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Original Article

Study of a structured action pathway and persistent monitoring tool among nurses to achieve cent percent management of hypoglycaemia in in-patients: A measure of quality of healthcare

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ABSTRACT

Background: Reporting and management of hypoglycaemia is a reflection of quality of healthcare delivery. The study evaluates success of a structured plan implemented in a tertiary care hospital in terms of an evidence-based hypoglycaemia management protocol, training and awareness among all nurses in the organisation to achieve 100% reporting of hypoglycaemia.

Methods: A prospective study was conducted over a 3-year period. An in-house hypoglycaemia management protocol was designed, included in the induction training programme of nurses and implemented in wards under the guidance of master trainers. Each episode of hypoglycaemia was reported, managed and logged into centralised database, Quality Flash Matrix (QF). The QF was analysed at end of each 24 h cycle to carry out a root cause analyses and appropriate correction in training modules. Data were extracted from hospital records, patient case records and QF in terms of total number of cases receiving insulin and total number of episodes of hypoglycaemia documented and reported.

Results: Incidence of hypoglycaemia recorded was 6.4, 5.3 and 4.7 per 1000 patient hours for the years 2011, 2012 and 2013, respectively. The percentage of episodes of hypoglycaemia reported improved from 78% (1st quarter 2011) to 100% (4th quarter 2012). Root cause analysis showed change in diet of patient with no corresponding change in insulin and vice versa being the commonest cause for hypoglycaemia consistent over the study period. **Conclusion:** Constant structured training of nurses, constant surveillance and appropriate feedback analysis result in decreased incidence of hypoglycaemia and increased reporting of episodes of hypoglycaemia.

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Introduction

Hypoglycaemia is one of the most feared complications of diabetes treatment. The incidence of hypoglycaemia is increased when attempts are made to achieve euglycaemia, as recommended by current treatment guidelines. It is estimated that approximately 90% of all patients who receive insulin experience episodes of hypoglycaemia.¹ It is also known that there is a threefold increase in severe hypoglycaemia and coma in intensively treated patients, as compared to conventionally treated patients.² Therefore, measures should be undertaken to decrease the frequency of hypoglycaemia in this high-risk patient population.³ American Diabetic Association (ADA) recommends the creation of a multidisciplinary steering committee guided by local diabetes experts. This committee can establish reasonable and achievable glycaemic management goals with use of protocols and order sets.⁴ However, it has been seen that in-patient providers often have insufficient knowledge about the many aspects of in-patient diabetes care and physicians do worse than attending nurses.⁵ Hence, there is a recent trend towards nurse-initiated hypoglycaemia treatment (NIHT) in hospitals. We describe one such programme implemented in a tertiary care hospital wherein a structured plan was initiated. This included designing an evidence-based hypoglycaemia management protocol, introducing structured training and awareness among all nurses in the organisation and promoting a reward-based reporting system. This study analyses the results obtained from the said programme. The study aims to analyse whether the ibid protocol results in improvement in nursing care in terms of reportage of hypoglycaemia incidents in in-patients and successful management of the same.

Material & methods

This was a single centre, prospective, observational study carried out at a tertiary care hospital over a 3-year period, from January 2011 to December 2013. Clearance was sought and obtained from the Institutional ethical committee. At the beginning of the study period, following sequence of events were implemented by a Diabetes Inpatient Safety Committee (DPSC). This was a multidisciplinary team, which included an endocrinologist, head nurse, diabetic educators, dietician and pharmacist.

Development and implementation of a Hypoglycaemia Treatment Protocol (HTP)

The DPSC defined hypoglycaemia as blood sugar level <70 mg/dL. This is based on studies, which demonstrates that counter-regulatory hormone responses are initiated at a plasma glucose level of 65–70 mg/dL in non-diabetic individuals and this definition is consistent with recommendations of the ADA Workgroup on Hypoglycaemia. Based on ADA Formula 15,⁶ the DPSC developed a nurse-directed HTP, which was made available in each department of the hospital (Fig. 1). A hypoglycaemia resuscitation kit was constituted, which included Sugar, Inj Dextrose and Inj Glucagon. This kit was made part of the crash cart available in each ward. The protocol was run as a pilot project in two ICU units and revised based on recommendations of attending physicians. Thereafter, the HTP was approved by the hospital Medical Executive Committee for use as a standing order to be implemented by nursing personnel for any bedside BG <70 mg/dL. It was then universally implemented across all wards of the hospital.

