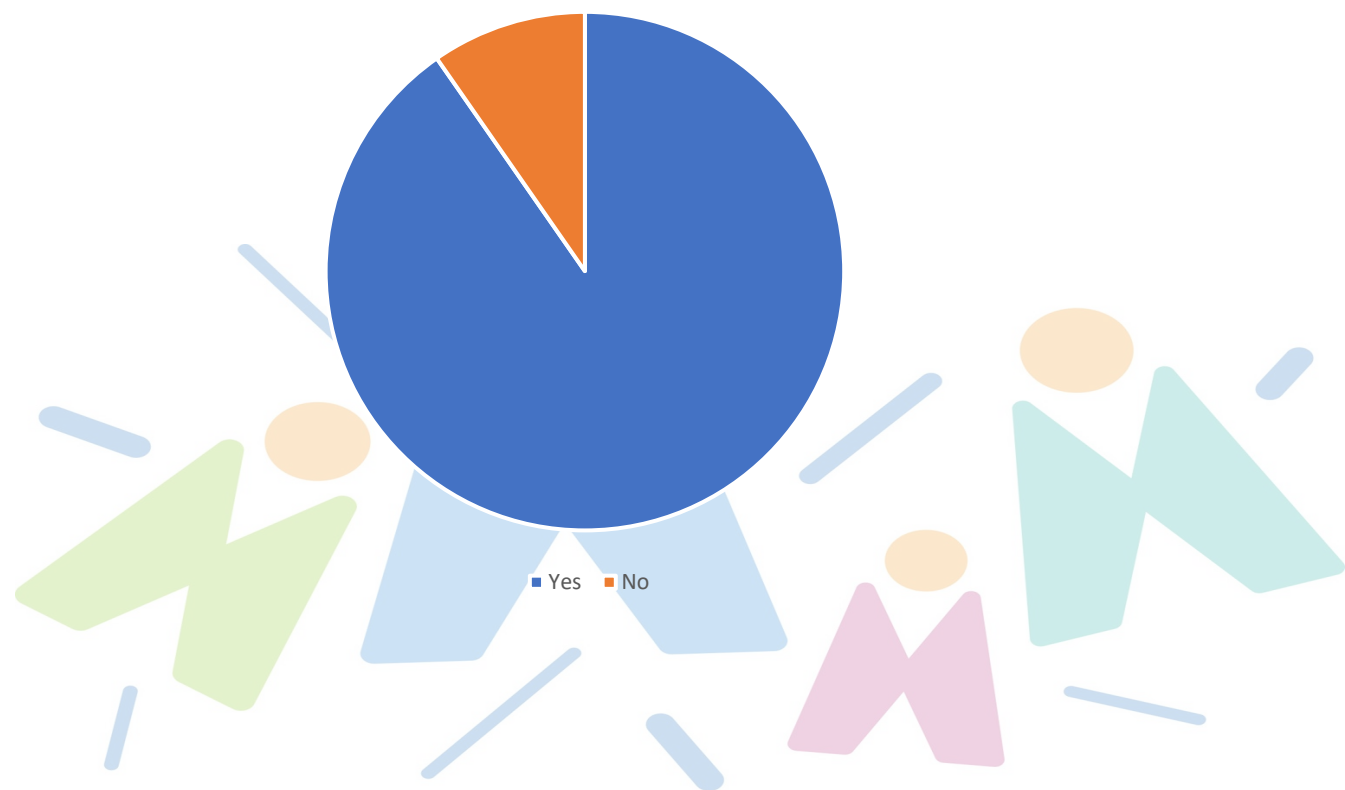
Target glucose settings

Preop Assessment

- Patient to be reviewed by a member of the diabetes team on day of surgery and determine if activity mode/ease off/temporary target is to be used perioperatively.
- Pump and sensor can be sited away from site of proposed surgery (at least 15cm if possible) and not between earthing plate and diathermy

- 28 out of 31 had pre-op assessment by diabetes team within 24hours before surgery
 - In those cases where pre-op assessment had not been undertaken prior to surgery, diabetes team informed <1 week prior to surgery (6days, 3 days) and/or not made aware pre-op on the day.

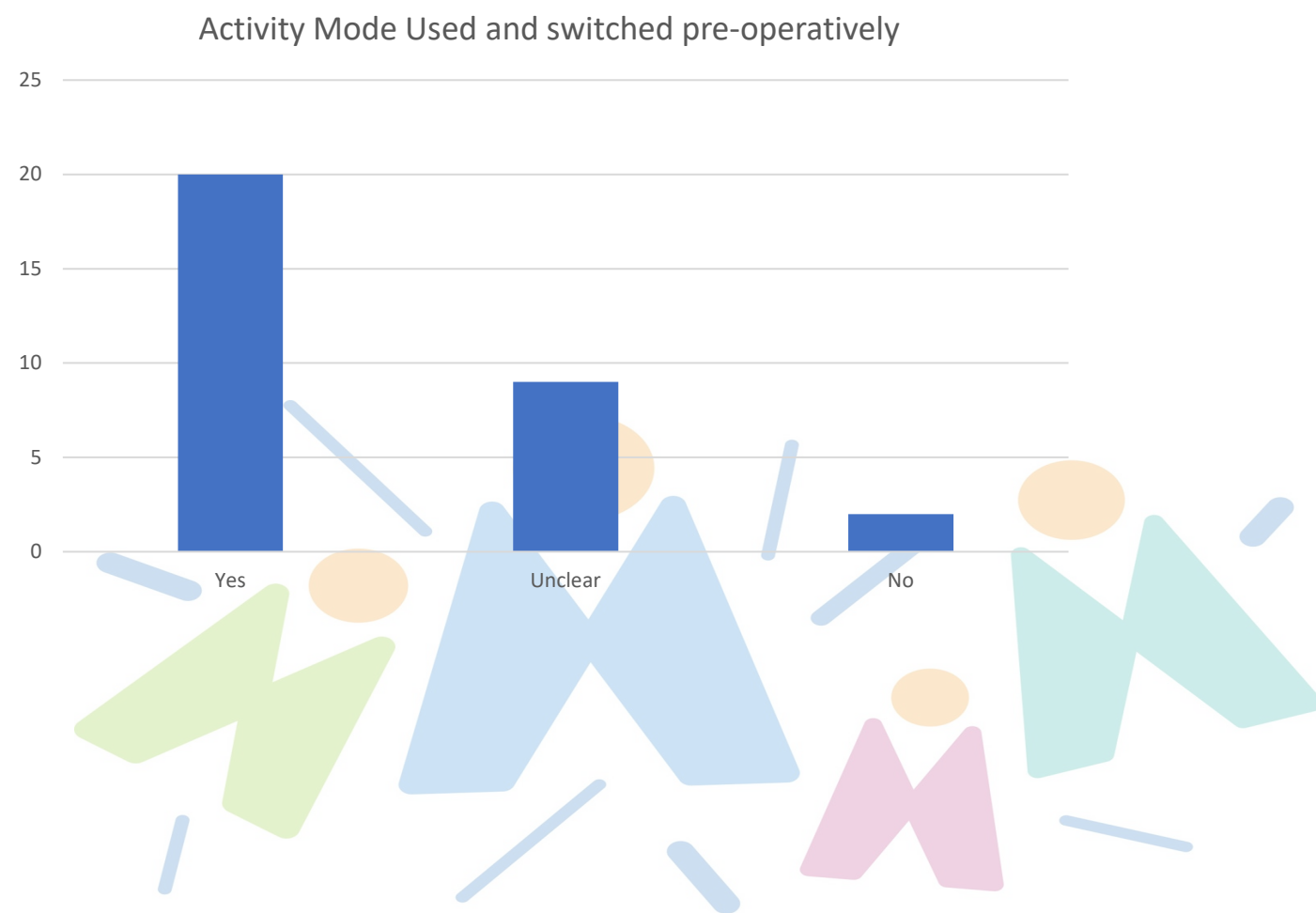
Pre-op Review on Day of Planned Surgery



Preop Assessment

- Patient to be reviewed by a member of the diabetes team on day of surgery and determine if activity mode/ease off/temporary target is to be used perioperatively.
- Pump and sensor can be sited away from site of proposed surgery (at least 15cm if possible) and not between earthing plate and diathermy

