Ward-based management of abnormal capillary glucose levels with a multi-disciplinary team approach

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INTRODUCTION:

Diabetes care is a key priority of the Trust's patient safety programme. National Audit has revealed a higher prevalence of inpatient diabetes at the Royal Free London. A collaborative, multidisciplinary approach piloted in Cardiology used improvement methodology which empowered front line clinical staff to correctly interpret the clinical significance of abnormal capillary glucose results in a timely manner and support prompt appropriate management.

Serious incident investigations revealed a need to improve staff awareness of abnormal capillary blood glucose levels, and accessibility to diabetes protocols and guidance. We set up a Diabetes Improvement group which included Diabetes Consultant, Diabetes lead nurse, pharmacy, Patient safety, ward Matron and 10W staff, dietician, Patient at risk & Resuscitation team, laboratory staff and quality & safety manager.

Our aim was to significantly reduce avoidable harm resulting from inpatient hyperglycaemia and hypoglycaemia events on 10W by January 2016.

METHOD:

- Baseline ward Diabetes care process mapping and audit showed high numbers of hyperglycaemic episodes with significant variation in management.
- A major proportion of hyperglycaemic events occurred out-of-hours (80%) when specialist Diabetes specialist staff were not available for input.
- The Diabetes Improvement work-stream met weekly to review data and share expertise.

A hyperglycaemia pathway was developed using improvement science methodology: plan, do, study, act (PDSA) and small tests of change. By creating an overall aim and mapping out our driver diagram as a team we were able understand where our problems lay in the system. This process allowed broad identification of issues pertaining to inpatient diabetes management. Diabetes care and treatment at times can be complex,requiring timely specialist input.

Data is measured by several process measures:

- 95% of patients that trigger are started on the hyperglycaemia/hypoglycaemia pathway.
- 95% of patients with hyperglycaemia (defined as above 20mmol/L) achieve blood glucose level control within 6 hours.
- 95% of patients with hypoglycaemia (defined as below 4mmol/L) achieve euglycaemia within 30 minutes.

Glycaemic management followed a clear pathway for treating patients with abnormal capillary glucose levels. Those with significant sustained hyperglycaemia (capillary blood glucose above 20 mmol/L) required assessment by ward Doctor within 30 minutes. Management was determined in part by patients' clinical stability. The pathway ensured early review of medication as well as diet.

We developed a hyperglycaemia pathway with guidance on adjusting and initiating oral hypoglycaemic agents and insulin. Posters were created for prescribing unscheduled insulin doses. The trust hypoglycaemia pathway was redesigned with the use of a hypoglycaemia box.

- One main target was controlling glucose levels within six hours of commencing the treatment pathway and efficacy was also assessed.

Hypoglycaemia (capillary blood glucose below 4mmol/l) management was categorised into mild-moderate and severe. A clear protocol reviewing insulin, administration of rapid-acting carbohydrates, or 10% dextrose or glucagon for severe cases was used.

- The aim was to raise blood glucose levels to above 4mmol/l within 30 minutes

Colour-coded capillary blood glucose charts were created to allow clearer identification of abnormal results. Simple alerts directing staff were introduced to trust glucometers to aid escalation for early patient review.

