

Improving the Quality of Assessment and Management of Hypoglycaemia in Hospitalised Patients with Diabetes Mellitus by Introducing 'Hypo Boxes' to General Medical Wards with a Specialist Interest in Diabetes

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Abstract

Diabetes is becoming more prevalent in the UK and this is represented in the in-patient cohort, such that 1 in 6 hospital patients have diabetes (1). The UK National Diabetes In-Patient Audit in 2012 estimated that 30% of patients experience one episode of hypoglycaemia during admission. Hypoglycaemia is associated with increased morbidity and mortality, and longer length of hospital stay.

It is therefore important that hypoglycaemia is managed promptly and effectively to reduce associated morbidity. The Joint British Diabetes Society recommends that all wards should have access to 'Hypo Boxes' (2).

We assessed all episodes of hypoglycaemia (<4.0 mmol/l) in the diabetes wards in over a 4 week period. 'Hypo Boxes' were installed to the wards and the appropriateness of treatment and time to correction of hypoglycaemia was re-assessed.

Assessment of hypoglycaemia pre-intervention revealed 45 episodes of hypoglycaemia in 14 patients, and 42% (n=19) of episodes were deemed to have been treated appropriately. Only 17.8% of episodes were corrected within 30 minutes, and 33.3% were corrected within 60 minutes. A third of patients (35%) did not have a further blood glucose checked.

Following intervention, there was a marked improvement in management. The proportion of appropriately managed episodes increased to 82% (n=35) and management of episodes of severe hypoglycaemia (<3.0 mmol/l) increased to 94%. The time to correction increased with 40% of episodes corrected to >4.0 mmol/l within 30 minutes, and a further 54% between 30-60 minutes.

In conclusion, the introduction of 'Hypo Boxes' improved the assessment and management of hypoglycaemia.

Problem

Hypoglycaemia is a well-recognised complication in patients with diabetes mellitus on insulin or sulphonylurea therapy. It represents a significant barrier to achieving optimal glycaemic control. Hypoglycaemia in hospital in-patients is increasingly common, mainly due to the increasing prevalence of type 2 diabetes in the UK population and a subsequent increase in the number of patients who have diabetes as a co-existing medical condition. The Joint British Diabetes Society estimate that 1 in 6 hospital in-patients will have diabetes (2).

Hypoglycaemia has been shown to be associated with serious adverse outcomes. Specifically, it is associated with an increase in hospital mortality, as well as a longer length of hospital stay (3). This relationship is dose dependent; both the length of stay and in-patient mortality increased as the number and/or severity of hypoglycaemic episodes increased (3). Previous work has demonstrated a strong association with the number of episodes of hypoglycaemia following one admission, and outpatient mortality at one year (3).

The UK National Diabetes In-patient Audit in 2012 demonstrated

that 20.4% of in-patients with diabetes had at least one episode of minor hypoglycaemia (3-3.9mmol/L) and 10.5% had at least one episode of severe hypoglycaemia (<3 mmol/L) (1). These episodes tend to not be treated appropriately, and patients are often given tea and toast, or biscuits, which provide an unpredictable glycaemic response and contain unnecessary saturated fats. The In-patient Audit also demonstrated that 39.8% of patients experienced at least one diabetes medication error, and these patients were twice as likely to experience a severe hypoglycaemic episode (16.8%), compared to those who did not have a medication error (1).

Hypoglycaemia in hospitalised patients with diabetes is becoming more prevalent and is associated with significant adverse outcomes. Therefore, prompt recognition and appropriate and effective management of hypoglycaemia is essential to improve patient outcomes. The Joint British Diabetes Society recommends that all hospital wards should have access to 'Hypo Boxes' to promote the correct management of these episodes (2).

Background

There has been a huge increase in the number of people with diabetes, and it is now one of the biggest health challenges facing

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the UK today. Between 1996 and 2012 the number of people diagnosed with diabetes mellitus in the UK increased from 1.4 million to 2.9 million people, and it is estimated that by 2025 there will be 5 million people with diabetes. The majority of these patients will have type 2 diabetes, which is largely due to the combination of an ageing population and the increasing numbers of overweight and obese patients (4).