- 20/31 had clear documentation of switch to activity mode prior to theatre
- 2 cases of clearly documented reason why not switched (raised glucose pre-op in HCL mode)
- 9 cases without clear documented switch to activity mode

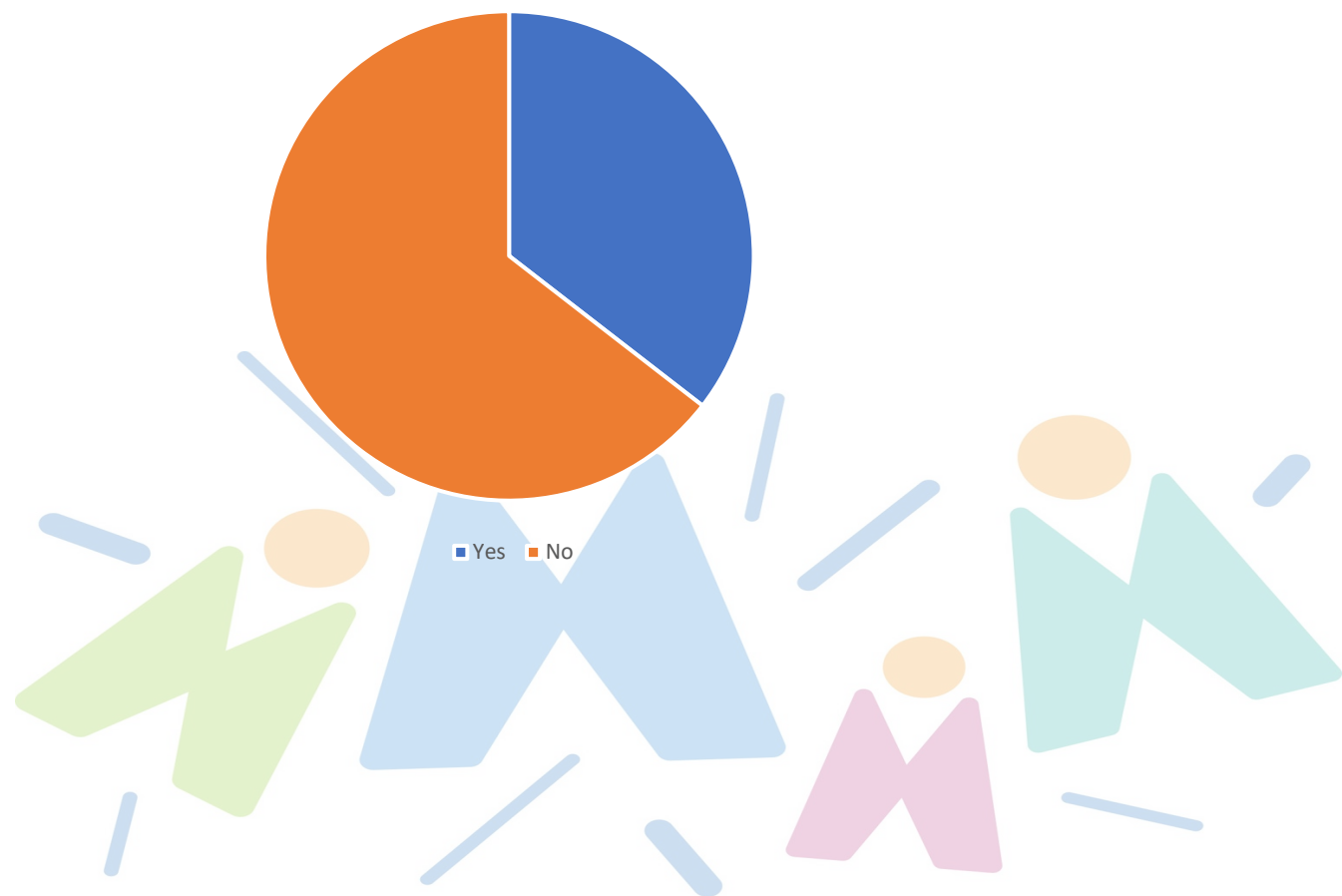


Preop Assessment

- Patient to be reviewed by a member of the diabetes team on day of surgery and determine if activity mode/ease off/temporary target is to be used perioperatively.
- Pump and sensor can be sited away from site of proposed surgery (at least 15cm if possible) and not between earthing plate and diathermy

- 11/31 had documented site of their tech.

Tech Site Documented on Day of Surgery



Standard 'Smart Phrase' Template

PDSN pre-op review

Review by: PDSN

Present: @FNAME@ and parent (specify who)

Pre-op Assessment

- Reviewed on ward preoperatively for:
- {Diabetes Type:34994}
- Lead Paediatric Diabetes Team/Consultant:
- {Diabetes Treatment Types:34996}
- Current insulin doses (BASAL/RATIOS)
- Last insulin doses
- Current mode
- Last diet and fluids: please record time for
- CGM/PUMP in situ: - record pod and sensor sites
- Will diathermy/xrays be used?
- Current blood glucose:

Plan

- First on the surgical list
- Nil by mouth as per trust policy
- Keep pump/CGM in situ for theatre - Anaesthetist to do POCT blood glucose every 30 mins throughout procedure
- Hourly blood glucose pre theatre on POCT glucometer
- If blood glucose less than 4mmol/L treat as per the hypo policy for children with diabetes
- If blood glucose above 14mmol/L check for ketones (contact paediatric diabetes specialist nurse on vocera for review if ketones above 0.6)
- Discharge once alert, tolerating diet and fluids, blood glucose stable and parents happy
- If has IV paracetamol please inform diabetes team as will need to advise parents on capillary glucose testing 12 hours post dose.

**IF DIATHERMY OR RADIATION TO BE USED IN THEATRE THEN PLEASE INFORM DIABETES TEAM ON 10667/Vocera 'Paediatric Diabetes Nurse'.