FIG 5: Hyper time to control within 6 hrs

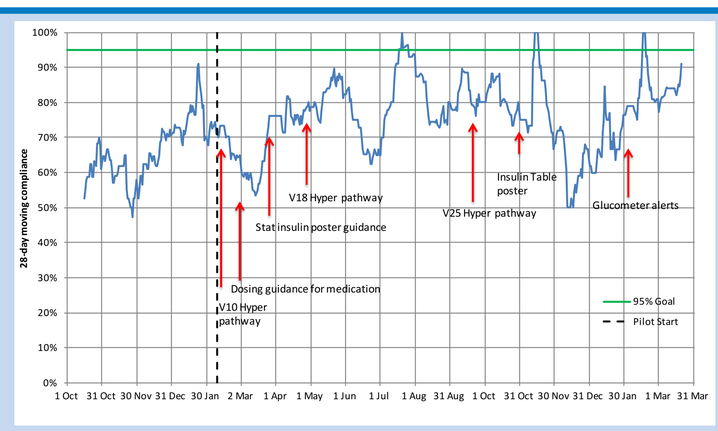


FIG 6: Hypo time to control within 30 mins/45/60 mins

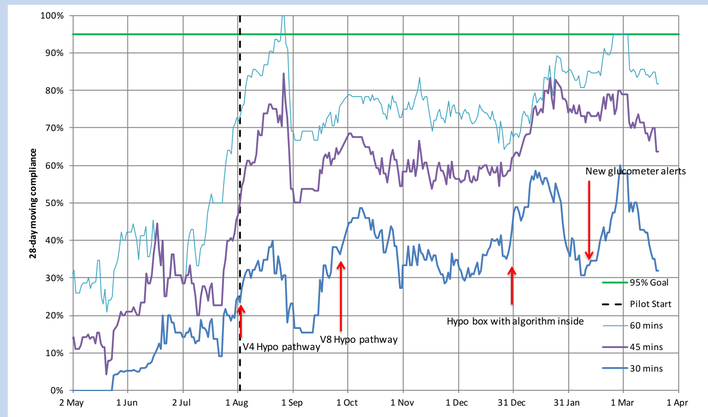


FIG 7:999999 codes with interventions over time

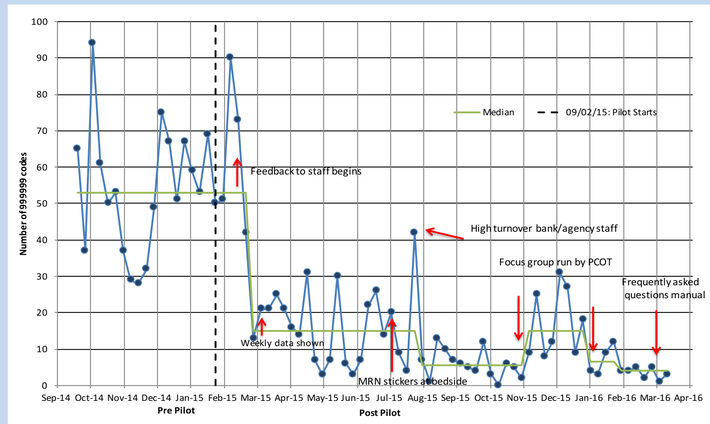
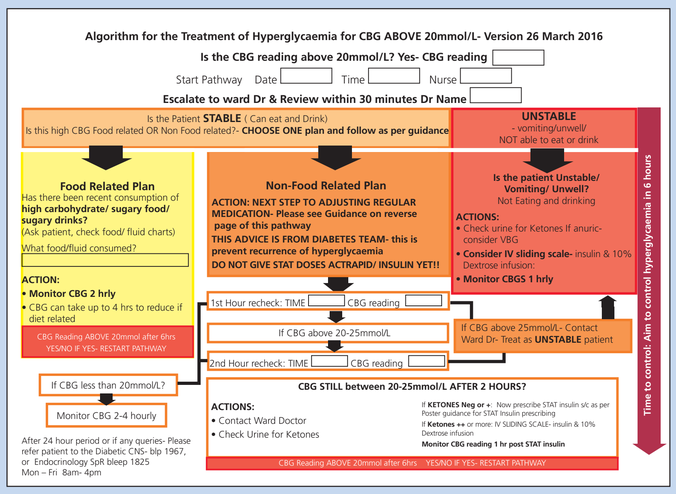


FIG 1: Hyperglycaemia pathway Version 26



Algorithm for the Treatment of Hyperglycaemia for CBG ABOVE 20mmol/L- Version 26 March 2016

Is the CBG reading above 20mmol/L? Yes- CBG reading ____

Start Pathway Date ____ Time ____ Nurse ____

Escalate to ward Dr & Review within 30 minutes Dr Name ____

Is the Patient **STABLE** (Can eat and Drink)
Is this high CBG Food related OR Non Food related?- **CHOOSE ONE plan and follow as per guidance**

UNSTABLE
- vomiting/unwell/
NOT able to eat or drink

Food Related Plan
Has there been recent consumption of **high carbohydrate/ sugary food/ sugary drinks?**
(Ask patient, check food/ fluid charts)
What food/fluid consumed? ____

ACTION:
- **Monitor CBG 2 hrly**
- CBG can take up to 4 hrs to reduce if diet related

CBG Reading ABOVE 20mmol after 6hrs YES/NO IF YES- RESTART PATHWAY

Non-Food Related Plan
ACTION: NEXT STEP TO ADJUSTING REGULAR MEDICATION- Please see Guidance on reverse page of this pathway
THIS ADVICE IS FROM DIABETES TEAM- this is prevent recurrence of hyperglycaemia
DO NOT GIVE STAT DOSES ACTRAPID/ INSULIN YET!!

Is the patient Unstable/ Vomiting/ Unwell?
Not Eating and drinking

ACTIONS:
- Check urine for Ketones If anuric- consider VBG
- **Consider IV sliding scale-** insulin & 10% Dextrose infusion:
- **Monitor CBGS 1 hrly**

1st Hour recheck: TIME ____ CBG reading ____

If CBG above 20-25mmol/L

2nd Hour recheck: TIME ____ CBG reading ____

If CBG less than 20mmol/L?