Fig. 1 – In-house hypoglycaemia management protocol.

Training the nursing professional

An educational initiative was implemented by master trainers certified by International Diabetic Federation. The primary nurses in the wards underwent an on-job training to recognise the clinical features of hypoglycaemia and to institute immediate remedial measures as first responders. Similarly, trainee nurses underwent similar instructional courses during the time of induction training. The training aimed to inculcate confidence in the ability to recognise and treat in-hospital hypoglycaemia.

Study of results obtained by implementation of protocol

The results obtained by implementation of the protocol were studied in the general wards. ICU and acute care wards were exempted. All diagnostic groups requiring glycaemic control therapy, i.e. patients with diagnosed diabetes mellitus with associated co-morbid conditions and on injectable insulin therapy, were included in the study. However, adolescent diabetes, gestational diabetes and diabetes associated with oncological condition were not included in the study. The nurse in charge of the ward recognised the clinical features of hypoglycaemia, immediately instituted the hospital hypoglycaemia treatment protocol and logged in the event in the critical input forms. The critical inputs were then logged into the hospital Quality Flash Matrix (QF). QF is the tracker where the clinical performance indicators are monitored round-the-clock in the hospital and hypoglycaemia is one of the 26 clinical performance indicators (Fig. 2). The QF captures data entered in critical input forms as well as attendant laboratory reports. In case of diabetic patients, it also takes into account the HbA1c values and blood sugar profiles. The QF captures clinical performance indicators on a 24-h cycle from 0001 h to 2359 h daily.

Analyses of performance and feedback loop for further training

At end of each 24-h cycle, the master trainers reviewed the QF to carry out a root cause analysis of each incidence of hypoglycaemia and reviewed the performance of the first responder. The process of developing, introducing and implementing the HTP throughout the hospital allowed the master trainers to identify practices associated with the occurrence of hypoglycaemia in the hospital. Based on this analysis, recommendations were generated, which then were implemented in the induction training protocol. The HTP module was made an integral part of nurses induction training programme for the hospital. The master trainers imparted further on-job training to the nurses and carried out surveillance of the nurse in proper handling, administration and monitoring of insulin injections and infusions.

Data collection and analysis of performance

In order to assess the success of the on-going programme, the following data were collected and analysed from the central patient database and QF matrix:

- (i) Total number of patients receiving injection insulin as part of their treatment.
- (ii) Total number of episodes of hypoglycaemia recorded in patient data records.
- (iii) Total number of episodes of hypoglycaemia reported on QF.
- (iv) Total number of instances of nurse- led interventions logged in critical input forms.
- (v) Root cause analysis of each episode of hypoglycaemia.

This was done using SPSS Ver 15. Discrete variables were analysed using chi-square test and Student t test while

Microsoft Excel - QUALITY FLASH June 10 - Dec 10		H	I	J	K	L	M
		6-Dec	7-Dec	8-Dec	9-Dec		
1	MAX HEALTHCARE Caring for you... for life	QUALITY FLASH					
2							
48	Developed in hospital (Y/N)					Age, Sex: 68Y/M DOA: 6/12/10 Dr.: DR. J D MUKHERJI Diagnosis: RESPIRATORY INFECTION Dept: 4TH FLOOR MSSH Describe incident with RBS/symp	
15	Other Adverse Event (including Acute Limb Ischemia, Patient Identification errors, Discrepancy in gauge/sponge count etc)						
49							
50							
51							
16	Hypoglycemia (Less Than 70mg/dl)			1		AT 2AM PATIENT COMPLAINED SWEATING, BLOOD SUGAR CHECKED, IT WAS 66MG/DL.	
52	Cause			unknown		Action Taken: 3 SUGAR SACHET GIVEN. INFORMED DNE	
53	Symptomatic/Asymptomatic			Asymptomatic		Date & time: 08.12.2010 @ 2.00 AM	
54	Area			4th Floor		rechecked RBS Level: 130mg/dl @ 4 AM	
17	Adverse Drug Reaction						
56	Area						
57	Drug and Reaction						
58	Impact						
59							
60							
18	No. of RRT						
61	Area						
62	Outcome						
63							
64							

Fig. 2 – Screen view of the QF.

continuous variable were analysed with Levene's two-tailed test.