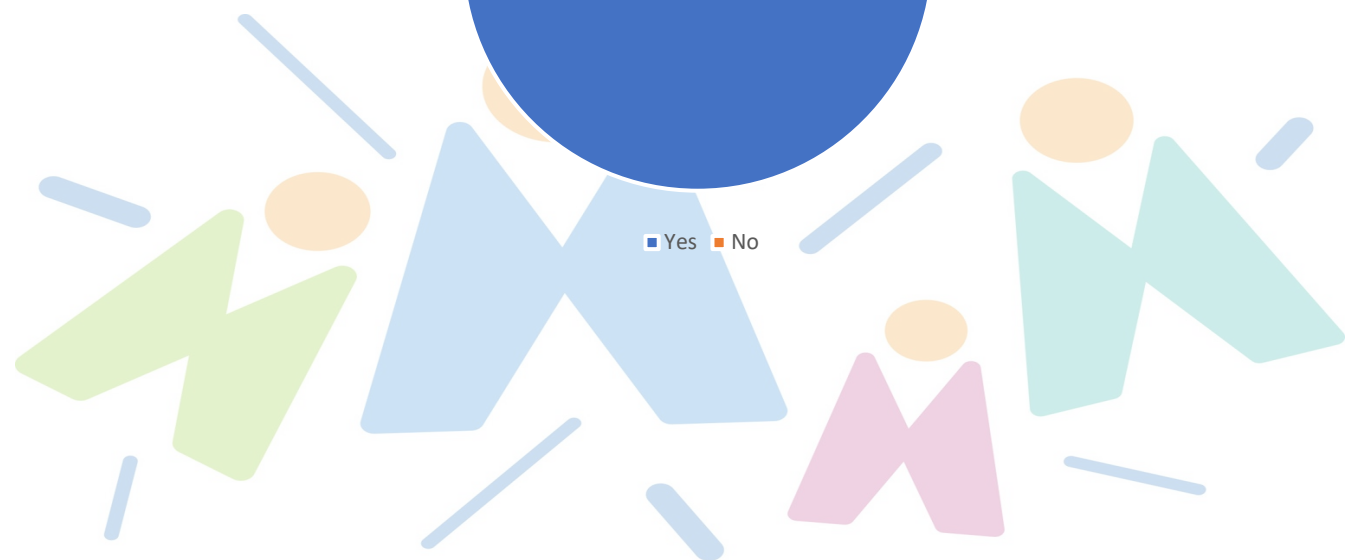
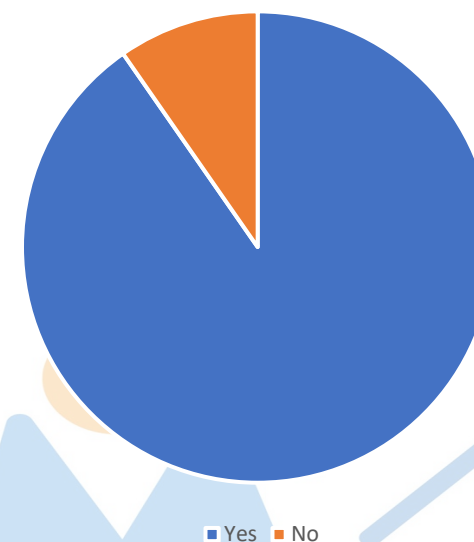


Surgery Listing

- Surgery is elective and length of procedure is < 2 hours
- Anticipated blood loss is minimal
- Child can be admitted on the morning of surgery and should be the first case on the list

- 28/31 were 1st on the list, of these the majority were AM lists with 3 being planned PM lists
- 1 case was not initially planned as first on the list but got moved to 1st on the day
- 1 case was due to be first on the list but due to issues with consent, was done later in the day
- 1 case was not clear from the documentation if they actually were first on the list on the day. There had been difficulties establishing IV access on the morning.

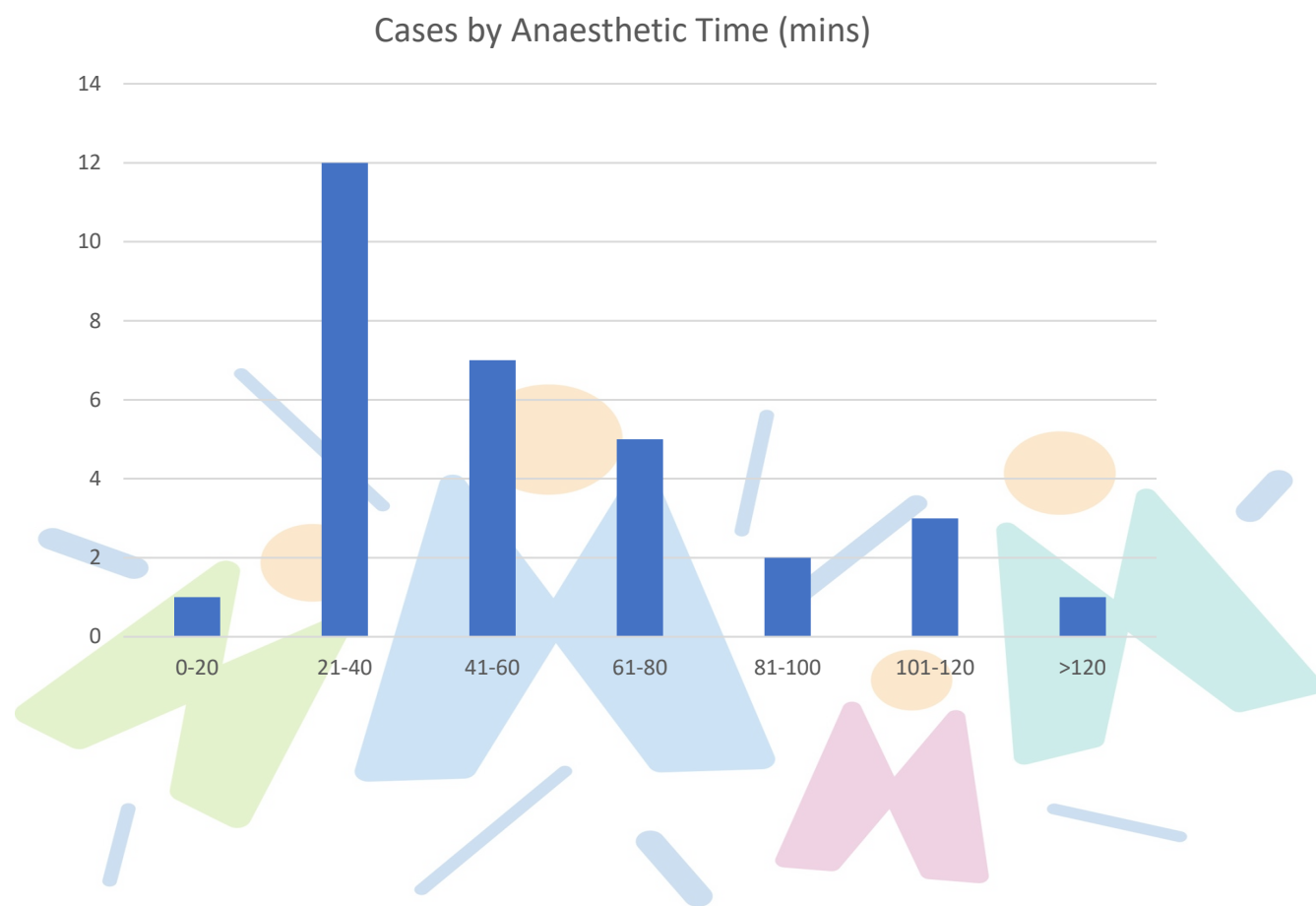
Was the Patient First on the List?