Type 1 and type 2 diabetes mellitus affects 5% of the Scottish population (Scottish Diabetes Survey 2013) (5). The UK In-Patient Audit has highlighted that approximately 17-20% of all in-patients have diabetes and that 41.6% of these patients are managed with insulin (1). The majority of patients in that audit were admitted for medical reasons other than their diabetes (65.6%), and 8.2% were admitted specifically for the management of their diabetes or a complication of this (1). These numbers are likely to continue to increase as the prevalence of diabetes continues to rise in the UK.

Patients with diabetes often have poorer outcomes, and this may be attributed to episodes of glycaemic excursion due to acute illness. The hospital environment poses additional risk factors which increase the risk of hypoglycaemia, including (2):

- Recovery from acute illness
- Inappropriately timed insulin with meal times or enteral feeding
- Incorrect insulin doses prescribed or administered
- Anorexia and vomiting secondary to acute illness

The elderly population may be more at risk of complications associated with hypoglycaemia due to frailty, malnourishment, polypharmacy, and other co-morbid conditions such as renal failure. There may also be a delay in diagnosis of hypoglycaemia due to cognitive impairment, reduced communication, or fewer adrenergic symptoms (6).

Baseline measurement

The aim of this project was to improve the recognition and appropriateness of management of episodes of hypoglycaemia (<4.0 mmol/l). Our data collection tool was based on that of the Joint British Diabetes Society guidance on The Hospital Management of Hypoglycaemia in Adults with Diabetes Mellitus. It included patient age and type of diabetes, usual treatment of diabetes, the initial blood glucose reading, treatment administered, blood glucose result post-treatment, as well as the time taken to repeat blood glucose.

The initial baseline measurements were carried out over a 4 week period throughout 3 diabetes wards in Glasgow Royal Infirmary. All patients with type 1, type 2, or secondary diabetes were reviewed with regard to any documented episodes of hypoglycaemia (<4.0 mmol/L) on finger prick glucose testing (Precision Xceed Pro Glucometer). Episodes were only included if they occurred whilst on these wards. They were excluded if they occurred prior to transfer from medical receiving wards. These episodes were then reviewed with regard to the treatment administered, whether this was appropriate for the patient and the time to correction to a blood

glucose of >4.0mmol/l. Data was collected from bedside blood glucose monitoring sheets, and information regarding treatment was obtained from nursing and medical notes. If there was no documentation of treatment then it was deemed to be inappropriate.

The appropriateness of management was based on the JBDS Guidelines for managing hypoglycaemia and patients should be given 15-20g of quick acting carbohydrate. If the patient is conscious and co-operative then 150-200ml of fruit juice, 90-120ml of Lucozade, or 5-7 glucose tablets is the most appropriate treatment. If the patient is alert but confused then the previous options may be suitable, or 1.5 -2 tubes of Glucogel can be used. Intramuscular glucagon may also be considered in this scenario if glucogel is ineffective, although this is less effective in patients on sulphonylurea therapy. If the patient is unconscious, or nil by mouth then 75-85ml of 20% dextrose or 150-160ml of 10% dextrose is recommended therapy. These treatments should be repeated if the blood glucose remains <4.0 mmol/l. These treatments should then be followed by a longer acting carbohydrate, such as the patients meal, 2 biscuits, or a glass of milk (2).

There were 45 episodes of hypoglycaemia which occurred in 14 patients in the pre-intervention group. This was an average of 3.2 episodes per patient (range 1-10 episodes). Five of these patients had type 1 diabetes, eight had type 2 diabetes and one patient had secondary diabetes due to alcohol excess and subsequent pancreatic insufficiency. The 5 patients with type 1 diabetes were on insulin therapy, as was the patient with secondary diabetes. Of the 8 patients with type 2 diabetes, 4 of these were on insulin monotherapy, 1 patient was on insulin and a GLP1 agonist (liraglutide), 1 patient was on combination therapy with insulin and gliclazide, and the remaining 2 patients were on oral hypoglycaemic agents (sulphonylurea as monotherapy, and the other on metformin, DPP4 inhibitor, and sulphonylurea). The average age of the patients was 63 years (range 22-86 years).