Monitor CBG 2-4 hourly

If CBG above 25mmol/L- Contact Ward Dr- Treat as **UNSTABLE** patient

CBG STILL between 20-25mmol/L AFTER 2 HOURS?

ACTIONS:
- Contact Ward Doctor
- Check Urine for Ketones

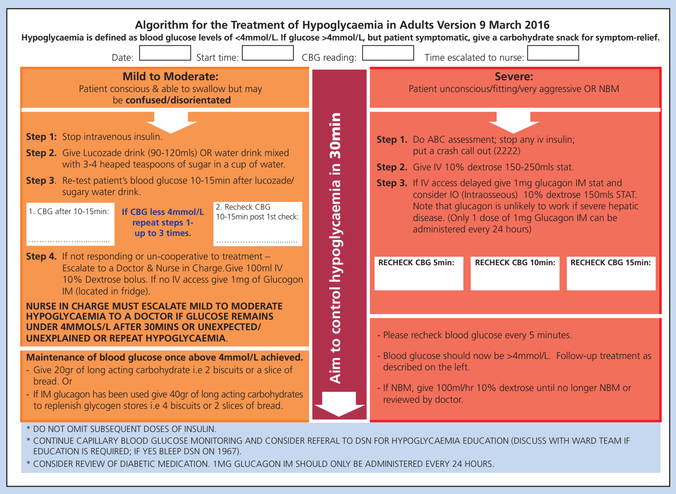
If **KETONES Neg or +**: Now prescribe STAT insulin s/c as per Poster guidance for STAT Insulin prescribing
If **Ketones ++** or more: IV SLIDING SCALE- insulin & 10% Dextrose infusion
Monitor CBG reading 1 hr post STAT insulin

CBG Reading ABOVE 20mmol after 6hrs YES/NO IF YES- RESTART PATHWAY

Time to control: Aim to control hyperglycaemia in 6 hours

After 24 hour period or if any queries- Please refer patient to the Diabetic CNS- blp 1967, or Endocrinology SpR bleep 1825 Mon – Fri 8am- 4pm

FIG 2: Hypoglycaemia pathway Version 9



Algorithm for the Treatment of Hypoglycaemia in Adults Version 9 March 2016

Hypoglycaemia is defined as blood glucose levels of <4mmol/L. If glucose >4mmol/L, but patient symptomatic, give a carbohydrate snack for symptom-relief.

Date: ____ Start time: ____ CBG reading: ____ Time escalated to nurse: ____

Mild to Moderate:
Patient conscious & able to swallow but may be **confused/disorientated**

Step 1: Stop intravenous insulin.
Step 2. Give Lucozade drink (90-120mls) OR water drink mixed with 3-4 heaped teaspoons of sugar in a cup of water.
Step 3. Re-test patient's blood glucose 10-15min after lucozade/ sugary water drink.

1. CBG after 10-15min: ____ **If CBG less 4mmol/L repeat steps 1- up to 3 times.** 2. Recheck CBG 10-15min post 1st check: ____

Step 4. If not responding or un-cooperative to treatment – Escalate to a Doctor & Nurse in Charge.Give 100ml IV 10% Dextrose bolus. If no IV access give 1mg of Glucogon IM (located in fridge).

NURSE IN CHARGE MUST ESCALATE MILD TO MODERATE HYPOGLYCAEMIA TO A DOCTOR IF GLUCOSE REMAINS UNDER 4MMOLS/L AFTER 30MINS OR UNEXPECTED/ UNEXPLAINED OR REPEAT HYPOGLYCAEMIA.

Maintenance of blood glucose once above 4mmol/L achieved.
- Give 20gr of long acting carbohydrate i.e 2 biscuits or a slice of bread. Or
- If IM glucagon has been used give 40gr of long acting carbohydrates to replenish glycogen stores i.e 4 biscuits or 2 slices of bread.

Aim to control hypoglycaemia in 30min

Severe:
Patient unconscious/fitting/very aggressive OR NBM

Step 1. Do ABC assessment; stop any iv insulin; put a crash call out (2222)
Step 2. Give IV 10% dextrose 150-250mls stat.
Step 3. If IV access delayed give 1mg glucagon IM stat and consider IO (Intraosseous) 10% dextrose 150mls STAT. Note that glucagon is unlikely to work if severe hepatic disease. (Only 1 dose of 1mg Glucagon IM can be administered every 24 hours)

RECHECK CBG 5min: **RECHECK CBG 10min:** **RECHECK CBG 15min:**

- Please recheck blood glucose every 5 minutes.
- Blood glucose should now be >4mmol/L. Follow-up treatment as described on the left.
- If NBM, give 100ml/hr 10% dextrose until no longer NBM or reviewed by doctor.