Surgery Listing

- Surgery is elective and length of procedure is < 2 hours
- Anticipated blood loss is minimal
- Child can be admitted on the morning of surgery and should be the first case on the list

- The mean anaesthetic time was 57mins
- Shortest case was 18min
- One case went beyond expected 2hrs at 132min

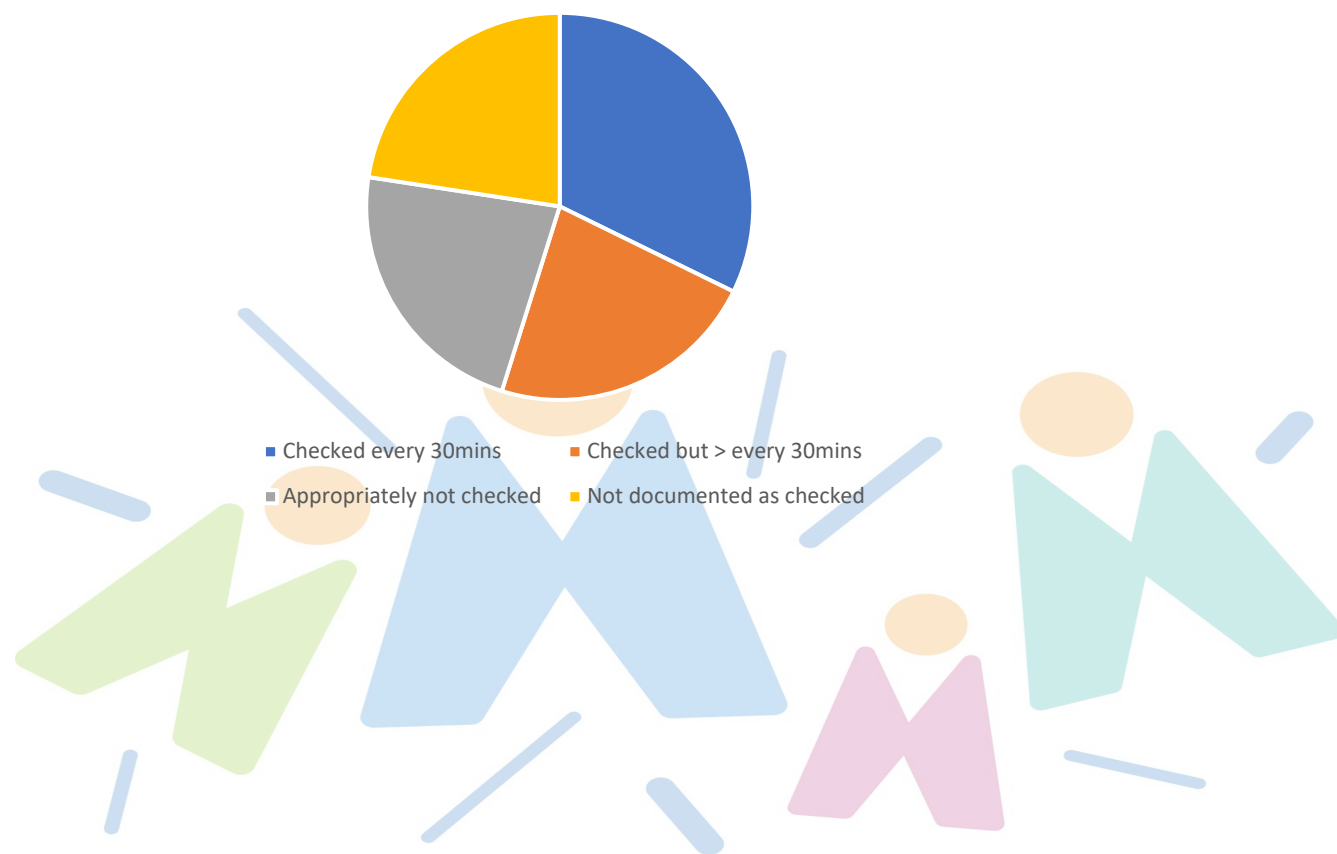


Intraoperative Blood Glucose Monitoring

- Capillary glucose able to be monitored every 30minutes
- If 2 consecutive CBGs >11mmol/L, remove the pump, store safely and commence a VRlll

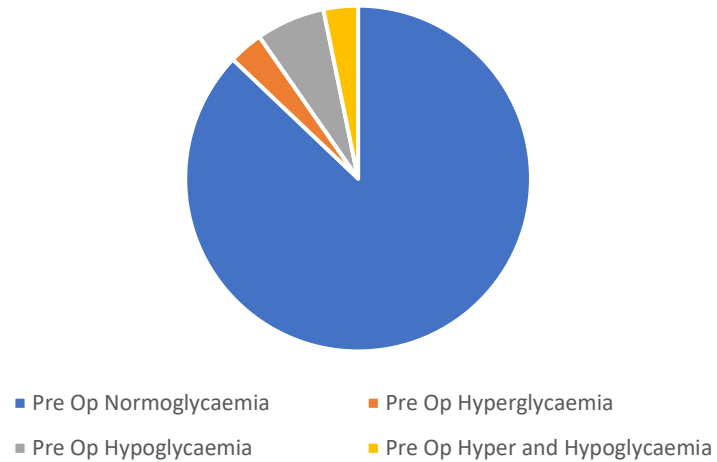
- 7 cases <30 mins and therefore not requiring intra-op blood glucose monitoring
- 7 cases with no documented capillary checks intra-op
- 10 checked every 30mins
- 7 checked but at increased intervals (45min-1hr)