There were 5 episodes detected with a blood glucose reading of 1.0-1.9 mmol/l, 18 episodes with a blood glucose reading of 2.0-2.9 mmol/l, and a further 22 episodes of hypoglycaemia with a blood glucose between 3.0-3.9 mmol/l. All of these episodes of hypoglycaemia with blood glucose on finger prick testing <4.0 mmol/l were assessed, and 19 episodes (42%) were treated appropriately compared to JBDS guidelines. The remaining 26 episodes (58%) were deemed to be managed inappropriately.

These 45 episodes included 23 episodes of severe hypoglycaemia with a BG of <3.0 mmol/l. Of these episodes of severe hypoglycaemia, only 56% (n=13) were managed appropriately.

Eight of the total episodes (17.8%) were corrected within the recommended 30 minutes. A third of episodes (33.3%) were corrected within 60 minutes, and just over a third (35%) did not have a blood glucose repeated for several hours.

See supplementary file: ds4959.doc - "Hypoglycaemia Management Algorithm"

Design

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It had been noted that the management of in-patient diabetes, and in particular hypoglycaemia, was sub-optimal and that episodes of hypoglycaemia were being treated inadequately which was potentially contributing to adverse patient outcomes. This occurred throughout the hospital, but in particular in the diabetes wards where such episodes were commonplace. The introduction of 'Hypo Boxes' was therefore felt to be an important intervention to reduce associated adverse outcomes with hypoglycaemia and address the current inconsistency in the management.

The Joint British Diabetes Society recommends that all in-patient wards should have access to Hypo Boxes that contain all the necessary equipment to adequately manage an episode of hypoglycaemia. These are placed in a prominent position on the ward so that they are easily accessible by nursing and medical staff. The audit collection tool and hypoglycaemia treatment algorithm used was based on that of the JBDS guideline 'The Hospital Management of Hypoglycaemia of Hypoglycaemia in Adults with Diabetes Mellitus' (2). Appendix 1.

'Hypo Boxes' were introduced to the wards following discussions with ward sister regarding the practicalities and objectives of the boxes. As well as introducing 'Hypo Boxes', ward based education was delivered on an informal basis to the nursing staff, and ward sisters encouraged use of the boxes and algorithms. The contents of the 'Hypo Box' used in our study were:

- Copy of the hypoglycaemia algorithm
- 3 vials of glucogel (10g carbohydrate each)
- 3 packets of dextrose tablets (4g carbohydrate per tablet)
- 3 bottles of GlucoJuice (15g carbohydrate each)

Each episode of hypoglycaemia was recorded on a chart next to the 'Hypo Boxes' and each episode was further evaluated to assess treatment. This was carried out in the same manner as for the pre-intervention group. This was completed over a 4 week period.

Strategy

The first PDSA cycle's aim was to collect data regarding episodes of hypoglycaemia, and to design an easy to use data collection tool. This focused on the treatment provided for episodes of hypoglycaemia as well as the time to repeat blood glucose levels. Over this 4 week period, our data collection improved so as to ensure that no episodes of hypoglycaemia were missed. The outcome of this cycle confirmed that episodes of hypoglycaemia were being inadequately managed and patients were not having repeat blood glucose testing performed in a timely manner. There also seemed to be a lack of documentation surrounding these episodes.

The second PDSA cycle involved increasing awareness of the problem throughout key ward members of staff, including awareness of the hypoglycaemia algorithm and recommended treatment options, as well as the importance of recognising and treating hypoglycaemia. We also gained approval from the wards to implement a change, and specifically agreed for the introduction of

'Hypo Boxes'. Our continued presence on the wards helped to emphasise the importance and was a continual reminder to nursing staff to assess these episodes of hypoglycaemia appropriately. Inclusion of ward doctors also helped to further increase awareness.

The third PDSA cycle involved the introduction of 'Hypo Boxes' to the wards, along with printed copies of the hypoglycaemia algorithm. The wards were given a 2 week period to allow them to get use to the boxes and to deal with any problems that may arise before data collection restarted. The 'Hypo Boxes' contained oral glucose such as GlucoJuice, GlucoTabs and GlucoGel. The boxes were located in easily accessible places and guidance on the use of these was circulated throughout all members of ward staff. The introduction demonstrated a marked improvement in both the appropriateness of treatment given for episodes of hypoglycaemia, as well as the time to correction. More patients had repeat blood glucose levels checked to ensure resolution, and to assess the need for further treatment.