* DO NOT OMIT SUBSEQUENT DOSES OF INSULIN.
* CONTINUE CAPILLARY BLOOD GLUCOSE MONITORING AND CONSIDER REFERAL TO DSN FOR HYPOGLYCAEMIA EDUCATION (DISCUSS WITH WARD TEAM IF EDUCATION IS REQUIRED; IF YES BLEEP DSN ON 1967).
* CONSIDER REVIEW OF DIABETIC MEDICATION. 1MG GLUCAGON IM SHOULD ONLY BE ADMINISTERED EVERY 24 HOURS.

FIG 3: Medications Dosing guidance

Management of Hyperglycaemia- CBG above 20mmol/L in a Stable Patient DOSING GUIDE Version 8

STEP 1 Increase oral anti-glycaemic agents if patient taking

DRUG	USUAL MAX DOSE	DOSING ADVICE	PRECAUTIONS
Increase 1st **METFORMIN (biguanide)**	1g BD - 3g daily (divided doses e.g. 1g TDS) with meals	↑ dose up to 50% if good renal & liver function ↓ dose if GFR <50mls/min)	Increased risk of lactic acidosis in renal impairment Avoid if GFR <30ml/min)
Increase 2nd **GLICLAZIDE (sulphonylurea)**	160mg BD	↑ dose up to 50% if good renal & liver function ✔ **Prescribe increased dose to take at meal times** ✖ **Do NOT prescribe stat doses**	Risk of hypoglycaemia in elderly, severe liver & renal disease Caution in mild to moderate renal impairment Avoid in severe renal impairment Avoid/reduce dose in severe hepatic impairment
Increase 3rd **SITAGLIPTIN (DPP-4 inhibitor)**	100mg OD	If on lower dose ↑ to: • **100mg** od if GFR >50mls/min • **50mg** od if GFR 30-50mls/min • Max dose 25mg od if GFR <30mls/min	Small risk of hypoglycaemia in combination with other agents

STEP 2 Increase regular insulin if patient on insulin

Patient might be receiving:
- **Basal insulin** e.g. Lantus, Levemir, Humulin I, Insulatard
- **Premixed insulin** (biphasic) e.g. Novomix 30, Humulin M3, Humalog Mix 25
- **Background (basal) and mealtime (bolus) insulin** e.g. bolus insulin - Novorapid, Humalog

1. Hyperglycaemia may have occurred due to previous dose, therefore adjust dose following day
2. Determine which dose is responsible for high blood glucose level - **SEE GRID BELOW**
3. Adjust one insulin at a time

SHORT & RAPID ACTING INSULIN ➡ Adjust by no more than 2-4 units (or 10-20% of current dose) daily

INTERMEDIATE/ LONG ACTING ➡ Adjust by no more than 2-4 units or 10-20% (whichever is greater) every 3-4 days

Which blood glucose is too high?		
	BREAKFAST	Adjust EVE long acting insulin (basal regime only) or EVE premixed insulin on BD premixed regime
	LUNCH	Adjust breakfast short acting insulin if on basal bolus regime. If on premixed BD - adjust morning dose
	EVENING MEAL	Adjust lunch short acting insulin on basal bolus regime or morning premixed insulin on BD premixed regime

FIG 4 Poster guidance for Unscheduled Insulin Doses

GUIDANCE FOR PRESCRIBING STAT DOSES OF INSULIN **10W DIABETES PILOT Feb' 15 Draft 3**

STOP

1. Have you started the patient on the Hyperglycaemia CBG above 20mmol/L pathway?
2. Could this be a **single isolated event** linked to recent sugary/ high carbohydrate food consumption? (look at food charts/ fluid charts) **If YES-** recheck CBG 2-4 hrly **If NO-** see below
3. For the Stable patient- Have you increased oral anti-glycaemic agents first? (if patient is on) – See Guidance on Hyperglycaemia pathway
AND Have you increased regular basal insulin (if patient already on) – See Guidance on Hyperglycaemia pathway with advice to increase regular basal insulin

If CBG reading is STILL above 20mmol/L after 2 hours after the 1st reading, and steps to increase oral agents/ regular insulin done already - then review patient for **STAT** insulin dose.
- **Type 1 diabetes &** those already on Novarapid/ Humalogue- **Discuss with patient & give Correction dose** of their usual short acting insulin. All other patients give STAT Actrapid