Number of cases with capillary glucose monitoring intraoperatively

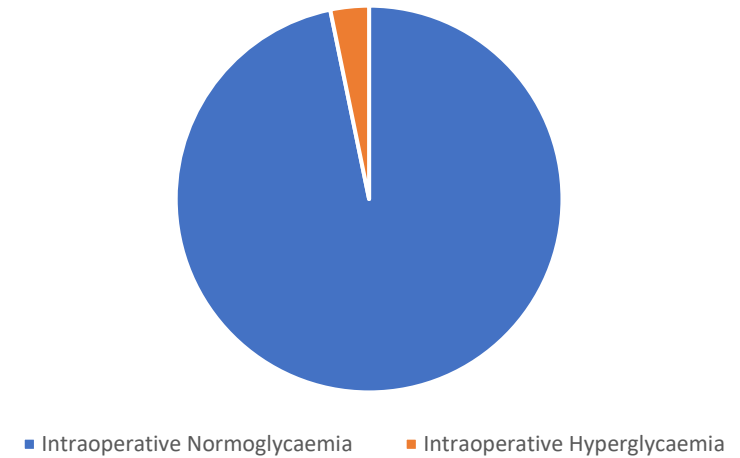


Blood Glucose Levels*

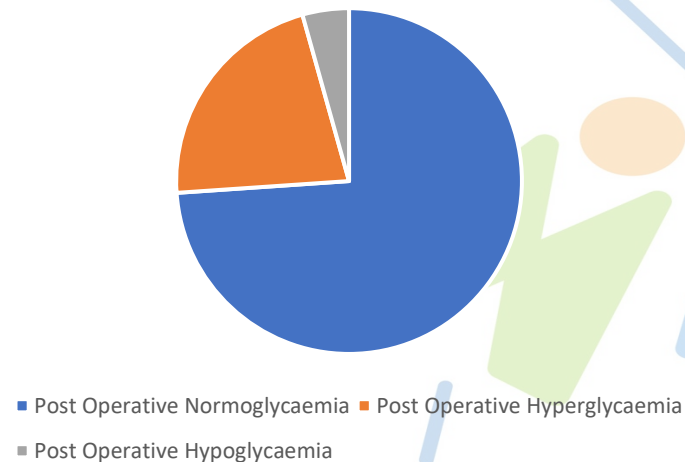
Pre Operative Blood Glucose States



Intraoperative Blood Glucose States

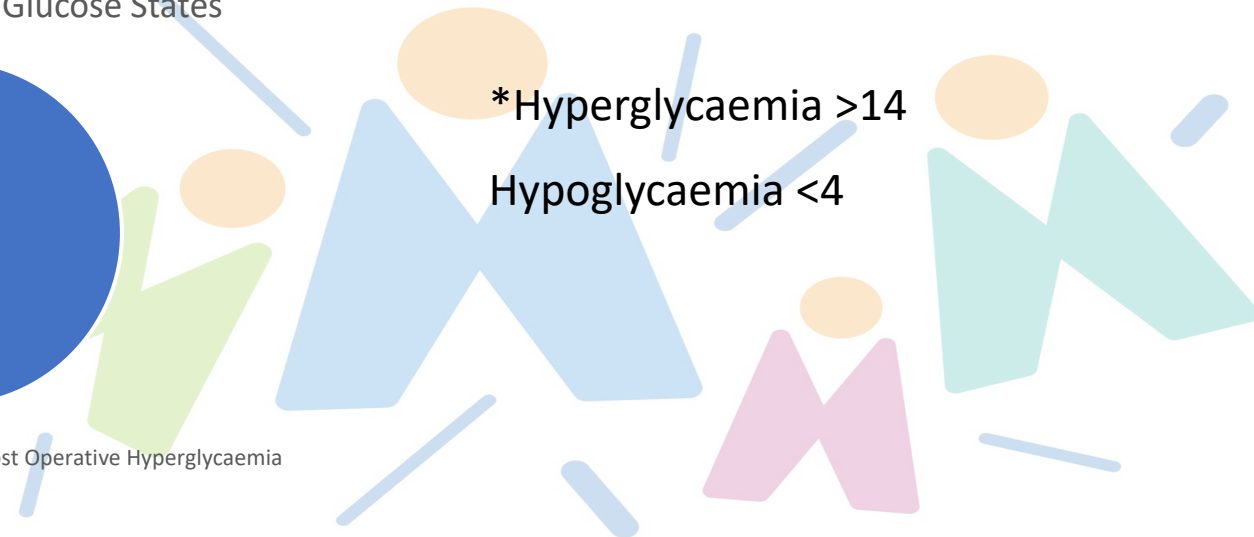


Post Operative Blood Glucose States



*Hyperglycaemia >14

Hypoglycaemia <4

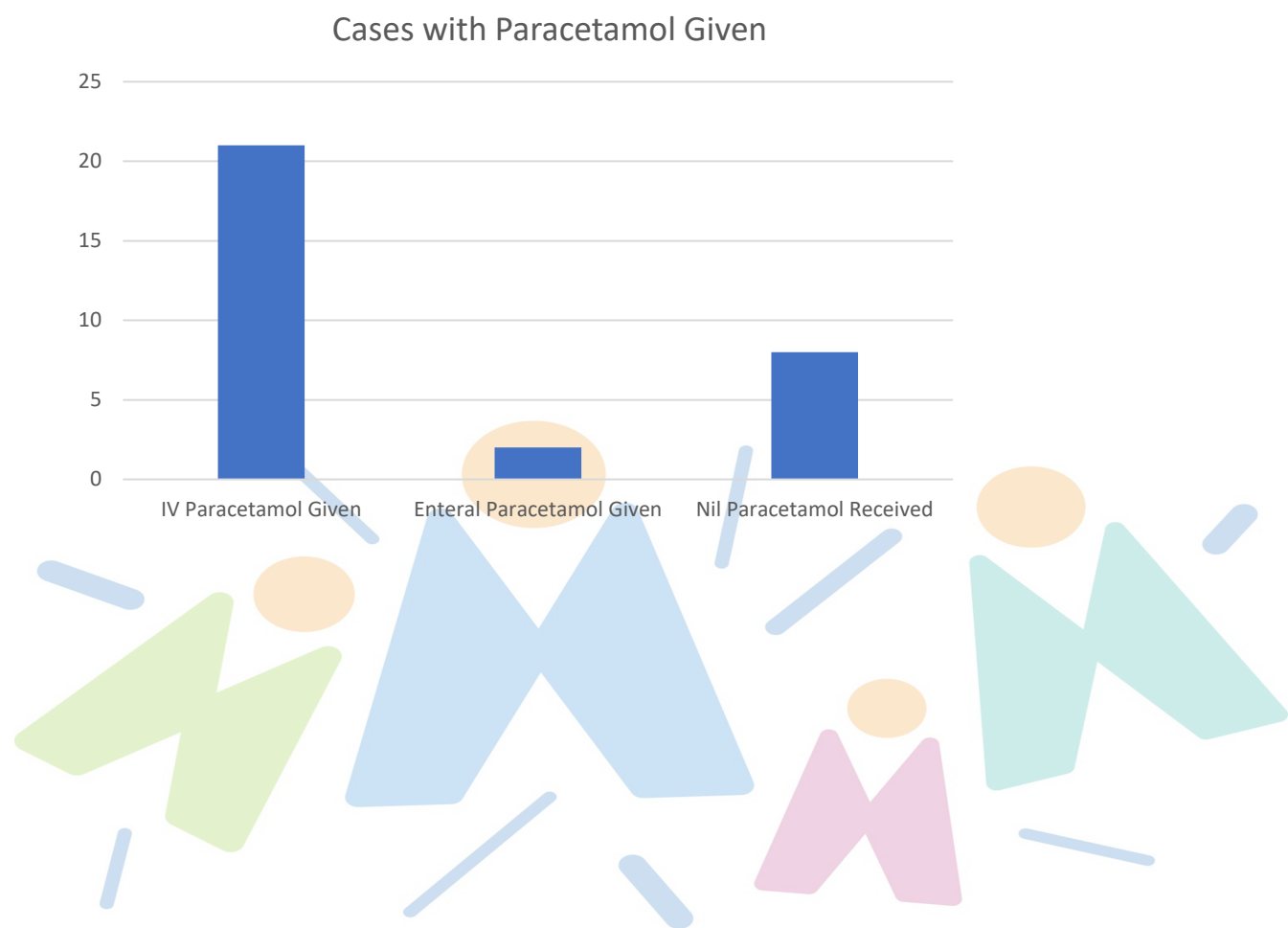


Intra-operative parameters of interest

- IV Paracetamol given to 21/31
- 2 received oral paracetamol post op
- 8 received none