The nursing staff found the 'Hypo Boxes' easy to use, accessible, and practical. Health care assistants and members of medical staff if present, as well as nursing staff, could use the 'Hypo Box'. This improvement was sustainable over the following 4 week observation period and staff were more equipped to ensure episodes were correctly managed. The medical staff on the wards were also involved. The hope is that when they rotate jobs the new medical staff will pick up from the nursing staff the significance of the 'Hypo Boxes'. Those doctors moving on will take this knowledge and continue to promote good practice with regard to hypoglycaemia in other hospital environments.

Results

Following intervention, there was a marked improvement in both the appropriateness of management and the time to correction. In the 4 weeks following intervention, there were a similar number of episodes with 43 episodes occurring in 23 patients. This was an average of 1.8 episodes per patient (range 1-7 episodes). 10 of these patients had type 1 diabetes mellitus and 13 patients had type 2 diabetes (43% and 57% respectively). The 10 patients with type 1 diabetes were on insulin monotherapy. Of the patients with type 2 diabetes, 8 patients were on insulin therapy either as monotherapy or in combination with oral hypoglycaemic agents. The remaining 5 patients were on combination oral hypoglycaemic therapy, and they all included a sulphonylurea. The average age was 62 years (range 34-89 years).

The number of appropriately managed episodes improved, with 82% (n=35) of episodes managed appropriately (compared to 42% pre-intervention). There were 3 episodes of hypoglycaemia with a blood glucose of 1.0-1.9 mmol/l, 11 episodes between 2.0-2.9 mmol/l and 29 episodes of hypoglycaemia with a blood glucose result 3.0-3.9 mmol/l. In the number of episodes of severe hypoglycaemia (<3.0 mmol/l), the appropriateness in management increased to 93% (n=13), with only 1 episode deemed to be treated inappropriately. The time to correction also improved with 40% of episodes being corrected within 30 minutes, and 54% corrected

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between 30 and 60 minutes. Overall, post-intervention 94% of episodes were corrected within 60 minutes, compared to 51% pre-intervention. There was 1 episode that was corrected within 90 minutes and only 2 episodes that did not have a further blood glucose repeated, which were both mild hypoglycaemic episodes between 3.5-3.9 mmol/l.

Lessons and limitations

This project emphasises the importance of involvement of all members of the multidisciplinary team to promote good clinical practice. The introduction of 'Hypo Boxes' was a simple intervention that produced significant positive results and was easy to use and readily accessible by all members of the team. We demonstrated that the use of algorithms and protocols improve our practice and can produce consistent and reproducible results, with the aim of improving patient outcomes. Education and awareness play an important role in encouraging the use of these guidelines. We would hope that with continued education and exposure to guidelines that we could achieve 100% of episodes being assessed and managed appropriately.

There is still room for improvement however, and it may be that further education and dissemination of the ongoing results to nursing and medical staff may help to promote the importance of good practice. This could include monthly run charts circulated to staff and posted in ward areas, to continue to encourage members of staff to adhere to the guidelines and strive to achieve better results. This would also aim to maintain these results and ensure that it becomes common practice.

Diabetes is becoming more prevalent and will be encountered in almost every hospital specialty. It is therefore increasingly important that this education is hospital wide and that 'Hypo Boxes' are introduced to all clinical areas and made available to every ward and department. This includes education to medical staff that rotate jobs frequently as this knowledge and skill set can be implemented in every job they encounter.

Although we demonstrated a significant improvement in results, the management of in-patients diabetes is a large problem and there are other areas that should be considered in future projects. This includes the precipitant to hypoglycaemia and changes to medications to prevent this reoccurring. Future projects should take all these factors into consideration and continue to improve the in-patient management of diabetes and any episodes of glycaemic excursion.

Conclusion

We demonstrated that the introduction of 'Hypo Boxes' to diabetes wards significantly improved the assessment and management of episodes of hypoglycaemia. The appropriateness of treatment and the time to correction improved, and ultimately this aims to improve patient outcomes, something which can be adversely affected by hypoglycaemia.

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Declaration of interests

Nothing to declare.

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