Results

During the study period, there was a steady decrease in episodes of hypoglycaemia noted in the in-patients who were on injectable insulin or oral hypoglycaemic agents (OHAS) (Table 1). There was a significant difference between incidences of hypoglycaemia in 3rd year of study, as compared to the 1st year (6.4 vs 4.7, $p = 0.03$, Student t test). The incidence of actual incidences of hypoglycaemia in the in-patients and

those reported are summarised in (Table 2). It is noted that there was a steady upward trend noted over the past 3 years about reporting of episodes of hypoglycaemia till the last two quarters in 2013 recorded 100% reporting. There was significant improvement noted in reporting of hypoglycaemia episodes at the end of the 4th quarter of 2013 as compared to the 1st quarter of 2011 (100% vs 78%, $p = 0.000$, Student t test). Root cause analyses showed that change in diet of the patient without corresponding alteration of insulin dose was the commonest cause of hypoglycaemia (Table 3). Though there was decrease in absolute number of episodes across the study period, the relative percentage remained the same, i.e. 52%, 57% and 54% for 2011, 2012 and 2013 respectively.

Table 1 – Incidence of hypoglycaemia in in-patients.

Year	No. of patients on injectable insulin/OHA	No of patient days	Episodes of hypoglycaemia	Incidence of hypoglycaemia
2011	256	6913	447	6.4
2012	279	7622	404	5.3
2013	213	6618	312	4.7

Table 2 – Actual episodes of hypoglycaemia in in-patients and incidences reported.

Time period	Actual episodes of hypoglycaemia (n)	Instances of hypoglycaemia reported and treated by nurse (n)	Percentage of instances reported and treated (%)
2011			
1st quarter	128	101	78
2nd quarter	113	86	76
3rd quarter	135	111	82
4th quarter	101	81	80
2012			
1st quarter	107	93	87
2nd quarter	116	110	94
3rd quarter	94	89	95
4th quarter	87	83	95
2013			
1st quarter	83	76	92
2nd quarter	91	88	97
3rd quarter	72	72	100
4th quarter	66	66	100

Table 3 – Root cause analyses for incidence of hypoglycaemia.

Root cause	Episodes of hypoglycaemia (n)		
	Year 2011 (n = 447)	Year 2012 (n = 404)	Year 2013 (n = 312)
Change of diet with no corresponding change in dose	235	232	167
Change in dosage of insulin/OHA	134	109	84
Starvation/fasting	23	15	12
Sepsis	17	11	16
Concomitant medication	14	19	11
Pancreatic endocrine tumour	03	02	04
Medication error	05	06	02
Pregnancy	05	03	11
Adrenal insufficiency	02	Nil	01
No cause identified	09	07	04

Discussion

The study shows that the nurse-initiated hypoglycaemia treatment (NIHT) protocol implemented in our hospital resulted in earlier recognition of hypoglycaemic episode and more prompt initiation of corrective measures. It is well documented that intensive insulin therapy significantly increased the risk of hypoglycaemia.⁷ In critically ill patients, intensive glucose control leads to moderate and severe hypoglycaemia, both of which are associated with an increased risk of death.^{8,9} It has also been documented that episodes of hypoglycaemia increase length of stay and add to financial burden of healthcare cost.¹⁰ Thus, it is evident that healthcare providers need to minimise the incidence of hypoglycaemia. It is seen that (a) lack of adequate awareness to recognise early hypoglycaemia; (b) inadequate or inappropriate recording/reporting of hypoglycaemia; (c) lack of quality root cause analyses for every hypoglycaemic incident and (d) delay in treating hypoglycaemia due to lack of standardised protocol are the major factors contributing to the morbidity and prolonged hospital stay for the diabetic patients.^{6–11}

In recent years, there has been an increasing emphasis on nurse-led diabetic management. A nursing professional often coordinates, and is aware of, the multiple services required by the patient, such as travel out of unit (e.g., physical therapy, radiograph), amount of food eaten (carbohydrates) and patient's day-to-day concerns and changes in medication order (by various providers). They are in a better position to judge and anticipate the changes in glycaemic profile of the in-patients. However, due to strict practice standards and regulations, nurses are restricted to initiate some treatments, especially when medication is involved, even in emergency situations. Nurses often have to await medical personnel's assessment and/or instructions prior to taking any actions. This is true even for medical conditions that they are capable of treating, such as hypoglycaemia. It is recognised that the ward nurse is the "first responder" to hypoglycaemic crises. Hence, the programme of training all nurses in evidence-based management of hypoglycaemic episodes was initiated in our hospital.