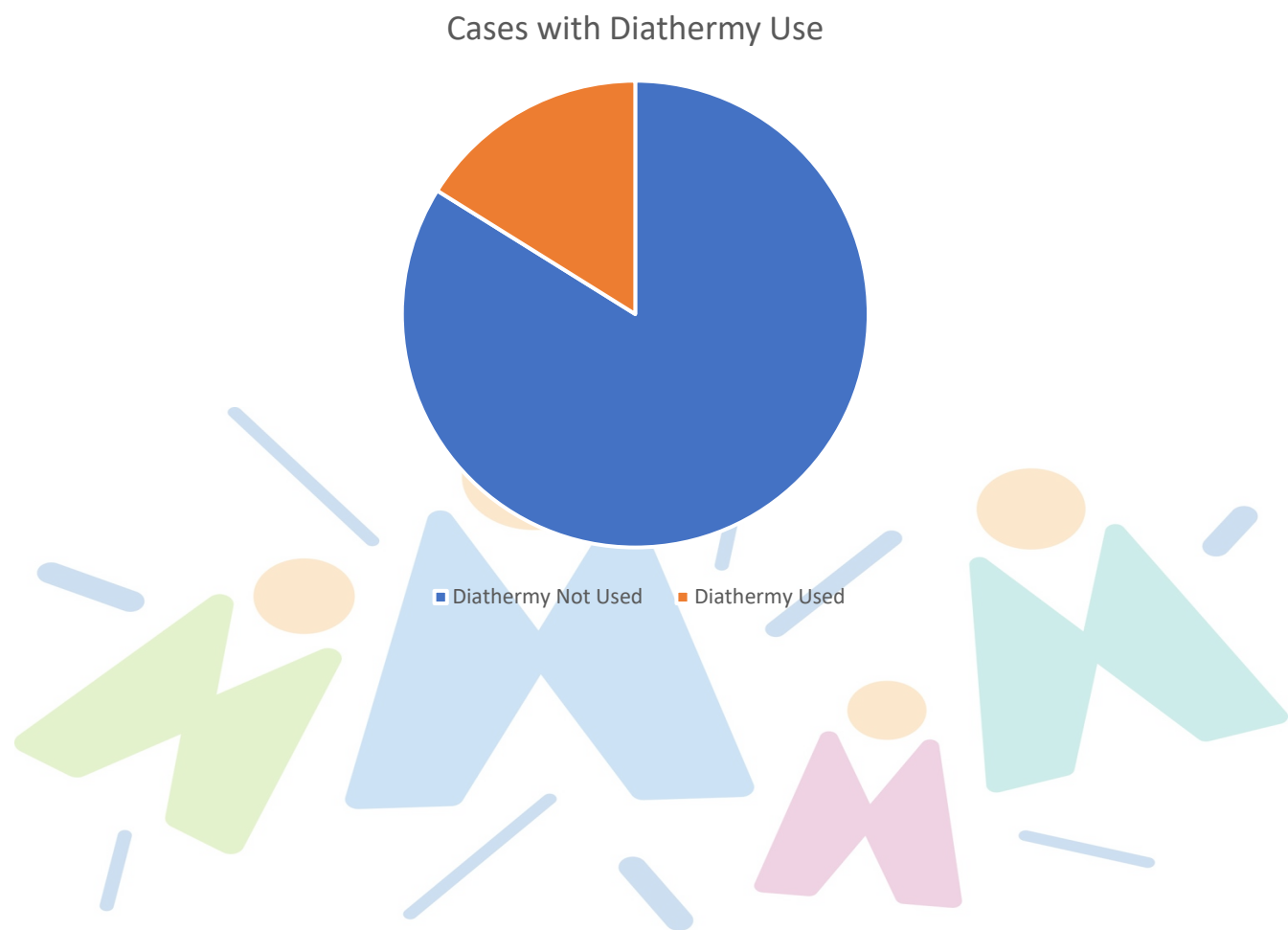
Papers suggesting interference of CGM (falsely elevated compared to capillary blood glucose) from paracetamol

- Matsuyama, M., Meiri, S., Sawada, H., et al. (2025)
- Maahs, D. M., DeSalvo, D., Pyle, L., et al. (2015)



Intra-operative parameters of interest

- 5 had documented use of diathermy intraoperatively.
- In all cases, this was bipolar
- 3/5 of these had tech site documented with 1 of these recognising tech site was going to be close to op site/diathermy and therefore moved pre-theatre.