REMEMBER- Maximum frequency **is 4 hourly** (includes ALL short acting insulin)- try and give before/ with meals
If possible doses should be given before/with meals

DOSING GUIDE

Weight (kg)	Dose (units)
≤50kg	1-4
51 - 75kg	2-6
75 - 90kg	4-6
91 - 100kg	5-8
>100kg	6-10

- **Do not use if DKA or Hyperosmolar Hyperglycaemic state (HSS or HONK) is suspected- please refer to Medical SpR (2527) or Diabetes team CNS (1967)**
- **PRN Actrapid can cause hypoglycamia and unstable blood sugars**

RESULTS:

Current "time to control" hyperglycaemia in patients increased to 81% of patients within 6 hours of starting pathway.

Current "time to control" hypoglycaemia in patients increased to 60% within 30 minutes of starting pathway.

We achieved a 95% reduction in "unknown" patient identifier glucometer codes used on 10W ward, ensuring better data quality and tracing of patients. By reducing the number of "unknowns" we have been able to interpret the data in a more efficient manner. Patients were logged as "unknown" for a number of reasons including practical issues pertaining to scanning of patient wristband, software issues, patient transfers and incorrect manual entry. By working closely with the ward staff and lab staff facilitating the focus group sessions, a manual was created on avoiding use of an unknown code. The process of correct code entry on the glucometer machine was redesigned and simplified based on staff feedback.

This similar approach also meant that the glucometer alerts could be modified based on staff feedback and tested for effectiveness.

Patients with diabetes have an average excess length of stay (LOS) of over 3 days, and from audit data there is an association of deterioration of inpatient glycaemia control with increased LOS.

The next phase of work encompasses parallel reviewing of the impact of pathways on patient outcomes, such as length of stay and mortality.

DISCUSSION:

Weekly feedback of data and improvement created a culture of teamwork and engagement and pride in improving compliance.

A 95% reduction in "unknown" patient identifier glucometer codes used on the ward, ensuring better quality data quality and tracing of patients.

The biggest success has been how rewarding the experience of improvement has been for the front line staff and the role of champions who were involved in the original incidents. From this vital work they have contributed to making a real difference to improving safety systems and culture on their ward. Diabetes nurse champions on the ward have been responsible for data collection with support from Patient safety team and present cases back to the improvement team for analysis leading to suggestions for change and further testing.

Staff have fed back that the pathways make them feel safe and more confident in managing diabetes care. Within the hyperglycaemia pathway, there is a further provision to assess if it is food induced hyperglycaemia or non-food induced. Asking the patient what food/fluid they recently consumed is an integral part of the pathway, identifying those patients who may be at high risk of not being compliant with diet and helps to prompt consideration of dietician input/ dietary advice which also empowers patients with their own care. The National Inpatient Diabetes Audit 2013 revealed that 33% of patients report not being enabled to take control of their diabetes while in hospital.

We strongly advocate patient empowerment, engagement and involvement of their diabetes. In line with the relevant National Guidance, work has been initiated to develop options for self-administration of insulin for inpatients with diabetes, where possible.

Scoping is underway to explore the patient perspective via patient focus groups forums.

CONCLUSION:

We have demonstrated ward-based pathways together with staff engagement can improve quality of care of in-patients with diabetes mellitus alongside traditional educational methods.

The pilot implementation and introduction of pathways have resulted in improved recognition, escalation and management of poorly-controlled diabetes by ward staff, as well as an improved awareness of patient risk associated with diabetes. Patients with Diabetes on the ward have observed and commented on heightened staff awareness of diabetes management, and reported feeling more actively involved in their care.

We feel this work has potential to be cascaded and tested using the same methodology and approach in a new clinical area. Our second pilot area will be a specialist renal ward, chosen due to recent serious incidents involving diabetes management and the triangulation of safety data.

All pathways and guidance are now included in a bedside booklet which will be tested in the new clinical ward area. This experience has demonstrated the challenges of bringing guidance to front line staff involved in health care. By using small tests of change we can promote a process from which bedside staff feel involved and empowered, this results undoubtedly in better patient process measures, care and ultimately outcomes.

REFERENCES:

National Diabetes Inpatient Audit 2013 http://www.hscic.gov.uk/catalogue/PUB13662/nati-diab-inp-audi-13-nat-rep.pdf

ACKNOWLEDGEMENTS:

10W ward staff, Diabetes Improvement Workstream group, Diabetes Clinical Nurse specialist team Patient Safety & Risk Team

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