In our study, we notice that there is steadily increasing awareness about symptomology of hypoglycaemia amongst nursing professional inculcated by continuous training. And this translates into a steady improvement in reporting of episodes of hypoglycaemia. This can be evidenced by the increasing congruency between the actual incidence of hypoglycaemia being recorded on QF and that being reported by ward nurses. At the end of the 3-year period, there was 100% congruency between the two, thus implying that each and every episode of hypoglycaemia was being recognised and treated. Another indirect evidence of the success of the nurse-initiated HTP is that the actual incidence of hypoglycaemic episodes has steadily declined over the past 3-year period. Our study is in line with other similar studies where implementation of a nurse-led, conservative intravenous insulin protocol in the intensive care unit and wards has been seen to be effective, safe and to markedly reduce the rates of hypoglycaemia.^{12–14}

Recognising, reporting and treating hypoglycaemia in hospitalised patients need to be assessed as a measure of quality of healthcare being provided by a healthcare set-up.

Assessing the quality of care has become increasingly important to providers, regulators and purchasers of care.^{15,16} Clinical indicators are measures that assess a particular healthcare process or outcome. They are seen as a valuable quantitative tool for quality assurance, particularly if collected as part of a more comprehensive programme.¹⁷ Reporting of incidence of hypoglycaemia in a patient, institution of remedial measures and recording successful outcome (or lack of same) are some of the important clinical indicators related to process as well as outcome.^{18,19} The emphasis on nurse-driven reporting, recording and documentation of hypoglycaemia at our Institution has resulted in cent percent reporting and management of all hypoglycaemic episodes. Introduction of a new stream of specialty nurses in the system – Diabetes Nurse Educator – has added value and enhanced the quality of nursing care delivered to the diabetic patient. It is recognised that use of group clinical supervision with an executive co-coaching approach for the implementation and to sustain quality service demands that 'good nursing' is accepted as being synonymous with 'good management'.²⁰ Our experience is in consonance with previously reported literature wherein a diabetes management mentor programme enhances the skill set of bedside nurses in dealing with complications arising from treatment of diabetes mellitus.²¹ In our experience, this has resulted in steadily improving efficacy in terms of the ward nurses successfully tackling events of hypoglycaemia. The practice of regular root cause analyses of all episodes of hypoglycaemia has helped to steadily reduce the episodes of hypoglycaemia in the in-patients admitted in the hospital. Root cause analysis of hypoglycaemic events indicated that by far the commonest reason for hypoglycaemia is change in type or quality of nutritional intake without concomitant dose adjustment of insulin or OHA. Unfortunately, though in absolute numbers, such incidences did come down over the study period, and they remained the same proportion wise. This indicates a felt need for more intensive patient education.

Similarly, the next common reason appears to be alteration in insulin/OHA dosage. It has been documented that use of bicarbonate-based substitution fluid during continuous venovenous haemofiltration, a decrease of nutrition without adjustment for insulin infusion, a prior diagnosis of diabetes mellitus, sepsis and need for inotropic support were found to be associated with hypoglycaemia. Simultaneous use of insulin and octreotide may also be associated with hypoglycaemia.²² Probable reason for this is the poor awareness amongst the medical professionals about how various disease states and concomitant medications interact with insulin/OHA requirements.

Though not addressed in our study, one major benefit of success of the nurse-led HTP is the potential significant long-term cost savings. Studies have demonstrated that reducing incidences of hypoglycaemia results in improved clinical outcomes. This may manifest as observed decreases in length of stay, inpatient complications and need for re-hospitalisation.^{23,24}

Conclusion

Nurse-initiated hypoglycaemia treatment protocol implemented in our hospital resulted in significantly better recognition

and management of hypoglycaemic episodes amongst diabetic in-patients.

Conflicts of interest

The authors have none to declare.

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