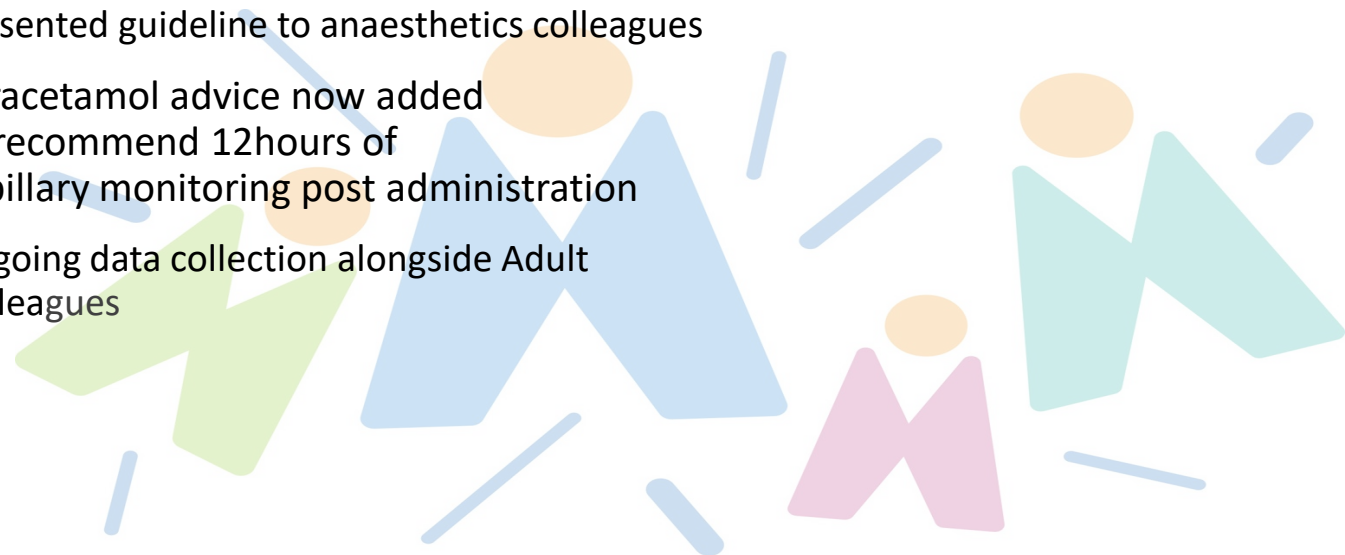
Same day discharges

- 100% discharge same day
- 100% stayed on pump throughout surgery



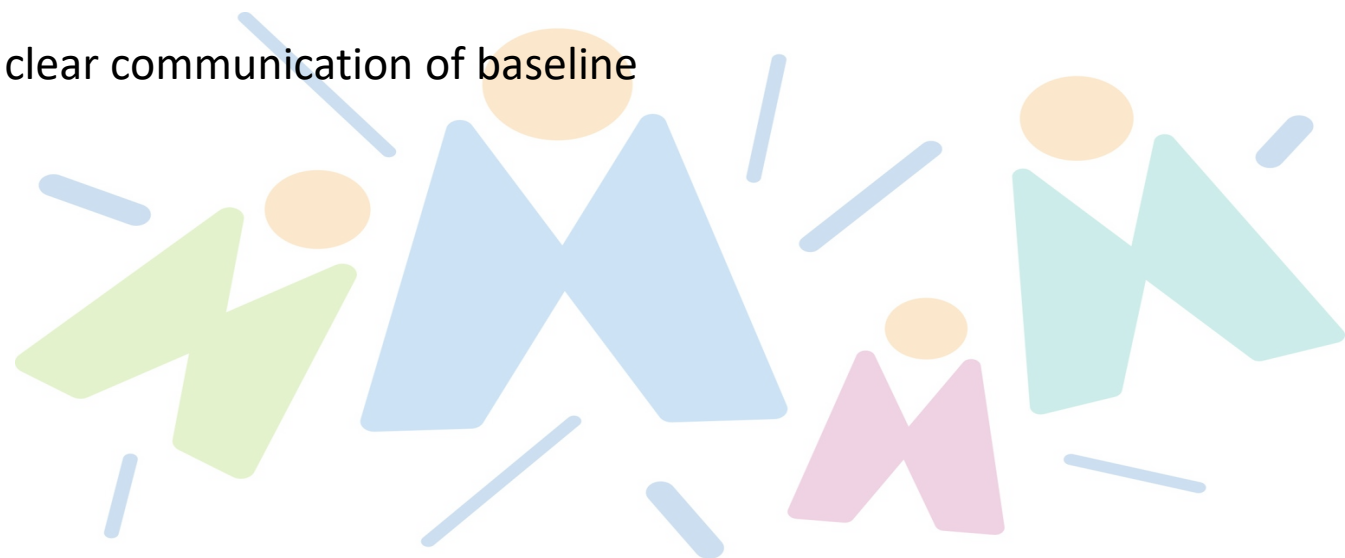
Main Issue Themes / Action Points

- Lack of general diabetes management parameters from non-MFT units
- Some variation in pre-op assessment documentation including documentation of tech site on the day of procedure
- Variable intraoperative blood glucose checks
- Paracetamol guidance not in guideline previously – but being given regularly.
- Generated template letter/guidance for local unit/DGH/parents requesting basal rates and most recent HbA1c
- Generated template/smart phrase for pre-op diabetic review to include tech site amongst other parameters
- Highlighted and educate on importance of capillary glucose monitoring/documentation
- Presented guideline to anaesthetics colleagues
- Paracetamol advice now added to recommend 12hours of capillary monitoring post administration
- Ongoing data collection alongside Adult Colleagues



Final Points

- Gradual introduction of HCL use in minor, elective surgery at MFT sites with multiple safeguards in place to ensure patient safety
- Appears safe with no adverse outcomes and intraoperative glycaemic control
- All cases were same day discharges with no conversion to VRH
- Generation of standardised smart phrase templates for pre- op review and local unit data collection to increase receiving team awareness
- Service used by whole region – therefore need for clear communication of baseline diabetes management from local units



Contact

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robert.clayson2@mft.nhs.uk





Guideline for Perioperative Care for People with Diabetes Mellitus Undergoing Elective and Emergency Surgery

Updated October 2023



Clinical Guideline
**Care of children under 18 years with Diabetes
Mellitus undergoing Surgery or MRI under GA**

Shared Decision Making and the use of CSII

(Academy of Medical Royal Colleges and Choosing Wisely UK)

BRAN

- what are the Benefits?
- what are the Risks?
- what are the Alternatives?
- what if I do Nothing?

Benefits

Avoidance of VRIII with its intrinsic dangers

- DKA caused by transition issues to and from VRIII are eliminated
- Electrolyte and fluid abnormalities that are associated with the use of the VRIII
- Risk of hospital acquired hypoglycaemia that is associated with use of VRIII

Person with diabetes has familiarity and can more easily continue self-management of diabetes

Risks

Failure of pump and/or cannula

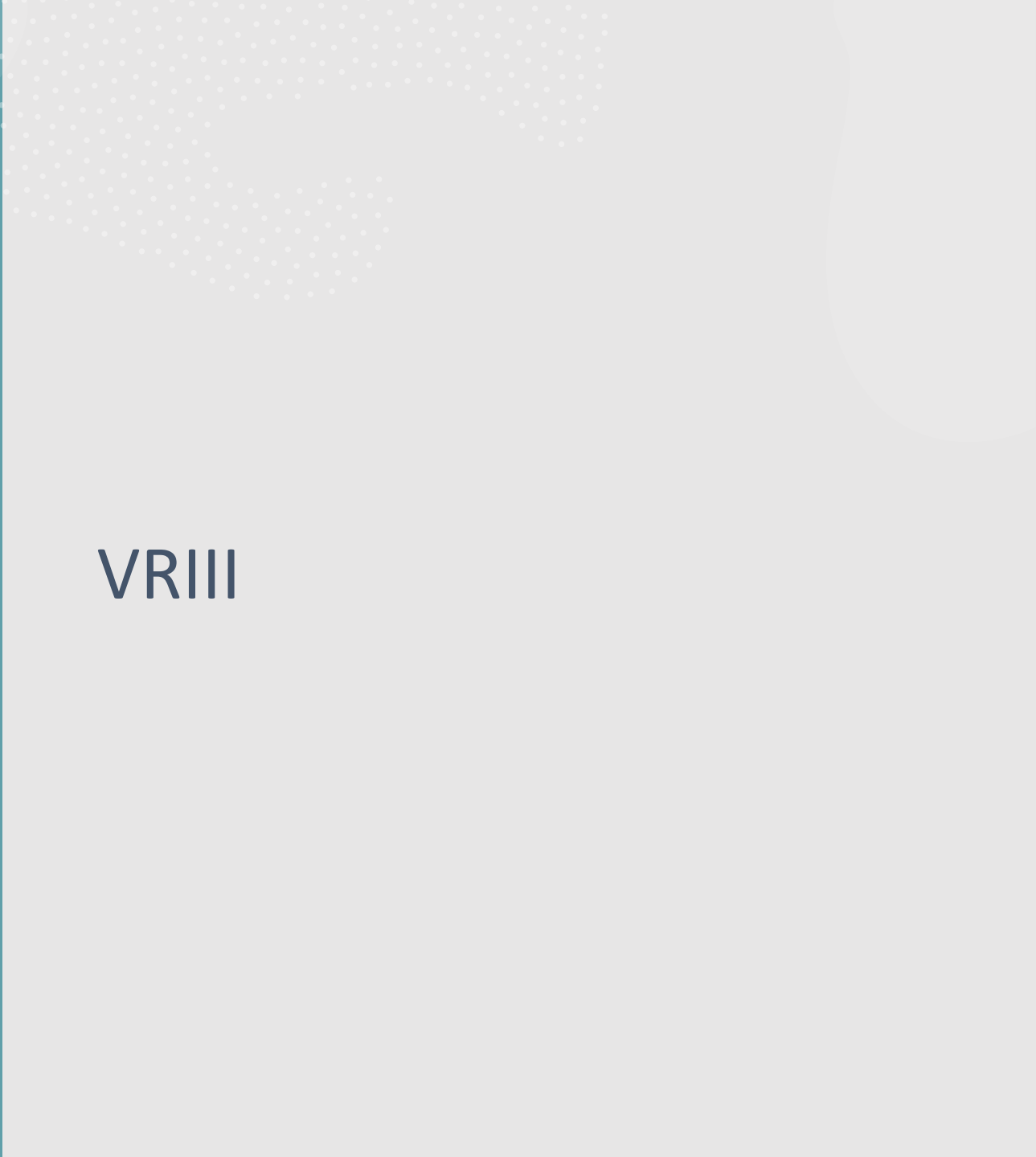
Use near diathermy/X-ray machines.

Familiarity of theatre staff with HCL systems, alarms etc

Person with diabetes is unconscious/sedated.



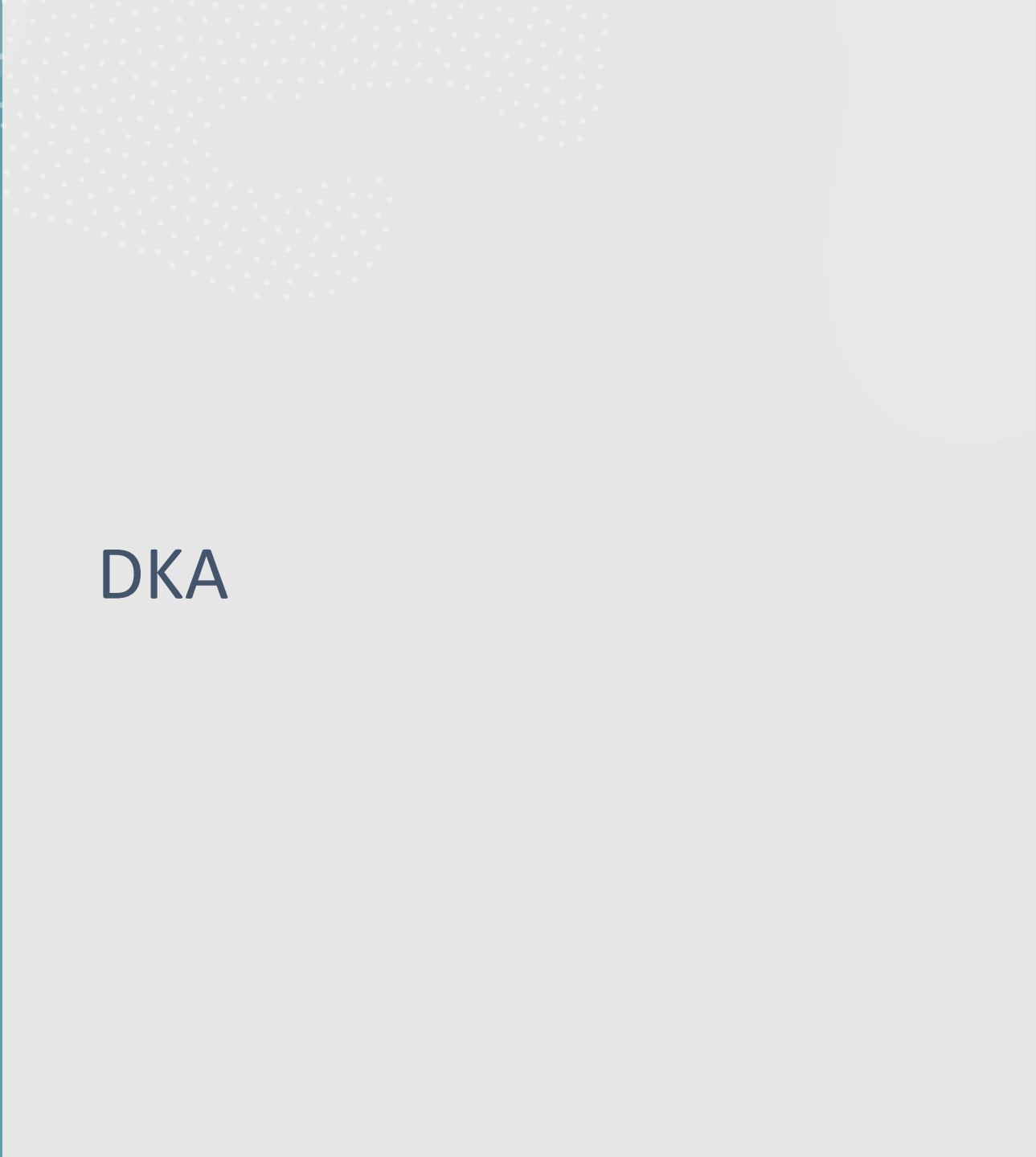
Alternatives



VRIII



Nothing



DKA

Guideline for Elective Surgery and Hybrid Closed Loop Insulin Pumps

Guideline

Category:	Guideline
Summary:	This guideline provides practical recommendations for the peri-operative management of adults and children with type 1 diabetes using hybrid closed-loop (HCL) insulin delivery systems undergoing elective procedures under general, regional, or sedation anaesthesia.

Oxford guideline

- Trust wide for both adults (non-pregnant) and paediatrics
- Specific for elective surgery and HCL
- Safety tips
 - Teflon cannula
 - CGM accuracy – ensure difference within acceptable thresholds
 - Change pod/cannula day before
 - Ensure pump fully charged (have spare consumables available at hospital)
 - Ensure CGM not set to expire the day before or day of surgery

Appendix 1: Examples of the Commonly Used Hybrid Closed Loop Systems

The table below shows the most commonly used HCL systems at the time of writing for visual identification. Diabetes technologies are evolving rapidly and dev

Appendix 4: How to Identify if Exercise/Activity Modes Are Active

Omnipod 5



Note: pod is controlled with the separate controller shown in this picture.

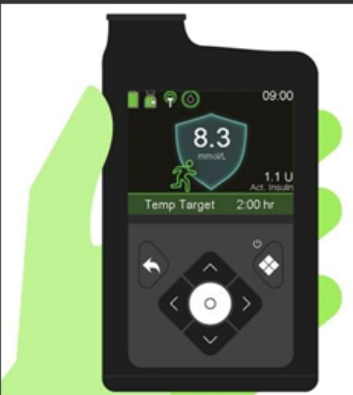
Tandem t:slim



Tandem t:slim X2



Medtronic 780G



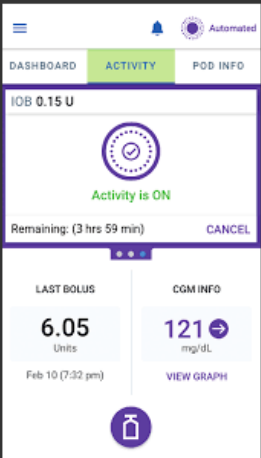
Medtronic 780G



YpsoPump



Omnipod 5



YpsoPump with CamAPS

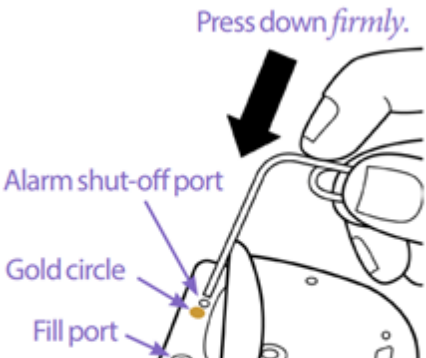


Appendix 2: Approved CGM Locations



Back of upper arm:	
	Libre 2/3 plus
	Dexcom G6/G7
	Medtronic Guardian4
	Medtronic SimpleraSync
Upper buttocks	
	Dexcom G6 (aged 2-17 years)
	Dexcom G7 (aged 2-6 years)

Pump



Appendix 6: Use of Insulin Pump and CGM Devices During Radiological Investigations